Designing of Efficient WiMax System using Complex Asymmetric Encoding with 4-QAM

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Abstract - The proposed WiMax OFDM system designed to achieve better performance and the lower error to maintain the quality of services of wireless communication. The system consists of basic OFDM architecture but it is used with different number of subcarriers which left impact on the BER and antenna diversity i.e. two transmitter antennas and two receiver antennas which delivers more power and collect more than the existing technologies. The modulation techniques are kept less complex due to higher grade modulation techniques making system more complex than 4-QAM and to reduce the error level complex asymmetric encoding is integrated and an digital FIR filtering made error rate slightly lower. The BER is calculated for all the different subcarrier numbers and the performance of the system is evaluated and found that BER is achieved better with 512 number of subcarriers with 4-QAM modulation.

Keywords - Wi-Max, MIMO, 4QAM, Complex Asymmetric Encoding.

I. INTRODUCTION

The increasing demand for high data rates in wireless communications [2] due to emerging new technologies makes wireless communications an exciting and challenging field. The spectrum or bandwidth available to the service provider is often limited and the allotment of new spectrum by the federal government is often slow in coming.

Also, the power requirements are that devices should use as little power as possible to conserve battery life and keep the products small. Thus, the designers for wireless systems face a two-part challenge, increase data rates and improve performance while incurring little or no increase in bandwidth or power. The wireless channel is by its nature random and unpredictable, and in general channel error rates are poorer over a wireless channel than over a wired channel. A major problem in the wireless channel is that out-of-phase reception of multi paths causes deep attenuation in the received signal, known as fading [9]. The distortion induced by the time-varying fading is caused by the superposition of delayed, reflected, scattered and diffracted signal components. Another problem of the wireless channel is variation over time, due to the movements of the mobile unit and objects in the environment. This results into severe attenuation of the signal, referred to as deep fade. This instantaneous decrease of the signal-to-noise ratio (SNR) results in error bursts which degrades the performance significantly.

In such fading environments, reliable communication is possible through the use of diversity techniques [3] in which the receiver is afforded multiple replicas of the transmitted signal under varying fading conditions. These techniques reduce the probability that all the replicas are simultaneously affected by a severe attenuation.

Commonly used methods include:

- Frequency diversity, in which the signal is transmitted on multiple RF carriers;
- Temporal diversity, in which channel coding and interleaving are used to replicate and distribute the signal in time;
- Antenna/spatial diversity, in which multiple antennas are used at the transmitter and/or the receiver to provide multiple replicas of the signal with decorrelated fading characteristics.

II. MIMO CHANNEL

MIMO systems formed by multiple transmit and receive antennas are under intense research recently for its attractive potential to offer great capacity increase see Fig. 1.

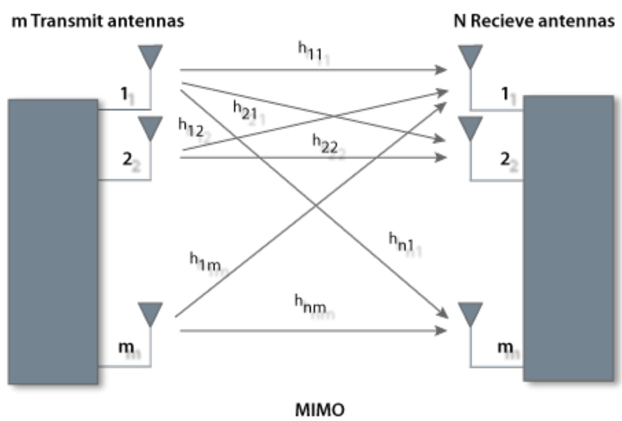

Fig. 1 MIMO Channel

MIMO transmission capitalizes on the fact that signals at different antennas experience independent fading in a scattering environment, if the antennas are well separated.

For a flat-fading MIMO system with *Nt* transmit and *Nr* receive antennas, the received signal at the *j*-th receive antenna.

Orthogonal Frequency Division Multiplexing (OFDM) [13] is a digital multi-carrier modulation technique which uses a large number of orthogonal sub-carriers to carry data. OFDM has become popular for several reasons. It divides the high-rate data stream into sub-channels which carry only a slow-rate data stream, thus it is robust in combating multipath fading in wireless channels. Its equalization filter design is simple. The implementation of Fast Fourier Transform / Inverse Fast Fourier Transform (FFT/IFFT) is practical and affordable. The guard interval between symbols eliminates inter-symbol interference (ISI).

