Performance Evaluation of Transmission over MIMO-WiMAX Using Adaptive Modulation

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***Abstract* - The Multiple-Input Multiple-Output based wireless system is a promising high data rate interface technology. A method based on Space-Time Block Coding (STBC) with Multiple-Input Multiple-Output (MIMO) set-up for use in wireless channels. In the special version of STBC called Alamouti code is used for exploiting the performance of MIMO in Adaptive modulation. The higher speed of communication without compromising in the accuracy is the prime focus of research work in wireless communication. The space time coding is one of the techniques which enable the higher speed with maintaining the error rate. In this paper, the analysis and study of the ber performance and capacity analysis is given. The OFDM system which is space time coding. The simulation has been performed with different modulation scheme. The comparative result has been given in this paper.**

***Index Terms* - MIMO, OFDM, STBC, AMC, WiMAX, BER 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 comunication, 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.

WiMAX is the upcoming wireless system which uses 802.16 IEEE standard. 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.

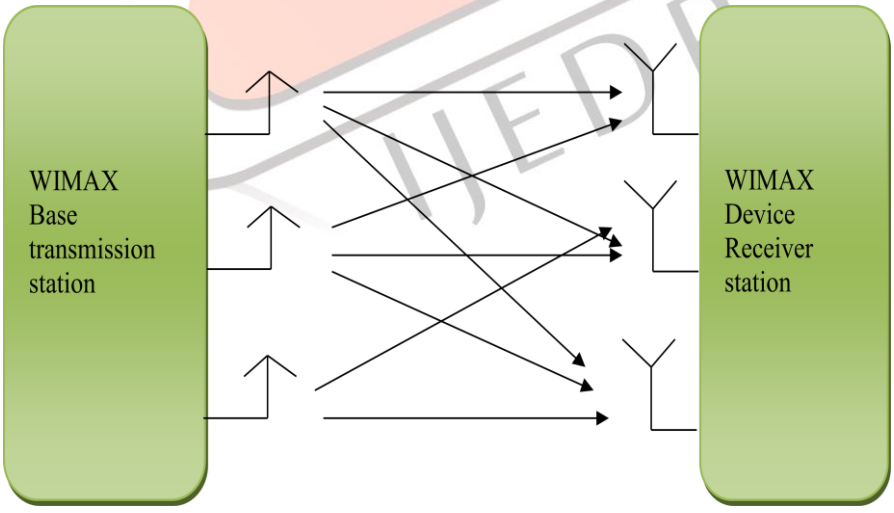

Fig: 1 MIMO WiMax system Communication

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 ration (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. ADAPTIVE MODULATION AND CODING

The traditional wireless systems are designed to provide good transmission quality for the worst channel conditions. As a result, signal to noise ratio that are much larger than the target are achieved over a large portion of the coverage area and transmission time, which leads to inefficient utilization of the full channel capacity. In addition, the integration of the voice and data transmission has caused different quality of service requirements over wireless systems.

Adaptive modulation is used to overcome these limitations, where the modulation level, coding rate, and other signal transmission parameters are dynamically adapted to the changing channel conditions without sacrificing the probability of bit error.

Adaptive modulation can increase average throughput, required transmit power, or reduce average probability of bit error by taking advantages of favorable channel conditions to send at higher data rates, at lower power and reducing the data rate as increasing power as the channel degrades. To implement such flexible adaptive modulation processor, the Software Defined Radio (SDR) technique is used.SDR is a highly configurable hardware platform that provides the technology for realizing the rapidly expanding wireless communication infrastructure. The software radio technique allows to describe radio functionalities defined by software.

