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Survey Paper on Performance Evaluation of 4G and 5G System using Space Time Block Coding Technique

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Abstract— In this paper, the review of the multiple input multiple output using space time block code on IEEE 802.16 system. The Worldwide Interoperability for Microwaves Access technology which can offer high speed voice, image, and video and data service up to base on standard 802-16 wireless MAN is configured in the same way as a traditional cellular network. The range of WiMAX makes the system very attractive for users, but there will be slightly higher BER at low SNR. In this paper the study of different types of 4G and 5G technique and explain the advantage and disadvantage of the system.

Keywords: - WiMAX, OFDM, Rayleigh Channel, MIMO-OFDM, BER

I. INTRODUCTION

The growth in the use of the information networks lead to the need for new communication networks with higher data rates. The telecommunication industry is also going to change, with a demand for a greater range of services, such as video conferences, or applications with multimedia contents, wireless communication has permeated nearly all acts of human life.

WiMAX (Worldwide Interoperability for Microwave Access) is a 4G technology and wireless communications standard designed to provide 28to 40 megabit-per-second data rates. Error free transmission is one of the main aims in wireless communications. With the increase in multimedia applications, large amount of data is being transmitted over wireless communications. This requires error free transmission more than ever and to achieve error free transmission multiple antennas can be implemented on both stations i.e. base station and user terminal with proper modulation scheme and coding technique. The 4th generation of wireless communications can be attained by Multiple-Input Multiple-Output (MIMO) in combination with Orthogonal Frequency Division Multiplexing (OFDM) [1].MIMO multiplexing (spatial multiplexing) and diversity (space time coding) having OFDM modulation scheme are the main areas of focus in our thesis study. MIMO multiplexing increases a network capacity by splitting a high signal rate into multiple lower rate streams. MIMO allows higher throughput, diversity gain and interference reduction. It also fulfills the requirement by offering high Alamouti Space Time Block Code (STBC) scheme is used with orthogonal designs over multiple antennas which showed simulated results are identical to expected theoretical results. With this technique both Bit Error Rate (BER) and maximum diversity gain are achieved by increasing number of antennas on either side. This scheme is efficient in all the applications where system capacity is limited by multipath fading [2].

Because of the characteristics of WiMAX system itself, and the problems of OFDM system which is sensitive to the timing and the frequency compensation. The OFDM system of the WiMAX adopts abruptly deliver mode, reliability, good efficiency and High data rate is achieved between the transmitter and the receiver if they are ideally synchronized.

Table 1: Key Characteristics of WiMAX (IEEE 802.16) Standard [3]

Characteristic	Description
Physical layer	Direct Sequence Spread Spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS), Orthogonal Frequency Division Multiplexing (OFDM).
Standard	802.16e
Frequency band s	2.4 GHz, 3.5GHz, 5GHz
Topology	Mesh,
Modulation scheme	BPSK, QPSK,QAM
Data rates	5.5 to 70 Mbps

However, there usually exists a small timing and frequency offset whose exists will dramatically degrade the performance of the whole OFDM systems. Hence, before signals can be demodulated, OFDM symbols have to be time-synchronized and carrier frequency offset compensated. This puts forward very high request to the mode piece of the synchronization system. In order to realize the synchronization, it must adopt synchronization algorithm of smaller calculation quantity. In the meantime, it should have higher examination of the first moment. Characteristics of WiMAX simulation model as shown in Table I.

- Features of WiMAX [3]
- Interoperability**:** The IEEE 802.16 standard is internationally accepted and the standard is maintained and certified by WiMAX forum covers fixed, portable and mobile deployments.
- Long Range: It covers up to 30 miles but in practice, it covers only 6 miles.
- QoS: QoS of WiMAX media access control (MAC) is designed to support a large number of users, with multiple connections per terminal.
- Mobility**:** WiMAX offers immense mobility especially IEEE 802.16e-2005.

This paper is organized as follows: In section II, the orthogonal frequency division multiplexing system and peak average peak ratio is formulated. Multiple input multiple outputs OFDM system is introduced in section III. In section IV discuss about IEEE 802.16 reference model. In section V explain the space time block code and simulation result. Finally, the conclusions are given in section VI.

