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Implementation Of WIMAX Physical Layer with 2x1 Alamouti scheme In SIMULINK

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Abstract--- **Wireless networks evolved to be the most integral part of the present day communication, providing internet access with various devices over the entire world. Wireless communications mostly utilize the services of Wi-Fi and cellular communications. But a major snag with Wi-Fi is its mobility and with cellular communications is its limited connectivity. An emerging technology named WIMAX (Wireless Interoperability for Microwave Access) can overcome these limitations and can provide high data rates to the mobile subscribers. WIMAX is given the IEEE standard 802.16. In this paper we are concerned with the performance analysis of WIMAX system for various modulation schemes and it is implemented using SIMULINK.**

IndexTerms —BER, LOS, OFDM, SNR, WIMAX.

I. Introduction

With the rapid onset in the utilization of digital networks, there high demand for the design of an efficient communication network. Even though broadband technology provides internet connectivity to almost a billion users across the world, it can't offer its services to remote areas. In the year 2003 IEEE developed a standard 802.16 commonly entitled as WIMAX, which has the capability of providing wireless data over a vast coverage area. Antithetical to the existing wireless networks that allow transmission using a single spectrum of frequency, WIMAX supports the transmission using a wide spectrum of frequencies. It can create an alternative to the traditional broadband services by permitting the remote users to get the internet access. The standard of 802.16 defined a Physical Layer (PHY) which can support various systems which operate at the frequency range 10GHz-66GHz. This frequency band requires the achievement of Line-of-sight due to the small wavelength. The amendment 802.16a is a typical model of WMAN (Wireless Metropolitan Area Network) which operates at the frequency range 2-11GHz and it does not demand LOS. The revised version 802.16e also operates with NLOS at the frequency range of 2-6GHz but with low data rates. In this paper 802.16e standard is considered for the analysis.

II. Characteristics of WIMAX

A. High Data Rate

The digital modulation schemes supported are BPSK, QPSK, *M*-QAM (where M value can be 16 or 64) with coding rates 1/2 and 3/4. Among these, the modulation schemes that can provide the higher achievable data rates are 16-QAM, 64-QAM. QPSK ensures the longer distance coverage.

B. Bandwidth

WIMAX ensures the availability of maximum bandwidth to the user when higher modulation schemes are used along with channel bandwidth set to 3.5MHz.Along with bandwidth it also ensures data rates as high as 10.5Mbps.

C. Throughput

Due to the efficiency of OFDM across broadband channels WIMAX offers great network throughput performance even at longer distances. It is highly resistant to the signal reflections during transmission.

III. Transmitter model

During transmission, in our model the data is generated using a Bernoulli binary generator from which a stream of zeros and ones are generated. As block wise transmission is being implemented forward error correction mechanism should be used. Depending on the factors such as block size and selected modulation scheme size of the generated data varies. The generated data is then modulated using any of the modulation schemes (mostly QPSK and QAM) and the modulated data is made to undergo the Alamouti scheme because of which the data is made to transmit via two different transmitting antennas through OFDM (Orthogonal Frequency Division Multiplexing).

A.Encoding block

In an OFDM burst there is a possibility of using modulation schemes with various coding rates. This feature is efficiently utilized under the Adaptive Modulation Coding. Processes like data randomization, FEC, encoding, interleaving, and

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modulation together comes under channel encoding process In FEC a combination of reed solomon encoder and convolutional encoder is used. In certain cases, there is a chance of repetition of data bits on contiguous subcarriers.

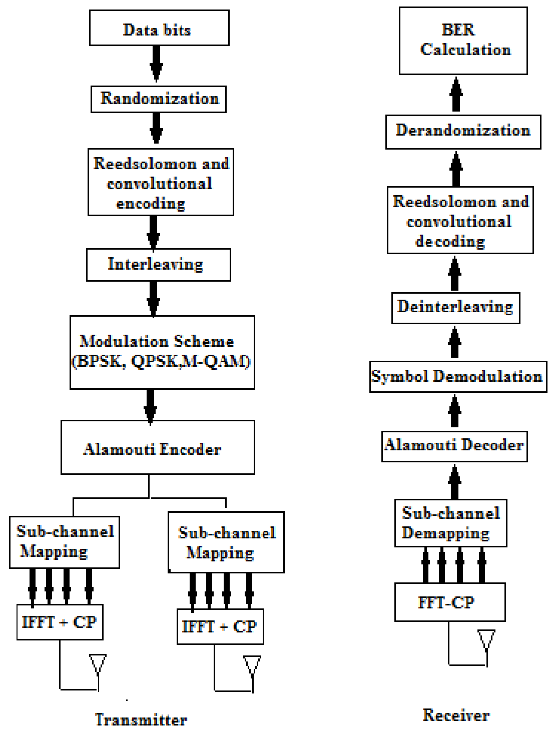

Fig.1: Block diagram of WIMAX system used in this paper.

