PERFORMANCE ANALYSIS OF MIMO-LTE USING VARIOUS MODULATION SCHEMES UNDER DIFFERENT CHANNELS

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Abstract— In wireless communication, user suffers from channel fading that is the signal attenuation varies significantly over the transmission. This can be overcome using proper diversity methods such as spatial, temporal, and frequency diversity. Cooperative communication introduces new diversity method called cooperative diversity. Cooperative diversity achieves with the cooperation of distributed relay nodes that help to establish a communication link between source node and destination node. Several theoretical studies have been carried out on cooperative communication and those studies suggest that the cooperative communication required less transmit power at the source and the relay. This makes cooperative communication is interference less and power efficient communication method. Also, cooperative communication enhances the coverage and the throughput of the system. A MIMO system uses multiple antennas at both the transmitter and receiver to improve the communication system performance by use of diversity and multiplexing techniques. MIMO system provides higher spectral efficiency, improves the reliability, fading mitigation and improved resistance to interference. Hence for the performance evaluation of the LTE system in downlink the proposed system determines the Bit Error Rate of the system for 2x2 MIMO channel applications. The System is developed here uses 2 input signal that needs to be transmitted over the channel.

Keywords—Long Term Evolution (LTE), Multi-Input Multi-Output (MIMO), Evolved Node B (eNB), User Equipment (UE), Codeword Bit Error Rate (CBER), Code Word (CW).

I. Introduction

Modern wireless communication systems push for high data rates, reliable communications, coverage enhancements, and less power requirements. Multiple-input multiple output (MIMO) relaying can be identified as a candidate for meeting these challenges. MIMO technique provides higher spectral efficiency and improves the reliability of the communication systems [1]. Cooperative relay communication enhances the throughput and extends the coverage area [3]. This also reduces the need to use high transmitter power, which in turn results in reduced interference to other nodes.

AF relaying protocol has been the most attractive relaying protocol among the research community, which forwards amplified version of the received signal at the relay node. AF relaying can be categorized into variable gain relaying or fixed gain relaying based on the availability of CSI at the relay node. Most of the research on variable gain AF relaying has been carried out assuming that the CSI of source-to-relay and relay-to-destination channels are available at the relay terminal. MIMO beam forming can be used to mitigate the severe effects of fading by exploiting channel knowledge at both the transmitter and receiver. In particular, transmit beam forming (TB) can be used at the transmitter, and maximum ratio combining (MRC) at the receiver. Dual hop MIMO AF relaying systems employing TB/MRC provide significant performance gains as in [4]. However, TB requires CSI at the transmitter, and it is not perfect for many practical scenarios. Also, the relay based communication systems are required to investigate for interferences at the nodes, such as co-channel interference (CCI) at the relay and the destination.

II. MIMO Communications

A MIMO system uses multiple antennas at both the transmitter and receiver to improve the communication system performance by use of diversity and multiplexing techniques. MIMO system provides higher spectral efficiency, improves the reliability, fading mitigation and improved resistance to interference [2].

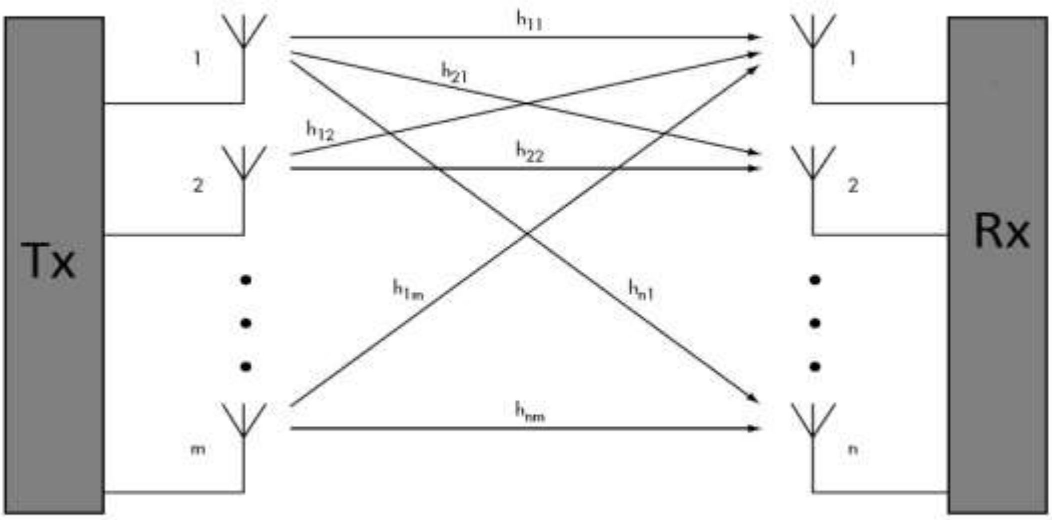

Fig.1: MIMO System

There are three main MIMO techniques have been proposed in the literature, such as precoding spatial multiplexing, and diversity coding. Precoding is a technique that uses the knowledge of CSI at the transmitter and the receiver to design precoder for multi-stream beam forming. In spatial multiplexing, a high rate signal is split into each transmit antenna with different low rate date streams and every stream use the same frequency band. In a situation where CSI is not available at the transmitter, diversity coding can be used to achieve better diversity gain similar to MRC system. In diversity coding method, signal is transmitted by applying space-time coding at the transmitter. Basic MIMO system. This MIMO system consists with n transmit antennas and m received antennas. Channel between ith receive antenna and jth transmit antenna is denote as hij. Therefore received signal can be modeled as

