A Brief Survey on MIMO LTE Wireless System

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Abstract - OFDM is a multi-carrier modulation conspires that encodes information onto a Radio Frequency (RF) signal. Unlike regular single carrier modulation plans, for example, AM/FM (sufficiency or recurrence modulation)that impart just each sign in turn utilizing one radio recurrence, OFDM imparts various rapid signs simultaneously on uncommonly figured, symmetrical carrier frequencies. The outcome is significantly more proficient utilization of transfer speed just as powerful communications during commotion and different impedances. OFDM is modulation technique known for its capacity to relieve multipath. In OFDM the rapid information stream is partitioned into R narrowband information streams, R relating to the subcarriers or subchannels for example one OFDM image comprises of R images adjusted by Quadrature Amplitude Modulation (QAM) or Phase Shift Keying (PSK)Most of the progressing research endeavors in helpful variety expect recurrence level channels with immaculate channel information. Notwithstanding, in down to earth situations, for example broadband remote organizations, these suspicions don't matter. Recurrence specific blurring and blemished channel information ought to be considered as a more reasonable channel model.

Keywords – MIMO, Wireless Communication, LTE, OFDM.

I. INTRODUCTION

1.1 BACKGROUND AND GENERAL OVERVIEW

The demand for high speed and widespread network access in mobile communications increases everyday as the number of users' increases and applications are constantly developed with greater demand for network resources[1]. As a result of this trend, mobile communications has experienced significant developments within the last two decades which is the result of tremendous research that have been carried out.

The 3GPP Long Term Evolution (LTE) is the framework that denotes the transformative move from third era of versatile communication (UMTS) to fourth era portable innovation. The principal deal with LTE started in discharge 7 of the 3GPP UMTS particulars including the fulfillment of its plausibility considers. This delivery likewise remembered further enhancements for High Speed Packet Access (HSPA). Determination of LTE and SAE (System Architecture Evolution) comprises the primary work done in discharge 8 of the 3GPP UMTS specifications[1,2]. As at the hour of composing, work is as of now in progress for the improvement of LTE which is highlighted in discharge 10 of the 3GPP Universal Mobile Telecommunications System (UMTS) particulars and named LTE-Advanced (LTE-A). An extensive synopsis of the transformative pattern of the 3GPP[3]

1.2 OFDM

OFDM is a multi-carrier modulation conspire that encodes information onto a Radio Frequency (RF) signal. Dissimilar to regular single carrier modulation plans, for example, AM/FM (adequacy or recurrence modulation)that impart just each sign in turn utilizing one radio recurrence, OFDM imparts different fast signs simultaneously on uncommonly processed, symmetrical carrier frequencies. The outcome is considerably more productive utilization of transmission capacity just as powerful communications during commotion and other interferences[3,4].

OFDM is modulation method known for its capability to mitigate multipath. In OFDM the high speed data stream is divided into R narrowband data streams, R corresponding to the subcarriers or subchannels i.e. one OFDM symbol consists of R symbols modulated by Quadrature Amplitude Modulation (QAM) or Phase Shift Keying (PSK). As a result the symbol duration is R times longer than in a single carrier system with the same symbol rate. The symbol duration is made even longer by adding a cyclic prefix to each symbol. As long as the cyclic prefix is longer than the channel delay spread, OFDM offers Inter Symbol Interference (ISI) free transmission[3,4].

1.2.1 There exist several communication transmission models as follows

1. Single Input and Single Output (SISO) system: It is uses only one antenna both at the transmitter and receiver.
2. Single Input and Multiple Output (SIMO) system: It uses a single transmitting antenna and multiple receiving antennas.
3. Multiple Input and Single Output (MISO) system: It has multiple transmitting antennas and one receiving antenna.
4. Multiple Input Multiple Output (MIMO) system: It uses multiple antennas both for transmission and reception. Multiple transmitting and receiving antennas will achieve antenna diversity without reducing the spectral efficiency.

