INTERNATIONAL JOURNAL OF SCIENTIFIC PROGRESS AND RESEARCH (IJSPR) ISSN: 2349-4689
Issue 111, Volume 39, Number 02, 2017

Performance Evaluation of MIMO System Using LTE

Drishti Saxena[1], Dr. Sanjeev Sharma[2] , Raunak Kudesia[3]

[1]*M.Tech., Dept. of Information Technology, School of Information Technology, RGPV, Bhopal*

[2]*Prof. & Head, School of Information Technology, RGPV, Bhopal*

[3]*B.Tech, Indian Institute of Technology, Bombay*

Abstract – Modern wireless communication system is getting better for the new generation of data communication technology, because it has to facilitate the user to communicate and share information through various wirelessly connected devices. Researchers are delicately exploring new dimensions of the technology and fixing the bugs day by day. It is every researchers aim to explore new techniques and analyze the existing technologies to make technology easier for the subscribers having several features. In the same context this work also analyzing for estimation of channel with utilizing pilot assisted scheme and spatial diversity uses different number of antennas at the transmitter and receiver side to make system more efficient for random channel behavior. The methodology of this work has better error probability than the existing work done on the same context. The proposed system utilizes multi antenna diversity for 4xM and 2xM, configurations where M is number of receiver antennas and modulation scheme is 32-PSK.

Keywords- Pilot Assisted, Spatial Diversity, 32-PSK, MIMO.

I. INTRODUCTION

The growing demand for services with high data rates and high spectral efficiency is the key to rapid technological evolution in the field of wireless communication. In the last two decades wireless communication has experienced a massive growth with a mission to provide new services with high data rates.

This revolution in the field of wireless communication is being caused by continuous technological breakthrough to enhance better transmission using signal processing algorithms. The new techniques which are being developed are gradually being incorporated in commercial products and new wireless communications standards are being proposed. Recently, Third generation (3G) and fourth generation (4G) mobile communication systems have been deployed commercially at many places to fulfill the need for packet-based services with high data rate. Moreover lot of advancements has been incorporated in 3G systems to improve the existing data rates. Some of these include- high speed downlink packet access (HSDPA) in wideband code division multiple access (WCDMA) systems, 1x evolution-data, 4G, MIMO-OFDM, MC-CDMA, etc.

But the 3G systems are unable to cope up with the growing demands for wireless multimedia services over the broadband networks. Hence next generation wireless communication systems which include 4G and beyond are being standardized even before the complete deployment of 3G systems in all parts of the world. The next generation wireless systems are expected to support much higher data rates than the existing system.

With the increased demand for higher data rate services such as voice, data, video and multimedia over wired and wireless networks, new baseband processing techniques are required to process the huge amount of data in a less time. These techniques must be able to provide high data rate at permissible bit error rate (BER), and minimum delay. Orthogonal Frequency Division Multiplexing (OFDM) in conjunction with multiple antennas (MIMO-OFDM) is one of such technology expected to provide desired service standards.

LTE-A is a 4th generation mobile telecommunication technology. LTE-A was finalized by the 3rd Generation Partnership Project (3GPP) in March 2011. LTE-A is not a completely new technology, rather it is an enhancement to LTE. The main objective of LTE-A is to increase the peak data rate to 1 Gbps on the downlink and 500 Mbps on the uplink, improve spectral efficiency from a maximum of 16 bps/Hz in R8 to 30 bps/Hz in R10, increase the number of simultaneously active subscribers, and improve performance at cell edges [7].Many technologies employed in LTE continue to be used in LTE-A, such as orthogonal frequency division multiplexing (OFDM), OFDMA, MIMO, and SC-FDMA. The main new technologies introduced in LTE-A are carrier aggregation (CA), enhanced use of multiple antenna techniques, and relay nodes (RN).

Orthogonal frequency division multiplexing (OFDM) is a well-known method of encoding digital data on multiple carrier frequencies. OFDM systems spilt the available bandwidth into many narrower sub-carriers. Data is transmitted as parallel streams over these sub-carriers. Each sub-carrier is modulated with varying levels of modulation schemes, such as: Quadrature Phase Shift Keying (QPSK), Quadrature Amplitude Modulation (QAM), and 64-state QAM (64-QAM). The main merits of OFDM are low implementation complexity; good tolerance for inter-symbol interference (ISI) induced by multipath, and high spectral efficiency.

The main purpose of this work is to study LTE technologies and their impacts on a network, addressing coverage and capacity aspects. The objectives of this work were accomplished through the development and implementation of a single user model, in order to evaluate the radius for this scenario and performing a first network coverage analysis. Afterwards a multiple users' model in a multiple services scenario was developed ("scenario to closer" from real network behavior), allowing several analyses regarding network settings variation being tested. For the development of these models a great amount of information, which provides solutions for LTE implementation, was collected and analysed. The different standardized bandwidths and also MIMO configurations were compared. The frequency band has an enormous influence on network behavior; therefore an analysis for the possible LTE frequency bands was performed. The impact of the penetration services percentages and the number of users in this network were also evaluated.