$$y = Hx + n \qquad \ldots (1.1)$$

Where y is the received signal vector, x transmitted signal vector, n is the noise vector and H is the channel matrix with (i; j) Th component is hij. Beam forming uses precoding technique and multiple antennas for directional signal transmission and reception [2]. This directionality of the transmission is obtained by multiplying the transmit/receive signal with precoding vector in order to obtain constructive interference in the relevant direction and destructive interference in other directions. Beam forming methods can be applied at both the transmitter and the receiver. Also, beam forming significantly reduces the interference and improves system capacity. Maximal ratio transmission (MRT) is the beam forming technique that can achieve both diversity and the array gains with transmit beam forming. MRC is the optimal combining method, where the signals from the received antenna elements are combined in the way that the instantaneous SNR is maximized. MRT with MRC provides reference for the optimum performance that the system may obtain using both transmit and receive diversity. In single stream beam forming, same signal is transmit through each of the transmit antennas after precoding with transmit beam forming vector. Then receive beam forming vector is design in the way that end-to-end SNR is maximized at the receiver input. Received signal of single stream beam forming can be modeled as,

$$y = Hw_1 x + n \qquad \ldots (1.2)$$

Where wt is the transmit beam forming vector and x is the transmit signal from all the antennas. At the receiver, receive combining vector wr is applied to y. This can be expressed as,

$$\hat{y} = w_r^H H w_1 x + w_r^H n \qquad \ldots(1.3)$$

Alamouti proposed a new way of transmit diversity scheme with the use of two transmit antennas when CSI is not available at the transmitter [2]. This achieved by transmitting a pair of symbols using two antennas at first and then transmits the transformed version of the symbols. This Alomouti scheme is led to the progress of space time block coding technique. In OSTBC, the data transmitted with orthogonal coding, such that multiple copies of the data transmit across multiple antennas. This improves the reliability of data transmission. Transmitting multiple copies of data increases the chance of correctly decode the received signal using the redundantly received data.

This OSTBC coding exploits the independent fading in the multiple antennas to improve the diversity gain. At the transmitter, OSTBC encoding done with N symbols $s_1, s_2, \ldots, s_N$ are mapped to a row orthogonal matrix $X \in \mathbb{C}^{m \times N_T}$, where entries of X obtained by linear combinations of $s_1, s_2, \ldots, s_N$ and their conjugates [1]. Also, NT is the number of symbol periods used to send a code word. Therefore, the code rate is $R = N / N_T$. Let x_k be the transmitted signal during the kth symbol period. We take $X = (x_1, x_2, \ldots x_{N_T})$. During the kth symbol period, we have the received signal at the destination as

$$y_k = Hx_k + n_k, k = 1, 2, \ldots, N_T \qquad \ldots (1.4)$$

Where n_k is the noise vector at the destination.

III. Simulation

The simulation model designed for the evaluation of the speed of the LTE sytem and to find the bit error rate is shown below. The model is designed in Matlab software version R2014a. The aim of the proposed work is to evaluate the performance of the system for two fading channels namely Rayleigh and Rician fading channel. The transmitter section of the simulation model is shown below.

Table.1: System Configuration

PARAMETER	VALUE
Channel Bandwidth	5MHz
Duplex mode	FDD
Transmit Channel Modulatin	OFDM
Channel type	Flat Static MIMO, EPA 0Hz, EVA 5Hz, EVA 70Hz
FEC coding	Turbo coding
SNR	12.1dB
Modulation	QPSK, 16-QAM, 64-QAM
Subcarrier spacing	15KHz
Antenna diversity	2×2 MIMO

