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Evaluation and Design an Efficient Mobile WiMax Architecture Using Coded OFDM System

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Abstract— *Although the increasing high speed requirement of WiMAX network world wide its performance is required to evaluate for optimum solutions .The increasing requirements of high speed WiMAX network over worldwide crates need to evaluate its performance for optimum solutions. The convolution coded OFDM systems are used for the improved BER performance but it is always required to find the best OFDM parameters for optimum system performance. This dissertation evaluates the performance of the Trellis coded WiMAX-OFDM system over the AWGN channel for Mobile communication application. In this dissertation OFDM system is modeled by using the different Trellis coded structures with variable constrain length for ½ code rate. As the FFT size affects the OFDM system design significantly. In this dissertation the performance of different Trellis structures is evaluated for coded interleaved OFDM system for variable FFT size along with the different modulation orders viz. BPSK, QPSK, and 4QAM.*

Key words: WiMAX, OFDM, Wireless Communication, AWGN, Interleaving, Trellis Coding

1. INTRODUCTION

WiMAX have become a popular standard and choice of communication system designers from last two decades. Early days of communication systems were basically dependent on analog solutions. The sources of information in communication systems are also analog in nature. We are now leaving in an era of a digital world. The numbers of users for communication systems are exponentially increasing and demand of higher processing speed of wireless communication systems have also significantly increased. We have reached to gigabits of data transmission capability till now. Many wireless communication applications have became part of human's life including. Short Message Services (SMS), broadband data transmission, broadband video streaming, high speeds file transferring, video and call conferencing etc.Data transmission using broadband Internet on Wireless Local Area Network (WLAN) with wider area network etc is an example and common uses of high speed wireless communication systems. The broadband utility and requirement is further extended by smoothly transmitting the multimedia data wirelessly by the engineers all-around the globe. This gives rise to the new concept of high speed wireless broadband communication it is require to design an cheaper and flexible system in worst environment. The Orthogonal Frequency Division Multiplexing (OFDM) is the used solution at physical layer of these high speed wireless applications.

WiMAX is a wireless technology based on defined standards which provides higher throughput broadband connections over the long distance communication links. WiMAX technology is used for a various types of applications, which includes wireless broadband

Connections, mobile hotspots uses and high speed data connectivity for business applications. WiMAX gives wireless Metropolitan Area Network (MAN) connectivity at higher speeds up to 70 Mbps. The coverage of the WiMAX base station on an average can reach to 5 to 10 km.

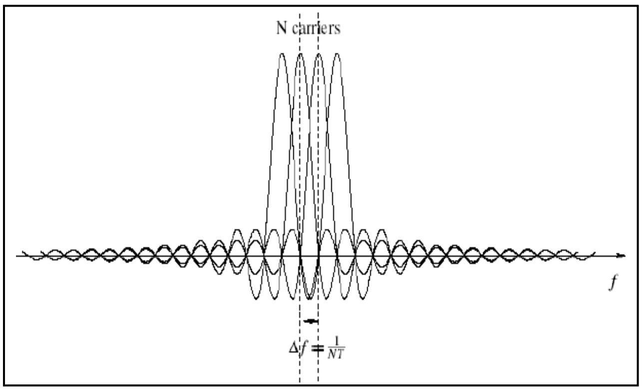


Figure-1: Fig. 1: OFDM Sub Carrier frequency responses

Figure 2 Prime features of the WiMAX-OFDM

The Mobile WiMAX uses the IEEE 802.16e standards [10] for designing the physical layer standards of wireless MAN. Most commonly OFDM is a standard modulation technique or multiplexing used for physical layer or MAC layer of MAN networks. Most of the WiMAX systems are based on the FFT size of 256 OFDM standards.

Common Internet traffic uses the 16 FFT-OFDM scheme. A basic architecture of the physical layer of the Mobile WiMAX is shown in the Figure 2.

Jagdish D. Kene et al [1] have presented a performance evaluation of the coded OFDM system, for the WiMAX application, they have compared the performance of the BER for the different kind of the decoder architecture. Yogendra Patel et al [2] have presented the performance enhancement of WiMAX OFDM and presented the BER comparison. Mohammed Aboud et al. [6] have implemented the OFDM based WIMAX system for Multi core Software defined radio system. Sweety et al. [13] has presented an performance evaluation of the OFDM system for WiMAX for different modulation types. They have concluded that under the less distorted channel the QAM can be used and for distorted channel the QPSK can be opted.

