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Advanced Techniques in MIMO-OFDM Systems for LTE Environment

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ABSTRACT: In this paper spatial multiplexing-MIMO communication schemes with OFDM modulation are considered with a focus on 4x4 systems. In order to achieve the 3GPP LTE and 3GPP LTE-A requirements, the design of detector's architecture with high performance, low latency and applicable computational complexity is a challenging research topic at the receiver due to the power and latency limitations of mobile communication systems. The challenge consists in providing a detector that achieves near-optimum performance, while offering polynomial computational complexity. Simultaneously, implementation In particular, the adopted strategy lies in shifting as much as possible of the computational complexity to the preprocessing step that is data independent.

Keywords: MIMO, 3GPP, LTE, OFDM, high data-rate,

INTRODUCTION

In Recent year, the wireless communication industry is facing new challenges due to constant evolution of new standards (2.5G,3G, and4G). Wireless system are expected to require high data rates with low delay and low bit-error-rate (BER). In addition, high data rate transmission and high mobility of transmitter and/or receivers usually result in frequency-selective and time-selective, i.e., doubly selective, fading channels for future mobile broadband wireless system. The rapidly growing IP data traffic cost-effectively and to improve cell-edge performance, 3GPP is working on the evolution of LTE called LTE-Advanced. LTE-Advanced is designed to meet or exceed the requirements of IMT-Advanced such as the support for the data rate of 1 Gbps and bandwidths up to 100 MHz. LTE-Advanced system is backward compatible with LTE [1]. This paper provides a technical overview of LTE-Advanced, describing the features such as carrier aggregation, enhanced advanced antenna techniques for the DL and the UL, relays, and coordinated multipoint (CoMP) transmission and reception. Features such as location services (LCS) and eMBMS are also discussed. In summary, this paper provides a technical overview of and beyond. Some of the key features of LTE Advanced will be Worldwide functionality & roaming, Compatibility of services, Interworking with other radio access systems and Enhanced peak data rates to support advanced services and applications (100 Mbit/s for high and 1 Gbit/s for low mobility). The IMT-Advanced systems will support low to high mobility applications and wide range of data rates, in accordance with service demands in multiuser environment. This paper provides a brief insight in to the LTE-Advanced standards and its key requirements which will be a pathway to next generation of wireless communication or 4G [2]. Orthogonal frequency division multiplexing (OFDM) is a method of encoding digital data on multiple carrier frequencies. OFDM has developed into a popular scheme for wideband digital communication, whether wireless or over copper wires, used applications such as digital television & audio broadcasting, DSL Internet access, wireless networks, power-line network, and 4G mobile communication [4].

An orthogonal frequency division multiplexing (OFDM) is an efficient high data-rate, having advantages of high spectrum efficiency, simple & efficient implementation by using the fast Fourier transform(FFT) & the inverse FFT(IFFT), mitigation of inter symbol Interference by inserting a cyclic prefix (CP) and robustness to frequency selective fading channels transmission technique for wireless communication [3].