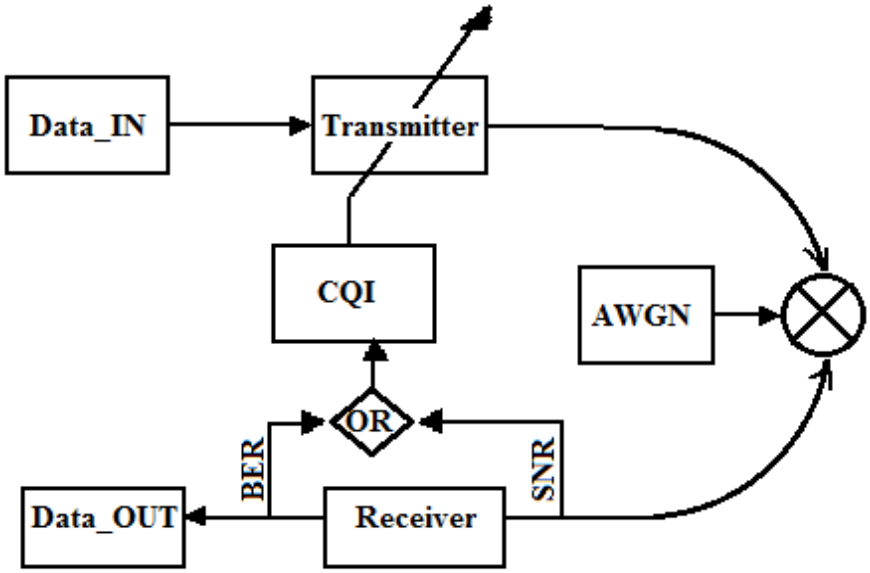

Fig 2. Adaptive modulation and coding system [3]

The function of AMC is based on SDR-CR combination. The receiver evaluate received packets (i.e. SNR or BER) to estimate the Channel Quality Indictor (CQI) system, then feedback the transmitter to reconfigure itself for the next packet send.

III. WIMAX SYSTEM

The different wireless technique has reached at hight 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.

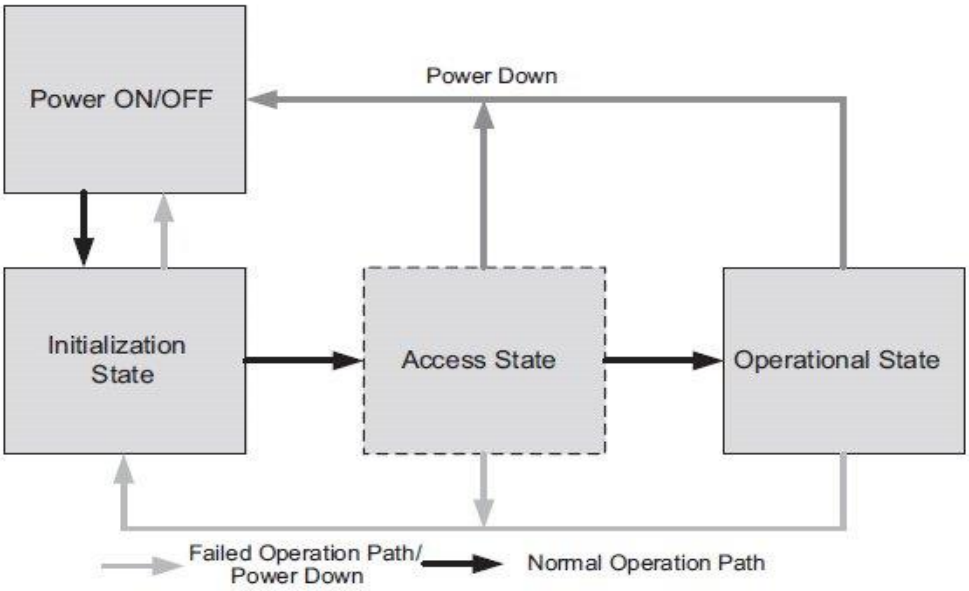

Fig: 3 WiMAX architecture

Features of WiMAX

There are certain features of WiMAX those are making it popular day by day. Some important features of WiMAX are Interoperability, Long Range, Mobility, Roaming, Handoff, Quality of Service, Interfacing, Accessibility, Scalability, Portability, Last Mile Connectivity, Robust Security etc.

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.