III. PROPOSED METHODOLOGY

The proposed Wi-Max communication system discussing in this paper is the working towards making better end to end performance i.e. bit error rate (BER). The block diagram of the proposed methodology is given in the Fig. 2. The main blocks are Modulation with 4-QAM followed by Serial to Parallel communication after that the Complex Asymmetric Encoding are applied and OFDM modulation is performed at the end Cyclic Prefix is added. The signal is transmitted through channel where noises are added. At the receiver end the reverse process is performed. First remove the Cyclic Prefix after that OFDM demodulation operation is performed than Complex Asymmetric Decoding is performed than parallel to serial conversion of signal is performed. At the end 4-QAM demodulation followed by Digital FIR Filtering is performed and data taken at the output.

The above mentioned system is implemented on the MATLAB R2011a and the implemented algorithm is explained with the flow chart given below. The flowchart is having major steps are:

a. *Start of Simulation*
b. *Create Simulation model with Different Number of Sub Carriers.*
c. *Generate data for transmission over Network*
d. *Modulate data with 4-QAM*
e. *Convert signal from Serial to Parallel Conversion*
f. *Signal is encoded using Complex Asymmetric Encoding*
g. *Modulate Signal with OFDM (Different Number of Subcarriers)*
h. *Add Cyclic Prefix(Extra bits for security and error control purposes)*
i. *Now signal is transmitting through channel during transmission various noises are added into the signal*
j. *Remove cyclic prefix in the received signal*
k. *Now demodulate with OFDM (Different Number of Subcarriers)*
l. *Decode signal with Complex Asymmetric Decoding*
m. *Convert signal from parallel to serial*
n. *Demodulate signal with 4-QAM*
o. *Apply Digital FIR Filtering*
p. *Now calculate bit error rate(BER)*
q. *Compare and Display Results*
r. *End of simulation*