The utilization of different reception apparatuses at the transmitter and collector in remote frameworks, prominently known as MIMO innovation, has quickly picked up in ubiquity over the previous decade because of its incredible execution improving abilities. Communication in remote channels is weakened overwhelmingly by multipath blurring. Multipath is the appearance of the communicated signal at a proposed collector through contrasting points or potentially varying time delays as well as varying recurrence (i.e., Doppler) moves because of the dispersing of electromagnetic waves in the climate. Subsequently, the got signal force vacillates in space (because of point spread) or potentially recurrence (because of postpone spread) as well as time (because of Doppler spread) through the irregular superposition of the impinging multipath components[3,4]. This arbitrary variance in signal level, known as blurring, can seriously influence the quality and dependability of remote communication. Also, the requirements presented by restricted force and scant recurrence transmission capacity make the assignment of planning high information rate, high dependability remote communication frameworks very testing.

MIMO innovation comprises a forward leap in remote communication framework plan. The innovation offers various advantages that help address the difficulties presented by both the impedances in the remote channel just as asset imperatives. Notwithstanding the time and recurrence measurements that are misused in traditional single radio wire remote frameworks, the influences of MIMO are acknowledged by abusing the spatial measurement (gave by the various reception apparatuses at the transmitter and the beneficiary). The advantages of MIMO innovation assists with accomplishing noteworthy execution increases, for example, cluster increase, spatial variety increase, spatial multiplexing addition and obstruction reduction[5,6]

1.3 WIRELESS MIMO-OFDM SYSTEM

High information rate and solid dependability in remote communication frameworks are turning into the prevailing variables for an effective misuse of business organizations.

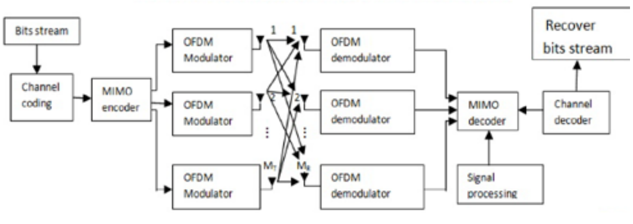

Figure 1.1 A MIMO OFDM System.

MIMO-OFDM, another remote broadband innovation, has increased extraordinary ubiquity for its ability of high rate transmission and its vigor against multipath blurring and other channel hindrances. In an OFDM framework, the transmitter balances the message bit succession into PSK/QAM images, performs IFFT on the images to change over them into time area signals, and sends them out through a remote channel.

The got signal is generally twisted by the channel attributes. So as to recuperate the sent pieces, the channel impact must be assessed and repaid in the collector (Cimini 1985), (Tufvesson and Maseng 1997), (Van de Beek et al 1995). Each subcarrier can be viewed as a free channel, as long as no ICI (Inter Carrier Interference) happens, and in this manner saving the symmetry among subcarriers. The symmetry permits each subcarrier segment of the got signal to be communicated as the result of the sent signal and channel recurrence reaction at the subcarrier. Accordingly, the sent signal can be recuperated by assessing the channel reaction exactly at each subcarrier. All in all, the channel can be assessed by utilizing a preface or pilot tones known to both transmitter and collector, which utilize different interjection strategies to gauge the channel reaction of the subcarriers between pilot tones. So as to pick the channel assessment strategy for the OFDM framework viable, various parts of usage, including the necessary exhibition, computational intricacy and time variety of the channel must be taken into account.[7,8].

1.4 OVERVIEW OF LTE SYSTEMS

We start by a brief description of the high level overall LTE system architecture, which consists of two parts; namely the radio and core network parts as shown in Figure 1.2. Since our main work in this thesis is related to the performance of the LTE physical layer, we will detail, more specifically, the physical layer of the radio part of LTE system[7,8]. Due to its significant importance and relevance in our analysis and evaluation, one section is dedicated to the frame structure of the physical layer in which we explain how the data is organized in the time and frequency domains as well as how the data is transmitted over the air. Finally, we conclude the chapter by presenting the MIMO-OFDM schemes as defined in LTE which are relevant to our study to understand the general structure of 4G (also called Evolved 3G) wireless communications systems, it is primordial to know its overall network architecture as well as the functionalities of each element. As any other wireless communications network, the 4G system consists of two main parts, namely the core network part and the radio part. The core side of the network is called System Architecture Evolution (SAE) and the radio part is known as Long Term Evolution (LTE). The term LTE encompasses the Evolved Universal Terrestrial Radio Access Network (E-UTRAN) and represents the radio access network. The description of each part will be presented separately in the following subsections

