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Evaluation of Efficient Wi-Max Mobile Network using MIMO and Mean Filter

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Abstract - The modern Wi-max mobile communication system is the future of wireless communication and the end to end performance of the system is need to be improved. This improvement is analyzed in terms of error rate. The bit error rate (BER) is a measure of information sent from source is how much received correctly. However if the whole communication system from source to destination is quite powerful to deliver information correctly to the destination, than such system is said to be efficient. In this paper we have taken same system under simulation with addition of MIMO technology with efficient 8-PSK modulation technique with different iterations by applying mean filtering. The simulation results shows the error rate reduced up to 10^{-7}.

Keywords - Wi-Max, MIMO, Mean Filtering, Mobile Network.

I. INTRODUCTION

WiMAX has emerged as a promising solution for last mile access technology to provide high speed internet access in the residential as well as small and medium sized enterprise sectors. At this moment, cable and digital subscriber line (DSL) technologies are providing broadband service in this sectors. But the practical difficulties in deployment have prevented them from reaching many potential broadband internet customers. Many areas throughout the world currently are not under broadband access facilities. Even many urban and suburban locations may not be served by DSL connectivity as it can only reach about three miles from the central office switch [3].

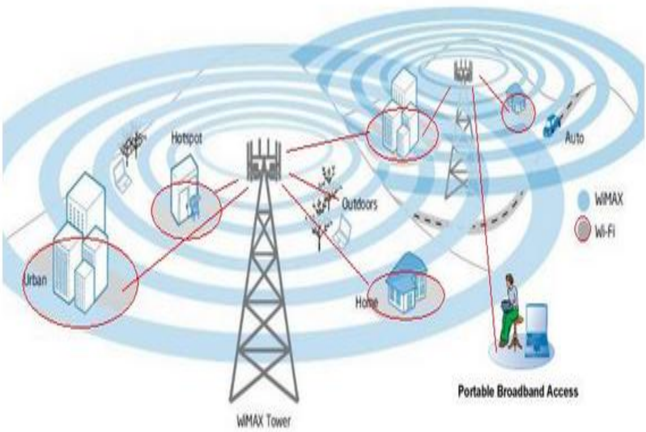

Figure. 1 WiMAX as the wireless broadband technology

On the other side many older cable networks do not have return channel which will prevent to offer internet access and many commercial areas are often not covered by cable network. But with BWA this difficulties can be overcome. Because of its wireless nature, it can be faster to deploy, easier to scale and more flexible, thereby giving it the potential to serve customers not served or not satisfied by their wired broadband alternatives. IEEE 802.16 standard for BWA and its associated industry consortium, Worldwide Interoperability for Microwave Access (WiMAX) forum promise to offer high data rate over large areas to a large number of users where broadband is unavailable. This is the first industry-wide standard that can be used for fixed wireless access with substantially higher bandwidth than most cellular networks [2]. Wireless broadband systems have been in use for many years, but the development of this standard enables economy of scale that can bring down the cost of equipment, ensure interoperability, and reduce investment risk for operators. The first version of the IEEE 802.16 standard operates in the 10–66GHz frequency band and requires line-of-sight (LOS) towers. Later the standard extended its operation through different PHY specification to 2-11 GHz frequency band enabling non line of sight (NLOS) connections, which require techniques that efficiently mitigate the impairment of fading and multipath [4]. Taking the advantage of OFDM technique the PHY is able to provide robust broadband service in hostile wireless channel. The OFDM-based physical layer of the IEEE 802.16 standard has been standardized in close cooperation with the European Telecommunications Standards Institute (ETSI) High PERformance Metropolitan Area Network (HiperMAN) [5]. Thus, the HiperMAN standard and the OFDM-based physical layer of IEEE 802.16 are nearly identical. Both OFDM-based physical layers shall comply with each other and a global OFDM system should emerge [4]. The WiMAX forum certified products for BWA comply with the both standards.