II. MIMO LTE

In a wireless communication system, MIMO is a smart antenna technology that makes use of multiple antennas at both the transmitter and receiver to enhance communication performance. The advantages of MIMO technology are to realize high data throughput and increase link range without requiring additional bandwidth or transmit power. MIMO improves spectral efficiency (i.e., more bits per second per Hertz of bandwidth). Diversity coding enhances the link's reliability (i.e., reduces fading). Spatial multiplexing improves data throughput. From an encoding point of view, two types of encoding methods can be used for MIMO systems: open-loop and closed-loop. The difference between open-loop and closed-loop is that the closed-loop approach requires channel information and uses weights computed from this channel estimation to perform precoding.

MIMO increases the overall data rates by transmitting two (or more) different data streams on two (or more) different antennas, while receiving them using two or more antennas. However, due to the increasing volume of mobile traffic over the years, the use of MIMO in LTE could not satisfy the requirements of LTE-A for advanced MIMO channel transmission and higher peak efficiency. Therefore, two major enhancements of MIMO in LTE-A were made.

MIMO is recognized as a good solution in the development of the forthcoming generation of broadband wireless networks. This system takes advantage of the multipath propagation, where the Receiver (Rx) antenna is reached by many copies of the transmitted signal. The difference in each component propagation path results in diversity of Time of Arrival (ToA), Angle of Arrival (AoA), signal amplitude and phase. In order to achieve a better performance, MIMO systems take advantage of all arriving arrays. It exploits independently the transmission channels between the Transmitter (Tx) and Rx antennas.

The diversity reception, well known in various radio applications, improves only the Bit Error Ratio (BER) statistics and reduces the probability of total outage. However the MIMO scheme, which is the result of parallel deployment of several space-separated antennas at input and output, does not only improve BER performance but also causes an increase of channel capacity. Nevertheless, the capacity in such system strongly depends on the propagation conditions in the radio channel and can vary significantly.

III. PROPOSED WORK

The proposed multiple input multiple output (MIMO) system is based on the M-PSK modulation scheme having antenna diversity of 4xM and 2xM configurations.

A. M-Phase Shift Keying (M-PSK)

PSK relies on carrier changing between distinct phases of the signal to define the status of information being transmitted. PSK default is considered for binary (two) levels of phase modulations. PSK is considered a very efficient process of data delivery because of low bit error rates in the delivery. A number of variations of PSK are used in wireless networking systems, among which are BPSK, QPSK. Most of current wireless systems employ some form of PSK. M-PSK regulates an info signal utilizing M-ary phase shift keying (PSK) and returns a complex baseband yield. The modulation arranges, M, which is equal to the quantity of focuses in the signal group of stars, is dictated by the M-ary number parameter.

B. Block Diagram of Proposed work

The methodology of this work having better error probability than the existing work done on the same context. Figure 3.1 illustrate the block diagram of proposed MIMO system. m number of antennas at both transmitter and receiver end. in the proposed work we are using M-PSK modulation scheme.

Multi-carrier modulations is used for MIMO system that utilization orthogonal waveform for modulate the sub-carriers are called orthogonal frequency division multiplex (OFDM) schemes. Since the sub-carriers are modulated by orthogonal waveforms, the sub-carriers are allowed to have overlapping spectrum, in this way accomplishing higher spectrum efficiency.