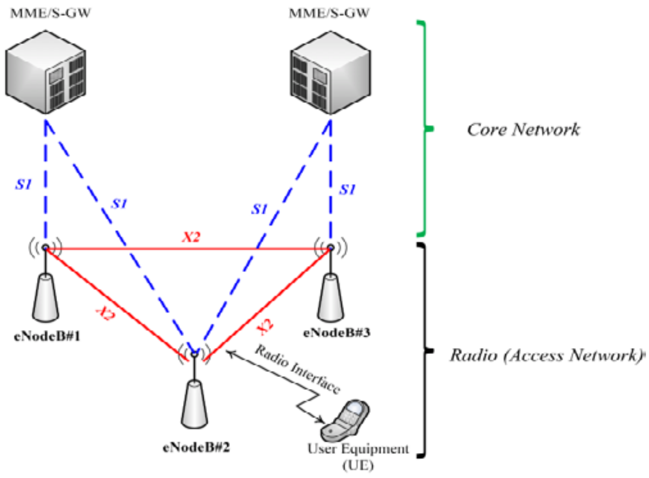

Figure 1.2 LTE System Architecture.

II. SYSTEM MODEL

2.1 INTRODUCTION

The main role of the LTE physical layer is to translate data into reliable signal for transmission across a radio interface between the eNodeB (enhanced NodeB) and the user equipment. It involves basic modulation, protection against transmission errors (using cyclic redundancy checks), multiplexing schemes as well as the antenna technology that are utilized. Multiplexing is a technique for sending multiple signals or streams of information on a carrier at the same time. The antenna technology involves the different configurations, schemes and techniques that can be incorporated into antenna systems to fulfill recommended requirements or to achieve desired goals

SC-FDMA is the multiplexing plan utilized for uplink transmission in LTE as of now clarified in Chapter one and OFDMA has been found to be a useful multiplexing plan for LTE downlink with numerous favorable circumstances, for example, improved unearthly effectiveness, less perplexing adjustment at the beneficiary, adaptable data transfer capacity transformation, and so forth. As for reception apparatus innovation, MIMO radio wires assume a critical part in the accomplishment of the presentation objectives of 3GPP LTE.

The LTE air interface comprises of physical channels and signals. Physical channels convey information from higher layers including control, booking and client payload (information) while the physical signals are utilized for framework cell recognizable proof, radio channel assessment and framework synchronization. The LTE air interface is intended for organization in matched (FDD Mode) and unpaired (TDD mode) range groups [3]. This proposal work is focused on or principally dependent on LTE downlink transmission, accordingly the main part of the work is on the physical layer with center around OFDMA and MIMO. The following area gives further insights regarding these innovations.

2.2 ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING

In OFDM frameworks, the accessible transfer speed is broken into numerous smaller subcarriers and the information is isolated into equal streams, one for each subcarrier every one of which is then tweaked utilizing differing levels of QAM modulation for example QPSK, 16QAM, 64QAM or higher requests as required by the ideal signal quality. The straight mix of the prompt signals on every one of the subcarriers comprises the OFDM images. The range of OFDM is portrayed in fig.2.1 . Every one of the OFDM image is gone before by a cyclic prefix (CP) which is successfully used to take out Intersymbol Interference (ISI) and the subcarriers are likewise firmly divided for effective usage of the accessible data transfer capacity

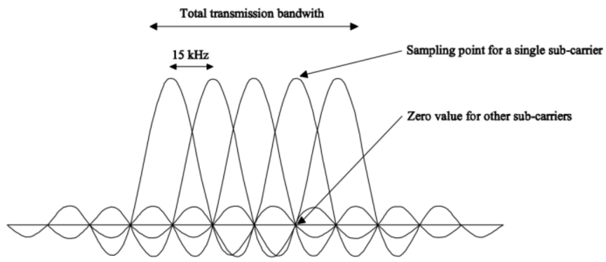

Figure 2.2 OFDM Spectrums.

2.3 ORTHOGONAL FREQUENCY DIVISION MULTIPLE ACCESS

Based on the various advantages that have been mentioned in the preceding sections, OFDMA is considered as an excellent multiple access schemes for the 3GPP LTE downlink. OFDMA uses multiple orthogonal subcarriers each of which is modulated separately. OFDMA distributes subcarriers to different users at the same time so that multiple users can be scheduled to receive data simultaneously; each of these is referred to as a physical resource block (PRB) in the LTE specification [4].