IEEE 802.16-2001 This first issue of the standard specifies a set of MAC and PHY layer standards intended to provide fixed broadband wireless access in a point-to-point (PTP) or point-to multipoint (PMP) topology [7]. The PHY layer uses single carrier modulation in the 10 – 66 GHz frequency range. Transmission times, durations and modulations are assigned by a Base Station (BS) and shared with all nodes in the network in the form of broadcast Uplink and Downlink maps. Subscribers need only to hear the base station that they are connected and do not need to listen any other node of the network. Subscriber Stations (SS) has the ability to negotiate for bandwidth allocation on a burst to-burst basis, providing scheduling flexibility. The standard employs QPSK, 16-QAM and 64-QAM as modulation scheme. These can be changed from frame to frame and from SS to SS, depending on the robustness of the connection. The standard supports both Time Division Duplexing (TDD) and Frequency Division Duplexing (FDD) as duplexing technique.

An important feature of 802.16-2001 is its ability to provide differential Quality of Service (QoS) in the MAC Layer. A Service Flow ID does QoS check. Service flows are characterized by their QoS parameters, which can then be used to specify parameters like maximum latency and tolerated jitter [10]. Service flows can be originated either from BS or SS. 802.16-2001 works only in (Near) Line of Sight (LOS) conditions with outdoor Customer Premises Equipment (CPE).

A. Application of IEEE 802.16 based network:

IEEE 802.16 supports ATM, IPv4, IPv6, Ethernet and Virtual Local Area Network (VLAN) services [1]. SO, it can provide a rich choice of service possibilities to voice and data network service providers. It can be used for a wide selection of wireless broadband connection and solutions. ¨ Cellular Backhaul: IEEE 802.16 wireless technology can be an excellent choice for back haul for commercial enterprises such as hotspots as well as point-to-point back haul applications due to its robust bandwidth and long range. ¨ Residential Broadband: Practical limitations like long distance and lack off return channel prohibit many potential broadband customers reaching DSL and cable technologies [3]. IEEE 802.16 can fill the gaps in cable and DSL coverage. ¨ Underserved areas: In many rural areas, especially in developing countries, there is no existence of wired infrastructure. IEEE 802.16 can be a better solution to provide communication services to those areas using fixed CPE and high gained antenna. ¨ Always Best Connected: As IEEE 802.16e supports mobility [8], so the mobile user in the business areas can access high speed services through their IEEE 802.16/WiMAX enabled handheld devices like PDA, Pocket PC and smart phone.

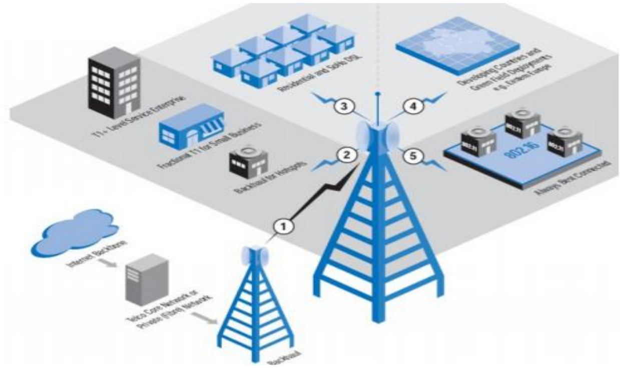

Figure 2: Application scenarios [3]

B. IEEE 802.16 PHY Layer:

The IEEE 802.16 standard supports multiple physical specifications due to its modular nature. The first version of the standard only supported single carrier modulation. Since that time, OFDM and scalable OFDMA have been included to operate in NLOS environment and to provide mobility. The standard has also been extended for use in below 11 GHz frequency bands along with initially supported 10-66 GHz bands. 10-66 GHz licensed band: In this frequency band, due to shorter wave length, line of sight operation is required and as a result the effect of multipath propagation is neglected. The standard promises to provide data rates up to 120 Mb/s in this frequency band [6].

II. PROPOSED APPROACH

The block diagram shows the Proposed Methodology. The Space Diversity with EGC, MRC and SC Liner Average Filtration Methodology in Fig. 2.1. In the proposed methodology EGC, MRC and SC modulation with Liner Average Filter has been used to minimize the Error Probability is calculated with SNR. The Block Diagram in the transmitter side the data is modulated by QPSK modulator the antenna diversity with 4, 8, and 16 is used. In receiver side Combining Techniques EGC, MRC & SC with Linear Average Filter for optimum performance of outcome.

