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Performance Analysis of MIMO-OFDM Using Zigzag Code over PSK Modulation

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***Abstract*- The IEEE 802.16 of standards is known as Worldwide Interoperability for Microwave Access. IEEE 802.16 standard defines Wireless metropolitan area network (MAN). It has been designed to provide high data rate communication in metropolitan area wireless networks. For broadband wireless access is employed for high speed and low cost, in which is easy to deploy, or provides a better alternative for extension of fiber-optic backbone. In this paper, we analyze bit-error rate performance of mobile WiMAX system using zigzag code over PSK modulation with different modulation order and Antenna order. The results show that the proposed zigzag-coded modulation presents a stronger error correcting capability as modulation order is decreased.**

***Index Terms*- MIMO, OFDM, FEC, WiMAX.**

I. Introduction

Wireless technologies are bringing revolution in telecommunication industries. Once exclusively military, satellite and cellular technologies are now commercially driven by ever more demanding consumers. With this increased demand comes a ever increasing need to transmit information wirelessly, quickly and precisely. To satisfy this need, communications engineer have combined technologies suitable for high rate transmission with forward error correction (FEC) techniques. Orthogonal Frequency Division Multiplexing (OFDM) is the standard being used throughout the world to achieve the high data rates necessary for data intensive applications that have now become a routine. The combination of Forward error correcting codes with spatial multiplexing opens up new dimensions in wireless communications, and can offer effective solutions to the challenges faced in realizing reliable high-speed wireless communication links [6]. This paper proposes a method with Spatial Multiplexing and multiple antenna systems for use in frequency-selective fading channels. A comparison is made between the diversity gain of MISO and MIMO systems in terms of BER for 16-PSK modulation scheme. The obtained results demonstrate that spatial multiplexing significantly improves the error performance in frequency selective wireless fading channels.

II. MIMO system

MIMO is an acronym that stands for Multiple Input Multiple Output. It is an antenna technology that is used both in the transmitter and the receiver for wireless radio communication. MIMO technology has attracted attention in wireless communications because it offers significant increases in data throughput and link range without additional bandwidth or transmission power. MIMO is considered suitable technology for WiMAX because it can exploit non-line-of sight channels [5].

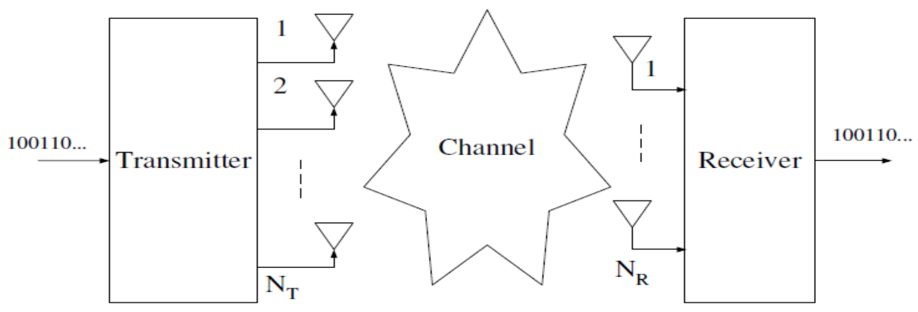

Fig: 1 MIMO system

III. SPATIAL MULTIPLEXING

In spatial multiplexing, each spatial channel carries independent information, thereby increasing the data rate of the system. This can be compared to Orthogonal Frequency Division Multiplexing (OFDM) technique, where, different frequency subchannels carry different parts of the modulated data. But in spatial multiplexing, if the scattering by the environment is rich enough, several independent sub channels are created in the same allocated bandwidth. Thus the multiplexing gain comes at no additional cost on bandwidth or power. The multiplexing gain is referred as degrees of freedom with reference to signal space constellation [2]. The number of degrees of freedom in a multiple antenna configuration is equal to min (N_T,N_R), where N_T is the number of transmit antennas and N_R is the number of receive antennas [3].

