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Performance Evaluation of MIMO-WiMAX Using Zigzag coding 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 evaluate bit-error rate performance of WiMAX system using zigzag with RS coded modulation for different code rate and code length. In this paper, we evaluate bit-error rate performance of WiMAX system with zigzag coded modulation with different code rate and code length. The results show that the proposed zigzag-coded modulation presents a stronger error correcting capability as compared to the Reed Solomon with Convolutional code.**

IndexTerms **- MIMO, OFDM, STBC, WiMAX, BER, Zigzag code etc**

I. INTRODUCTION

Wireless network is a type of network that utilizes some form of wireless link to communicate with each other. The wireless network comprises of different nodes which communicate with each other over a wireless communication, this wireless channel may be of radio wave or infra-red, which is responsible for establishment of wireless channel or wireless link between nodes. This paper we have worked out on WiMAX; to make the system more reliable we have used digital communication technique .Digital communication technique that provide many advantage over analog communication process, it get easy to detect error in digital communication by adding Forward error correction code (FEC) or backward error correcting code (BEC), which is not possible in analog communication.

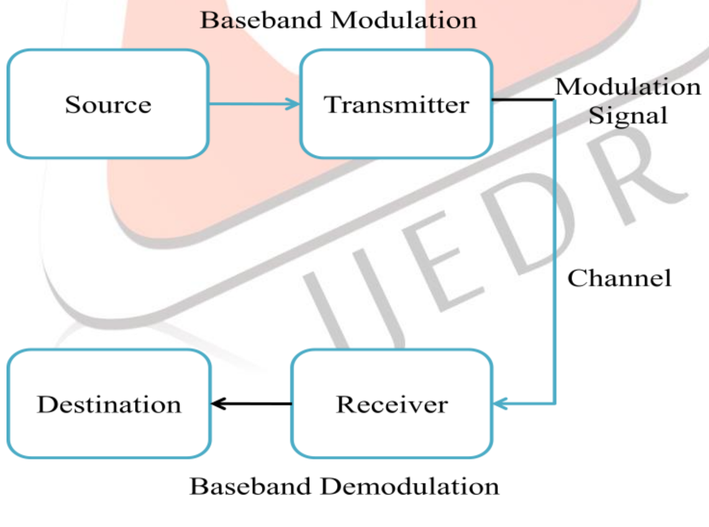

Fig. 1 Wireless communication

WiMAX is the upcoming wireless system which uses 802.16 IEEE standards. By using WiMAX technology we can overcome the limitations of the existing wireless communication like short coverage area, low data rate and lack of security. In our thesis, we have tried to improve the performance of WIMAX using adaptive modulation technique over MIMO system.

