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PERFORMANCE OF IEEE 802.16E MIMO-OFDM SYSTEM WITH ALAMOUTI SCHEME

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ABSTRACT

WiMAX is a wireless digital communications system,also known as IEEE 802.16 that is intended for wireless "Metropolitan Area Networks". WiMAX can provide broadband wireless access (BWA) up to 30 miles (48.2803 km) for fixed stations, and 3-10 miles (4.8-16.0 km) for mobile stations. In contrast, the Wi-Fi-802.11 wireless local area network standard is limited in most cases to only 100 - 300 feet (30.8 – 91.44 meter). It is also known as 802.16 networking or wireless networking. The new area of communication, currently employed in some parts of the world, is Worldwide Interoperability for Microwave Access (WIMAX). It is the latest technology which is approved by IEEE 802.16 group, which is a standard for point-to-multipoint wireless networking. The MIMO-OFDM is a key technology for next-generation cellular communications (Mobile WiMAX, IMT Advanced) as well as wireless Personal Area Network, wireless Local Area Network (IEEE 802.11a, IEEE 802.11n) and broadcasting (DAB, DVB). In this paper analysis of the multiple antenna technologies like SISO, MIMO system under different combination of modulation technologies like BPSK, QPSK, 8-QAM and 16-QAM with mobile wireless channel AWGN used and the results shows under the bit error rate versus signal to noise ratio.

Keyword: **- Worldwide Interoperability for Microwave Access (WiMAX), Additive White Gaussian Noise channel (AWGN), Orthogonal Frequency Division Multiplexing (OFDM), Multiple-Input And Multiple Output (MIMO), Bit Error rate (BER), Signal to Noise ratio (SNR).**

I. INTRODUCTION

Pursuance for better ways of living has been instrumental in advancing human civilization. The wireless Communication services available at any time and place free people from the limitation of being attached to fixed devices. Nowadays, thanks to the remarkable progress in wireless technology, affordable wireless communication service has become a reality. Wireless communication systems can be found all around the world today. WiMAX which represents (World Interoperability for Microwave Access) is a major part of broad band wireless network having IEEE 802.16 standard provides innovative fixed as well as mobile platform for broad-band internet access anywhere in anytime. IEEE 802.16 standard has bandwidth of 2GHz-11GHz for fixed applications and 2-6GHz for mobile applications. It is considered the most interesting opportunity which is able to provide data throughput up to 70 Mbps and radio coverage distances of almost 50 kilometers, and to complete wired network architectures, ensuring a cheap flexible solution for the last-mile. WiMAX can be seen as the fourth generation (4G) of mobile communications systems. WiMAX is an IEEE 802.16 standard based technology responsible for bringing the Broadband Wireless Access (BWA) to the world as an alternative to wired broadband. Potential wireless applications include cell phones, 802.11-based wireless Local Area Networks (LANs), Bluetooth, smart homes and appliances, voice and data communication over the Internet, and video conferencing.

II. IEEE 802.16-WiMAX

Based on the IEEE 802.16, the WiMAX Forum develops system profiles, which define mandatory and optional capabilities for WiMAX products. The list of features tested in system profiles is more stringent than the underlying standards, but does not include any new feature that is not included in the standards [7]. Initially, the WiMAX Forum focused on the 10-66GHz frequencies in the Wireless MAN-SC physical layer specifications of IEEE Standard 802.16-2001.

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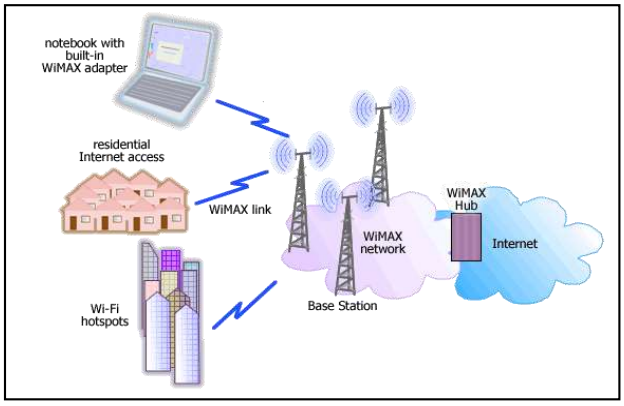

FIG. 1 WIMAX NETWORK

The WiMAX Forum collaborated on the IEEE Std 802.16c-2002 amendment to develop the system profiles for Wireless MAN-SC, it is forum helped developing IEEE Std 802.16-Conformance Jan-2005, IEEE Std 802.16-Conformance Feb-2005 and IEEE Std 802.16-Conformance Mar-2005 for a Protocol Implementation Conformance Statement (PICS) Performa, Test Suite Structure (TSS) and Test Purpose (TP) and Radio Conformance Test (RCT), respectively [7]. It is a new broadband wireless data communication technology or mobile internet based around the IEEE 805.16 standard that will provide high-speed data communication up-to 70 Mb/s over a wide area. The letters of WiMAX stand for worldwide interoperability for microwave access and it is a technology for point-to-multipoint wireless networking. The WiMAX technology is expected to meet the needs of a large variety of users from those who are in developed nations wanting to install a new high speed wireless data network very cheaply with the minimum cost and time required.