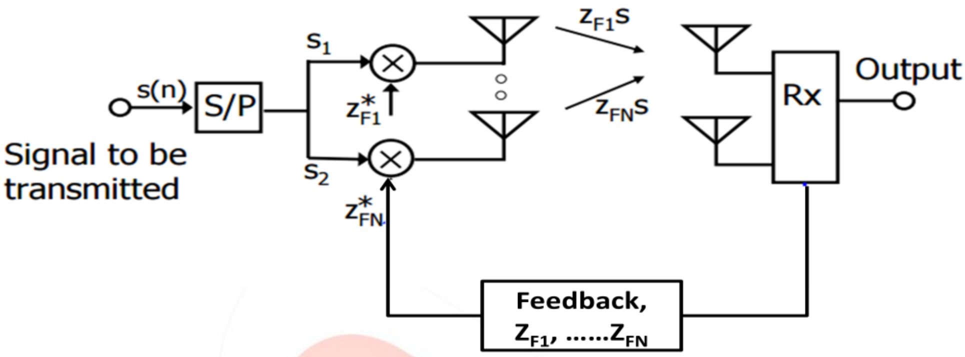

Fig: 2 Several different data bits are transmitted via several independent (spatial) channels.

IV. ZIGZAG-CODED MODULATION

The coding process is made up of three basic parts: encoding, transmission through noisy channels, and decoding. A message is encoded using a predetermined coding scheme, which can be as simple or as complex as the sender desires. A codeword is defined as any output of an encoding scheme. The codeword is what is transmitted. During transmission, noise may introduce errors to the codeword, resulting in corruption of the message. This error-ridden message is then received by the intended recipient and decoded using specific decoding algorithms [1].

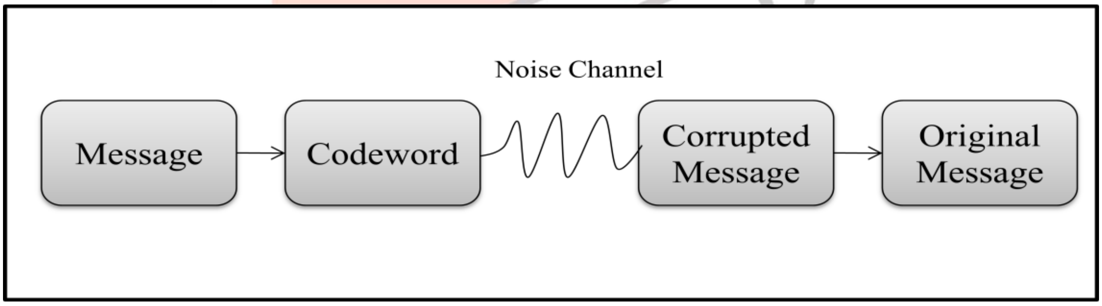

Fig: 3 block diagram zigzag code

The zigzag code is described by a highly structured zigzag graph [1]. A zigzag code is a type of linear error-correcting code [6]. In this coding the input data is partitioned into segments of fixed size and the sequence of check bits to data is added, in each check bit is the exclusive OR of the bits in a single segment and of the previous check bit in the sequence.

$$D = \begin{bmatrix} d(1,1) & d(1,2) & \dots & d(1.J) \\ \vdots & \vdots & \dots & \vdots \\ d(I,1) & d(I,2) & \dots & d(I,J) \end{bmatrix}_{I\times J} \quad \text{and} \quad \begin{bmatrix} p(1) \\ \vdots \\ p(I) \end{bmatrix}_{I\times 1} \qquad (1)$$

The parity check bits are generated according to

$$P(i) = \left(p(i-1) + \sum_{j=1}^{J} d(i,j)\right) \bmod 2, \qquad 1 \le I \le I, \qquad (2)$$