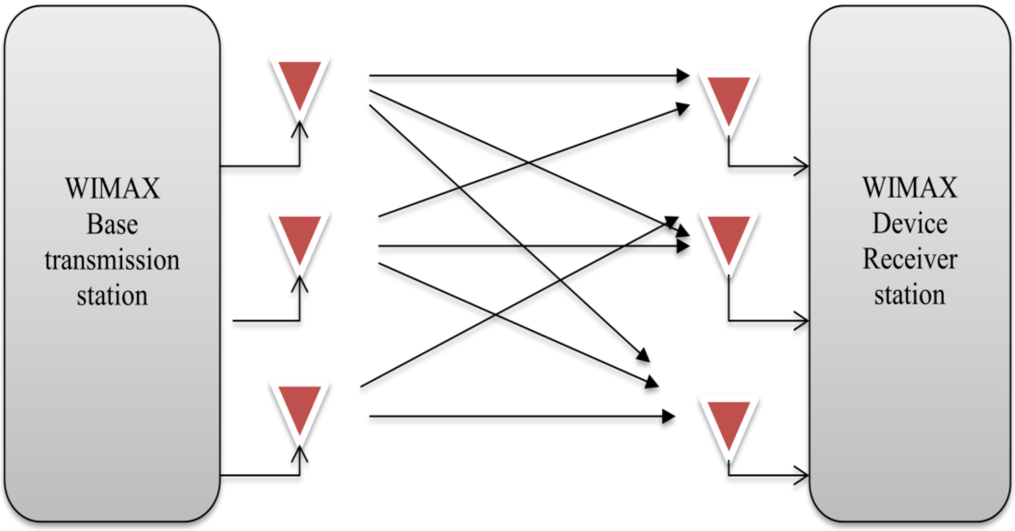

Fig: 2 MIMO WiMAX system Communication

Generally, behavior of communication channel is multipath fading and time variant. It may be depend on various factors of the channel such as the path-loss, the path-loss between the transmitter and receiver or channel fading due to multipath propagation. Therefore using single modulation technique will not fulfill the requirement of wireless channel [1]. Adaptive modulation technique is use to improve the performance of wireless communication system by adjusting transmission parameter like modulation, for code-rate, and power depending on the channel state adaptively. In adaptive modulation allows tuning to signal modulation scheme depending on the signal to noise ratio (SNR).

MIMO system is further use to increases the performance of wireless channel , as compare to single antenna system, through output of MIMO system provide great improvement on system performance, which provide high capacity gain in wireless system communication system without requiring additional power or bandwidth. One of the promising techniques with appears to next generation broadband wireless communications is represented by combining the technology of adaptive modulation technique and MIMO wireless technique [2]. In figure 1 we have shown diagram of 3×3 MIMO.

II. 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.

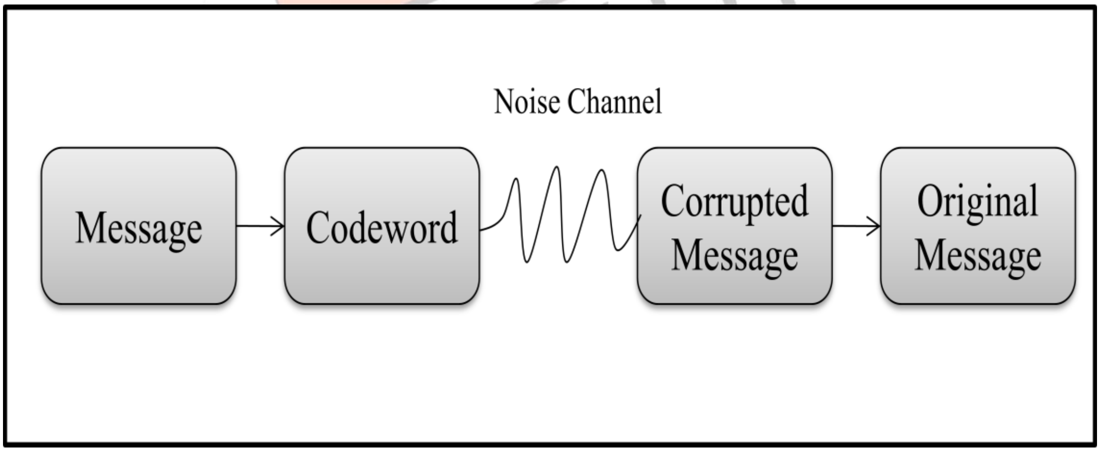

Fig: 3 block diagram zigzag code

Channel coding represents the source information over the channel in such a manner that minimizes the error probability in decoding by adding the redundant bits systematically with the data. Channel coding is important for wireless channel because it reduces the bit error rate at the receiver. Hence in this way the reception quality improves. In general channel coding can be performed by error detecting and correcting codes. Coding methods are based on logical or mathematical operations. Zigzag code has a big advantage, in that it can choose a higher code rate. Modulation used here is of the M-QAM modulation type, and possesses such advantages as small radiation outside the band and higher bandwidth efficiency. It is robustly applicable in practical communication systems [1].

A. ***Encoding of Zigzag Codes***

A coded modulation scheme is used for ultra-high speed transmission. This paper introduces a family of error-correcting codes called zigzag codes. The zigzag code is described by a highly structured zigzag graph. 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. The Zigzag codes show upto 0.5 dB performance gain over structured low density parity check codes (LDPC). This paper deals with bit-error-rate (BER) performance of WiMAX systems that uses the various coding and modulation schemes.

