An Extensive Review On Wireless MIMO System Using LTE

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Abstract - High spectral efficiency and high transmission speed due to the applications of audio, video and internet services are the challenging requirements of future wireless broadband communications. In a multipath wireless channel environment, the deployment of Multiple Input Multiple Output (MIMO) systems which enhance channel capacity enormously has led to the achievement of high data rate transmission without increasing the total transmission power or bandwidth. This work presents an extensive review on the Performance Evaluation of MIMO System Using LTE. In practice, wireless communications channels are time varying or frequency selective especially for broadband and mobile applications. To address these challenges, a promising combination has been exploited, namely, MIMO with Orthogonal Frequency Division Multiplexing (OFDM), which has already been adopted for present and future broadband communication standards such as LTE or WiMax. The performance of MIMO OFDM system with LTE can be evaluated in terms of bit error rate (BER) against signal to noise ratio (SNR) with various modulation schemes.

Keywords- MIMO, LTE, OFDM, BER, SNR.

I. INTRODUCTION

The measurement of the performance in communication systems has always been a matter of extreme interest since their very origin. Besides the channel capacity, which basically provides information about the limiting error-free information rate that can be achieved; this performance is usually quantified in terms of the Symbol Error Rate (SER) or the Bit Error Rate (BER). Depending on the characteristics of the channel fading and the modulation scheme, the performance analysis can be conducted following different approaches.

The appearance of new digital communication systems that employ new modulation or transmission schemes leads to the necessity of evaluating their performance in order to enable a fair comparison with the existing techniques. Some examples are the use of multiple antennas, usually referred to as multiple-input multiple-output (MIMO) systems, or the orthogonal frequency division multiplexing (OFDM) technique. Both MIMO and OFDM have been incorporated in many commercial and under-development wireless communication technologies.

The analytical performance of most of wireless communication systems under different fading conditions has already been accomplished when perfect channel state information (CSI) is assumed to be known at the receiver side (or even at the transmitter side, if required) [5, 6]. These results hence are useful to determine the maximum achievable performance of these systems under ideal conditions. However, in practice there exist many factors which may limit their performance: the appearance of interfering signals, the consideration of imperfect CSI, or non-idealities due to physical implementation such as carrier frequency offset (CFO), in-phase/ quadrature (I/Q) imbalance and direct-current (DC) offsets are valid examples.

MIMO systems have been under high consideration since Alamouti introduced the well known Space-Time Block Codes (STBC) which consists of data coded through space and time to improve the reliability of the transmission, as redundant copies of the original data are sent over independent fading channels. .Research on STBC has been intensive over the past years. MIMO and especially STBC have also been adopted in IEEE 802.11n order to achieve higher data rate and to provide more reliable reception than traditional single antenna communications.

OFDM can reduce the effect of frequency selective channel. This is because in OFDM, the data stream that is to be transmitted is divided into multiple parallel streams and the wideband channel is divided into a number of parallel narrowband subchannels and thus each subchannel has a lower rate data stream. OFDM is also used for its simplicity of implementation in the digital domain by the use of DFT. Moreover, OFDM is bandwidth efficient since the parallel subcarriers are orthogonal to each other and as a result overlaps each other without causing interference. With the use of cyclic prefix, OFDM has also been proven as a robust modulation technique under multipath frequency selective fading environment.

Cellular systems have experienced an exponential growth over the last years. Indeed, cellular phones have become a critical business tool and part of everyday life in most developed countries, as they are rapidly supplanting the old wire line systems. The explosive growth of wireless systems coupled with the proliferation of laptop and palmtop computers indicate a bright future for wireless networks, both as stand-alone systems and as part of the larger networking infrastructure. However, many technical challenges remain in designing robust wireless networks that deliver the performance necessary to support emerging applications.

Signal amplitude and phase are subject to numerous scattering components during transmission. When these components are of similar strength, the fading process is described as following a Rayleigh probability distribution, while if some of the scattering components are stronger than others, the fading is no longer following a Rayleigh distribution but a Rician probability distribution and referred as Rician fading.

