Performance Evaluation of SISO/MISO WiMAX System Using Adaptive Modulation and Coding (Revised Version)


Abstract— WiMAX is considered as one of the most important technologies that can provide a broadband wireless access in metropolitan area and supports numerous multiple antenna choices that include space time block codes (STBC) where adaptive modulation and coding (AMC) is used. In this paper a new studies of performance analysis of SISO/MISO WiMAX systems under various type of fading are proposed. Initially the proposed study compares between the different types of fading and their effect on the transmitted signal. It also studies the effect of the AMC in SISO/MISO WiMAX systems and presents the effect of using orthogonal frequency division multiplexing (OFDM). A graphical user interface using different type of WiMAX modulation techniques will be designed. The results obtained indicate the possibility of switching the order of modulation and coding via the bit error rate and throughput.

Index Terms— 802.16d, AMC, BER, CP, IEEE Std, OFDM, PHY Layer, SISO, SNR, Space Time Block Codes, WiMAX.

1 INTRODUCTION

In electronics and telecommunications, modulation is the process of varying one or more properties of a high frequency periodic waveform, called the carrier signal, with a modulating signal which typically contains information to be transmitted [1]. This is done in a similar fashion to a musician modulating a tone (a periodic waveform) from a musical instrument by varying its volume, timing and pitch. The three key parameters of a periodic waveform are its amplitude (volume), its phase (timing) and its frequency (pitch). Any of these properties can be modified in accordance with a low frequency signal to obtain the modulated signal. Typically, a high frequency sinusoid waveform is used as carrier signal, but a square wave pulse train may also be used. In telecommunications, modulation is the process of conveying a message signal, for example a digital bit stream or an analog audio signal, inside another signal that can be physically transmitted. Modulation of a sine waveform is used to transform a baseband message signal into a passband signal, for example low frequency audio signal into a radio frequency (RF) signal. In radio communications, cable TV systems or the public switched telephone network (PSTN) for instance, electrical signals can only be transferred over a limited passband frequency spectrum, with specific (non zero) lower and upper cutoff frequencies. Modulating a sine wave carrier makes it possible to keep the frequency content of the transferred signal as close as possible to the centre frequency (typically the carrier frequency) of the passband. The modified can take multiple forms, such as analog modulation (AM, FM, PM, QAM, SM, SSB) digital modulation (ASK, FSK, PSK, CPM, MPSK, MSK, PPM, OOK, SC-FDE, DMTF, TCM) Spread spectrum (CSS, DSSS, FHSS, THSS) [2].

2 MATERIAL AND METHODS

In this work the MATLAB program is used in the simulation using the model of WiMAX system (IEEE 802.16d with and without time block codes (STBC)). To demonstrate the performance analysis of the considered system, the BER as a function of the SNR and the throughput were investigated. Further, a comparison between the theoretical and simulated case is also done. The adaptive modulation used the following modulation techniques for modulating and demodulating the signal: BPSK, QPSK, 16-QAM and 64 QAM with different coding rate. Different types of channel fading (frequency selective fading, frequency flat fading and no fading channels) were tested. All the plotting is done to evaluate the performance on the basis of BER Versus SNR and throughput versus time. Above mentioned parameters are chosen in order to make the scenario more practical. MATLAB is used as a comprehensive tool today and extensively used in research and development for communication system.

3 SIMULATION RESULTS

In the next sections, simulation results for the BER and throughput will be presented and discussed along with the underlying assumption for the single input single output and multi input single output (SISO/MISO) WiMAX systems using AMC [3], [4]. The different scenarios and channel models are considered in the simulations so that the fading case can be studied.

3.1 System GUI using AMC

In this work a GUI for the WiMAX using AMC has been designed. The simulation model for the GUI for the considered system was implemented in MATLAB. Fig. 1 shows the GUI for the different modulation schemes and coding rate used in the simulator of the WiMAX system.
3.2 BER Results for various type of modulation schemes

This section presented the BER vs. SNR plots for different modulation schemes and coding rates used in the simulation. Fig. 2 shows the BER curves using BPSK, QPSK 16 QAM and 64 QAM. It can be seen from Fig. 2 the lower modulation and coding scheme provides better performance with less SNR. BPSK give better result compared to 64 QAM. By setting threshold SNR, AMC can be used to achieve highest transmission speed with a target BER [5].