II. LITERATURE REVIEW

Akhilesh Venkatasubramanian et al. [1], the information rates of remote correspondence frameworks working in a recurrence specific foundation can be enhanced by utilizing Multiple-Input Multiple-Output (MIMO) in relationship with Orthogonal Frequency Division Multiplexing (OFDM). The inadequacies of Code Division Multiple Access (CDMA) can be overwhelmed by utilizing Interleave Division Multiple Access (IDMA) which is effectively incorporated into MIMO frameworks. IDMA joined with OFDM can be utilized to execute recurrence particular channels. In this paper we diagram the fundamental standards of an OFDM-IDMA transmitter and collector took after by reenactment results to think about the productivity of actualizing OFDM-IDMA. The execution of our collector is characterized by the reproduction aftereffects of the vitality per bit to clamor control ghostly thickness proportion (Eb/N0) and Bit Error Rate (BER). An emotional diminishing in BER is accomplished by utilizing the channel translating and channel estimation strategies proposed. It is discovered that the OFDM-IDMA framework is more compelling than simply utilizing IDMA or OFDM-CDMA. Along these lines the entire research is to attempt and actualize a system that ends up being to a great degree successful over the effectively existing strategies.

R. Prasad et al. [2], the motivation reaction of remote channels between the Nt transmit and Nr get recieving wires of a MIMO-OFDM framework are gather roughly inadequate (ga-meager), i.e., the Nt Nr channels have few huge ways in respect to the channel postpone spread and the time-slacks of the huge ways amongst transmit and get reception apparatus sets concur. Regularly, remote channels are likewise aggregate roughly bunch scanty (gac-meager), i.e., each ga-inadequate channel comprises of groups, where a couple of bunches have every single solid segment while most bunches have every single powerless segment. In this paper, we cast the issue of assessing the ga-meager and gac-scanty square blurring and time-differing diverts in the inadequate Bayesian learning (SBL) structure and propose a bundle of novel calculations for pilot-based channel estimation, and joint channel estimation and information discovery, in MIMO-OFDM frameworks. The proposed calculations are fit for assessing the meager remote channels notwithstanding when the estimation network is just halfway known. Further, we utilize a first-arrange autoregressive displaying of the worldly variety of the ga-scanty and gac-inadequate channels and propose a recursive Kalman separating and smoothing (KFS) system for joint channel estimation, following, and information recognition. We likewise propose novel, parallel-usage based, low-intricacy strategies for assessing gac-inadequate channels. Monte Carlo reenactments represent the advantage of abusing the gac-scanty structure in the remote divert regarding the mean square mistake (MSE) and coded bit blunder rate (BER) execution.

R. Prasad et al. [3], It is notable that the motivation reaction of a wideband remote channel is roughly scanty, as in it has few huge parts in respect to the channel postpone spread. In this paper, we think about the estimation of the obscure channel coefficients and its help in OFDM frameworks utilizing a meager Bayesian learning (SBL) structure for correct deduction. In a semi static, square blurring situation, we utilize the SBL calculation for channel estimation and propose a joint SBL (J-SBL) and a low-many-sided quality recursive J-SBL calculation for joint channel estimation and information location. In a period changing situation, we utilize a first-arrange autoregressive model for the remote channel and propose a novel, recursive, low-multifaceted nature Kalman sifting based SBL (KSBL) calculation for channel estimation. We sum up the KSBL calculation to acquire the recursive joint KSBL calculation that performs joint channel estimation and information location. Our calculations can productively recuperate a gathering of around inadequate vectors notwithstanding when the estimation framework is incompletely obscure because of the nearness of obscure information images. Additionally, the calculations can completely abuse the relationship structure in the numerous estimations. Monte Carlo reproductions represent the viability of the proposed methods regarding the mean-square blunder and bit mistake rate execution.

Mel Li et al. [4], in this paper, we will examine the Least Mean Square (LMS) and Recursive Least Square (RLS) calculations. At that point, we apply these two calculations to a Multiple-input Multiple-output (MIMO-OFDM) framework in light of Space-Time Block Coding (STBC), and do a few reproductions on these two calculations. From the reproduction, it is discovered that the merging pace of the RLS calculation is quicker than LMS calculation, i.e., the execution of RLS is superior to LMS calculation.