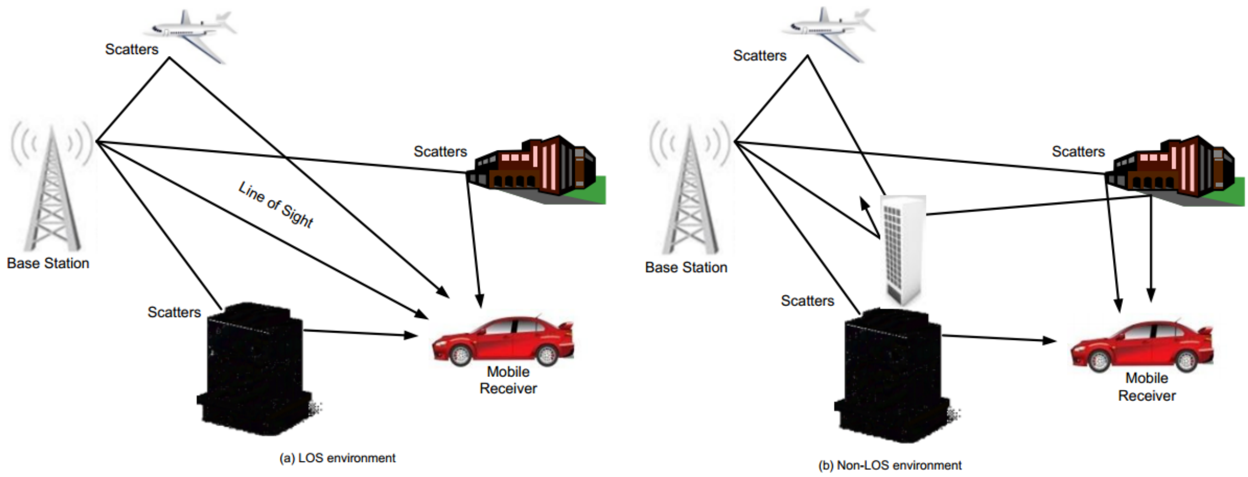

Figure 1.1 Signal Propagation in a Wireless Environment, with and without LOS.

Figure 11 illustrates a transmission where the strongest components are the Line of Sight (LOS) components which are directly transmitted from the transmitter to receiver without any reflection, while other components which are reflected are referred to as Non Line of Sight (NLOS) or scattering components. Therefore, with the description of Rayleigh and Rician distributions, the probability density function of the received signal follows a Rician distribution in a LOS environment Figure 1.1(a), while a Rayleigh distribution is followed in a NLOS environment Figure 1.1(b). According to the type of dispersion, time or frequency, frequency-selective fading or time-selective fading is induced respectively.

II. MIMO OFDM SYSTEM MODEL

A system model for MIMO-OFDM over frequency-selective fading channels is considered. A block diagram of a MIMO-OFDM system with nT transmit antennas and nR receive antennas is shown in Figure 2.1.

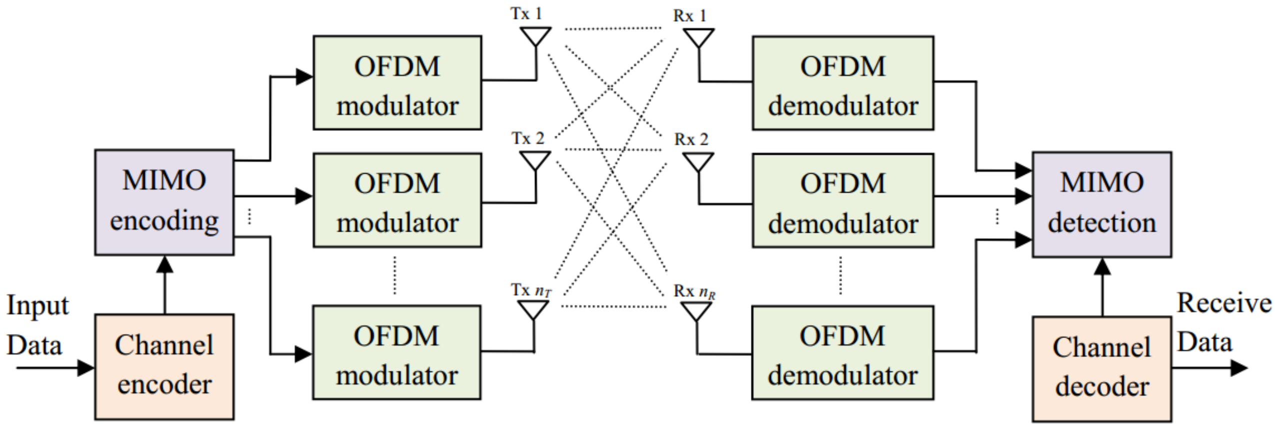

Figure 2.1 Block diagram of a MIMO-OFDM system.