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

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 $p(0) = 0$

Concatenated (I,J) Zigzag Codes

If we concatenate several component zigzag codes then a stronger code can be obtained. The first constituent code encodes the original data $\Pi 1(D) = D$, the remaining K-1 constituent codes encode K-1 different interleaved versions of D using K-1 length (I×J) random interleaves. The k^{th} constituent code generates a parity check vector $pk = [pk(1), \dots, pk(I)]T$ and the parity check matrix is denoted by [1]

$$P = \begin{bmatrix} p1(1) & \dots & pk(1) \\ \vdots & \ddots & \vdots \\ P1(I) & \dots & pk(I) \end{bmatrix}_{I\times K} \qquad (3)$$

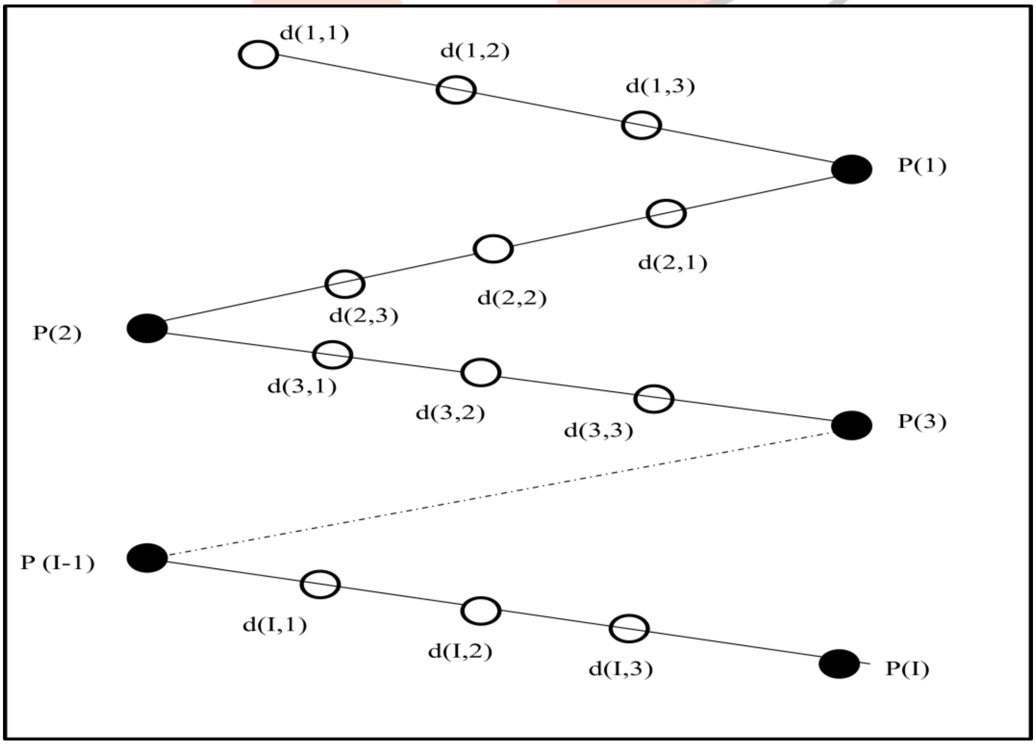

Fig. 3 The structure of zigzag codes.

B. DECODING OF ZIGZAG CODES

We perform the A Posterior Probability (APP) decoding of zigzag codes, this process starts with the information of posterior probabilities for each data bit then the data bit value is chosen which corresponds to the MAP probability for that data bit, after reception of a corrupted code-bit sequence, the process of decision making with APPs allows the MAP algorithm to determine the most likely information bit that have been transmitted at each bit time [7].

Decoding of concatenated (I,J)-zigzag codes

Like that of the LDPC codes, the a posteriori probability (APP) decoding of zigzag codes involves non linear operational the parity check nodes, which is computationally complex and is less attractive from the implementation point of view. We next describe allow- complexity iterative Max-Log-MAP (MLM) –based decoding algorithm for concatenated zigzag codes, which is of the same natures the min-sum decoding of LDPC codes. For each constituent code, based on the parity check relation the algorithm performs forward and backward recursions and updates the log-likelihood ratio (LLR) of the information bits.

$$l^a(d(i,j)) = \log\frac{P(d(i,j)=0|y)}{P(d(i,j)=0|y)} + \frac{P(d(i,j)=0)}{P(d(i,j)=1)}, \qquad 1 \le i \le I, 1 \le j \le J \quad (4)$$

Where the first term is the posterior LLR given the channel output, and the second term is the a priori LLR of the information bit. Typically the information bits are assumed equiprobable and therefore the second term is zero. The LLR of a parity check bit is given by

$$l^a(p_k(i)) = \log\frac{P(p_k(i)=0|y)}{P(p_k(i)=0|y)}, \qquad 1 \le i \le I, 1 \le k \le K \qquad (5)$$