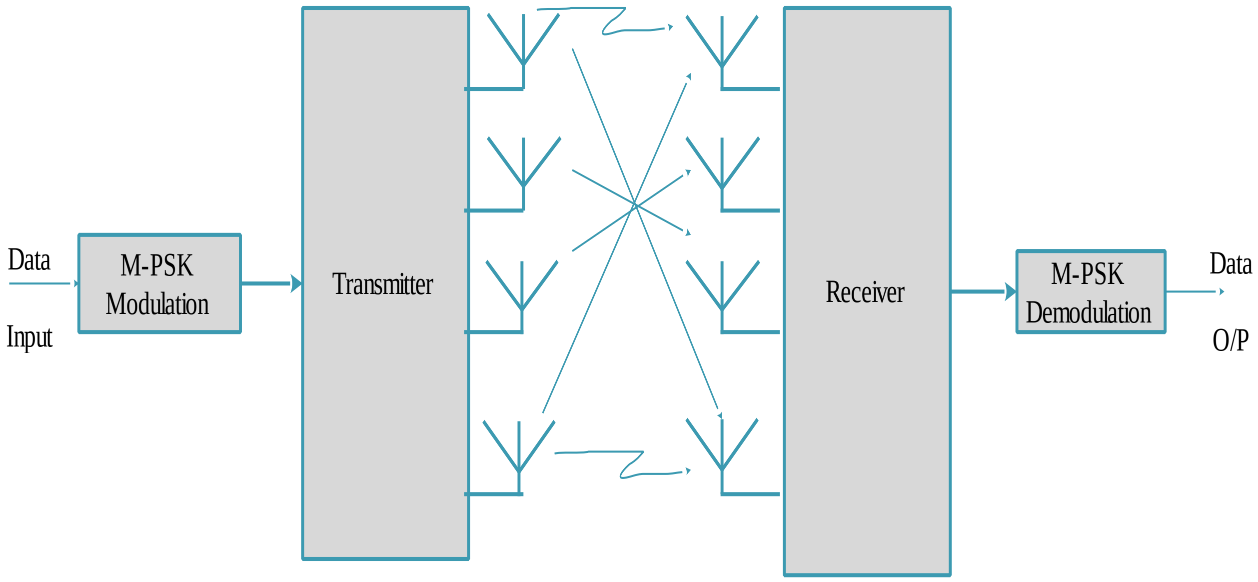

Figure 3.1 Proposed MIMO technique by using M-PS.

C. Flow of Process

The flow of process has illustrated in Figure 3.2 the flow of the process has start with the initialization of parameters and generate random signal which is to be transmitted for the experimental purpose. Modulate generated random signal with M-array phase shift keying modulation s (M-PSK).

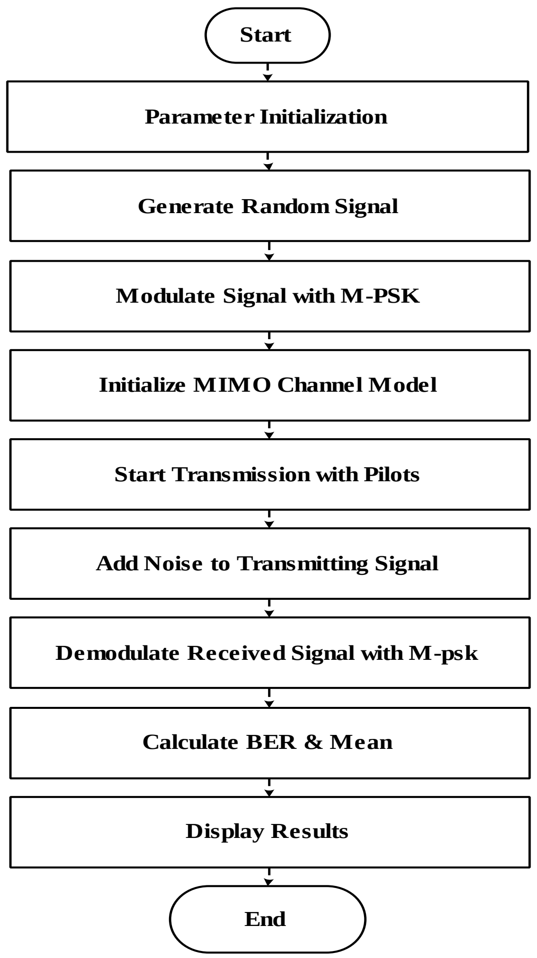

Figure 3.2 Process flow of proposed system.

Next, Initialize MIMO channel Model as demonstrated in Figure 3.1 and start symbol transmission using pilots. Now, add noise to transmission signal for experimental purpose. Next, demodulate received signal with M-PSK demodulation. Calculate bit error rate and mean of the received signal. Finally, display result on screen.

IV. IMPLEMENTATION AND RESULTS

The simulation of the proposed system has done on MATLAB Simulator the performance of the proposed work has been evaluated on basis BER analysis. Bit error rate of proposed system has given below in Figure 4.1 Figure 4.2 and Figure 4.3.

MATLAB is a software program which is used for numeric computation, data analysis and graphics. MATLAB has one advantage for engineers over programming languages like C or C++ is that MATLAB programs includes functions that numerically solve the large system of linear algebraic equations, system of common differential equations, roots of transcendental equations, definite integrals, statistics problems, control system problems and many more problems are solved using MATLAB software. It also offers some toolboxes that are planned to solve problems in specialized areas.

The performance of the proposed system has demonstrated in graph Figure 4.1 BER performance of the proposed system with 10k pilots and 4 transmitters and 4 receiver antenna. Bit error rate performance of the proposed system with 10k pilot's symbols and 4 transmitter and 2 receiver antenna. BER performance of the proposed system with 10 k pilot symbols and 4 transmitters and 4 receiver antenna.

