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Performance Evaluation of MIMO-OFDM using AWGN Channel with Different Modulation Scheme in WiMAX Technology

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ABSTRACT

MIMO-OFDM is a critical technology and a good option for 5G telecommunications networks. The present MIMO hardware and software developments, as well as MIMO-OFDM equalisation approaches, are briefly covered. Mobile devices have grown into very sophisticated communication tools that serve as sensors in a cloud computing environment. Several improvements have been made to the core network in order to provide a high quality of service (QoS) and to support novel and diverse access ways. With the introduction of the IEEE 802.22 standard, cognitive radio (CR) networks have become increasingly important in the optimal utilisation of available spectrum resources with less interference between neighbouring users. In this paper, performance analysis of MIMO-ODFM using AWGN with different modulation scheme in WiMAX technology. The results of this investigation are performing between signal to noise ratio verses BER using MatlabR2013a tool.

KEYWORDS: *Bit Error Rate (BER), MIMO, Signal to Noise Ratio (SNR), OFDM, Modulation scheme, AWGN*

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1. INTRODUCTION

The most recent technological advancements, particularly in wireless communication systems, have raised the demand for quicker and more effective data transmission solutions. This need resulted in the development of the Fifth Generation Wireless System (5G) system. 5G is a new technology that offers new and powerful capabilities. It will improve the user experience a whole new level by meeting various communication requirements such as high speed, low latency, and dependable connectivity Furthermore, 5G will be able to handle the dramatic rise in traffic demand for connected devices.

The usage of massive multiple-input multiple-output (MIMO) with a high number of antennas at the base station has received substantial attention in fifth generation (5G) and subsequent systems (B5G/6G) [1]. In MIMO-OFDM systems, like STBC-based transmit diversity system; channel state information (CSI) is required for coherent detection and decoding [2]. MIMO-OFDM is an appealing system for high data rate, yet it shows a significant reduction in PAPR because of the nonlinear region of the High Power Amplifier and degradation of Bit Error Rate (BER) [3].

WiMAX, which stands for Worldwide Interoperability for Microwave Access, is a standard-based technology that aims to provide wireless data over long distances in a number of methods, ranging from point-to-point connectivity to complete mobile cellular access. It is based on the IEEE 802.16 standard, often known as Wireless MAN. The WiMAX Forum, which was founded in June 2001 to promote standard conformity and interoperability, coined the term "WiMAX." According to the forum, WiMAX is "a standards-based technology that enables the delivery of last-mile wireless broadband connectivity as an alternative to cable and DSL." Mobile WiMAX, the latest WiMAX iteration, is based on IEEE Standard 802.16e, which was adopted in December 2005. It is an addition to IEEE Std 802.16-2004 [3].

2. ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING

Furthermore, the combination of Orthogonal Frequency Division Multiplexing (OFDM) with MIMO produced an intriguing result. Over the last decade, MIMO-OFDM systems have piqued the interest of academics [4]. One of the first fully validated and functional massive MIMO test beds is proposed in the context of collaboration between the University of Bristol and Lund University, associated with National Instruments (NI) [5]

Orthogonal frequency-division multiplexing (OFDM) is a digital communication method that was originally designed for use in cable television networks. OFDM is comparable to the broadcasting technology known as frequency division multiplexing (also known as FDM), which employs a large number of transmitters and receivers to transport information on different frequencies across a single wire, such as an electrical power cable [7].

Bell Labs was the first to adopt OFDM in 1984 [7], and it has since become extensively employed in wireless applications such as mobile telephony and broadband communications. OFDM has emerged as a viable alternative to single-carrier modulation systems such as frequency division multiple access (FDMA), time-division multiple access (TDMA), and CDMA in wireless communications. It is utilised in applications such as digital video transmission, digital audio broadcasting, and digital cable television [7]. The Figure 1 shows the FDM and OFDM.