OFDM is widely used technology for WiMAX implementation [6]. OFDM is used as multiplexing technique or modulation technique which supports the higher channel utilization. Therefore it is required to design efficient coding method by evaluating the parametric performance for WiMAX OFDM which is the main focus of the paper.

The OFDM signal transmission technique contains the following major advantages:

It offers the efficient use of the available bandwidth spectrum

OFDM become more resistant to the frequency selective fading due to orthogonality compared to single carrier communication systems

OFDM is capable of minimizing the ISI and IFI by using the insertion of the additional cyclic prefix.

Using pre channel coding and interleaving can compensate for channel distortions.

OFDM is computationally efficient by using FFT techniques to implement the modulation and demodulation functions

No need to implement a channel estimator in OFDM.

OFDM is less sensitive to sample timing offsets as compared to single carrier systems.

It provides excellent protection against co-channel interference and parasitic impulsive noise.

The main drawbacks of the OFDM system can be listed as follows;

1) The OFDM signal has a noise like amplitude with a very large dynamic range; therefore it requires RF power amplifiers with a high peak to average power ratio.
2) It is more sensitive to carrier frequency offset and drift than single carrier systems are due to leakage of the DFT.

2. CHANNEL CODING TECHNIQUES

For improving the efficiency of OFDM system n terms of BER various pre channel encoding architecture have been designed. Commonly used channel coding methods are as follows:

Convolutional Coding:

Convolutional codes are represented by the three main parameters and size of the block code is represented Where; n= the number of output bits. k= the number of input bits m= number of the memory component The ratio of the input bits to the output bits is given by code rate.

The code rate is the one of the measure of the coding efficiency. Most commonly the range of input and output bits (k and n) ranges from 1 8. The number of memory elements m ranges from 2 10.

Constrain Length: It is another design parameter abbreviated by

Where L is the constrain length is also represented by L or K.

The constraint length L represents the number of bits in the encoder memory that directly affects the generation of output n bits. in some literatures the constrain length L is represented by approximate product of the $k\ m$. an example of the convolutional encoder with the constrain length 3, and the code rate of 1/3 is shown in the Figure below.

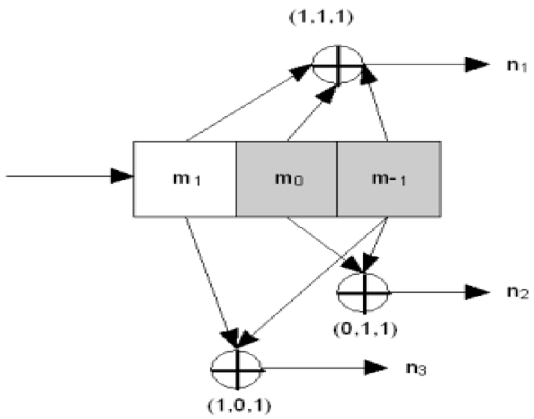


Figure 3 Convolutional encoder for OFDM

Trellis Encoder: Trellis encoder uses two or more Convolutional coder connected in parallel with inter leaver between them. In Trellis coder based convolutional code is converted in to the recursive symmetric convolutional codes.