2.4 MULTIPLE IN MULTIPLE OUT (MIMO) ANTENNAS

MIMO antenna technology is one of the key technologies leveraged on by LTE. It is a technology in which multiple antennas are used at both the transmitter and at the receiver for enhanced communication: The use of additional antenna elements at either the base station (eNodeB) or User Equipment side (on the uplink and/or downlink) opens an extra spatial dimension to signal precoding and detection. Depending on the availability of these antennas at the transmitter and/or receiver, the following classifications exist

Single-Input Multiple-Output (SIMO): A simple scenario of this is an uplink transmission whereby a multi antenna base station (eNodeB) communicates with a single antenna User Equipment (UE).

Multiple-Input Single-Output (MISO): A downlink transmission whereby a multi-antenna base station communicates with a single antenna User Equipment (UE) is a scenario.

Single-User MIMO (SU-MIMO): This is a point-to-point multiple antenna link between a base station and one UE.

Multi-User MIMO (MU-MIMO): This features several UE's communicating simultaneously with a common base station using the same frequency- and time-domain resources.

As a result of the requirements on coverage, capacity and data rates, integration of MIMO as part of the LTE physical layer is highly imperative since it necessitates the incorporation of transmission schemes like transmit diversity, spatial multiplexing and beam forming.

2.5 MODULATION

One of the main design goals of LTE is to achieve high peak rates, and many multiple methods are employed in order to meet this goal, a sophisticated way is by utilizing adaptive modulation. This is the ability to adjust modulation schemes based on signal quality. Adaptive modulation provides a tradeoff between delivered bit rate and the robustness of the digital encoding, so as to balance throughput with error resilience. In 3GPP LTE, QPSK, 16QAM and 64QAM are supported modulation schemes. High order modulation like 64QAM work best with strong signals which is usually achieved near the base station while low order modulation like QPSK possess better signal recovery in poor signal quality areas. Adaptive modulation is therefore essential in LTE because it provides benefits to users on both high and low signal strength areas.

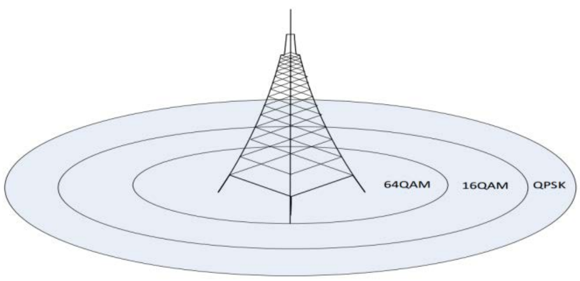

Figure 2.2 High order Modulation techniques work near base station.

2.6 CHANNEL CODING

The current 3G frameworks use turbo coding plan, yet because of the high pinnacle information rates upheld by LTE [29], it gets basic to know whether this equivalent turbo coding plan can scale to high information rates while keeping up sensible interpreting intricacy. It is right now discussed that turbo coding has a specific disadvantage that it isn't amiable to resemble executions which limit the feasible disentangling speeds. The hidden purpose for this issue is the dispute for memory assets among equal processors which happens because of the turbo code interior interleaver. Then again, it is contended that turbo codes can likewise utilize equal usage if turbo interior interleavers can be made dispute free.

A coding plan that has inalienable parallelism and accordingly offers high disentangling speeds is the Low thickness Parity Check (LPDC) code which is as of now expanding in accessibility. LPDC potential offers chances to accomplish high throughput which is made conceivable because of its intrinsic parallelism of the disentangling calculation while keeping up great mistake revising execution and low interpreting multifaceted nature.

2.6.1 Channel Coding in LTE

The preferred channel coding for LTE is turbo coding. This selection in favor of turbo coding is based on few reasons:

UMTS release 6 HSPA also uses turbo code.

For backward compatibility reasons, dual-mode LTE terminals will need to implement turbo code therefore some decoding hardware can be reused.

To avoid increased implementation complexity as the terminals have to support two different coding schemes.

There are some significant channel coding plans utilized in the LTE framework

Turbo coding: essentially utilized for huge information bundles which basic event in downlink and uplink information transmission, paging and broadcast multicast (MBMS) transmissions. As it were, for Uplink shared channel (UL-SCH), downlink shared channel (DL-SCH), Paging Channel (PCH) and Multicast Channel MCH [9, 23].

Rate 1/3 tail gnawing convolutional coding for the most part utilized for downlink control and uplink control just as communicated control channel.