Multiple-input & multiple-output or MIMO is the use of multiple antennas at both the transmitter & receiver to improve communication performance. It is one of several forms of smart antenna technology. MIMO technology has attracted attention in wireless communications, because it offers significant increases in data throughput and link range without adding bandwidth or increased transmit power. It achieves this goal by spreading the same total transmit power over the antennas to achieve an array gain that improves the spectral efficiency and/or to achieve a diversity gain that improves the link reliability (reduced fading) [6]. Because of these properties MIMO is an important part of modern wireless communication standards. Space-time-trellis-coding (STTC) is an attractive & promising solution, which achieves bandwidth efficient transmit diversity by using specially designed channel codes at the transmitter end in combination with some additional signal processing at the receiver. Use with MIMO-OFDM for improves the data-rate and the reliability of wireless communication. [10] The decoding of signal STTC codes are simulated by using three different decoding techniques, these are MMES (minimum mean square error), ZF (zero forcing), ML(maximum likelihood) using soft decision decoding It is due to significant decrease in the computational complexity, which is addressed in this thesis. As a result, the present work has led to the proposal of an original detector that is promising from both the computational complexity and the performance points of view. [11] Namely, it leads to an almost constant - in the constellation size - computational complexity, while offering near-maximum likelihood performance. Consequently, the proposed soft-decision detector compares to existing 4x4 detectors as a very efficient solution. we propose a noise reduction method for balanced STTC communication for high data rate and throughput. In the process of noise reduction we minimized the rate of interference in open channel. The design process simulates in MATLAB 7.8.0 and test for result 2 states, 4 states and 16 states for MIMO OFDM. The wireless channel suffers from attenuation due to destructive multipath in the propagation media. [15] These forms of attenuation result in the inefficient and unreliable transmission of data over many radio channels. Some possible, but non-pragmatic, solutions to combat this degradation are to increase transmission power, antenna size, or antenna height. A practical alternative to these solutions would be to transmit some less-attenuated replica of the signal to the receiver thereby increasing the probability that the receiver will receive a less corrupted signal. This scheme of transmission and reception is called diversity and is one of the most important techniques used to mitigate the effects of fading in wireless communications. These codes are called Balanced STTC because they use the points of the constellation with the same probability. Comparing to known codes, these codes offer the best performance. Therefore, the systematic search for good codes can be reduced to this class. Increasing demand for high-performance 4G broadband wireless is enabled by the use of multiple antennas at both base station and subscriber ends. [12] Multiple antenna technologies enable high capacities suited for Internet and multimedia services, and also dramatically increase range and reliability. In this article we describe a multiple-input multiple-output OFDM wireless communication system, lab test results, and field test results obtained in San Jose, California. These are the first MIMO system field tests to establish the performance of MIMO communication systems. Increased capacity, coverage, and reliability are clearly evident from the test day we are living in the world of technology. According to Moore's law, the development of technology will be doubled within every eight years. Hislaw may be dead in present times, but the people used to current technologies, feel the demand of new technology especially in mobile communication. The first analog mobile communication system was introduced in 1981, comes in front with the AMPS technology providing data bandwidth up to2.4Kbps. Its deal was only with the voice channels. In 1992, the second generation mobile communication system was launched. This was the first digital system has run their system with GSM & CDMA one providing data bandwidth up to 64Kbps. The upgraded generations of these technologies came with the feature of data. Then the addition in the list of development came in front in 2002 with EDGE, CDMA2000 providing bandwidth up to 2Mbps. [9] Now as the latest fully standardized running technology offering service since 2012 using WiMAX & LTE (Long Term Evolution) technology. Now it's the time to board on LTE-A network to meet the demand. Basically LTE-Advanced is considered as 4th generation of mobile communication [1]. Wireless technologies are going to take new dimension in our lives. LTE-A should make an important difference and added.

A. Multiple Input Multiple Output

Multiple-Input Multiple-Output (MIMO) technology is a wireless technology that uses multiple transmitters and receivers to transfer more data at the same time [8]. MIMO technology takes advantage of a radio-wave phenomenon called multipath where transmitted information bounces off walls, ceilings, and other objects, reaching the receiving antenna multiple times via different angles and at slightly different times. Multipath is a natural occurrence for all radio sources. Radio signals bounce off objects and move at different speeds towards the receiver. In the past multipath caused interference and slowed down wireless signals.

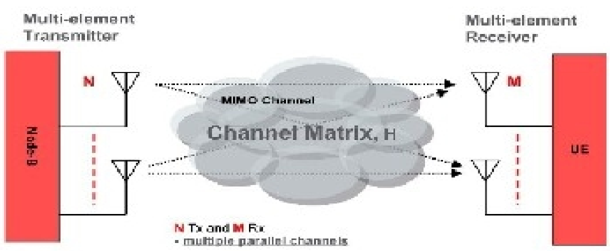

Fig. 1. MIMO system.

MIMO takes advantage of multipath to combine the information from multiple signals improving both speed and data integrity LTE- A uses this advantage.

RESULTS

The results of this dissertation are based on M-ary PSK modulation technique over fast Rayleigh fading channel. We have simulated the proposed approach for 2-PSK (M = 2), 4-PSK (M = 4), 16-PSK (M = 16) and the number of OFDM subcarriers are assumed to be 124. Moreover in our result we have considered that there is perfect channel state information (CSI) at both transmitter and receiver so that maximum diversity is confirmed. Fig.2 illustrates the noise reduction in balanced STTC for OFDM based Rayleigh channel with 2-PSK modulation scheme in terms of symbol error rate (SER) and signal to noise ratio (SNR) gain while Fig.3. and Fig.4. Represent the evaluation of same codes but with 4-PSK and 16-PSK modulation schemes. We simulate the result with 2 transmit and 2 receive antennas and the decoding of the signal STTC codes are simulated by using three different decoding techniques, these are MMSE (minimum mean square error), ZF (zero forcing) and ML (maximum likelihood) using soft decision decoding with viterbi algorithm. Our result shows that out of these three decoding techniques the ML decoding using viterbi algorithm gives much better result than MMSE and ZF decoding. Moreover our result shows that the 16-PSK modulation scheme can reduce more noise than 2-PSK and 4-PSK for same codes having similar antennas and similar bit rate.A brief view for various simulation parameters are listed in the following table.

Table 1: Various simulation parameters.