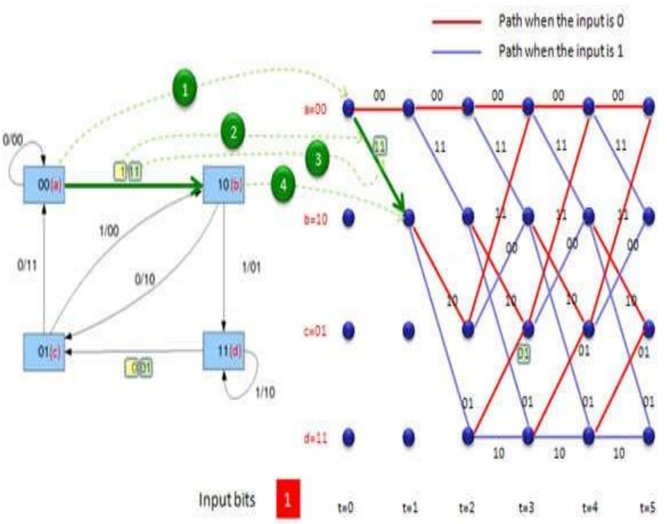


Figure 4 An Trellis tree and State diagram

3. PROPOSED OFDM TRANSRECEIVER

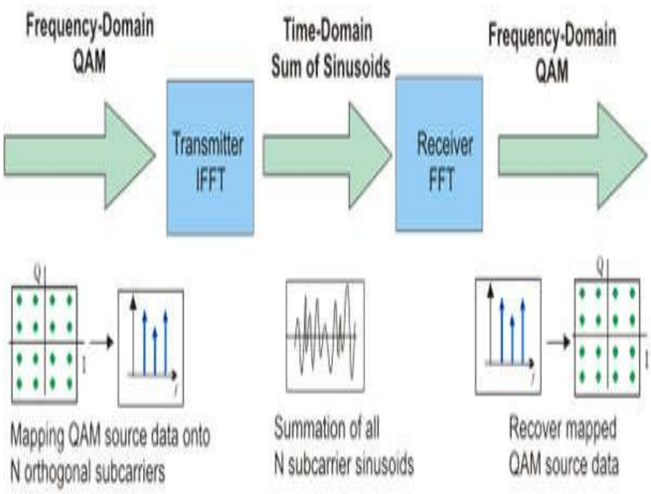


Figure 5 Simplified OFDM Diagram

Simplified block diagram of a procedure of the OFDM system is shown in the Figure 5. It can be observed that efficiency of the OFDM is highly dependent on IFFT and FFT efficiency. The M-QAM modulation is implemented on the input bit stream before being transmitting the information bit on the selected channel through an OFDM transmitter. The digital data to be transmitted is converted into a mapped sub carrier's amplitudes and phases by using QAM modulation techniques at the transmitter section. After data is modulated a serial to parallel convertor block converts it into N parallel multiple sub-carrier streams. Orthogonal spectral representation of multiple sub-carriers is then transformed into equivalent time domain data using an IFFT block which is computationally very efficient. At the receiver the FFT block performs the vice versa. The procedure is equivalent to conversion of frequency domain to time domain to frequency domain

4. RESULTS AND DISCUSSIONS

In the current work it has proposed to design the system with Trellis coded bit interleaved system of COFDM. It is concluded that using pre coding may reduce BER and using bit interleaving reduces burst errors and makes system robust against channel noise. Following major conclusions are drawn experimentally

It has been concluded that designing the OFDM system with minimum FFT size may minimize the BER but at the cost of smaller SNR performance.

It is also concluded that as the NFFT size is increased the SNR performance of the system for different modulation techniques are increased significantly it is because more data can be transmitted with higher capacity.

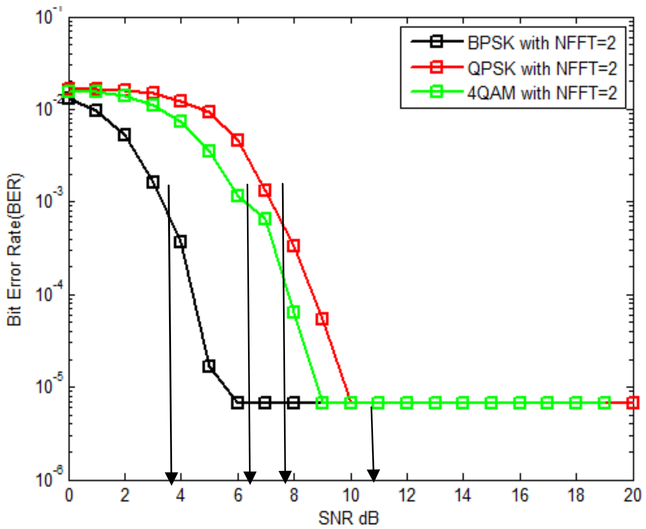
Therefore it has become necessary to carefully adopt the proper coding and modulation method at higher SNR value While higher SNR and BER performance is achieved by 4QAM with the more payload capacity also.

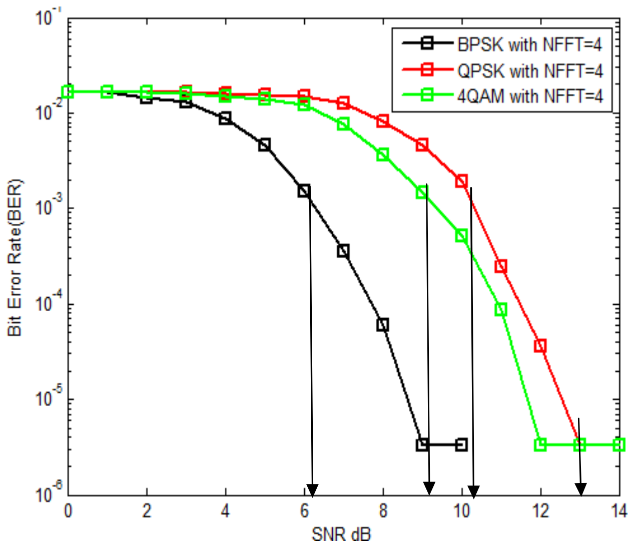
It is found that using the Trellis Encoder significantly improved the BER performance of the system