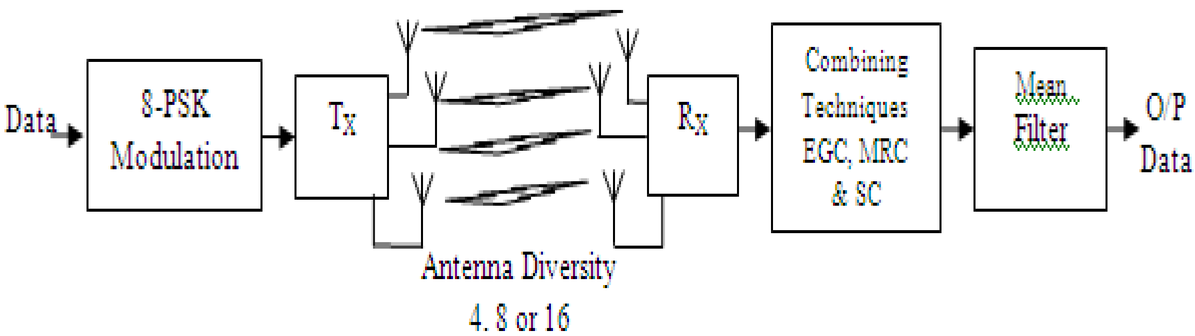

Figure. 2.1 Block Diagram of Proposed Methodology

The flow chart of proposed methodology is shown in Fig. 2.2, it shows the step by step execution of algorithm. When the simulation starts it is need to create environment first which is created with the help of variable in simulation tool. Than we characterize the channel matrix for multiple antennas at transmitter and receiver both. After that the data is generated and converted into signal QPSK modulation is applied.

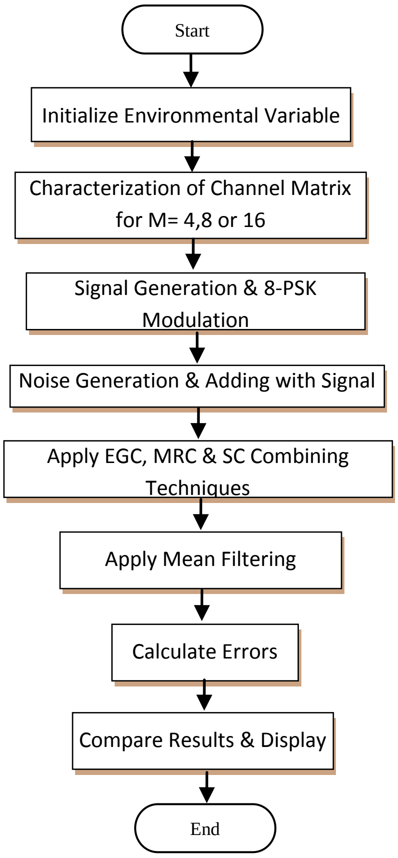

Figure. 2.2 Flow chart of Proposed Methodology

After complete preparation of signal it is transmitter through wireless channel where signal encountered with noises and get corrupted. Due to these noises and interferences we have to use effective combining techniques. After application of combining technique we have applied linear average filter which significantly reduces the effect of noises.

At the end we will calculate the errors with and without filter application in system and in the next section results are displayed.

III. SIMULATION RESULTS

This section explains the results of proposed methodology after simulation. The simulation of proposed system is under different antenna configurations i.e. 4 antenna at receiver and 4 at transmitter, similarly 8 or 16 antennas both side. The combining techniques (EGC, MRC and SC) is also compared with and without filtering. For enhancing the performance of the system mean filtering is also added with combining technique.

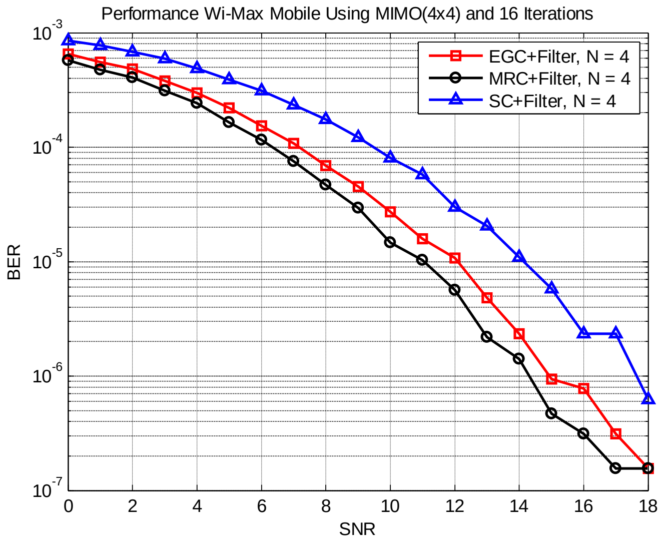

Figure. 3.1 BER vs SNR Curve using 4x4 antenna with Linear Average Filter

The simulation of proposed system with equal gain combining(EGC), maximal ratio combining(MRC) and selection combining(SC) is shown in the Fig. 3.1 and the outcome with this technique using mean filtering is that , when we use 4 antennas with all the combining techniques we will get the better results with MRC with filtering. The optimum BER achieved is $1.9x10^{-7}$ at 18dB SNR.