III. WIMAX SYSTEM

The different wireless technique has reached at height like WLAN, WIMAX and others. The IEEE standard committee introduced standards for networking elements, for an instance, IEEE 802.16 in 1999. The 802.16 family standard is called Wireless Metropolitan Area Network (MAN) commercially known as WiMAX (World Wide interoperability for Microwave Access) which is an industry-led, nonprofit organization and responsible for testing, the certificating and promoting the compatible interoperable wireless products based on IEEE 802.16 working group and ETSI's Hiper MAN standard. The original IEEE standard addressed 10 to 66 GHz in licensed bands and 2 to 11 GHz in unlicensed frequency range. In time to time, they certified different versions of WiMAX based on different criteria such as carrier based wireless, fixed and portable wireless devices etc.

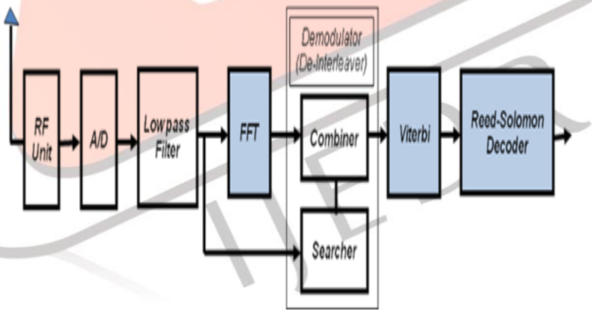

Fig: 4 WiMAX architecture

IV. STYLING ADDITIVE WHITE GAUSSIAN NOISE (AWGN)

AWGN is a noise channel. This noise channel model is good for satellite and deep space communication but not in terrestrial communication because of multipath, terrain blocking and interference. The AWGN is used to simulate background noise of channel. The mathematical expression as in received signal $r(t) = s(t) + n(t)$. This passed through the AWGN channel where s (t) is transmitted signal and n (t) is background noise. The AWGN Channel block adds white Gaussian noise to a real or complex input signal. If the average received power is P'[W] and the noise power spectral density is N0 [W/Hz], the AWGN channel capacity equation 1 is.

$$c_{awgn} = W\log_2\left(1 + \frac{p'}{N_0 W}\right) {}^{Bit}/_{Hz}. \qquad (5)$$

Where $\frac{p'}{N_0 W}$ is the received signal-to-noise ratio (SNR).

The channel capacity concept to an additive white gaussian noise (AWGN) channel with B Hz bandwidth and signal-to-noise ratio S/N is the Shannon–Hartley theorem equation 2 is.

$$C = B\log\left(1 + \frac{S}{N}\right). \qquad (6)$$

V. Bit Error Rate calculation

The BER of an un-coded system is obtained by averaging the BER of each subcarrier. Under the assumption of gray QAM mapping, it is known that the BER and symbol error rate (SER) are related as $BER \approx \frac{SER}{Q}$. To estimate the BER, we consider an error event with a correct vector, s, and an error vector s′ which satisfies $E_S\{S\ S^*\} = E_S'\{S'\ S'^*\} = I$ where ∗ denotes conjugate transposition, Es stands for the expected value . which part of section, we will use H to represent the actual channel matrix if spatial multiplexing is used, and the effective channel matrix if STBC is used.

$$BER \approx \frac{SER}{Q} \approx \frac{E_H}{q}\{E_s\{\textstyle\sum_{s\neq s'} P_r\,[s \to s' \mid H, s, s']\}\}$$

$$\geq \frac{E_H}{q}\left\{E_s\left\{\textstyle\sum_{|s-s'|=D_{min}} P_r[s \to s' \mid H.s, s']\right\}\right\} \qquad (3)$$

VI. Results and discussion

System description

The system description for the simulation is given in fig 5. The image data are transmitted through the MIMO WiMAX system with zigzag coding.