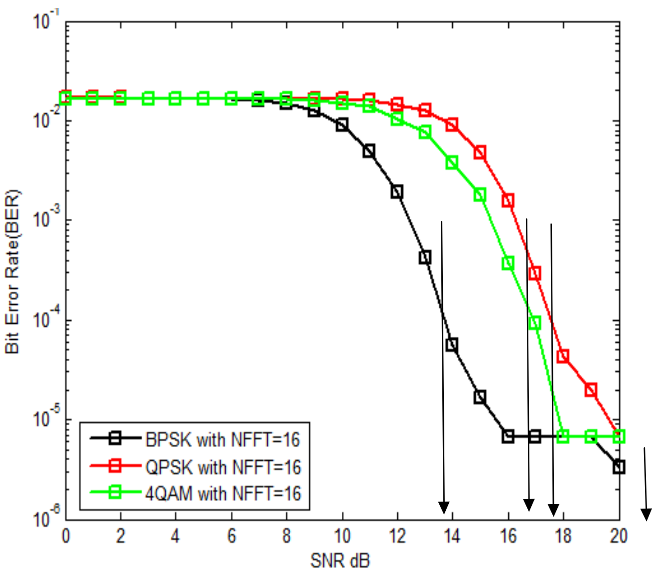
In the dissertation different Trellis structures are implemented for code rate of ½ by increasing the constrain length from 3 to 10.

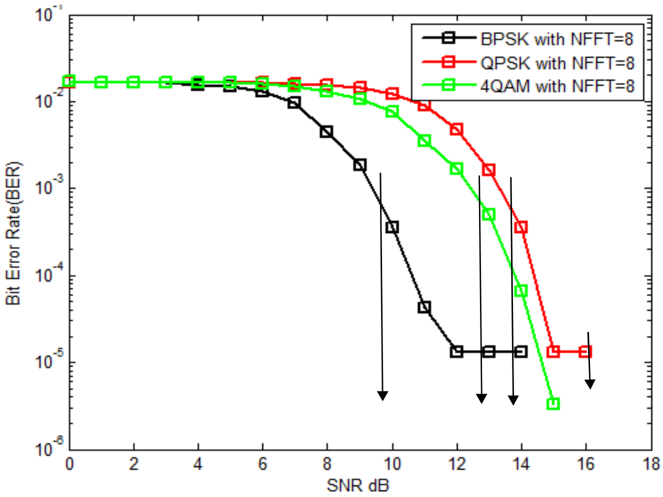
It is found that at SNR less than 12 the constrain length 3 gives minimum BER and at higher SNR greater than 12 the constrain length 7 Trellis structure is performing better in terms of the BER.

Parameters	Used Value	Data Description
Data size	10000	Size of the input data samples
len_fft	2 to 256	Size of the FFT
sub_car	52	OFDM data sub-carriers used
EbNo	0 to 20	SNR Range
Iterations	30	Repetition count
Fd	100 Hz	Maximum Doppler Shift frequency
H	Channel	AWGN channel
Cr	171/133	Code rate used to design the Trellis Encoder









5. CONCLUSIONS

This paper has focused to designing of OFDM based WiMAX communication systems. The OFDM is widely opted wireless WIMAX scheme and attracted many researchers. OFDM has number of applications Viz. Broadband Internet, Digital Video Broadcasting, Audio Broadcasting, Wi-Fi, and in mobile WiMAX applications. The efficiency of OFDM depends on the efficiency of the channel performance therefore many techniques are designed for channel fading reduction and for coding.

It has proposed to design the system with Trellis coded bit interleaved system. Using pre coding may reduce BER and using bit interleaving makes system robust against noise. It has been concluded that designing the OFDM system with minimum FFT size may minimize the BER but at smaller SNR performance. While higher SNR and BER performance is achieved by 4QAM with the more payload capacity also. It is found that using the Trellis Encoder significantly improved the BER performance of the system. In future is also required evaluating the performance of the symbol error rates and interleaving methods for different symbol rates and sizes.

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