III. LITERATURE SURVEY

Andrey Rashich, Sergei Gorbunov[1]; The paper addresses the BER performance of nonorthogonal multicarrier (SEFDM, Spectrally Efficient Frequency

Division Multiplexing) signals in LTE fading channels. The one tap ZF-equalizer and equivalent OFDM presentation of SEFDM signals is used to perform channel correction. Demodulation is done using trellis based demodulator. The proposed receiver structure has relatively low computation complexity compared to SEFDM demodulators which use sphere decoder. Thus the proposed receiver is applicable to SEFDM signals with high number of subcarriers as in WiFi, LTE, DVB-T2 systems. The resulting BER performance of SEFDM in various LTE fading channels using the proposed receiver is comparable with performance of QPSK OFDM with the same number of subcarriers. The analysis is done under assumption of perfect channel knowledge.

A. B. Abdullahi, A. Hammoudeh and B. E. Udoh,[2] Orthogonal Frequency Division Multiplexing (OFDM) is the transmission scheme adopted for downlink of the popular Long Term Evolution (LTE) technology. It is a multi-carrier technique which divides a large system bandwidth into multiple narrowband sub-carriers and treat the frequency selective fading as flat fading. LTE employ Multiple Input Multiple Output transmission in conjunction with OFDM (MIMO-OFDM) to improve the data rates and system performance. In this work, the Physical Downlink Shared Channel (PDSCH) performance of MIMO system based on LTE specification, is evaluated using linear and non-linear receiver's decoder in ITU defined channel models with different modulations. The result are presented for Transmit Diversity (TD) scheme using different antenna configurations, and Spatial Multiplexing (SM) scheme using optimum performance configuration with the said receiver structure. The result shows the needs of equipping wireless system with multiple antennas for system Bit Error Rate (BER) and the overall system capacity. Significant improvement in BER is achieve with Sphere Decoding (SD) receiver as compared with Minimum Mean Square Error (MMSE) receiver and improved system capacity with the increase in the Base Station (BS) transmitting antennas.

B. Yu, L. Yang and H. Ishii,[3] Little cell is an alluring and promising innovation for improving limit in rush hour gridlock hotspots utilizing cell densification. In this work, they propose the limit upgrade for little cells under macrocell-helped design using the adaptable 3-dimensional (3D) beamforming encouraged by the appropriation of the dynamic recieving wire framework (AAS) at base stations (BSs). Rather than traditional macrocell network, more unique and adaptable 3D beamforming with thin beamwidth is practical in the little cell layer in light of the fact that the administration inclusion and versatility power are essentially upheld in the macrocell layer. This dynamic bar variation in full measurements can improve the got signal quality and simultaneously control the obstruction all the more adequately, which is particularly valuable for the thick little cell arrangement situation where the impedance issue is one of the significant concerns. Specifically, execution examination between the customary sectorization with fixed down-tilt plan and UE (client hardware)- explicit 3D beamforming is contemplated. Besides, a novel UE bunch explicit 3D beamforming is proposed as a more reasonable activity contrasted with UE-explicit beamforming. Framework level reenactments show the noteworthy increase of limit upgrade with 3D beamforming over the customary sectorization with fixed down-tilt as far as both the cell normal limit (up to 124.8% addition) and the cell edge client throughput (up to 454.3% addition). It is likewise demonstrated that UE bunch explicit beamforming can accomplish execution equivalent to that of UE-explicit beamforming.

A. Lozano and N. Jindal,[4] A contemporary point of view on communicate radio wire variety and spatial multiplexing is given. It is contended that, with regards to most present day remote frameworks and for the working focal points, transmission procedures that use all accessible spatial degrees of opportunity for multiplexing beat methods that unequivocally penance spatial multiplexing for variety. Arriving at this resolution, in any case, necessitates that the channel and some key framework highlights be enough displayed and that reasonable execution measurements be received; inability to do so may achieve obviously various ends. As a particular model, this difference is outlined utilizing the 3GPP long haul development framework plan.