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

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.

$$C = B \log\left(1 + \frac{S}{N}\right). \qquad (2)$$

V. BIT ERROR RATE CALCULATION

The BER of an uncoded 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 . In this 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.

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

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

VI. RESULTS AND DISCUSSION

System description

The system description for the simulation is given in fig 4. The image data are transmitted through the MIMO WiMAX system with AMC code.

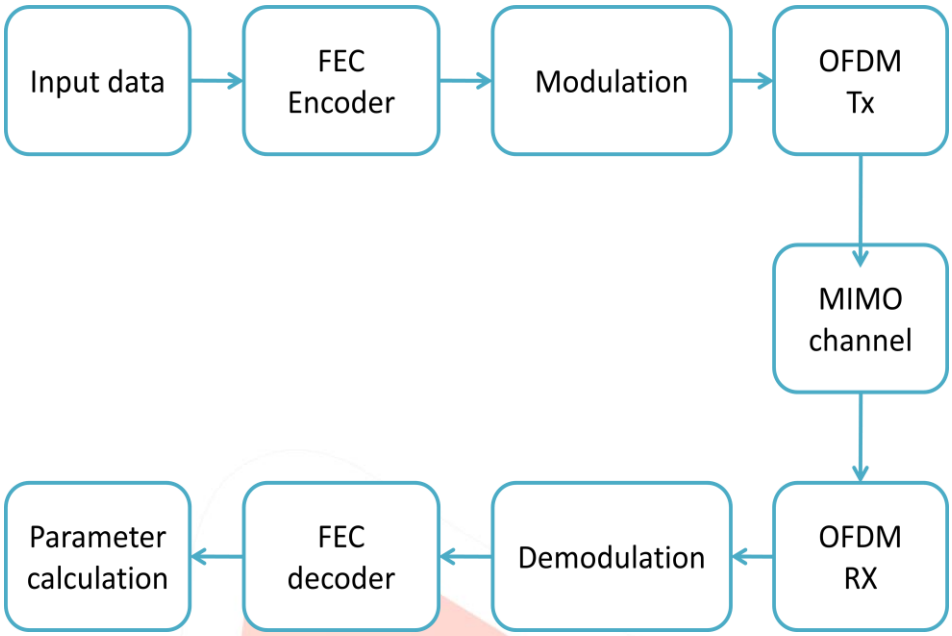

Fig: 4.System block diagram

The BER performance graphs for the simulated WiMAX physical layer and MIMO-OFDM with the implementation of channel coding under adaptive modulation schemes over AWGN channel, Rayleigh and Rician multipath fading channels.