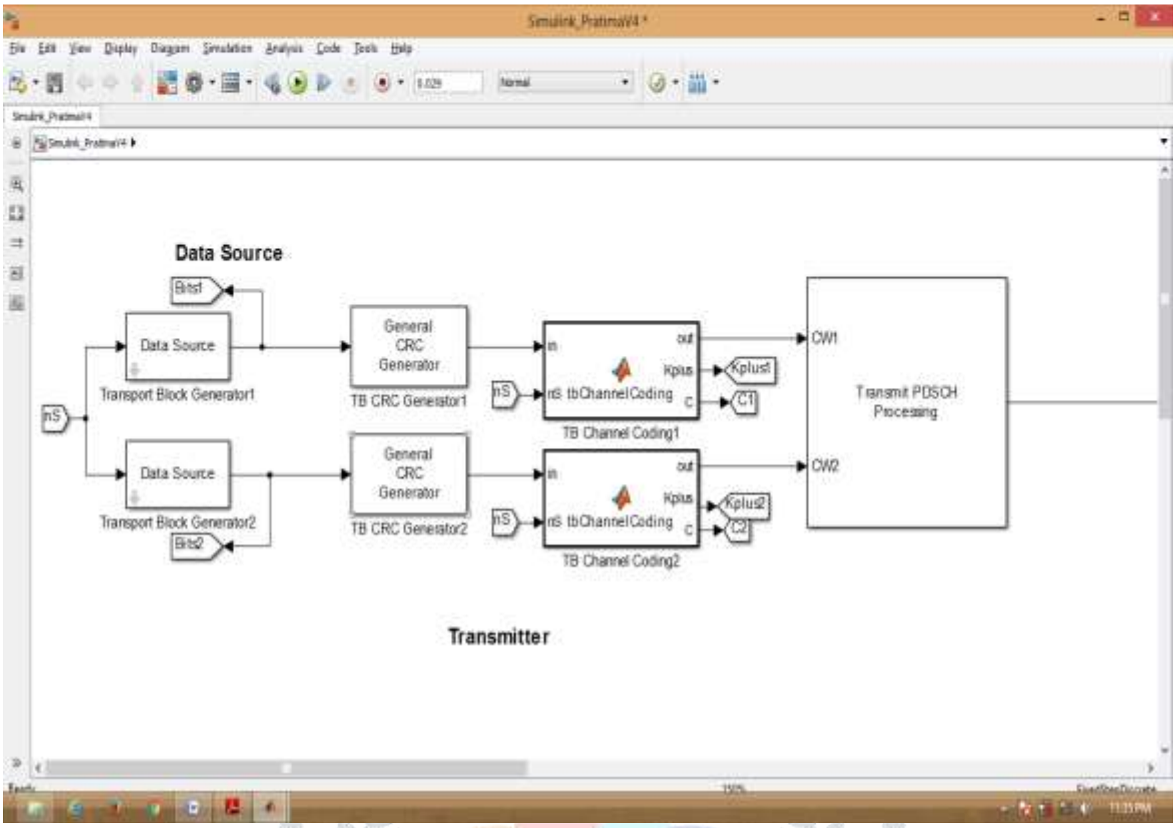

Fig.2: Transmitter Model of the Proposed Work

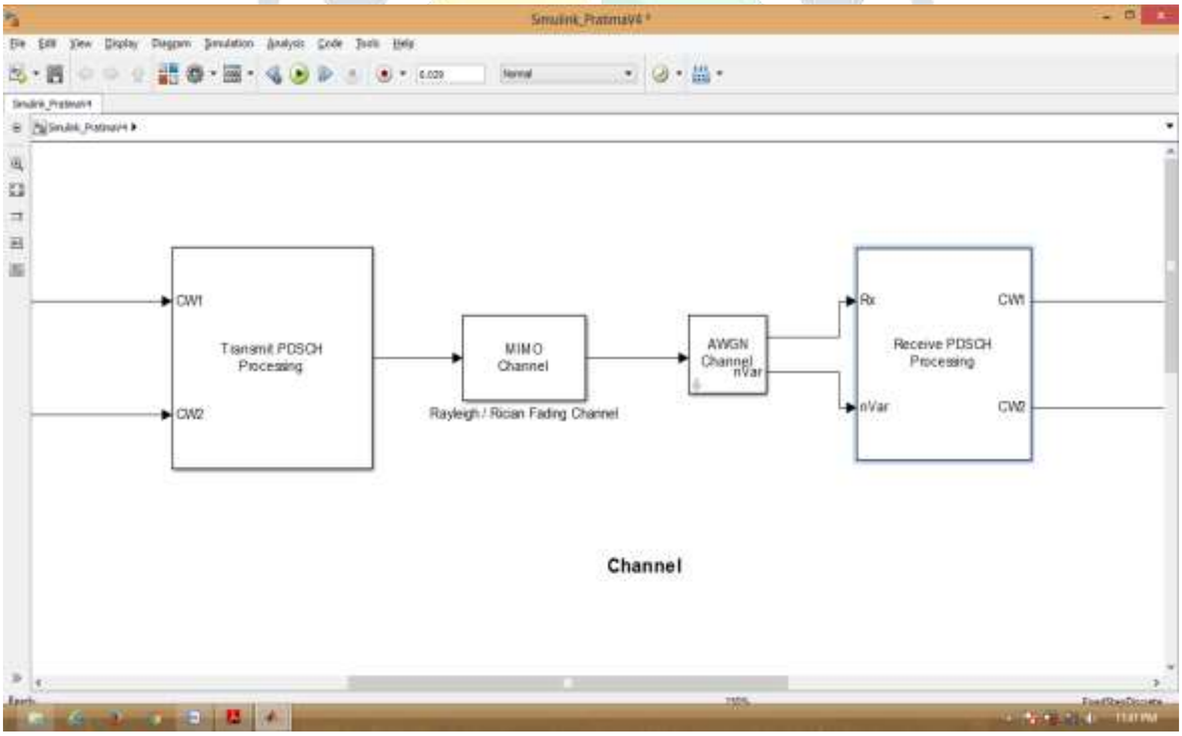

Fig.3: Channel Type of the Proposed Work

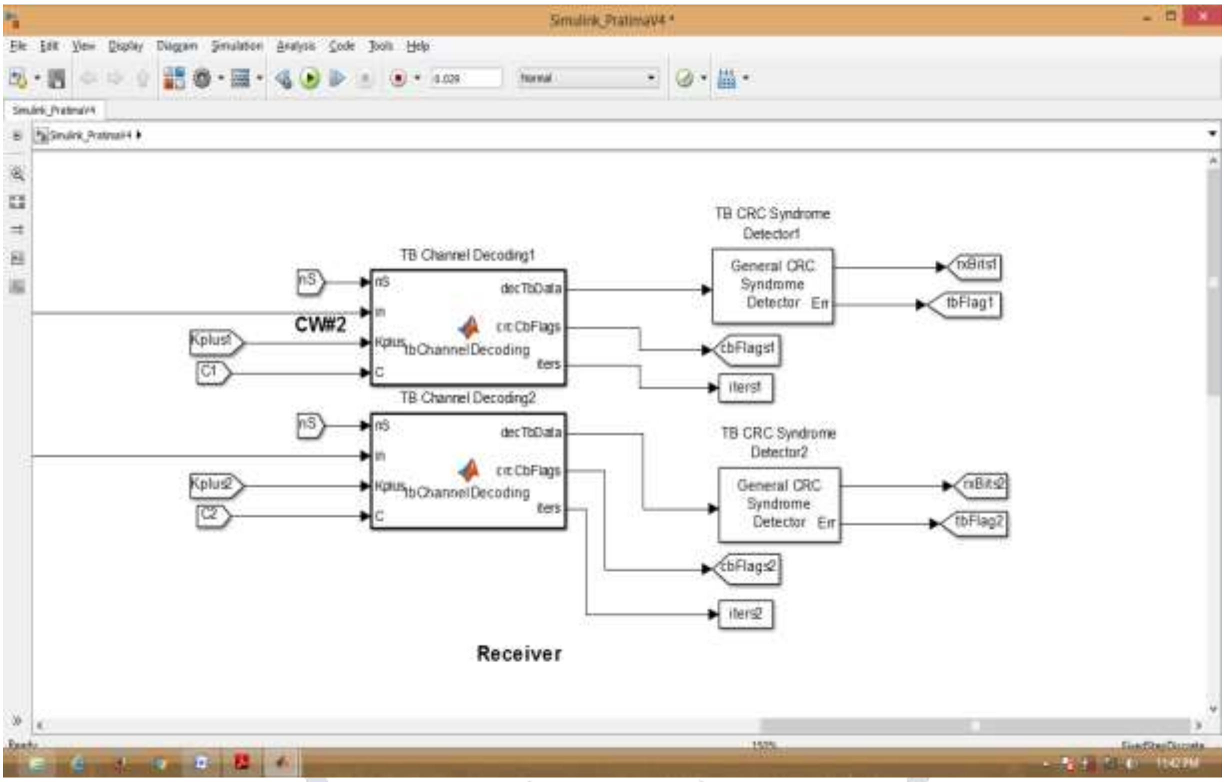

Fig.4: Receiver Model of the Proposed Work

IV. Result

In this section the result obtained for the proposed system with the mentioned configuration and channel type is shown.

The proposed system model is tested for two fading channel types namely Rayleigh and Rician fading channel. The same system is used for the two cases. Once the Rayleigh Fading Channel is selected and then the Rician Fading Channel is selected. For the simulation and to obtain the output the system took long time as observed in this particular PC used for simulation. The time required here is due to the computation complexity and also depends on the PC configuration. The PC Configuration includes Dual Core processer with 1GB of RAM. Hence it is expected that if higher configuration PC would be used the time requirement for processing would have been comparatively lesser. The obtained result as obtained in the model is shown in the figure below.