In MIMO-OFDM systems, there exists the additional frequency diversity of frequency-selective fading channels. Therefore, MIMO encoding strategies in MIMO-OFDM systems can be space-time, space-frequency, or space-time-frequency approach. In other words, information symbols can be jointly mapped into transmit antennas (i.e., space domain), subcarriers (i.e., frequency domain), and subsequent OFDM symbols (i.e., time domain). Theoretically, the maximum achievable diversity order is nT x nR x min(L, K), where L is the number of resolvable propagation paths and K is the FFT size . Guidelines for the design of full- diversity space-frequency codes and full-diversity space-time-frequency codes.

With respect to channel estimation in MIMO-OFDM systems, time and frequency correlation of the channel parameters can be exploited for the estimation process, which is similar to SISO-OFDM systems. MIMO-OFDM systems a channel matrix of size nR x nT needs to be estimated, instead of the scalar as in SISO-OFDM systems. The channel estimation can be performed based on space-time pilot insertion or space-frequency insertion. This work assumes that the channel state information is available.

III. RELATED WORK

SR. NO.	TITLE	AUTHORS	YEAR	APPROACH
1	Performance evaluation of MIMO system using LTE downlink physical layer	A. B. Abdullahi, A. Hammoudeh and B. E. Udoh,	2016	The Physical Downlink Shared Channel (PDSCH) performance of MIMO system based on LTE specification, is evaluated using linear and non-linear receiver's decoder
2	Non-orthogonal multiple access (NOMA): Concept, performance evaluation and experimental trials,	A. Benjebbour, K. Saito, A. Li, Y. Kishiyama and T. Nakamura,	2015	Performance evaluation gains and our experimental trials related to NOMA.
3	Performance evaluation of SVD-MIMO-OFDM system with a thinned-out number of precoding weights,	T. Mahler, J. Kowalewski, T. Schipper and T. Zwick	2015	SVD-based 4×4 MIMO-OFDM system with our adaptive bit and power allocation (ABPA) algorithm
4	An analytical approach for antenna performance evaluation for MIMO systems,	C. Wang, S. Xiao, W. Wang, C. Wang and S. Liu,	2015	An analytical approach for antenna performance evaluation in multiple-input-multiple-output (MIMO) systems
5	Simulating the Long Term Evolution (LTE) Downlink Physical Layer,	C. Yahiaoui, M. Bouhali and C. Gontrand	2014	Comprehensive analysis of Long Term Evolution Advanced (LTE) downlink (DL) physical layer
6	System Level Assessment of Vehicular MIMO Antennas in 4G LTE Live Networks,	L. Ekiz, A. Posselt, O. Klemp and C. F. Mecklenbrauker,	2014	A measurement campaign targeting at system level evaluation of vehicular multiple-input-multiple-out (MIMO) antennas.

A. B. Abdullahi, A. Hammoudeh and B. E. Udoh, [1] 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 exploration 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.

A. Benjebbour, K. Saito, A. Li, Y. Kishiyama and T. Nakamura, [2] Non-orthogonal multiple access (NOMA) has been attracting a lot of attention as a promising downlink multiple access scheme for LTE enhancements and 5G. This exploration work introduces an overview of the concept, performance evaluation gains and our experimental trials related to NOMA. The goal is to clarify the benefits of NOMA over orthogonal multiple access (OMA) such as OFDMA adopted by Long-Term Evolution (LTE), also its combination with MIMO is discussed. Using computer simulations, NOMA performance gains are assessed from both link-level and system-level perspectives. Also, our NOMA test-bed and the measurement results are explained. Our evaluation results and measurements show that NOMA provides higher gains compared to OFDMA. These gains are more than 30%.

K. Mitsuyama, T. Kumagai and N. Iai, [3] There are designing system parameters for manufacturing a prototype SVD-based 4×4 MIMO-OFDM system with our adaptive bit and power allocation (ABPA) algorithm. Designing the parameters at the cost of a minimum amount of feedback is important to achieve high spectral efficiency in time division duplex (TDD) systems. Constructed a performance evaluation system for the SVD-based MIMO system and evaluated the bit error rate (BER) performances when the number of precoding weights fed back was thinned out under three MIMO channel models with different delay spreads. The measurement results demonstrated that the amount of feedback can be reduced by one eighth in the model with the largest delay spread, keeping BER performance degradation.