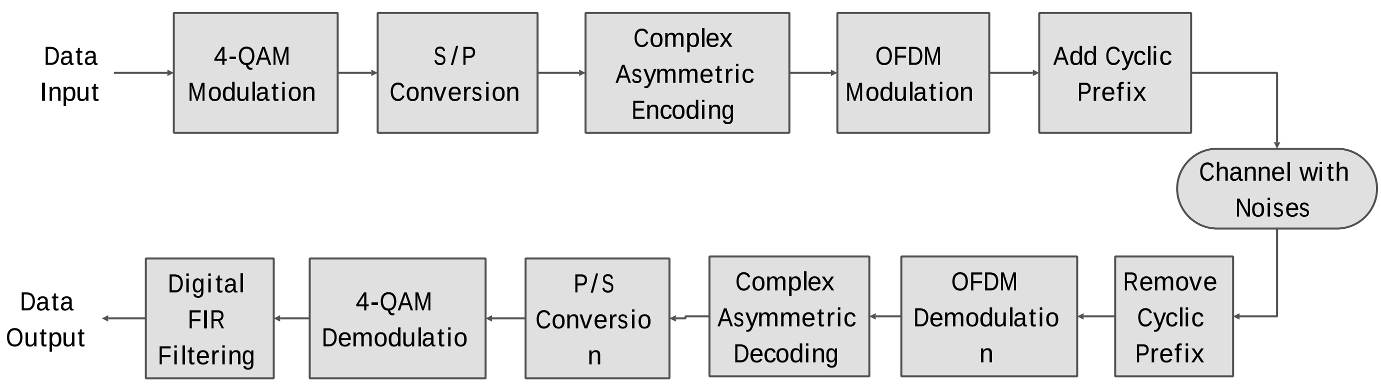

Fig. 2 Block Diagram of the Proposed Approach

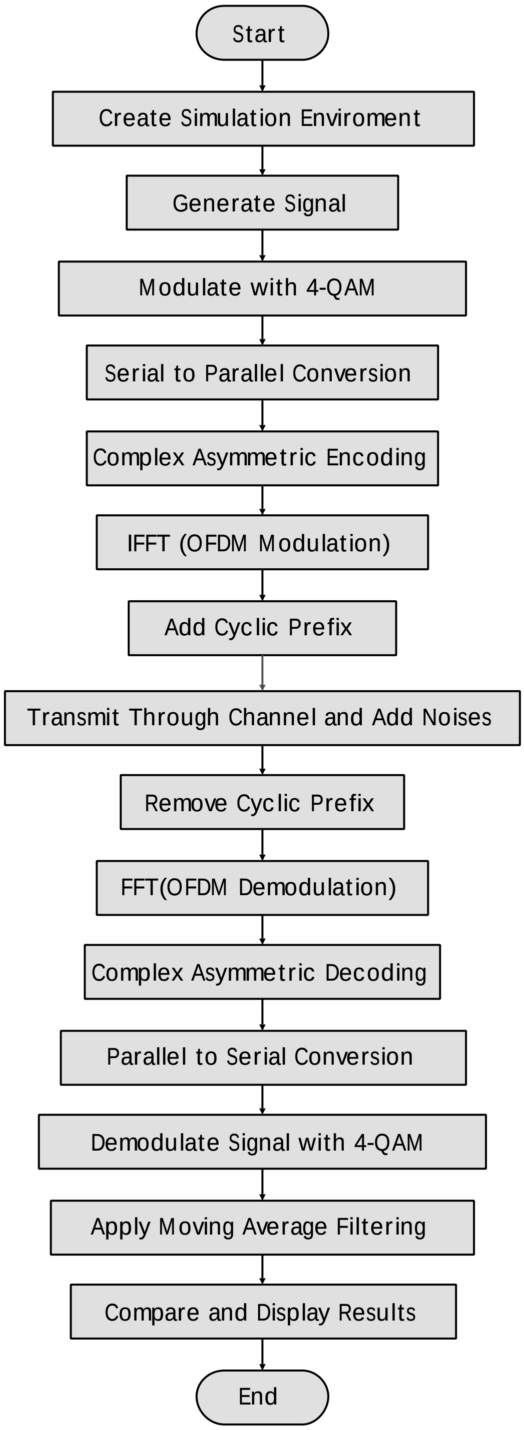

Fig. 3 Flow chart of the Proposed Methodology

IV. SIMULATION RESULTS

The proposed system explained in the previous section is implemented as per the algorithmic flow chart and the simulation outcomes considering different modulation techniques i.e. 4-QAM and Subcarriers 64, 128, 256 and 512 are given below.

The system is evaluated with 64 subcarriers with 4-QAM modulation and QPSK modulation. The BER is calculated with above mentioned parameters the system better perform with 4-QAM modulation which is 6x10^{-8} refer Fig. 4.

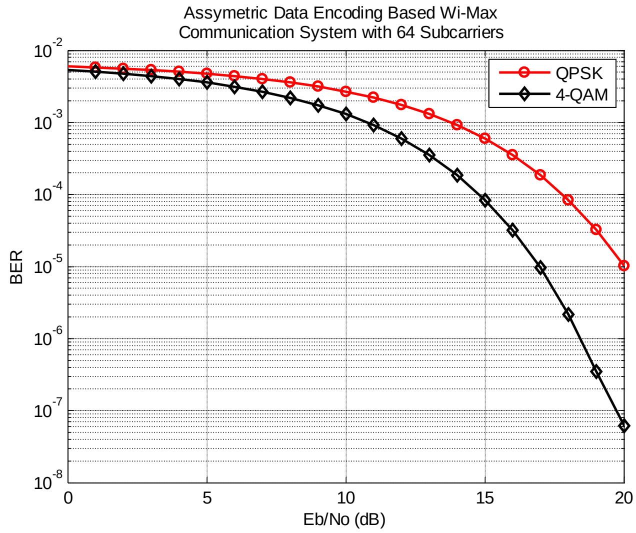

Fig. 4 BER Performance of the Wi-Max System with Complex Asymmetric Coding, MIMO-OFDM based system with 64 subcarriers

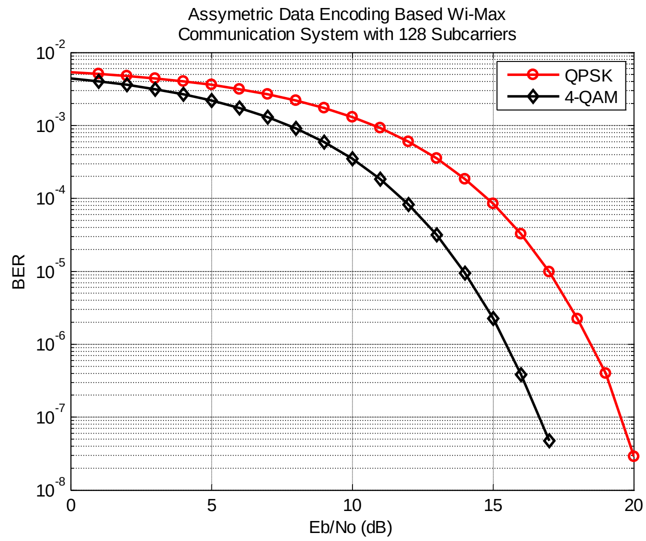

Fig. 5 BER Performance of the Wi-Max System with Complex Asymmetric Coding, MIMO-OFDM based system with 128 subcarriers