Modulation scheme	2-PSK, 4-PSK, 16-PSK
Number of subcarrier for OFDM	124
Symbol length	64
Channel estimation	Perfect
Signal estimation	Correlated
Channel	Fast Rayleigh fading channel with AWGN floor
Decoding techniques	MMSE, ZF, Soft decision ML

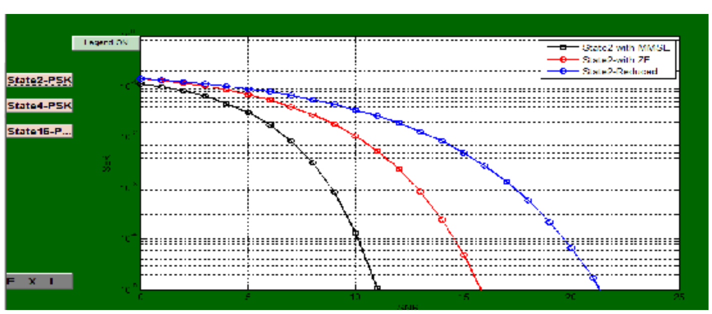

Fig. 2. The relation of symbol error rate (SER) and SNR gain with 2- state PSK and conditions taken for decoding are MMSE and ZF and reduction of noise in transmission state.

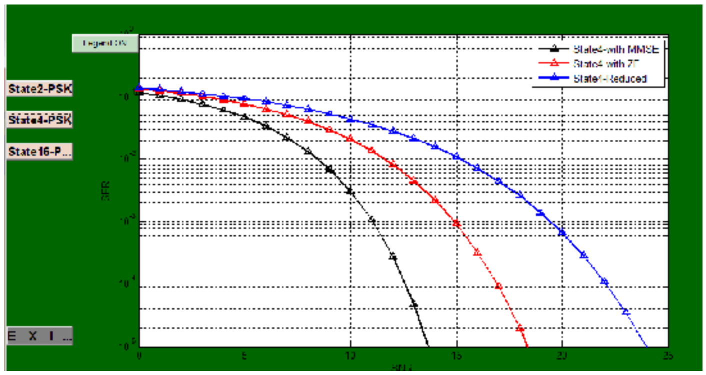

Fig. 3. The relation of symbol error rate (SER) and SNR gain with 4- state PSK and conditions taken for decoding are MMSE and ZF and reduction of noise in transmission state.

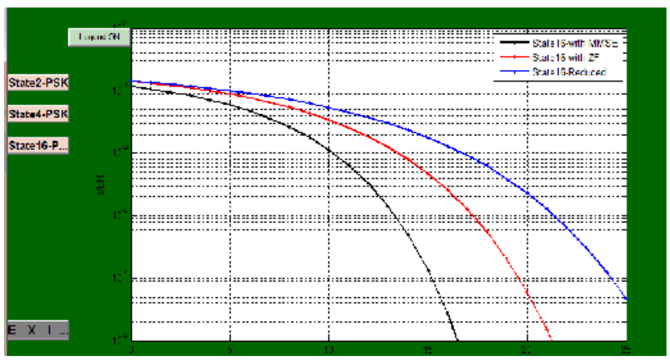

Fig. 4. The relation of symbol error (SER) rate and SNR gain with 16- state PSK and conditions taken for decoding are MMSE and ZF and reduction of noise in transmission state.

CONCLUSION

LTE Advanced offers high speed access to internet, with high speed internet connection on mobile, where users can enjoy voice calls, video calls, and high speed downloads or uploads of any data and watch internet TV in live or on demand services. The main targets for this evolution are increased data rates, improved spectrum efficiency, improved coverage, reduced latency and packet optimized system that support multiple Radio access Technologies. The paper has presented toward LTE-Advanced technologies (Orthogonal Frequency Division Multiplexing (OFDM), also focused on LTE Advanced technologies (MIMO enhancements for LTE-Advanced, carrier aggregation, peak data rate, mobility and co-ordinated multi-point transmission (CoMP). LTE-Advanced is a very flexible and advanced system, further enhancements to exploit spectrum availability and advanced multi-antenna techniques.

In addition to relaying and repeater solution to enhance coverage and cell edge data rates, an evolution of the inter-cell interference coordination in the form of coordinated multipoint transmission/reception is yet another technology to enhance performance. want to mention that, in our country, the complete 4G technologies can be implemented using MIMO-OFDM technique. And this would be far more effective and can make a revolutionary step to cope with the modern wireless world as well as the user demand. Generally, multiple-input multiple-output (MIMO) beam forming is helpful in mitigating such interference because it can spatially suppress some of the multipath. However, the effectiveness of this suppression is very limited. In this paper, we propose an ICI/ISI-aware orthogonal symbol generation techniques which explicitly takes into account the multipath characteristic of the channel.

Carrier and user data's are spread spectrum with time and frequency respect to the exact corresponding domains are derived to maximize the signal-to-interference-plus-noise ratio by decreasing BER. In this paper, via simulations, that the proposed techniques those can dramatically reduce the ISI, ICI, block error rate, permitting good performance for channel delay profiles that would break conventional links. This is vitally important for the extension of indoor wireless LAN designs to outdoor uses.

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