With the initial value $p(0) = 0$

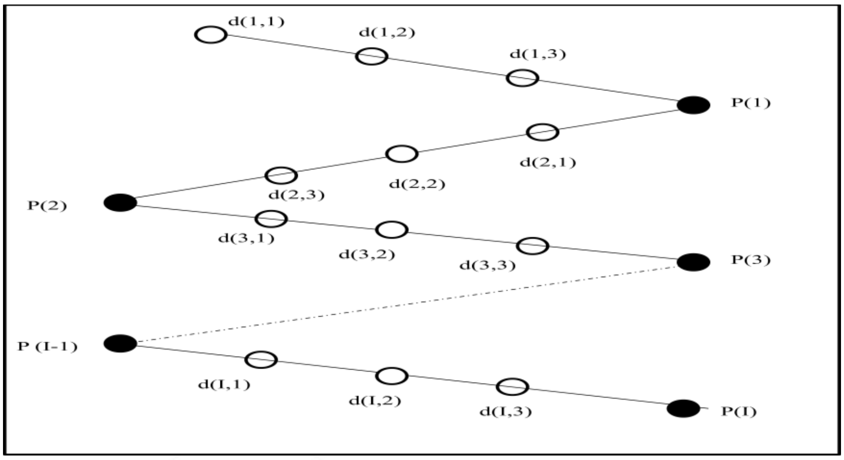

Fig. 4 The structure of zigzag codes.

V. Rayleigh channel

Rayleigh fading occurs when there are multiple indirect paths between the transmitter and the receiver and no direct non-fading or line-of sight (LOS) path. It represents the worst case scenario for the transmission channel [4]. Rayleigh fading assumes that a received multipath signal consists of a large number of reflected waves with independent and identically distributed phase and amplitude. The envelope of the received carrier signal is Rayleigh distributed in wireless communications.

VI. Results and Discussion

The Simulation is done in MATLAB R2012a with FFT size 512 for mobile WiMAX system. The code rate is always taken as ½ and Antenna order as 2×2 MIMO is used in comparing PSK different modulation order. The Input is generated randomly. All the results are drawn in Rayleigh fading environment. Spatial Multiplexing technique is used at the MIMO.

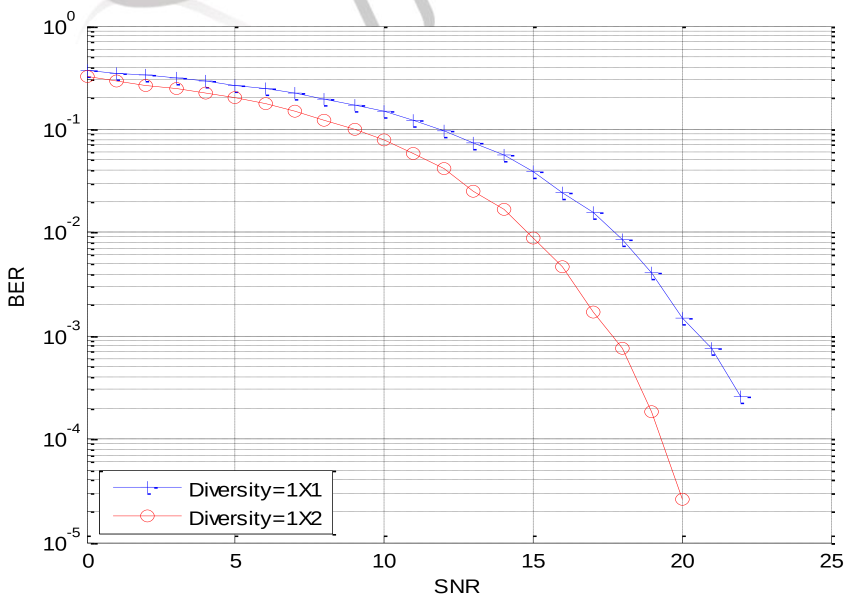

Fig 5: BER Performance comparison of SISO and SIMO for 16PSK.