Muhammet Nuri Seyman et al. [5], some of peak average peak ratio (PAPR) discount techniques were proposed for multiple-input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) structures; but, maximum of them contain very high computational complexity and are not applicable to MIMO-OFDM systems with area frequency block coding (SFBC). on this paper, we suggest a low-complexity PAPR reduction scheme for SFBC MIMO-OFDM systems, in which the enter series is accelerated by a hard and fast of segment rotation vectors respectively after which each resulting sequence is decomposed into numerous sub-sequences based totally at the linear belongings of SFBC. After computing the inverse fast Fourier transform (IFFT) to convert each frequency-domain sub-collection into a time-domain signal, we carry out equal SFBC encoding operations in the time area for producing candidate signal units, wherein the only with the bottom maximum PAPR is chosen for transmission. With the proposed scheme, we can generate a huge wide variety of candidate signal sets by means of computing only some IFFTs. In comparison to preceding related schemes, the proposed one achieves comparable PAPR reduction overall performance with much decrease computational complexity.

Biswajit Sahoo et al. [6], they employed a broadband orthogonal frequency division multiplexing (OFDM) signal to increase the frequency diversity of the system as different scattering centers of a target resonate variably at different frequencies. They have resolved and exploited die multipath components with short pulse, multi-carrier wideband radar signals. Therefore, for both OFDM and CE-OFDM measurement models, they assumed that the clutter and noise are temporally white and circularly symmetric zero means complex Gaussian process with unknown covariance's. In this paper, the problem of detecting a moving target by exploiting multipath reflections is addressed. In they have developed the measurement model accounting for only a finite number of specular multipath reflections.

Li Mei et al. [7], they proposed a scheme to obtain an aggregate form of sensor data with precision guarantees. The precision constraint is partitioned and allocated to individual sensor nodes in a coordinated fashion. They develop a candidate-based method for precision allocation and prove its optimality for single-hop networks. The key idea is to let each sensor node estimate and report to the base station tire normalized energy consumption rates for several candidate error bounds based on historical sensor readings. The purpose of precision allocation is to differentiate the quality of data collected from different sensor nodes, thereby balancing their energy consumption.

Mukesh Patidar et al. [8], using experiment results they verify that energy efficiency of wireless sensor network is enhanced by parallel particle swarm optimization, dynamic awakening approach and sensor node selection. In, the dynamic energy management mechanism is particularly exploited for target tracking applications. Stationary sensor nodes are clustered first, and each cluster is related to a specified coverage task for part of the sensing field. These mobile sensor nodes are regarded as stationary sensor nodes. They obtained the cluster centroids and boundary curves. In, the PPSO is implemented by cluster heads to maximize coverage area and minimize communication energy in each cluster.

III. ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING

The OFDM (Orthogonal Frequency Division Multiplexing) is a wide band wireless digital communication technique that is based on block modulation, with the wireless multimedia application becoming more and more popular, the required bit rate are achieved due to OFDM multicarrier transmission for video communication, very high bit rate/high-speed communication is required.

OFDM has been popularly standardized in many applications such as high performance wireless LAN, IEEE 802.11 (Wi-Fi), in Asynchronous Digital Subscriber Line (ADSL) and in power line communication. It uses in military application. It has great importance in wireless internet service. It used in WiBRO and WiMAX services [5].

$$\tilde{S} = x(t) + jy(t) \quad (1)$$

$$= \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} A_k e^{j2\pi({k}/{T_S})t} \quad (2)$$

Where A_k is the complex data of the k_{th} subcarriers and T is the OFDM symbol period [6]. Low let us discuss some advantages of OFDM: It has maximum spectral efficiency according to Nyquist rate. It controls overlapping of bands in channels. Its implementation technique is easier because it uses IFFTs. It has perfect synchronization of transmitter and receiver. It is well suited for high bit rate applications. In OFDM system timing recovery is very straight forward. In this system effects of delay spread can be easily compensated using cyclic prefix. It uses efficient bandwidth range.

OFDM also has some disadvantages. The main disadvantage of multicarrier modulation is that it exhibits a high peak to average power ratio. Because of high PAPR two problems occur which are: Problem 1- It increased the complexity of A/D and D/A converters and problem 2– It reduced the efficiency of RF power amplifier .The other disadvantages are OFDM system is very sensitive for frequency errors, it causes carrier offset problem. It needed higher input back off factor before the peaks in the signal experience significant distortion.