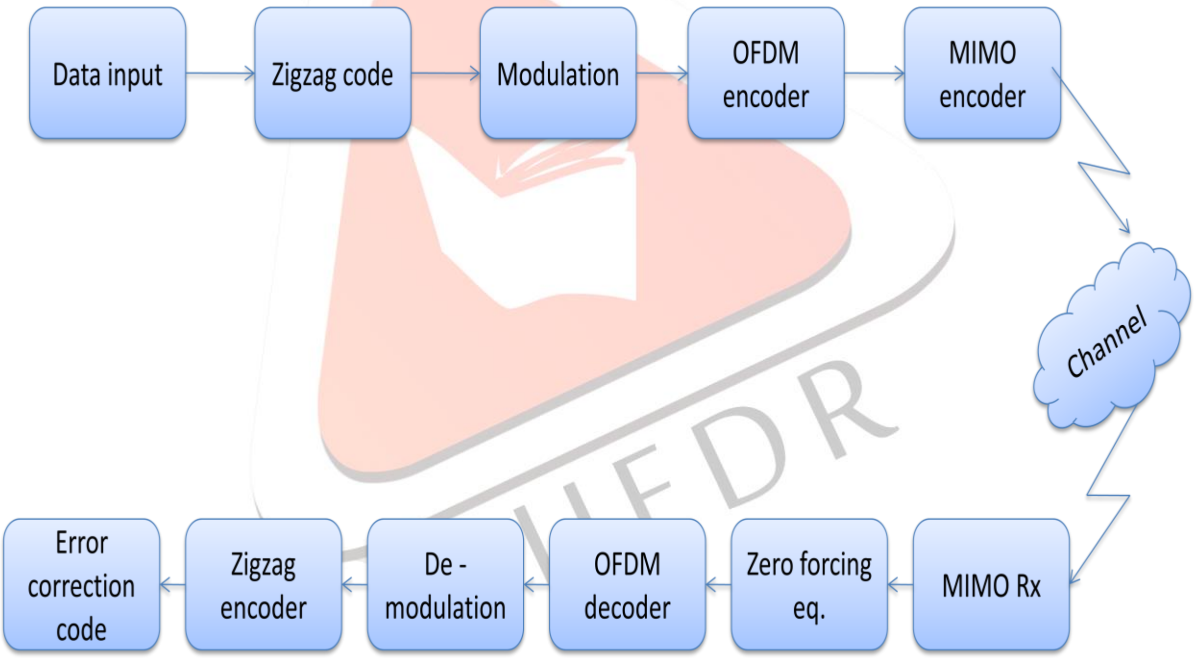

Fig: 5 System block diagram

The results of the simulation are presented in this section. At the time of simulation some parameters are set like CP length, coding rate, code length, modulation and range of SNR values. The input is generated randomly. We have plotted the BER to SNR figures for different modulation and zigzag coding.

