A SURVEY ON PHYSICAL LAYER PERFORMANCE OF MIMO-WIMAX

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ABSTRACT: The IEEE 802.16 WiMAX standard for BWA (Broadband Wireless Access) was designed to offer end users high transmission data rates across wider regions. Wireless communication requires MIMO systems because they enable data to be sent and received through multiple antennas. This study examines how the MIMO-WiMAX physical layer performs while using different modulation techniques and channel coding approaches for multipath fading channels. To enhance the BER performance of WiMAX systems, the Alamouti Space Time Block Code method for MIMO is being investigated.

Keywords: MIMO, OFDM, STBC, WiMAX.

I. INTRODUCTION:

WLANs and wireless wide area networks (WANs) are separated by the Wireless MAN (WAN) technology called WiMAX (Worldwide Interoperability for Microwave Access). It enables internet connectivity across a distance of up to 30 miles (50 Km) at 75 megabits per second (Mbps). The IEEE 802.16d standard for fixed wireless access i.e., Fixed WiMAX, and IEEE 802.16e standard which supports mobility for mobile applications is called Mobile WiMAX. Based on OFDM (orthogonal frequency division multiplexing), IEEE 802.16e defines WiMAX as an air interface standard. OFDM is a multicarrier method where the frequency of the carrier is divided into multiple subcarriers to transmit a different stream of bits, used to lower ICI (Inter Carrier Interference) and ISI (Inter Symbol Interference). WiMAX consists of multiple physical layers and Medium Access Control options (MAC).

MIMO technique increases data transmission throughput and connection range significantly without requiring extra bandwidth or transmission power. It contains various approaches to provide both diversity and multiplexing gain. Increasing performance by using several antennas at both ends (transmitter as well as receiver).

II. LITERATURE SURVEY

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1. WIMAX

WiMAX is the term provided by the WiMAX Forum. WiMAX solves the difficulties that exist in conventional broadband connectivity by offering improved services to customers. It works on a frequency ranging from 2 to 11GHz in non-line-of-sight (NLOS) regions and 10-66GHz in LOS (line-of-sight) regions.

HOW WIMAX WORKS

WiMAX is similar to Wi-Fi but works at higher speeds over larger distances. The range of Wi-Fi is about 30m whereas the WiMAX range is up to 50km. Two parts comprise a WiMAX system:

A single WiMAX tower may cover a wider area as 3,000 square miles and operates similarly to a mobile phone tower (8,000 square kilometers). Its receiver could be a standalone box or wireless access like Wi-Fi[1]. A WiMAX Tower links directly to a receiver through broadband access. It can communicate with another WiMAX tower through a wired connection via a LOS microwave link. Similar to Wi-Fi, WiMAX relies on radio waves to transmit data from one computer to another.

2. MODULATION TECHNIQUES

The IEEE 802.16 PHY consists primarily of three standards, each of which is suited to a distinct operating context [1]. The Wireless MAN-SC PHY is proposed for frequencies ranging from 10 to 66 GHz, where SC stands for single-carrier modulation. Raw data rates may reach 120Mb/s with a channel bandwidth of generally 25MHz or 28MHz. Two options have been specified for the frequency range below 11GHz i.e., Wireless MAN-OFDMA and Wireless MAN-OFDM. This frequency range has a rather long wavelength i.e., a Non-LOS (NLOS). Flaws like multipath propagation and fading are thus more prevalent in both of these standards.

The subcarriers of OFDM are selected to be orthogonal to one another throughout the symbol period, preventing inter-carrier interference, and making it a more effective form of multicarrier modulation. The WiMAX physical layer is based on OFDM modulation and is designed for NLOS operation in frequency ranges below 11GHz for licensed bands [2]. In the frequency domain, an OFDM symbol has 256 subcarriers. It has excellent spectral efficiency, is resistant to multipath propagation issues, and minimizes receiver complexity.