Figure 4.1 illustrate the performance of proposed multiple input multiple output MIMO system having 4 transmitter antenna and one receiver antenna 10k pilot symbols are used for the simulation purpose signal to noise ratio SNR is represented on X axis of plot and BER is represented on Y- axis of plot.

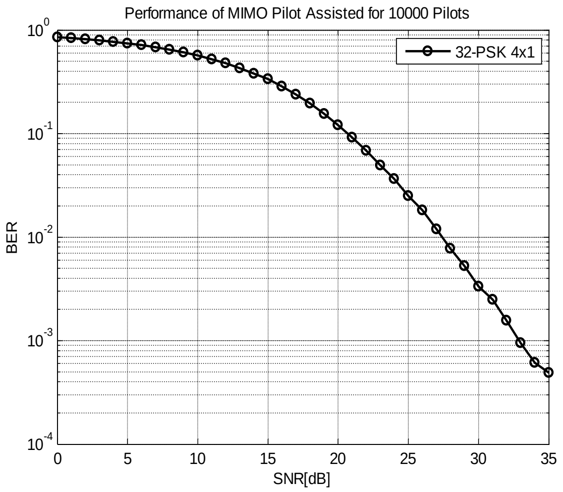

Figure 4.4 BER Performance of Proposed System with 10K Pilots and 4 transmitter and 1 receiver antenna.

Figure 4.2 illustrate the performance of proposed MIMO system on the same pilot ie 10k. And 4 transmitter antenna and two receiver antenna instead of one used in last experiment. Increasing the number of antenna the performance of the proposed 2 receiver antenna is better than single antenna.

Further we will increase the number of antenna for receiver in next experiment its very clear from the experiment that increasing number antenna diversity reduces and the performance of the system enhanced linearly.

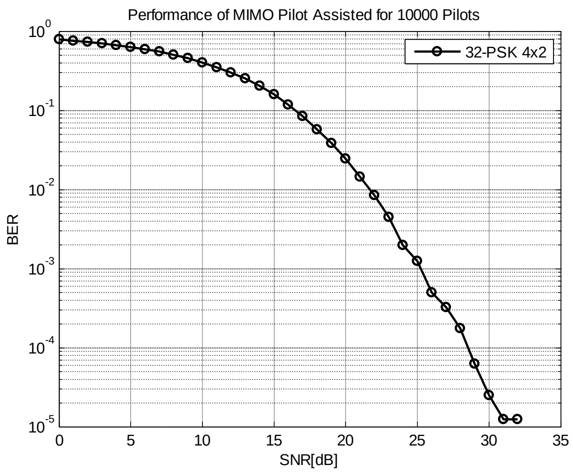

Figure 4.2 BER Performance of Proposed System with 10K Pilots and 4 transmitter and 2 receiver antenna.

Figure 4.3 illustrate the plot of proposed system with four transmission and for reception antennas its clearer that the performance of the system has again better than the last experiment. In Figure 4.3 pilot symbol is 10k.

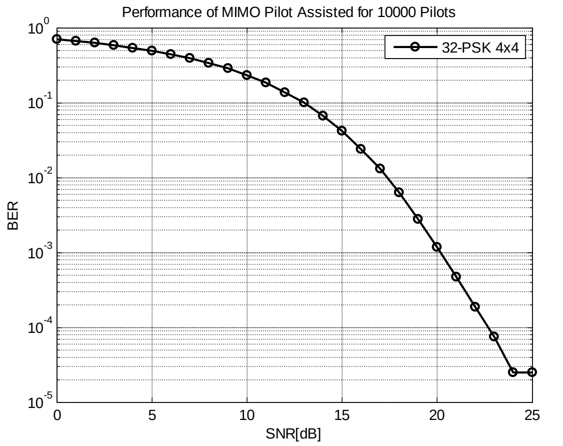

Figure 4.3 BER Performance of Proposed System with 10K Pilots and 4 transmitters and 4 receiver antenna.

V. CONCLUSION AND FUTURE SCOPE

The proposed MIMO Using LTE wireless system is implemented and simulated. In this work, baseband processing of various wireless communication systems is performed based on OFDM and the signal processing techniques used in OFDM based systems such as MIMO-OFDM. The architecture, using MATLAB/C programming languages was utilized for programming. The major importance wireless communication applications that uses OFDM is to make computations faster by parallel processing, signal processing which is the demand of next generation high data rate wireless communication systems. A basic framework of simulation assuming a simple LTE model, MIMO-OFDM models. On the basis of this result, BER and SNR performance of the system has been improvised. Our future research work would deploy implementation of high complexity communication system like, WCDMA, V-Blast SC-CDMA, MC-CDMA etc. Designing and development of computationally efficient algorithms for OFDM based communication systems by providing parallel implementation of FFT and IFFT.

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