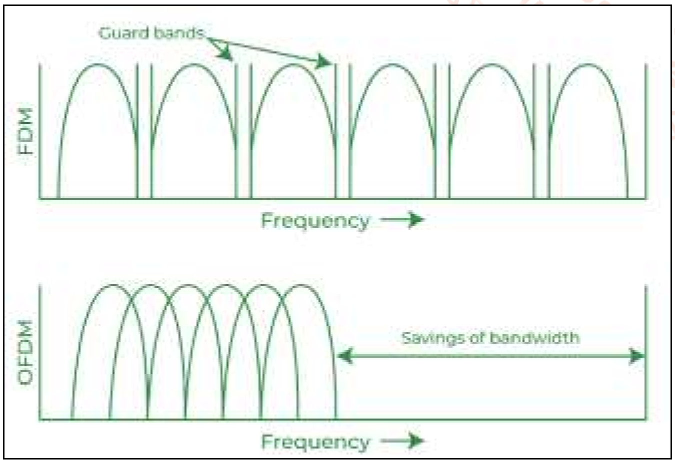

Fig.1: FDM and OFDM [7]

3. MIMO SYSTEM

Only a few papers [8] discuss the waveforms tested using MIMO systems. Nonetheless, several authors [9–14] have analyzed the MIMO channel estimation and modeling problem. Let us consider the MIMO system model with N_t (Tx) transmit and N_r (Rx) receive antennas, as depicted in Figure 2.

$$y = Cx + n \quad (1)$$

Where x is the transmit signal vector, and C and n are the fading channel matrix and the noise vector, respectively.

Advantages of a MIMO system [15]

A MIMO system provides better signal strength even without clear line-of-site as they utilize the bounced and reflected RF transmissions. The higher throughput allows better quality and quantity of video sent over the network. Multiple data streams reduce the number of lost data packets, which results in better video or audio quality.

Typical MIMO Configurations [15]

- 2x2 MIMO (two transmit antennas, two receive antennas)
- 3x3 MIMO (three transmit antennas, three receive antennas)
- 4x4 MIMO (four transmit antennas, four receive antennas)
- 8x8 MIMO (eight transmit antennas, eight receive antennas)

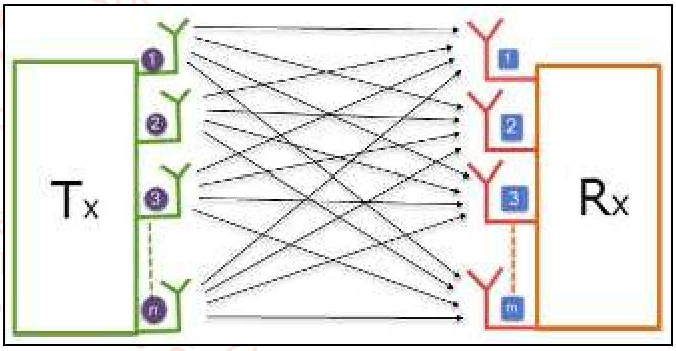

Fig. 2: Structure of MIMO system [15]

4. MODULATION TECHNIQUE

The technique of superimposing a low-frequency signal over a high-frequency carrier signal is known as modulation. Modulation is classified into three types: frequency modulation, amplitude modulation, and phase modulation. Modulation is a method used in electronics to impose information (speech, music, graphics, or data) on a radio-frequency carrier wave by modifying one or more wave properties in line with the information signal.

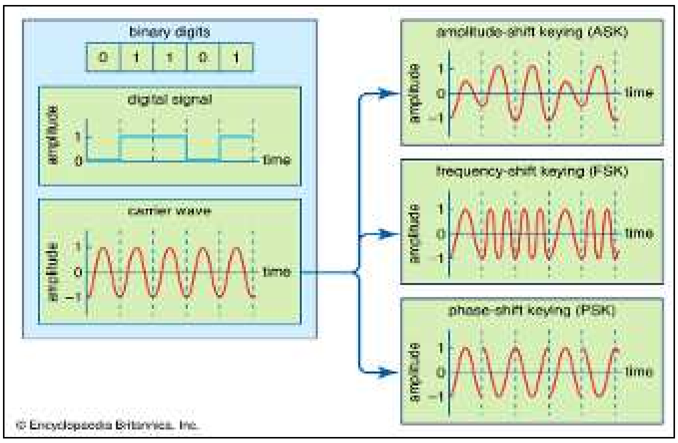

Fig. 3: Modulation schemes [16]

There are several types of modulation, each of which is intended to change a certain feature of the carrier wave. Amplitude, frequency, phase, pulse sequence, and pulse length are the most regularly changed features. The Figure 3 shows the modulation scheme.