B. Randomization block

Randomization is the process used to avoid the occurrence of continuous zeros or ones. It is done in order to make the PAPR value lesser when compared with the Gaussian noise value. By employing this mechanism the non linear distortion occurred at transmitter side can be regulated. More over it helps in reducing peak values in spectral response.

C. FEC block

The randomized data given to this block is encoded using outer Reed Solomon encoder and inner convolutional encoder. Then interleaving process is done in two phases, in the first phase mapping of coded bits on to the contiguous subcarriers is avoided. In the second phase the coded bits are mapped alternatively onto the constellation bits which are of less or more significance.

D. Alamouti Encoder (MIMO encoder)

This encoder is used to convert single input data stream into multiple streams of output data. Here transmitter diversity is employed as two transmitter antennas and one receiver antenna are used. Multiple data symbols are transmitted at a time over the two transmitter antennas. This process also helps in reducing the interference between the data symbols.

E.OFDM block

In this block IFFT of signal is done initially. Inverse Fast Fourier transform (IFFT) of 'X (k)'is defined as:

$$x(n)=\frac{1}{N}\sum_{n=0}^{N-1} x(k)e^{j\frac{2\pi kn}{N}} \text{ for } n=0,1,\ldots N-1 \qquad (1)$$

The generation of OFDM symbols is equivalent to the above equation. Implementing inverse fast Fourier transform (IFFT) is an efficient way of implementing IDFT. Hence for the generation of OFDM symbols IFFT is used. After applying IFFT time domain symbols are obtained and to these symbols cyclic prefix is added. Here 256 subcarriers are needed so a 256 point FFT is used in the simulation. Now this data is sent to the Rayleigh fading channel model and AWGN channel.

F.Adaptive Modulation and Coding

AMC is the mechanism which is employed in this project. According to this process based upon the received SNR value a modulation scheme is selected at the transmitter side. Slower data rates are attained when QPSK is selected and higher data rates are achieved using 64QAM. The modulation scheme is selected depending on the received SNR we have assumed as shown below:

Table.1 AMC parameters considered for this paper

Modulation	Coding rate	Receiver SNR threshold (db)
BPSK	1/2	6.4
QPSK	1/2	9.4
QPSK	3/4	11.2
QAM-16	1/2	16.4
QAM-16	3/4	18.2
QAM-64	1/2	22.7
QAM-64	3/4	24.4

IV. Alamouti Scheme

In order to substantially upgrade the throughput and capacity of wireless systems in both flat as well

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as frequency selective fading channels, particularly if the environment is containing multiple scattering antennas at both transmitting and receiving ends of the system alamouti scheme can be applied. Excessive data rates can be acquired by employing MIMO systems without increasing the bandwidth and transmitted power. Furthermore it provides a diversity edge which results in a remarkable rise in the capacity, i.e. enhancement in SNR and simultaneously in BER at the receiver. “Space-time coding” (STC) and the “maximum ratio combining” (MRC) techniques are implemented to perform the MIMO transmission and reception, respectively.

Alamouti launched a scheme named STBC (Space Time Block Coding) which permits the transmission through two similar antennas at a data rate same as transmission through one antenna. This scheme increases diversity at the receiver. The following figure illustrates the alamouti scheme implementation in both time and space domains for encoding the data. This method increases the performance by encoding the data signals over multiple transmitters. By this method it can attain diversity of two because it can transmit two data symbols in two time intervals.

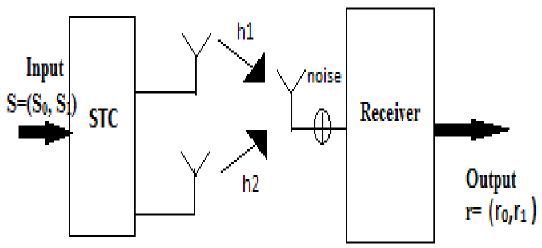

Fig.2 Alamouti scheme [2x1]

To utilize the extensive diversity provided by MIMO, STBC is a systematic approach. It is used to acquire gains which occur through spatial diversity by employing multiple transmitting and receiving antennas. Besides, a diversity gain which is proportional to the number of antennas at transmitting and receiving sides can be obtained. One popular implementation of this code is the alamouti scheme with two transmitting antennas and one receiving antenna which was employed in our system. The following figure shows the simulink block for alamouti scheme.

V. Channel Model

The modulated data is transmitted through Rayleigh fading channel followed by Additive white Gaussian Noise channel. Rayleigh Fading channel is one of the models which can propagate through the domain of radio signal. Rayleigh Fading is suitable when there exists many objects in environment which can scatter radio signal are present before reaching the receiver. Rayleigh Fading is most applicable when there is no propagation dominant during LOS between transmitter and receiver. Rayleigh fading channel is a model that can be used to illustrate the form of fading that occurs when multipath propagation exists.