E. Virtej, M. Kuusela and E. Tuomaala,[5] Symmetrical Frequency-Division Multiplexing is a multi-carrier modulation conspire, where data images are communicated in equal over the channel by utilizing a lot of subcarriers. One of the fundamental focal points is expanded vigor against recurrence particular blurring and narrowband impedance. In this work they study the presentation of two double codeword Single-User Multiple-Input Multiple-Output (SU-MIMO) plans, for example per radio wire rate control (PARC) and Precoded MIMO (PREC), in an OFDM arrangement. For PARC they think about 2times2 and 4times4 reception apparatus arrangements and for Precoded MIMO 4times4 radio wire setup as it were. Our examination is performed with a downlink Long Term Evolution (LTE) framework test system. The outcomes demonstrate that regarding normal part throughput the four-stream plans beat the double stream conspire by roughly 75-90%. Also, the four-stream plans have noteworthy inclusion gain contrasted with the double stream plot. When contrasting the four-stream plans against one another, the general increase of the precoded plot in normal part throughput is around 5-6%. From inclusion viewpoint, PREC is around 13-20% better than PARC.

K. Suto and T. Ohtsuki,[6] Space-time block coded OFDM (ST-OFDM) has been proposed as an attractive solution for a high bit rate data transmission in a multipath fading environment. Space-frequency block coded OFDM (SF-OFDM) has been also proposed as another solution. These two systems utilize the STBC with the 2×2 transmission matrix, using two transmit antennas. If they apply the STBC with the 4×4 transmission matrix to OFDM, using four transmit antennas; they can expect the performance improvement. In addition, applying the STBC with the 4×4 transmission matrix to OFDM, they can form block codes over the space, time, and frequency domains, that is, they can implement the space-time-frequency block coded OFDM (STF-OFDM). In this work, they apply the STBC with the 4×4 transmission matrix to OFDM and compare the performance of the three systems (ST-OFDM, SF-OFDM, STF-OFDM). They show that the best system with respect to the error rate performance differs in the different channel conditions.

IV. PROBLEM FORMULATION

To overcome the problems of BER reduction and channel estimation of SEFDM system, channel estimation of CR system, this study should be a creditable one. The following are the scopes of improvements highlights of the research work. The main problems and scope for improvements of this work are:

- Existing SEFDM system model have different channel like ETU, EVA and EPA with NFFT size variations which has lots of scope for improvements.
- The effect of noises are further reduced with the use of some linear or higher phase level modulation techniques.
- The problem of fading and noises are defined by the Extended channels weer not sufficient enough to define current channel model in full the perspective of fading, interference and high speed network.
- The received signals are full of mixed with the noises so more efficient detection schemes are required to filter out the information part from the received signal.

V. PROPOSED METHODOLOGY

The focus of the Advanced development in the MATLAB software is based on the adaptive modulation techniques. The OFDM model consists of basic model (without cyclic prefix) and model with cyclic prefix. The OFDM simple model which the data stream is first subdivided into a number of sub-streams where each one has to be modulated over a separate carrier signal, called sub carriers. The data bits are directly mapped to the complex modulation symbols by using adaptive modulation techniques which are BPSK, m-PSK, 32-QAM or 64-QAM.

The resulting modulated signals are then multiplexed before their transmission by applying the Inverse Fast Fourier Transform (IFFT). Thus the multiplexed signal passes through the SUI or ETU channels which is designed for high speed wireless scenarios. In the receiver, OFDM symbols are detected by using adaptive modulation techniques detector and sub carriers are demodulated by the FFT, which is the reverse operation of the IFFT. The values are then de-mapped into binary values and finally parallel to serial converter converts the binary values to the serial and sends out the information bits. For the second model, it uses the concept of cyclic prefix that adds additional bits at the transmitter end and then the receiver removes these additional bits in order to minimize the inter symbol interference, improve the bit error rate and reduce the power spectrum.

The performance of the proposed wireless communication system can be enhanced with the modifications in the below parameters of the basic system architectures. For Example:

VI. CONCLUSION AND FUTURE WORK

To develop a novel algorithm to obtain optimal solution for BER reduction and channel estimation problems. The solution methodologies that are used to solve the BER and Channel estimation problems are reviewed. The review of conventional techniques for solving BER and system performance has been dealt in detail. The advantages and disadvantages of the conventional and heuristic approaches are presented. The research works in the areas of error reduction and system performance of MIMO- OFDM system are discussed analysis and evaluation of the performance of MIMO-OFDM schemes in 4G LTE systems. More specifically, we derive an average BER performance for 4x4 diversity MIMO schemes in the 3GPP 5 MHz Long Term Evolution (LTE) system over a different newer channel models having consideration of current fading and interference in channel. To show the BER performance improvement of the MIMO-OFDM with efficient modulation schemes.

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