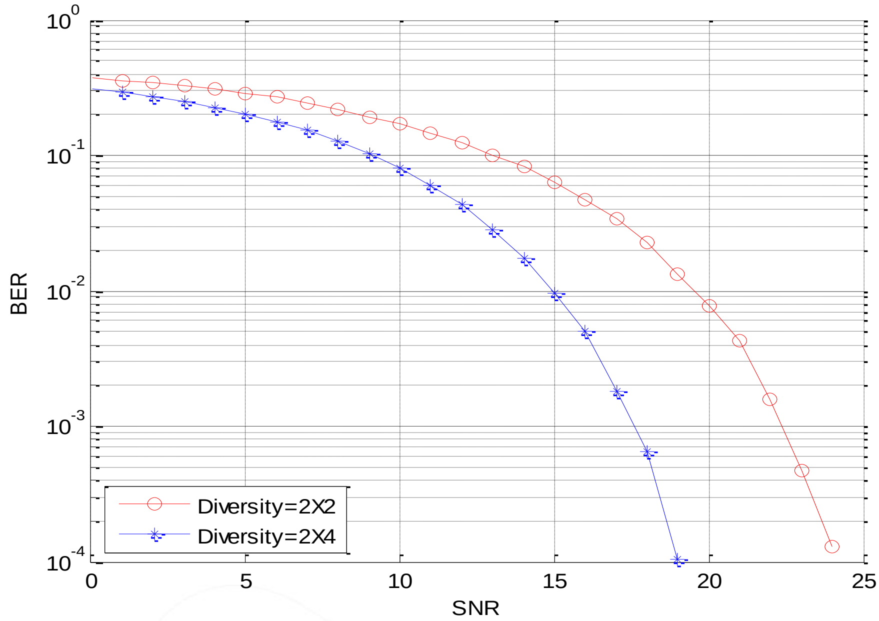

Fig 6: BER Performance comparison of MIMO with Zigzag coded 16PSK Modulation.

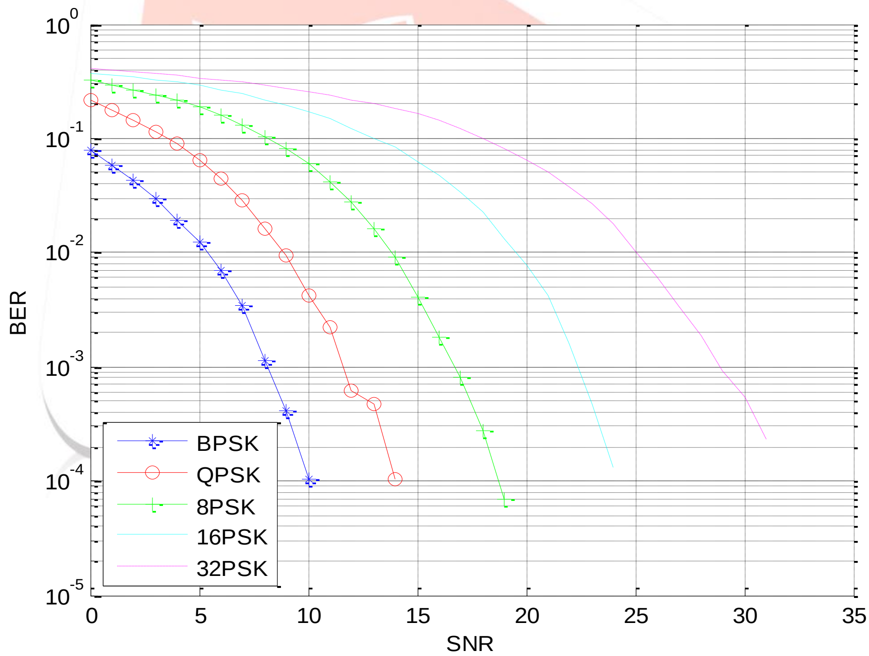

Fig 7: Performance comparison of Zigzag coded PSK with different Modulation order.

VI.CONCLUSION

The BER Vs. SNR plots are drawn by using different combinations of number of transmitting and receiving antennas used in the mobile WiMAX. It is seen that SIMO performs better than SISO and the performance is better for more number of Antennas at the receiving end. It is observed that Antenna order of 2×4 performs better than 2×2.

The BER Performance of Zigzag code using PSK modulation is compared for different modulation order and it is concluded from the results that the performance is better for lesser value of modulation order. So BPSK gives better results than QPSK and QPSK performs better than 16PSK.

VII. References

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