OFDM offers parallel data streams and MIMO capabilities in the downlink. Sizes of 128, 512, 1024, and 2048 bits are available for the FFT (fast Fourier transform). 16-QAM, 64-QAM, and QPSK modulations are supported by OFDM. By giving each receiver a share of the carriers, this air interface enables multiple access [3].

The null, pilot, and data carriers are included in OFDM symbols: Data carriers are used for data transmission. To estimate the channel, the receiver uses the phase and amplitude of the pilot carriers, which are known to it. Null carriers are used to prevent energy from leaking into adjacent channels [4].

3. FORWARD ERROR CORRECTION CODE

Error-correcting coding is crucial for lowering the bit error rate, and modulation techniques increase spectral efficiency to obtain a greater transmission data rate [5]. Higher data speeds and a low bit error rate are essential for reliable communication in mobile communication applications.

FEC is a technique used in digital signal processing to improve data integrity. This is achieved by including redundant bits just before transmitting or storing data. FEC enables the receiver to rectify mistakes without the need for a reverse channel to request data resend. FEC (Forward Error Correction) codes may identify and correct a small number of errors in the data stream without retransmitting the entire stream. Block codes like the Reed-Solomon code and Convolutional codes are two types of FEC methods. The Viterbi algorithm is a convolutional code decoding technique.
Reed-Solomon error correction is a coding method in which a polynomial is constructed from the data symbols and then an oversampled polynomial is sent in place of the data symbols [6]. Convolutional codes are effective in the correction of random errors. Convolution codes provide an alternative to block codes for error control coding. These codes are widely employed to ensure reliable data transmission in a variety of applications like radio, digital video, satellite communication, as well as mobile communication [6]. Convolutional coding involves the combining of some predetermined number of input bits. Input bits are held in a shift register of fixed length, and mod-2 adders are utilized to add them together.

4. MIMO-WIMAX SYSTEMS

MIMO transmission is a highly efficient spectrum-saving technique that employs multiple antennas at both ends. MIMO stands for multiple input-multiple outputs, and it refers to a system using multiple antennas. MIMO technology uses multiple signals (both sent into and received from the wireless channel) to improve the efficiency of the wireless channel. Spatial diversity, Spatial Multiplexing (SM), and beamforming techniques are three types of MIMO techniques that are ideal for WiMAX because it supports a wide range of smart antenna technologies [7]. The combination of WiMAX with MIMO technology provides an alternative for future broadband wireless systems that demand dependable, efficient, and high-rate data transfer. When compared to basic WiMAX, MIMO systems in WiMAX have superior BER performance [8].

Multiple signals of the same kind are sent out using a diversity approach, and the finest of the received signals is chosen using space-time block codes [4]. These methods are utilized to lessen the effects of multipath fading and enhance transmission reliability without reducing bandwidth or adding extra power. When several pathways are used to connect the transmitter and receiver antennas, the BER of the communication system is increased.

5. MULTIPATH FADING CHANNELS

When communicating over a wireless channel, the signals emitted by the base station can't reach directly to the mobile user. The environment has several obstacles that inhibit the LOS (line-of-sight) path. Multiple reflections along the path of a signal from its source to its destination cause considerable amplitude and phase changes in the received signal [9]. Statistics such as Rayleigh fading and Rician fading are used to illustrate the impact of the propagation conditions on a radio signal. When there is no direct LOS between the sender and the receiver, Rayleigh fading is often used. The received multipath signals are of about the same intensity in Rayleigh fading. Rician fading is used when there is a strong dominating element, generally LOS, coupled with additional multipath NLOS signal components [10].

III. CONCLUSIONS

Day by day, new applications and network scenarios are being created for 802.16 WiMAX technologies as a result of the technology's rise. The BER (Bit-Error Rate) of the OFDM physical layer under various modulation techniques and channel circumstances must be studied to evaluate the performance of WiMAX 802.16 technology. Various modulation techniques such as BPSK, QPSK, QAM 16, and QAM 64 is studied as part of the performance analysis of the WiMAX system under various application generating high load data traffic. WiMAX uses MIMO systems for multiple CC code rates and modulations to improve BER performance.
REFERENCES