C. Wang, S. Xiao, W. Wang, C. Wang and S. Liu,[4] An analytical approach for antenna performance evaluation in multiple-input-multiple-output (MIMO) systems is proposed. By considering the elevation angles of the electromagnetic rays at both the base station (BS) and mobile station (MS), a three-dimensional (3D) channel model is introduced. Then the analytical approach which evaluates the effects of antenna configurations on channel capacity and diversity performance of MIMO systems is derived. In order to verify the proposed method, a link-level simulation is implemented, in which the effects of isolation on system throughput, and the effects of envelope correlation coefficients (ECC) on equivalent diversity gain are evaluated, respectively. The simulation results validated our proposed approach.

C. Yahiaoui, M. Bouhali and C. Gontrand, [5] In this exploration work investigate a comprehensive analysis of Long Term Evolution Advanced (LTE) downlink (DL) physical layer performance using Multi Input Multi Output channel (MIMO) based on standard parameters. The work consists firstly in modeling LTE physical downlink shared channel (PDSCH). The developed model is based on an independent functional blocks in order to facilitate reproduction of signal processing techniques results used in LTE and particularly to evaluate the physical layer downlink components. Thereafter, it was integrated in the simulator, basic structure with AWGN channel including evaluation of using diversity and spatial multiplexing transmissions on downlink connections and multipath fading channel model. The simulation examples are illustrated with different digital modulation and MIMO scheme. BER and throughput results with multipath impact on transmission channel quality are also considered. These results show that the model implemented in Matlab faithfully advantages introduced in the LTE system.

L. Ekiz, A. Posselt, O. Klemp and C. F. Mecklenbrauker,[6] In this contribution, present the results of a measurement campaign targeting at system level evaluation of vehicular multiple-input-multiple-out (MIMO) antennas. Our measurements are performed on a test track served by a Long Term Evolution (LTE) base station operating in the 800 MHz band. show system level evaluation results obtained by using two reference monopole antennas and two automotive qualified, integrated prototype antenna systems. The presented results are gathered in line-of-sight (LOS) as well as non-LOS conditions. As vehicular antenna systems are limited by the available integration space, analyze the specific impact of antenna decoupling on system level performance. System level performance metrics include parameters such as ergodic capacity and condition number of the MIMO channel matrix. Achieve antenna decoupling for the reference monopoles by increasing their separation. In case of the integrated antenna system use a decoupling branch to decrease antenna coupling and correlation at the measurement frequency. discuss a system level evaluation process for ranking antenna systems based on channel specific parameters. The applicability of the process for MIMO system performance evaluation is shown with a comparison of an integrated antenna system with the described reference antenna system.

IV. PROBLEM FORMULATION

A combination of multi-input multi-output (MIMO) techniques and orthogonal frequency division multiplexing (OFDM) has been considered as a key technique for high-speed wireless communications. This is because OFDM transmission offers high spectral efficiency and robustness against intersymbol interference (ISI) in multipath fading channels. Meanwhile, MIMO techniques significantly increase data rate and/or link reliability. Specifically, the ergodic capacity of MIMO systems over fading channels is shown to increase linearly with the minimum of the number of transmit and receive antennas. In fact, MIMO-OFDM has been adopted in current and future standards, including WiMAX (Worldwide Interoperability for Microwave Access) and 3GPP LTE/LTE-Advanced.

Among a variety of MIMO schemes, antenna selection appears to be a promising approach for OFDM systems. In antenna selection, only a subset of antennas is selected for transmissions subject to a given selection criterion. Therefore, this technique requires a low implementation cost and small amount of feedback information, compared to other beamforming or precoding techniques. Also, antenna selection is robust to channel estimation errors because the phase information is generally not required.

V. CONCLUSION

With the constant demand of high spectral efficiency and high transmission speed for audio, video and internet applications, MIMO-OFDM has become the most promising technology combination for present and future wireless communications. MIMO offers spatial diversity and therefore increase the capacity while OFDM allow systems to work in time varying or frequency selective environment. While intensive research has been conducted on channel estimation for STBC-OFDM systems, to date there has been little work on joint iterative channel estimation and data detection techniques for MIMO-OFDM systems. The aim of this research work is therefore to review performance of MIMO-OFDM systems using LTE for fixed and mobile communications. Also in addition, some recent works on energy-efficient MIMO-OFDM systems, focused on spatial multiplexing MIMO schemes. Consequently, energy-efficient antenna selection MIMO-OFDM systems remain an open research problem.

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