5. BLOCK DIAGRAM OF PROPOSED WORK

In this work, the principles of MIMO and OFDM are addressed, as well as a space-time block coding scheme for MIMO- OFDM and an analysis of the system using AWGN Channel OFDM Technology. This Technology is a Digital Communication method that divides a large transmission capacity into little subcarriers using the Inverse Fast Fourier Transform (IFFT). This method is known as orthogonal FDM or OFDM. Figure 4 depicts the block diagram of the OFDM system. The figure 4 shown the Block diagram of OFDM using IFFT, Modulation, P to S and Channel [17]

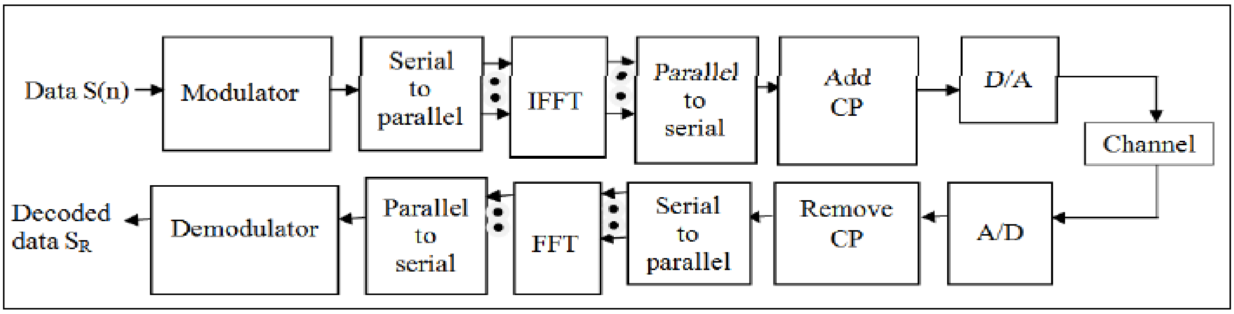

Fig. 4: Block diagram of OFDM using IFFT, Modulation, P to S and Channel [17]

6. SIMULATION RESULTS

The sent and received signals in a MIMO-OFDM system are independent of each other signal interference produced by AWGN or multipath is significantly diminished. The theoretical analysis would be validated by simulation. The simulation is carried out in a static AWGN channel and uses five different types of modulation modes. The following simulation parameters are used for MIMO-OFDM system. Figure 5 shows performance analysis of 2*4 MIMO using BPSK, QPSK, 8-QAM and 16-QAM Modulation with AWGN. Figure 6 Performance of BPSK Modulation using 2*2, 2*4 and 2*8 MIMO with AWGN.

Parameters of MIMO-OFDM system

Modulation mode: BPSK/QPSK/8PSK/16QAM/64QAM
System model: MIMO-OFDM
Transmitting antenna number: 2
Receiving antenna number: 2
CP length (subcarriers): 512
IFFT length (subcarriers): 2048
Pilot interval: n 2, 4, 8, 20, 50, 100