WiMAX is capable of working in different frequency ranges but according to the IEEE 802.16, the frequency band is 10 GHz to 66 GHz. A typical architecture of WiMAX includes a base station built on top of a high rise building and communicates on point to multi-point basis with subscriber stations which can be a business organization or a home. The base station is connected through Customer Premise Equipment (CPE) with the customer. This connection could be a Line-of-Sight (LOS) or Non-Line-of-Sight (NLOS).

III. MIMO SYSTEM

Wireless MIMO channels have been recently attracting a great interest since they provide significant improvements in terms of spectral efficiency and reliability with respect to single input single-output (SISO) channels. The gains obtained by the deployment of multiple antennas at both sides of the link are the array gain, the diversity gain, and the multiplexing gain. The array gain is the improvement in signal-to-noise ratio (SNR) obtained by coherently combining the signals on multiple-transmit or multiple-receive dimensions while the diversity gain is the improvement in link reliability obtained by receiving replicas of the information signal through independently fading dimensions. These gains are not exclusive to MIMO channels and also exist in single-input multiple output (SIMO) and multiple-input single-output (MISO) channels. In contrast, the multiplexing gain, which refers to the increase of rate at no additional power consumption, is a unique characteristic of MIMO channels. The cost of this increased rate is the added cost of deploying multiple antennas, the space requirements of these extra antennas (spatially on small handheld units), and the added complexity required for multi-dimensional signal processing.

A. MIMO systems capacity

The MIMO systems provide tremendous capacity gains, which has incited significant activity to develop transmitter and receiver techniques that realize these capacity benefits and exploit diversity. This sub topic describes the Shannon capacity limits of single user MIMO system. The limits of single user MIMO systems show the maximum data rates that can be transmitted over the MIMO channel.

B. Channel unknown to the transmitter

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The channels are assumed to have small error probability and we assume no constraints on the delay, we further assume the channel knowledge is unavailable at the transmitter and known only at the receiver.

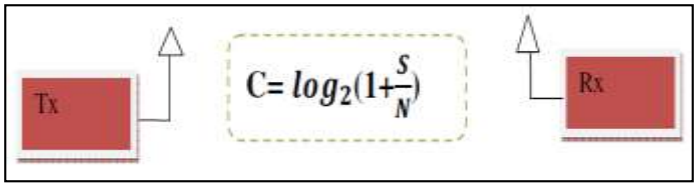

Fig. 2 Single Input Single Output (SISO) Capacity

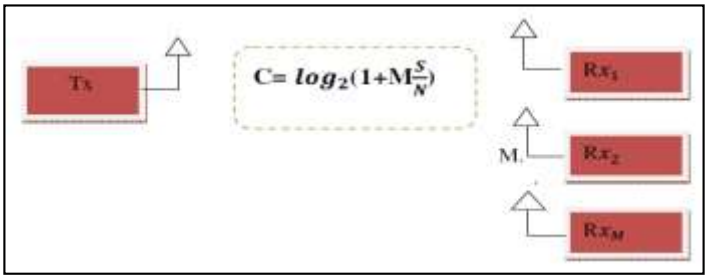

Fig. 3 Single Input Multiple Output (SIMO) Capacity

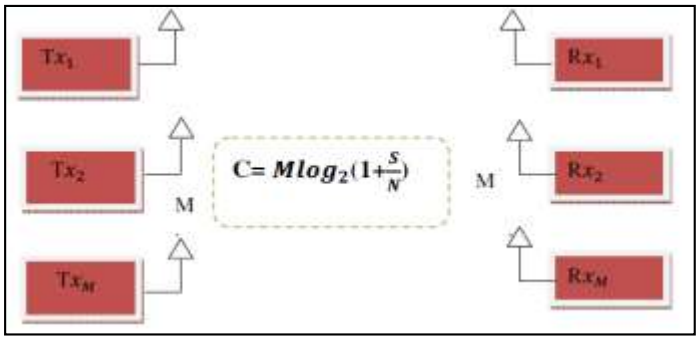

Fig 4 Multiple Input Multiple Output (MIMO) Capacity

From the above figures we can easily see that the normalized capacity of multiple antenna increases with the number of antennas. For SIMO system provides logarithmic growth of the bandwidth efficiency limit while MIMO system provides linear growth of bandwidth efficiency.

C. Alamouti space-time coding scheme (2×2)

The Alamouti space-time coding scheme for the system with two transmission antennas and two reception antennas in a memory less channel. The transmission scheme is the same as with the 2×1 system.

Received signals at receive antenna 1 are:

$$R_0(t) = h_{11}(t)X_1(t) + h_{21}(t)X_2(t) + n_0(t) \quad (1)$$

$$R_1(t) = -h_{11}(t){X^*}_2(t) + h_{21}(t){X^*}_1(t) + n_0(t+T) \quad (2)$$

Where n_0 represents noise at receive antenna 1.