Now the system is evaluated with 128 subcarriers with 4-QAM modulation and QPSK modulation. The BER is calculated with above mentioned parameters the system better perform with QPSK modulation which is 3x10^{-8} refer Fig. 5.

Again the system is evaluated with 256 subcarriers with 4-QAM modulation and QPSK modulation. The BER is calculated with above mentioned parameters the system better perform with 4-QAM modulation which is 1.3x10^{-8} refer Fig. 6.

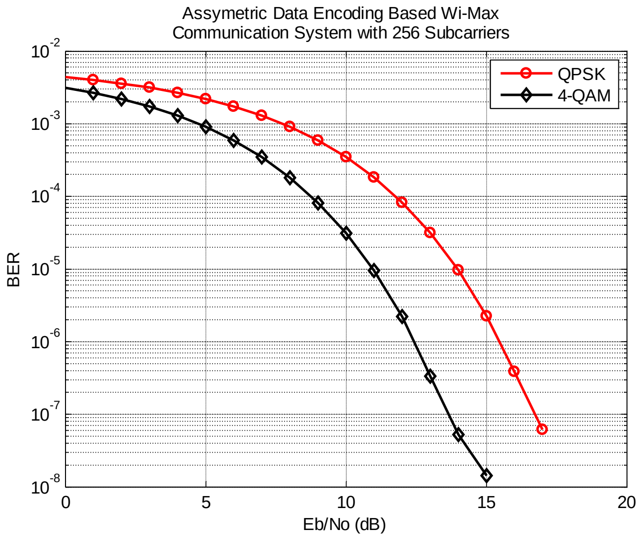

Fig. 6 BER Performance of the Wi-Max System with Complex Asymmetric Coding, MIMO-OFDM based system with 256 subcarriers

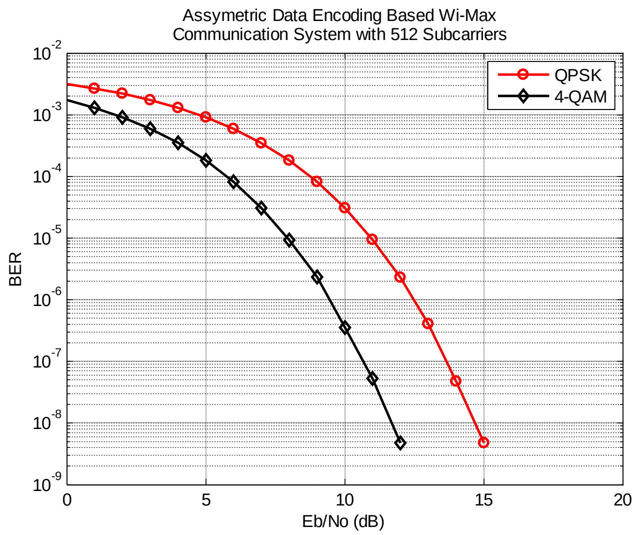

Fig. 7 BER Performance of the Wi-Max System with Complex Asymmetric Coding, MIMO-OFDM based system with 512 subcarriers

Then the system is evaluated with 512 subcarriers with 4-QAM modulation and QPSK modulation. The BER is calculated with above mentioned parameters the system better perform with 4-QAM modulation which is $5x10^{-9}$ refer Fig. 7.

V. CONCLUSION AND FUTURE SCOPE

The proposed Wi-Max wireless system is simulated and the results are found in terms of BER. The BER achieved is $5x10^{-9}$ better than the existing work. The values of BER is varying with the changes in modulation techniques as well as subcarriers and can be say that the with 512 subcarriers and 4-QAM modulation, Complex Asymmetric Coding based MIMO-OFDM system outperform, the error rate is better than the previous techniques. As the subcarriers are increases the system also starts performing better and better. Now there is scope to work towards making this system better by utilizing the equalization techniques at the receiver side. The equalization techniques are better shield against the interferences and noises added during communication.

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