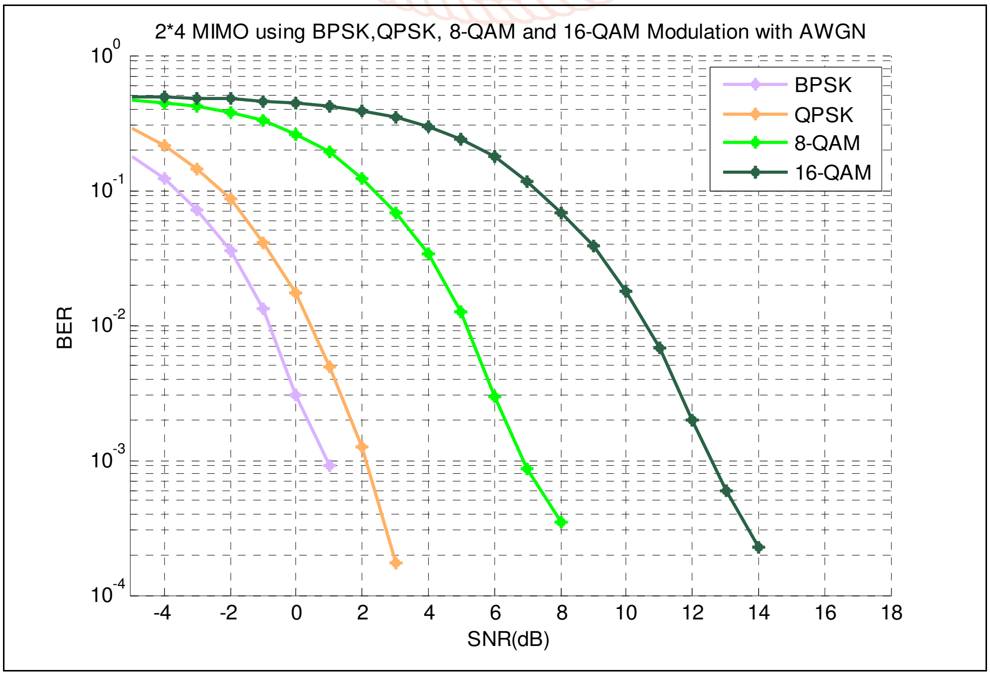

Fig.5 Performance analysis of 2*4 MIMO using BPSK, QPSK, 8-QAM and 16-QAM Modulation with AWGN

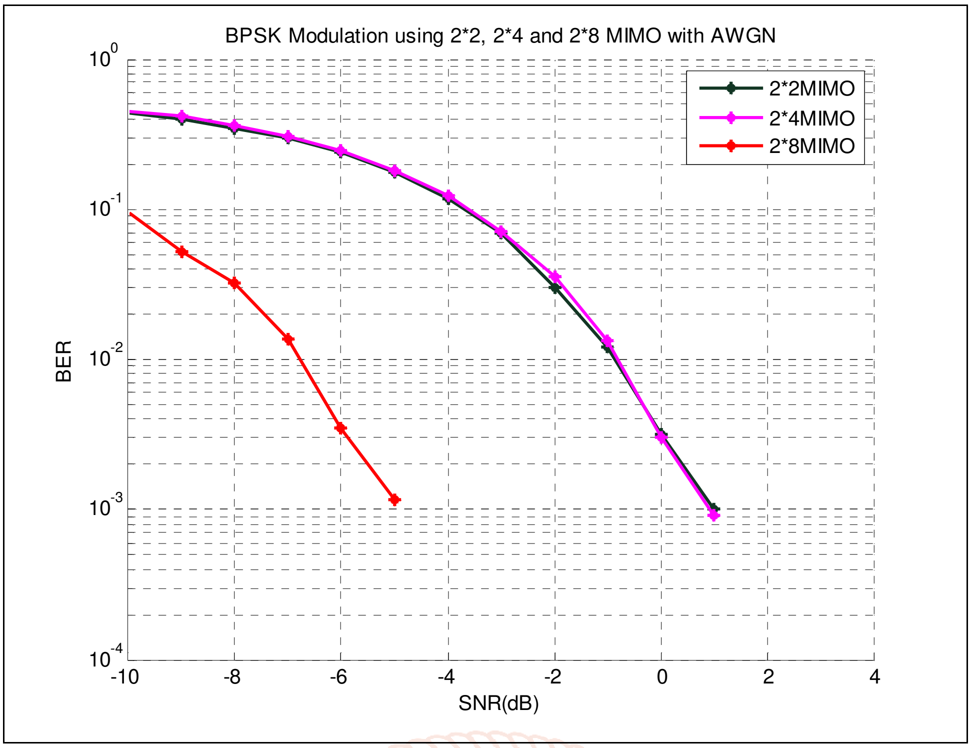

Fig. 6: Performance of BPSK Modulation using 2*2, 2*4 and 2*8 MIMO with AWGN

Result analysis: Figure 5. Shows the BER performance of different modulation scheme's such as BPSK, QPSK, 8-QAM and 16-QAM modulated for 2 ×4 MIMO-OFDM system under AWGN. At the target BER = 10^{-2} , the SNR have been received -1 dB, 1.00dB, 3.2dB and 10.4dB for BPSK, QPSK, 8-QAM and 16-QAM modulation scheme respectively. In Figure 6, shows BER performance of BPSK modulated 2 × 2, 2 × 4 and 2 × 8 MIMO-OFDM system under AWGN. At the target BER = 10^{-2}, the SNR have been received -5 dB, 0.5dB and 0.53dB for 2 × 2, 2 × 4 and 2 × 8 MIMO-OFDM system respectively.

7. CONCLUSION

The combination of MIMO transmission techniques with the OFDM waveform has brought an emerging technology to the wireless telecommunication field. In the last decade, MIMO-OFDM has drawn distinguished advances in terms of hardware and software innovations. The purpose of this work is to investigate a variable pilot aided channel estimate method in MIMO-OFDM system with many modulation modes Variable pilot patterns are suggested to estimate the transmitted OFDM symbols by allocating comb type pilot efficiently cycle across the frequency subcarriers.

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