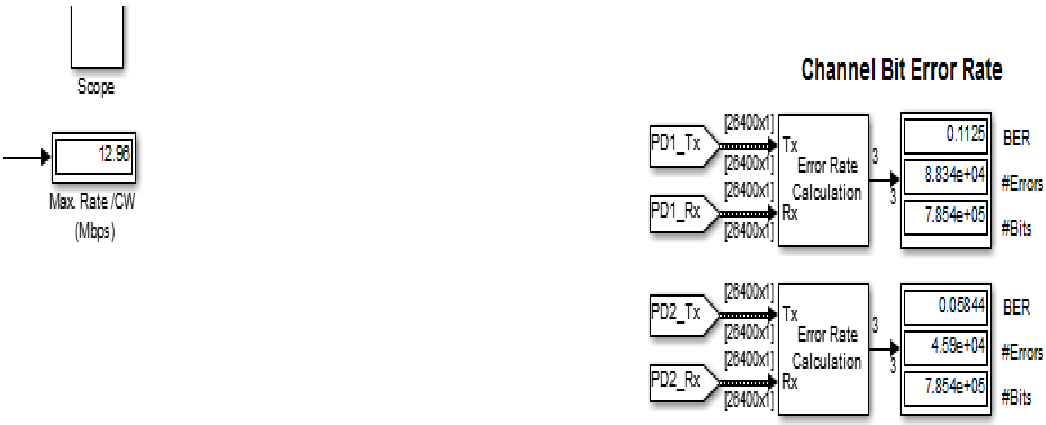

Fig.5: Result (Speed and BER) as obtained for Rayleigh Fading Channel

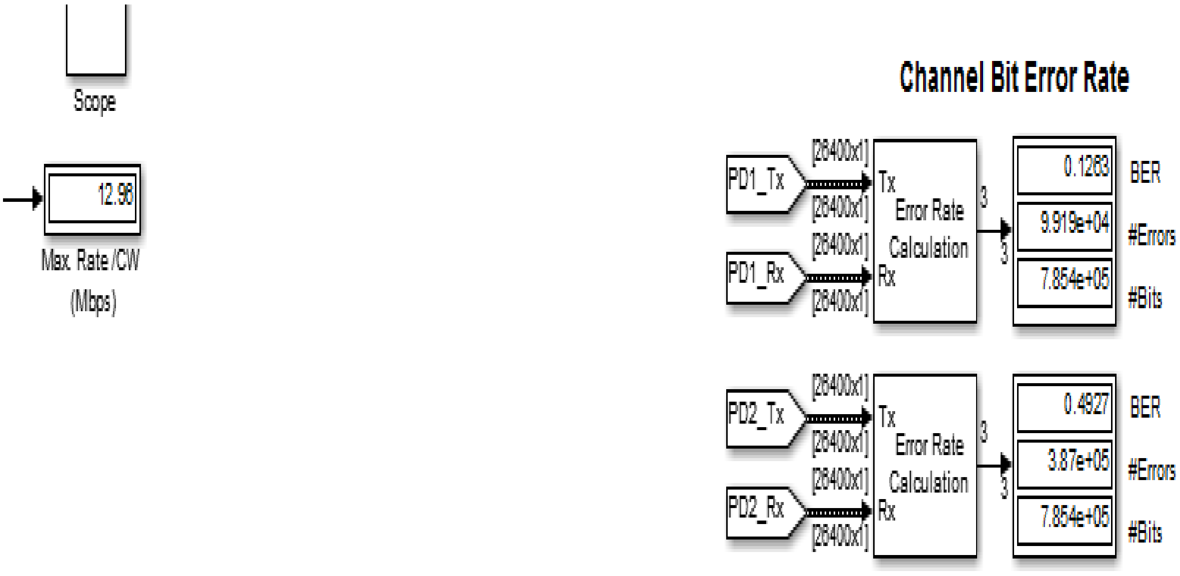

Fig.6: Result (Speed and BER) as obtained for Rician Fading Channel

The table below shows the results obtained for the Rayleigh fading channel for the system configuration.

Table 2: Result obtained for Rayleigh Fading

Configuration	**Speed in Mbps**	**Bit Error Rate (CW1, CW2)**
16QAM, 2x2, EPA 0Hz	12.96	0.1125, 0.0584
64QAM, 2X2, EPA 0HZ	19.6968	0.2079, 0.1456
QPSK, 2x2, EPA 0Hz	6.2	0.0013, 0.0003
16QAM, 2x2, EVA 5Hz	12.96	0.1651, 0.1454
64QAM, 2x2, EVA 5Hz	19.6968	0.2513, 0.2343
QPSK, 2x2, EVA 5Hz	6.2	0.0400, 0.0228
16QAM, 2x2, EPA 5Hz	12.96	0.1977, 0.0700
64QAM, 2x2, EPA 5Hz	19.6968	0.2855, 0.1633
QPSK, 2x2, EPA 5Hz	6.2	0.0388, 0.0036
16QAM, 2x2, EVA 70Hz	12.96	0.1300, 0.1326
64QAM, 2x2, EVA70Hz	19.6968	0.2172, 0.2200
QPSK, 2x2, EVA 70Hz	6.2	0.0310, 0.0321
16QAM, 2x2, flat static MIMO	12.96	0.2785, 0.0485
64QAM, 2x2, flat static MIMO	19.6968	0.3597, 0.1463
QPSK, 2x2, flat static MIMO	6.2	0.0549, 0.0000

The simulation model designed for the evaluation of the speed of the LTE sytem and to find the bit error rate is shown below. The model is designed in Matlab software version R2014a. The aim of the proposed work is to evaluate the performance of the system for two fading channels namely Rayleigh and Rician fading channel.