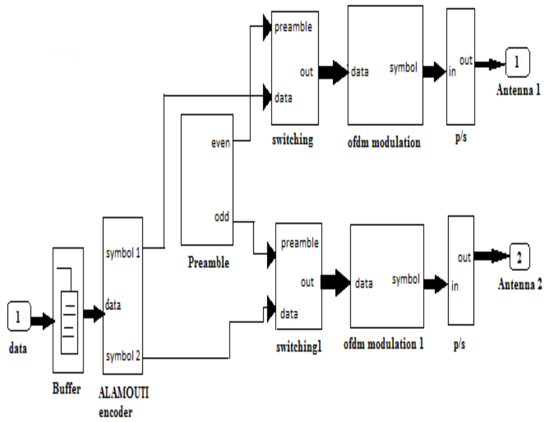

Fig.3 Alamouti Tansmitter design

The Rayleigh fading channel model inspects propagation of radio signal on the statistical base. It serves ideal under circumstances where there is no dominant signal. In the simulation of our WIMAX system we used Rayleigh Fading channel to analyze its performance based on BER plot. AWGN is a noise that possesses all frequencies uniformly distributed in a frequency band. Rician fading occurs when there is Line Of Sight between the transmitter and its corresponding receiver. In general Rayleigh fading channel has high BER than Rician and in turn compared to AWGN also.

VI. Receiver Model

The same processes which are performed at the transmitter model are repeated at the receiver but in a vice versa model. Initially at receiver (in simulation) cyclic prefix is removed resulting in elimination of inter symbol interference (ISI). The data is then fed to the FFT of size 256 for frequency domain transformation. Scalable OFDM can also be implemented in order to alter the FFT size. Due to the noise in channel, transmitted message signal gets distorted. In order to tranquilize this effect there is a necessity to know how channel distorted the transmitted signal so that we can reconstruct the original signal. This process is known as equalization. In WIMAX system this entire process performed under channel estimation, interpolation. Its reverse process (de-interleaving & decoding) is carried out to obtain the original input data. The De interleaving process alters the

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sequence of bits in data, so the BER remains faultless. At the end of the receiver the received bits are compared with the generated bits at the random generator which gives the Bit Error Rate i.e. the no. of error bits transmitted out of the total bits generated. These BER values are obtained from the Error Rate calculation block from which the values are exported to the workspace and plotted against the SNR values. The graph is presented under Results section.

VII. Results

The figure given below shows the comparison of BER of the WIMAX system using various modulated schemes which changes with respect to the SNR. As adaptive modulation and coding technique is being implemented here every modulation scheme will be having some constraints based on the SNR threshold values.

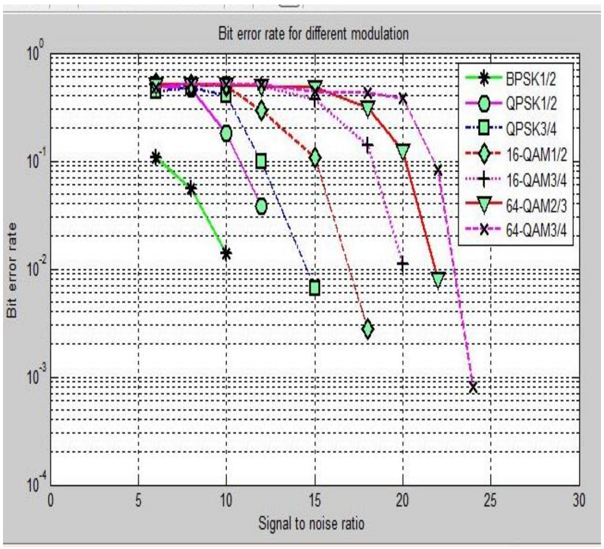

Fig.4 Plot of BER Vs SNR

VIII. Conclusions

In this paper we have studied a WMAX communication system in which Alamouti scheme and OFDM are implemented simultaneously and BER for various modulation schemes is observed. Using the Alamouti scheme the data is transmitted through 2 transmitting antennas and one receiving antenna. And finally we conclude that the modulation scheme QPSK or QAM is suitable for the WIMAX communication system and we concluded it based on the BER graphs we have obtained. From our observations it is clear that among the modulation schemes implemented 64- QAM provides higher data rates but with a lesser coverage area whereas QPSK offers limited data rate but with a vast coverage area. In this paper we have considered the channel as Rayleigh fading channel but in future other channel models like Rician and Nakagami fading channels can also be implemented.

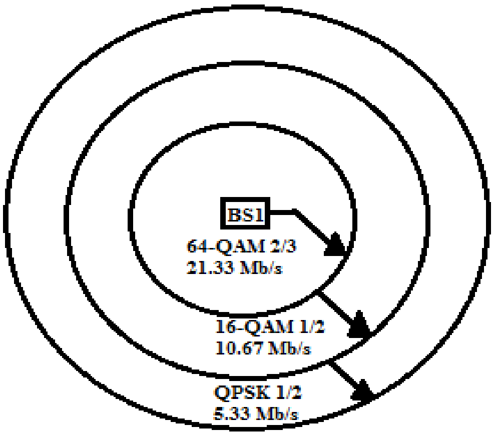

Fig.5 Data rate analysis

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