3.3 Theoretical and Simulated BER Results

The theoretical and simulated BER performance are considered in this section. Fig. 3 shows the comparison of the theoretical and simulated BER performance using BPSK, QPSK 16 QAM and 64 QAM. It can be seen from the results that the simulated BER results are approximately matched the theoretical results.

3.4 BER results of the OFDM system using different types of modulation

In this section, the performance of BER versus SNR is discussed for the OFDM system [6], [7] using BPSK, QPSK 16 QAM and 64 QAM. The result obtained in this case is shown in Fig. 4. From Fig. 2 and Fig. 4 it can be seen that the BER result for OFDM system is approximately matched the theoretical result.

4 PERFORMANCE RESULTS OF THE WiMAX SYSTEM

The overall system performance in terms of BER versus SNR is discussed in this section for several channel type (AWGN and fading channel) and using different modulation techniques.

4.1 Performance Result in AWGN Channel

The considered system was first tested in AWGN channel environment. The result obtained in this case is depicted in Fig. 5. From Fig. 2 and Fig. 5 it can be seen that the BER result for considered system is approximately matched the theoretical BPSK result.
frequency selective fading is worst BER results and the best BER results was obtained in the absence of channel fading.

4.2 Performance Results in Fading Channel
Second, the considered system was tested in the presence of different types of channel fading (frequency selective fading, frequency flat fading and no fading channels). The BER results for the considered cases for different values of the SNR are considered in this section. Fig. 7 shows the BER performance versus SNR for various type of channel fading. From these results it can be seen that the BER results in the presence of the

4.3 Results of SISO – WiMAX System
In the next sections, simulation results will be presented when using both single antennas at the transmitter and receivers sides (SISO) and multiple antennas at the transmitter side and single antenna at the receiver side (MISO) at the transmitter side i.e. (SISO/MISO) WiMAX systems [8], [9]. This section discuss the throughput result for the considered system (SISO – WiMAX system) using AMC. The throughput curve versus time is shown in Fig. 8.

Next, the results show the effect of applying AMC in the considered system in the presence of fading channel [10], [11]. Fig. 9 shows the BER results versus SNR for SISO – WiMAX sys-
tem using different modulation schemes and coding rates in the considered system in the presence of channel fading.

4.4 Results of MIMO – WiMAX System

Next, the above experiments are repeated again for MISO – WiMAX system. The BER performance for the MISO – WiMAX system using different modulation schemes and coding rates in the presence of fading channel is shown in Fig. 10. Fig. 10 shows the BER results versus SNR for MISO – WiMAX system using different modulation schemes and coding rates in the considered system in the presence of channel fading. From the results, in the particular case of the BPSK signal, the SISO system actually performed better than the MISO system.

4.5 Results of SISO – WiMAX System Without Fading

Fig. 11 shows the BER results versus SNR for SISO – WiMAX system using different modulation schemes and coding rates in the considered system in the absence of fading. From these results it can be shown that the considered systems in the absence of fading were performed better compared to the case of presence of fading. Moreover, the SISO system showed very little improvement when compared to MISO system.

5 CONCLUSION

In this paper the adaptive modulation and coding for a SISO/MISO – WiMAX system have been carried out. The main contribution of this work are the design of a GUI for the
proposed system using different type of the modulation techniques, shows the effect of different types of fading on the transmitted signal and study in details the effect of the AMC in the considered systems. The BER and throughput curves were used to compare the performance of different order of modulation and coding rate. The effect of channel fading and no channel fading were also evaluated in the form of BER. The results show that the best BER results were obtained in the absence of channel fading. Performance results present the effect of modulation and coding rate show that for the case of BPSK signal, the SISO system performed better than the MISO system. In general, the proposed systems using BPSK modulation technique under different channel conditions provides satisfactory performance among the six considered modulations. The concept of modification depends on dealing with users who are close to the station by the high order of modulation and coding rate.

REFERENCES


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