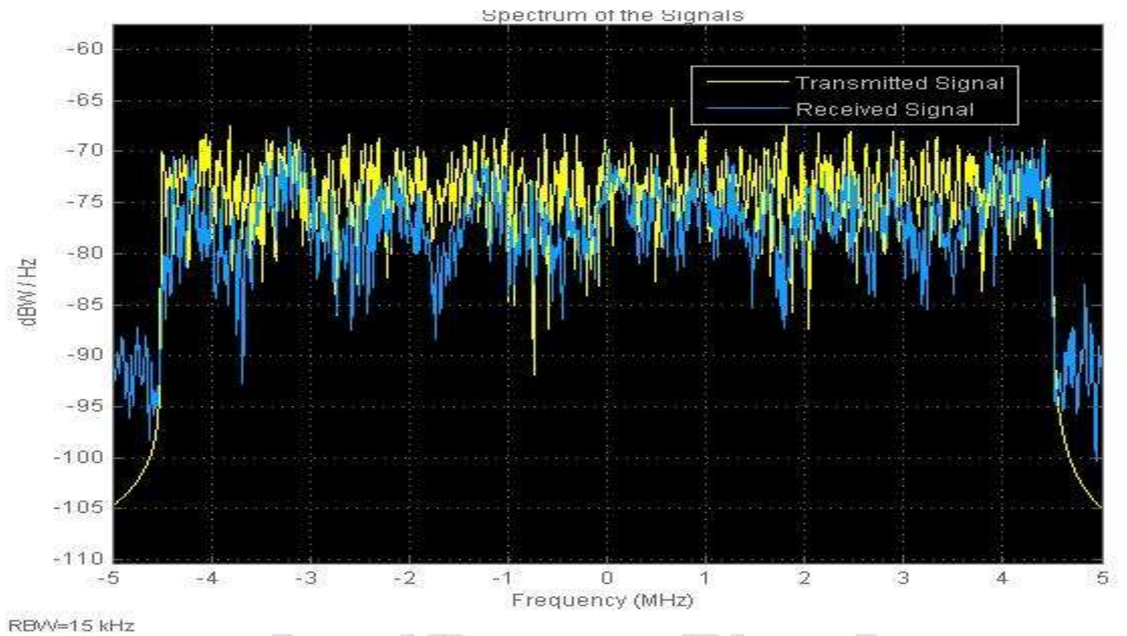

Fig.7: Transmitted and Received Signal Spectrum for 16QAM, 2x2, EVA 5Hz channel with Rayleigh Fading Channel

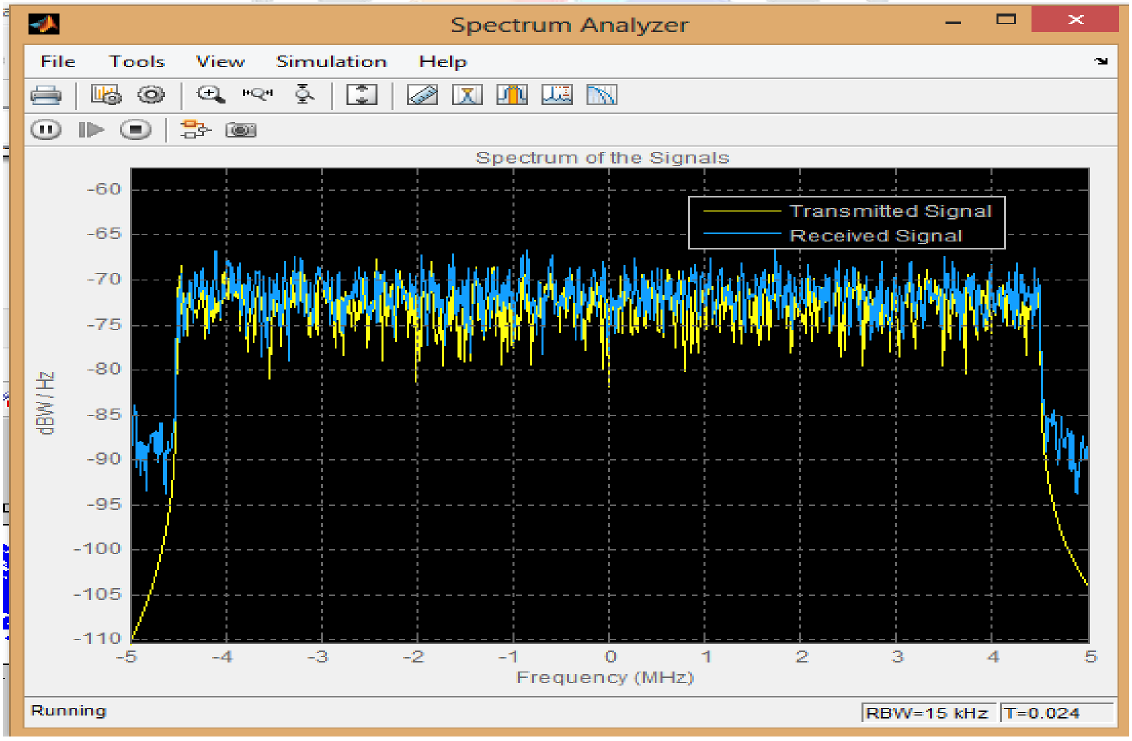

Fig.8: Transmit and received Signal spectrum for 16QAM, 2x2, EVA 5Hz channel with Rician Fading Channel