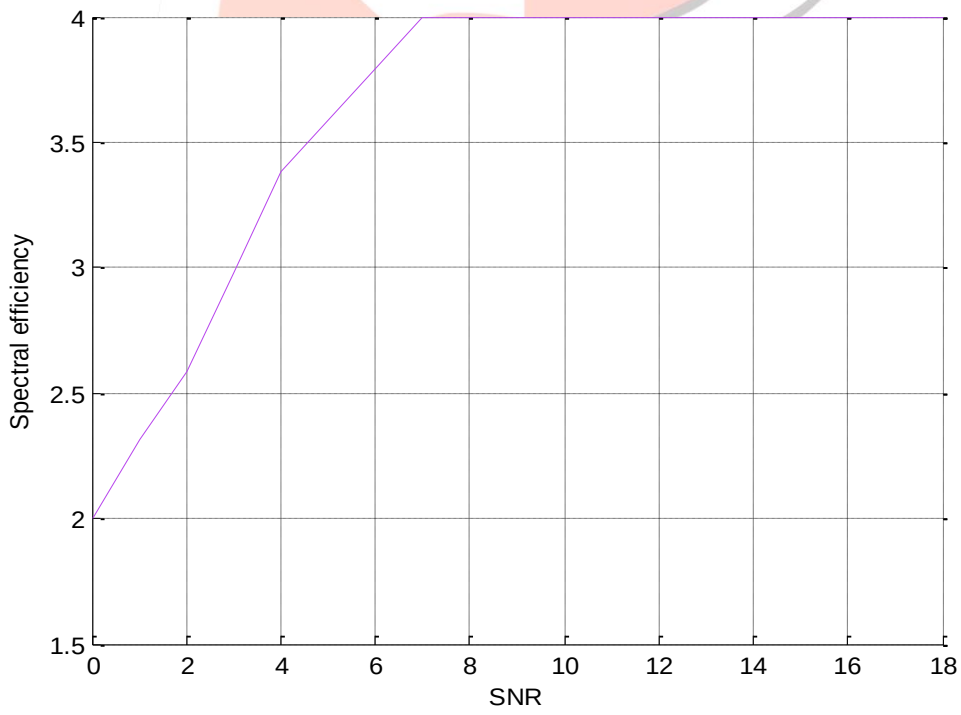

Fig: 5 Performance of spectral efficiency Vs SNR

Initially Spectral efficiency is increases at low SNR and at high level SNR it achieve high level then constant through out SNR.

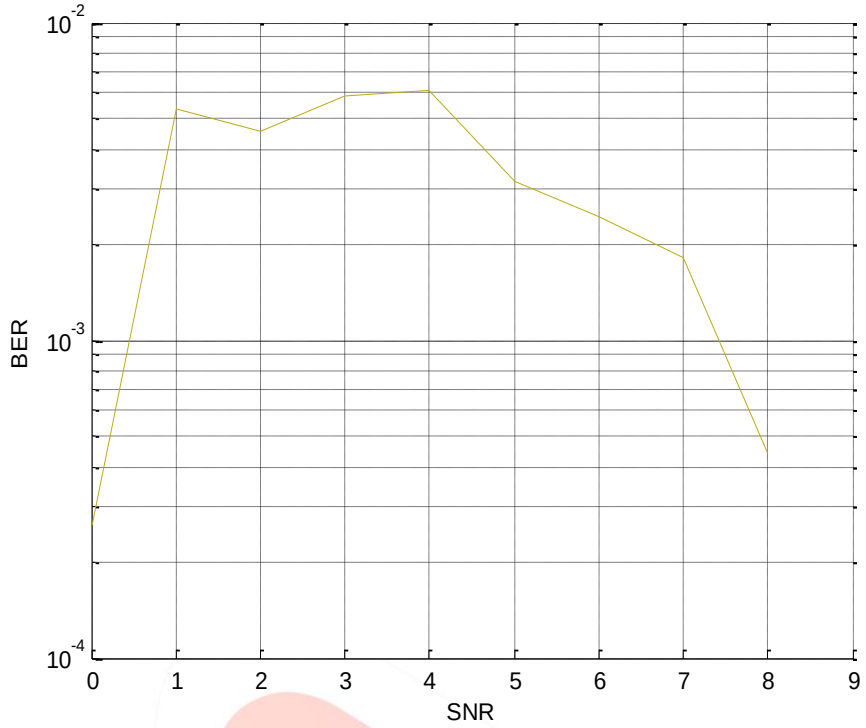

Fig: 6 Performances of BER Vs SNR

BER is the number of error bits occurs within one second in transmitted signal. BER defined mathematically as follow;

$$BER = \frac{Number\ of\ Bits\ of\ Error}{Total\ Number\ of\ Bits\ Transmited}$$

When the transmitter and receiver's medium are good in a particular time and Signal-to-Noise Ratio is high, and then Bit Error rate is very low. In our paper simulation we generated random signal when noise occurs after that we got the value of Bit error rate.

$$SNR = \frac{Signal\ Power}{Noise\ Power}$$

The BER performance graphs for the simulated WiMAX-MIMO with the implementation of communication channel and adaptive modulation coding under QAM, BPSK, digital modulation schemes over AWGN channel,

VII. Conclusion

In this paper, performance enhancement of WiMAX system is done with adaptive equalizer. 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. Finally, performance of WiMAX system is evaluated using adaptive modulation. Using adaptive adaptive modulation coding technique bit error rate is improved.

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