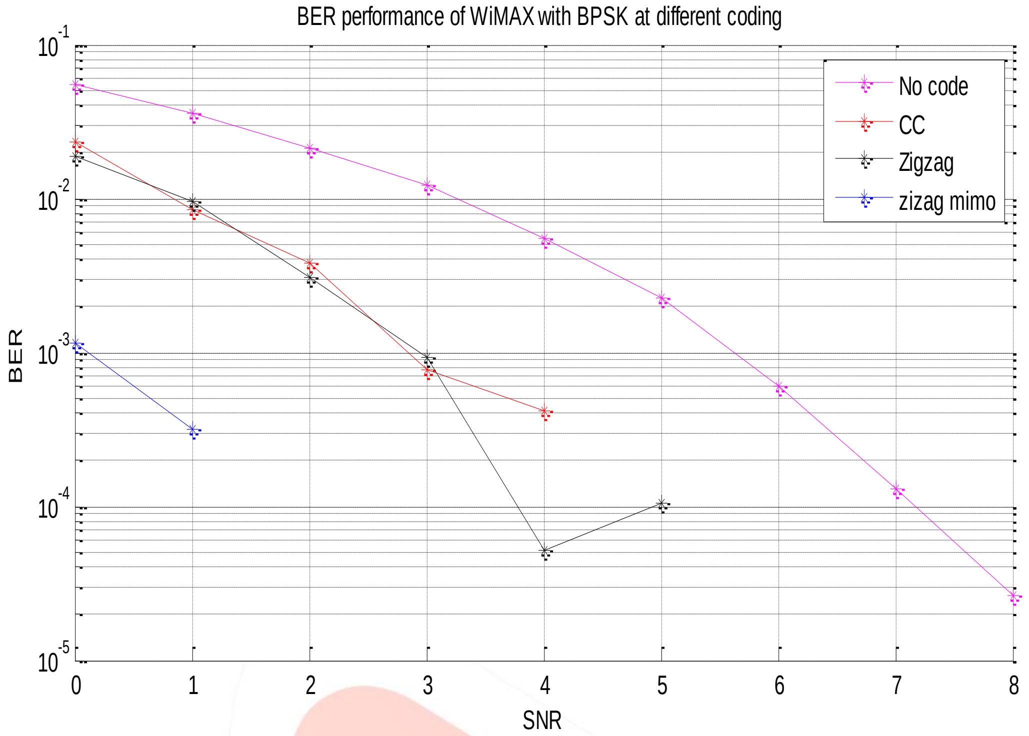

Fig: 6 BER performance evaluation of different code and BPSK modulation for WiMAX

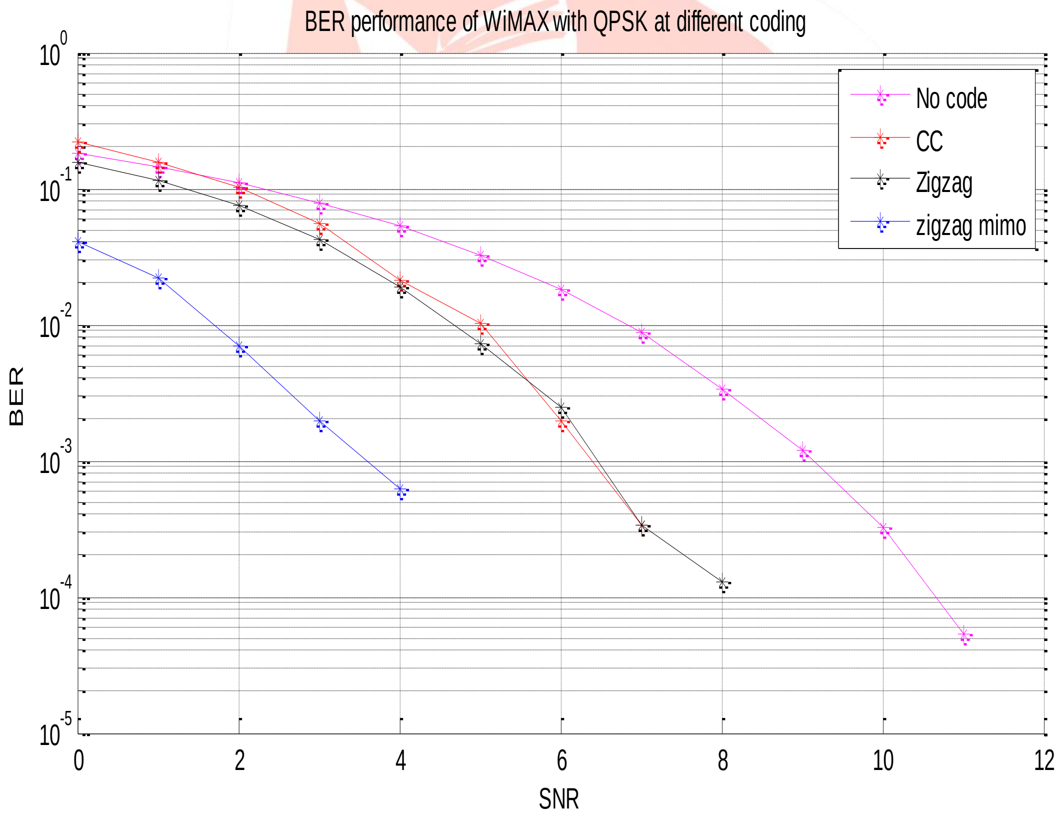

Fig: 7 BER performance evaluation of different code and QPSK modulation for WiMAX

VII. CONCLUSION

In this paper, performance enhancement of WiMAX system is done with MIMO. BER for different adaptive modulation techniques are evaluated in slow frequency selective fading channel. In frequency selective fading, channel is affected by more ISI and noise then in flat fading. The performance of WiMAX system and FEC coding, for the transmission of reliable data over communication channel Forward- Error- Correction techniques are necessary. The redundant bits are added to the data stream before its transmission so the effect of error which may occur during transmission can be reduced. In the receiver side system is enabled by the redundancy to detect and correct the errors. The simulation results we can conclude in zigzag codes with modulation techniques type performs better and gives a stronger error detecting.

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