The PAPR of the discrete time base band OFDM signal is defined as the ratio of the maximum peak power divided by the average power of the OFDM signal [6].

$$PAPR(a_n) = \frac{\max|a_n^2|}{P_{av}(a_n)} ....(3)$$

$$P_{av}(a_n) = \frac{1}{N}\sum_{n=0}^{N-1} E\{|a_n^2|\} ....(4)$$

Where E {.} denotes the expected value.
The PAPR (in dB) of the OFDM signal can be defined as

$$PAPR = 10\log_{10}\{\frac{P_{peak}}{P_{avg}}\} ....(5)$$

Where, is the average power consumed by each frame, and is the maximum of power for one OFDM frame. When BPSK modulation is used on each sub carrier, binary block coding can be directly implemented before modulation. If the power in each sub carrier is normalized to 1 W, is *N* W.

IV. MIMO-OFDM

Multiple-Input Multiple-Output uses multiple antennas at both sides which provides transmit diversity and receiver diversity. It's applicable in every kind of networks like PAN, LAN, WLAN, WAN, MAN. MIMO system can be applied in different ways to receive either a diversity gain, capacity gain or to overcome signal fading.

The quality of a wireless link can be described by three basic parameters, namely the transmission rate, the transmission range and the transmission reliability. Conventionally, the transmission rate may be increased by reducing the transmission range and reliability. By contrast, the transmission range may be extended at the cost of a lower transmission rate and reliability, while the transmission reliability may be improved by reducing the transmission rate and range. However, with the advent of MIMO assisted OFDM systems, the above-mentioned three parameters may be simultaneously improved. Initial field tests of broadband wireless MIMO-OFDM communication systems have shown that an increased capacity, coverage and reliability achievable with the aid of MIMO techniques.

Furthermore, although MIMOs can potentially be combined with any modulation or multiple access technique, recent research suggests that the implementation of MIMO aided OFDM is more efficient, as a benefit of the straight forward matrix algebra invoked for processing the MIMO OFDM signals. MIMO OFDM, which is claimed to be invented by Airgo Networks, has formed the foundation of all candidate standards proposed for IEEE 802.11n. In recent years, this topic has attracted substantial research efforts, addressing numerous aspects, such as system capacity, space/time/frequency coding, Peak-to- Average Power Ratio (PAPR) control, channel estimation, receiver design, etc. Recently, Paulraj et al. and Stuber et *al* provided compelling overviews of MIMO-OFDM Communications. Furthermore, Nortel Networks has developed a MIMO OFDM prototype, which demonstrates the superiority of MIMO OFDM over today's networks in terms of the achievable data rate.

V. IEEE 802.16 REFERENCE MODEL

In figure 1, there are four types of sub layer are used in IEEE 802.16 reference model.

- Convergence Sub layer (CS)
- MAC common part sub layer
- Security sub layer
- Physical sub layer

In convergence sub layer classification of the higher-layer protocol PDU into the appropriate connection- Suppression of payload header Information- Delivery of the resulting CS PDU to the MAC SAP associated with the service flow for transport to the peer MAC SAP- Receipt of the CS PDU from the peer MAC SAP- Rebuilding of any suppressed pay load header information [7]. MAC common part sub layer (MAC CPS) classification of the system access- Bandwidth request/allocation- Connection establishment/maintenance- Quality of service - Power saving mechanisms and handover mechanism Security sub layer classification of the authentication- Secure key exchange and encryption.

There must be a control of Peak to Average Power Ratio (PAPR) in wireless environment. The Mobile WiMAX must be working on a licensed bands rather than unlicensed bands. The main purpose of this standard was to provide platform for interoperability between vendors. WiMAX forum works similarly to Wi-Fi forum which provide standard to business organizations and manufacturers to recommend standards of equipment interoperability.

VI. CONCLUSION

WiMAX-OFDM in the 3.5 GHz band is of practical interest due to the potential for large-scale WiMAX deployment Communication system can operate with a lower transmit power, transmit over longer distances, tolerate more interference, use smaller antennas and transmit at a higher data rate. These properties make the code energy efficient. Hence, new codes were sought that would allow for easier decoding and encoding. The task of the decoder and encoder easier is using a code with mostly high-weight code words.

Error detection and correction techniques are essential for reliable communication over a noisy channel.

Hence, MRC schemes provide very good Sresults; this is also an agreement with theoretical results. However, in MRC scheme, to receive better signal quality more than two receivers may require. To counteract this Alamouti proposed a scheme in which more than one transmitter can be used to transmit signals, as signal generated from these antenna's will travel different path, hence may provide better quality signal at the receiver. As this scheme is somewhat compromising scheme, therefore results may not be up to the level of MRC. However, this scheme is very simple and has potential to combat with fading of the channel.

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