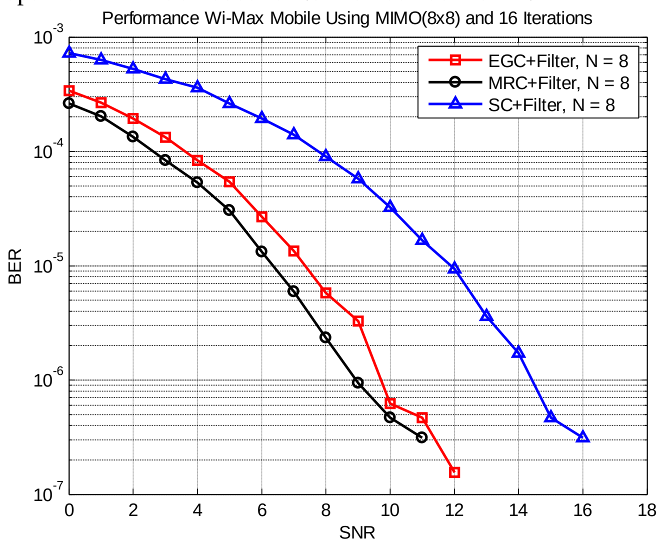

Figure. 3.2 BER vs SNR Curve using 8x8 antenna with Linear Average Filter

The simulation of proposed system with equal gain combining(EGC), maximal ratio combining(MRC) and selection combining(SC) is shown in the Fig. 3.2 and the outcome with this technique using mean filtering is that , when we use 8 antennas with all the combining techniques we will get the better results with MRC with filtering. The optimum BER achieved is $2.9x10^{-7}$ at 11dB SNR.

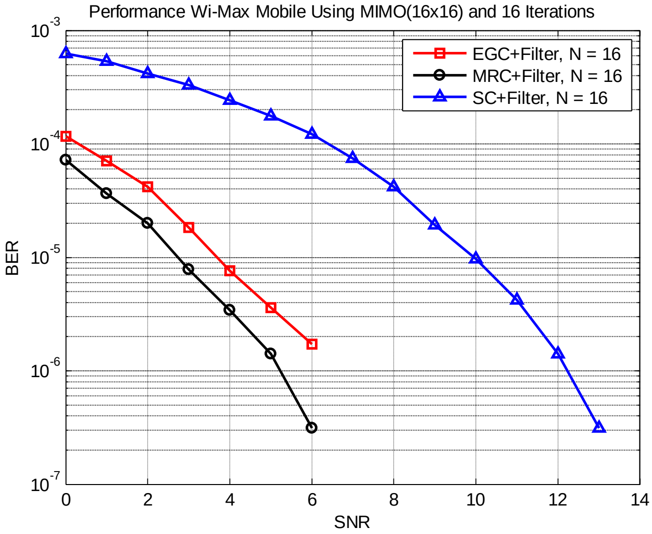

Figure. 3.3 BER vs SNR Curve using 16x16 antenna with Linear Average Filter

The simulation of proposed system with equal gain combining(EGC), maximal ratio combining(MRC) and selection combining(SC) is shown in the Fig. 3.3 and the outcome with this technique using mean filtering is that , when we use 16 antennas with all the combining techniques we will get the better results with MRC with filtering. The optimum BER achieved is $3x10^{-7}$ at 6dB SNR.

IV. CONCLUSION AND FUTURE SCOPE

The wireless communication is the modern technique and should have robustness against noise and interference, so as we seen the previous section simulation results shows that MRC is best technique for combining in space diversity when higher number of MIMO configuration is used. The mean filter has enhanced the performance of this technique, and 8-PSK modulation scheme is used to make signal robust against interference. In future if the higher modulation technique is used with this system the performance will also increase.

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