At receive antenna 2 the received signals are:

$$R_2(t) = h_{12}(t)X_1(t) + h_{22}(t)X_2(t) + n_1(t) \quad (3)$$

$$R_5(t) = -h_{21}(t){X^*}_2(t) + h_{22}(t){X^*}_1(t) + n_1(t+T) \quad (4)$$

At time instances t and $t+T$, respectively, where n_1 represents noise at receive antenna 2. Again, the estimates of the signals in the decoder/combiner are given as in equation 5 and 6.

$$\widehat{X_1} = {h^*}_{11}(t)R_0(t) + h_{21}(t){R^*}_1(t) + {h^*}_{12}(t)R_2(t) + h_{22}(t)R_5(t) \quad (5)$$

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$$\widehat{X_2} = h^*{}_{11}(t)R_0(t) - h_{21}(t)R^*{}_1(t) + h^*{}_{12}(t)R_2(t) - h_{22}(t)R_5(t) \quad (6)$$

IV. SIMULATOR RESULTS

The WiMAX 802.16e simulink model was used with AWGN (Additive White Gaussian Noise) and different modulation schemes used like BPSK, QPSK, 8-QAM and 16-QAM. The performance of used New scheme Alamouti with combination of MISO (multiple input and single output). The simulation results are shown in figure 5 and 6.

A. Performance of 2 × 2-MIMO system over AWGN channel

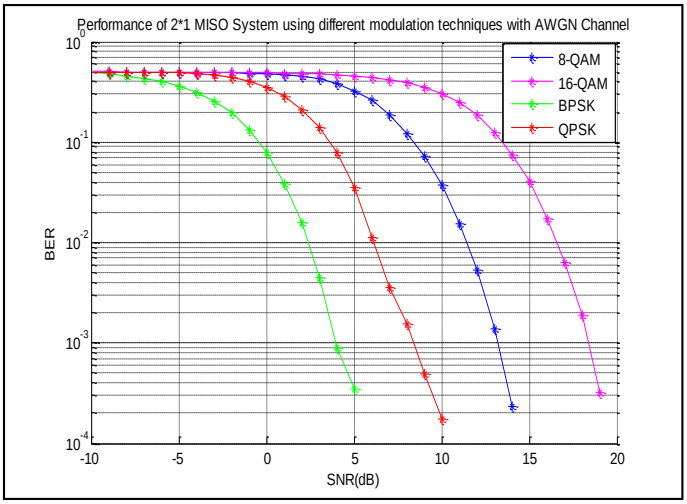

Fig. 5: Performance analysis of 2 × 1 MISO system using different modulation techniques with AWGN channel

B. Performance of 2 × 2-MIMO system over AWGN channel

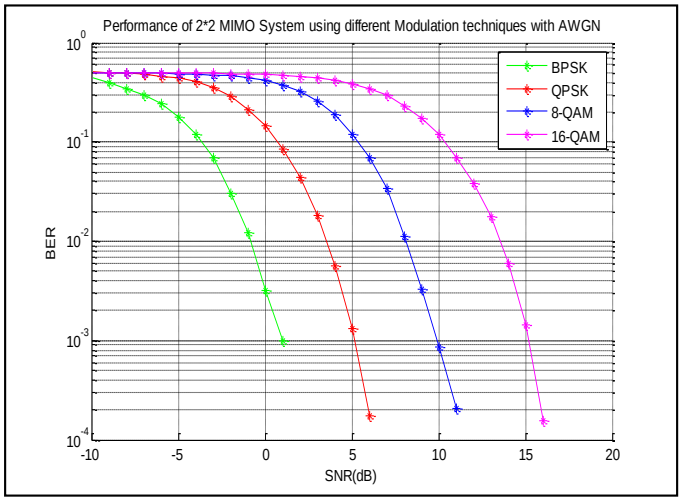

Fig. 6: Performance analysis of 2 × 2 MIMO system using different modulation techniques with AWGN channel

V. CONCLUSION

A MIMO-OFDM modulation technique can achieve reliable high data rate transmission over broadband wireless channels. We developed a program in MATLAB R2013a, to study MIMO-OFDM systems behavior under different conditions. We have used the parameters data rate 1Mbps, number of transmitted bits 100000, AWGN channel, 64 subcarriers OFDM signal, four types of modulation BPSK, QPSK, 16QAM and 64QAM. In

this performance, we have used the Alamouti scheme with communication AWGN channel and different modulation techniques. The performance is displayed in figure 5 in terms of the BER verses SNR logarithmic plot, in this plot we analysis the 16-QAM, SNR is increased 3.7dB on BER at 10^{-3} as compared to 8-QAM and Modulation Techniques at a constant signal power, and another performance is displayed in figure 6, in this plot we analysis the 16-QAM, SNR is also increased 5.3dB on BER at 10^{-3} as compared to 8-QAM and modulation techniques at a constant signal power.

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