The BER curve obtained after the simulation of the system for the SNR range from -5 to 13db is shown below. This range is chosen because for simulation the system has been configured for 12.1db of SNR. Other values of SNR can be chosen and this part is left for the future work.

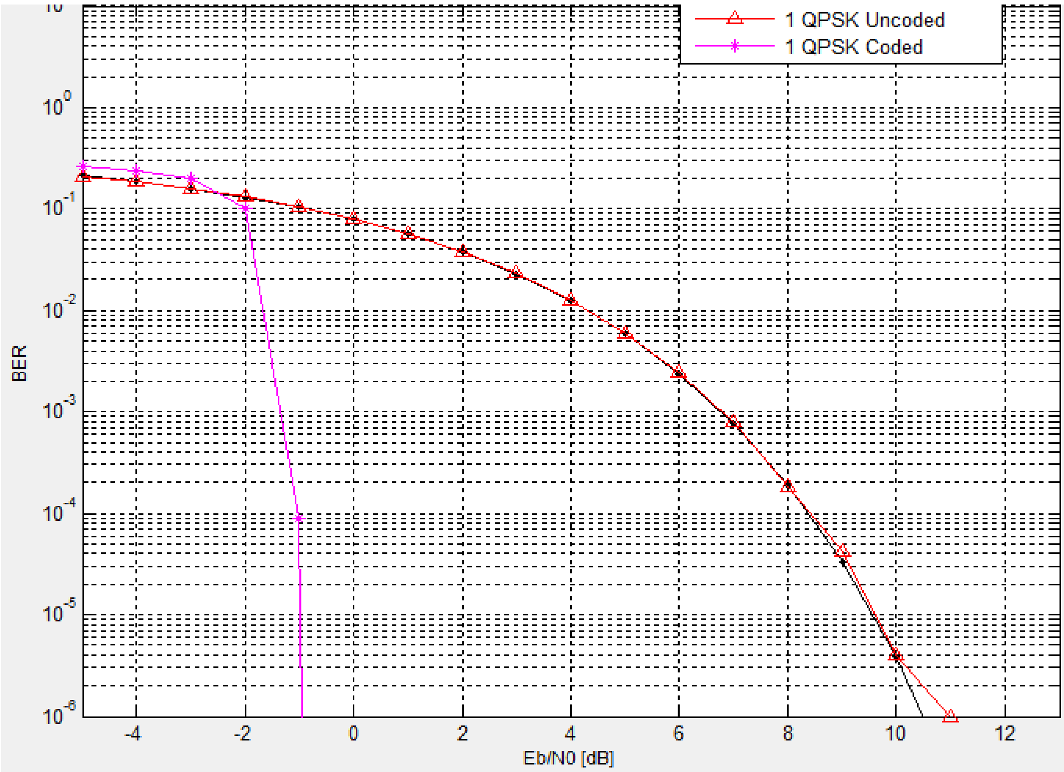

Fig.9: Bit Error Rate of the QPSK Signal

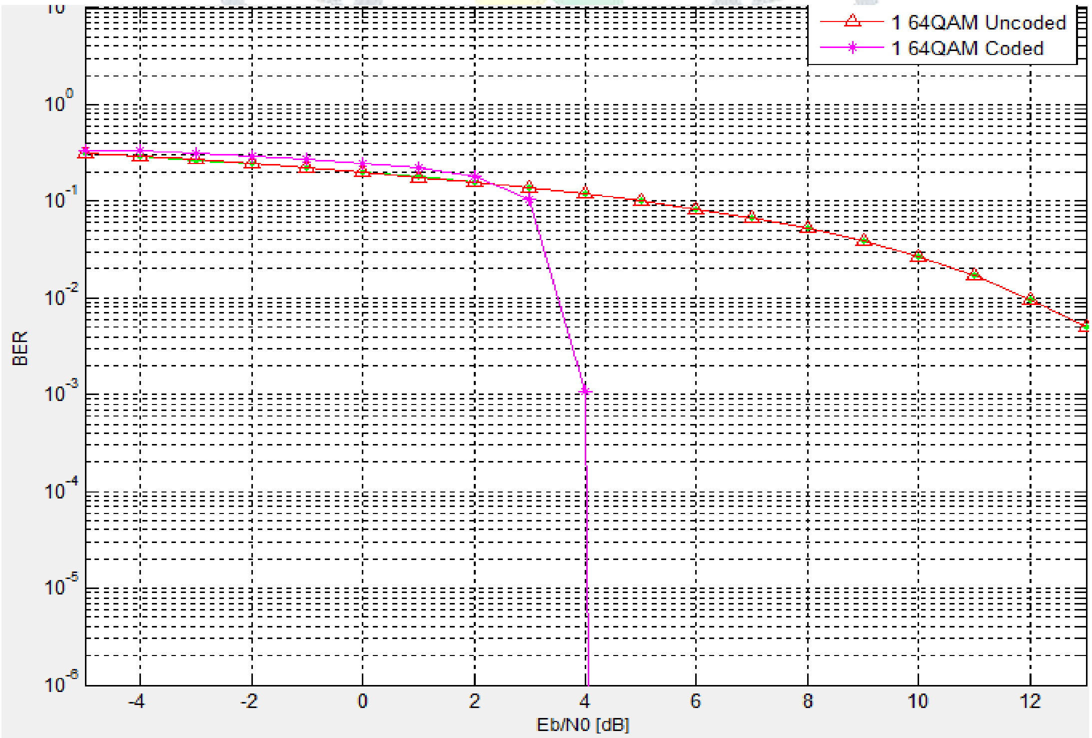

Fig.10: Bit Error Rate of the 64-QAM Signal

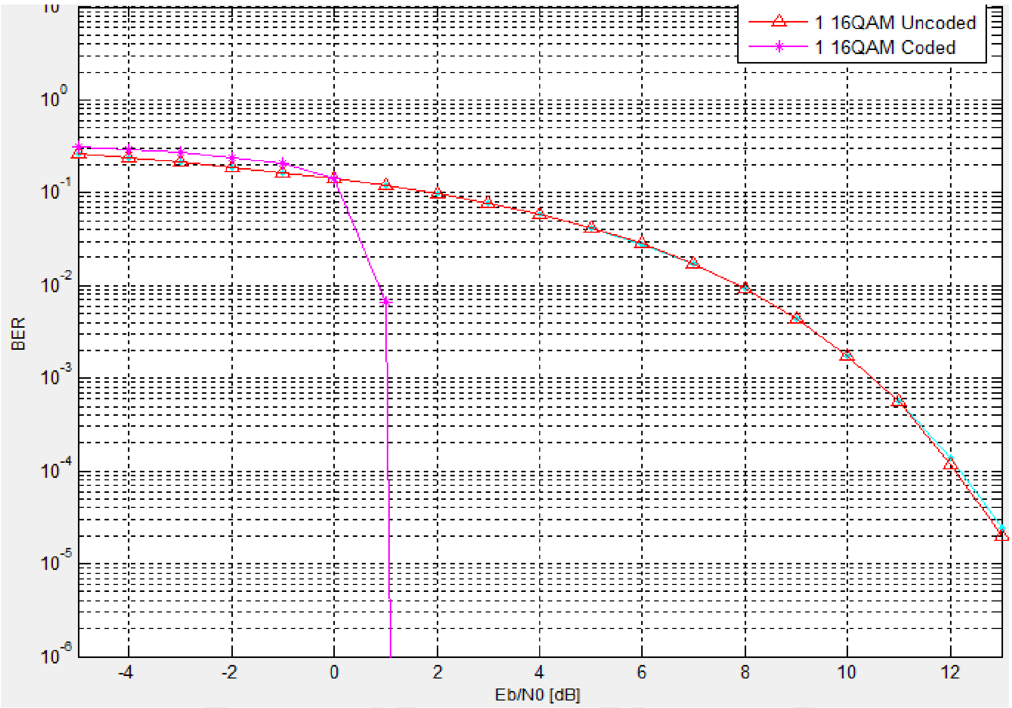

Fig.11: Bit Error Rate of the 16-QAM Signal

V. Conclusion

The main aim of the presented work is to evaluate the performance of the LTE system for different fading channel types. For this the LTE communication model is firstly build. Special considerations and precaution has been taken to design the network components as per the 3GPP standardization. For this a deep literature survey has been done as presented in the literature review section of the thesis. The motivation for the presented work has been obtained from the literature survey itself. Literature survey also helped in finding the problems in the system as discussed in the problem identification part of the thesis. The system designed for the analysis is shown in the methodology part of the thesis. This section also provides all the consideration and configuration done for the proposed system. Finally in the result section of the output of the proposed system has been shown and discussed. The proposed system illustrates the behavior and performance for the two channel fading type namely the Rayleigh and Rician fading channels. The results obtained shows that the Rayleigh fading channel provides better result as compared to the Rician fading channel in terms of Bit Error Rate for the configuration chosen for the system.

Much of the work has been done on the PDSCH channel it could be checked of the PUSCH Chanel type also. The system is evaluated and analysis is done for 12.1 db of SNR value as it is observe in the literature that at this SNR value the result obtained is better. One can choose other value of SNR and check the performance of the proposed system.

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