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Performance Analysis and BER Comparison of 4x4 MIMO OFDM System over Rayleigh and Rician Fading Channel

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Abstract: In modern days, we are using wireless modern communication systems, which require high data rates and more band width efficiencies. The most well-known 4G technology of wireless standard is Long Term Evolution (LTE) which espoused OFDMA (Orthogonal Frequency Division Multiple Access) and MIMO (Multi Input Multi Output) techniques. These techniques are employed on downlink of LTE.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 analyzing the performance of OFDMA and MIMO using 16-QAM, 64- QAM and QPSK modulation over Rayleigh and Rician fading channels by using BER (Bit error Rate)for the performance evaluation of the LTE system in downlink the proposed system determines the Bit Error Rate of the system for MIMO system applications. For the modulation on

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message three supported modulation schemes in LTE namely 16-QAM, 64- QAM and QPSK are applied and then with the use of OFDM the information is transmitted over the network where the signal is distorted by the noise addition using the Rayleigh and Rician Fading channel. Then AWGN is added to model the actual scenario of the transmission medium. At the receiver side this signal is received and the OFDM demodulation is performed then as per the received bits the BER is calculated and then the result is compared among the modulation scheme and the bandwidth used for basically two fading channel types namely Rayleigh and Rician Fading channel.
Keywords: MIMO, OFDM, BER, SNR, Rician, Rayleigh, 16-QAM, 64- QAM, QPSK.

1. INTRODUCTION

Wireless communications is an unexpectedly developing section of the communications industry, with the ability to offer high-quality, high-speed data trade among transportable gadgets placed everywhere with within the world. It has been the concern of research for the reason that 1960s, the high-quality improvement of wireless conversation era is because of the confluence of numerous factors. First, the call for wireless connectivity is exploding. Second, the dramatic advances in VISL generation have enabled the implementation in small, low energy regions of a complicated signal processing and coding algorithm. Third, the second one era wireless a conversation standard, which includes CDMA, GSM, TDMA, permit the transmission of virtual voice and information at low volume. In addition, the third generation of wireless communications can provide customers an extra superior provider that achieves better potential via advanced spectral efficiency [1].

Modern wireless communication systems drive for prime knowledge rates, reliable communications, improved coverage and lower power necessities. Multiple input and output (MIMO) will be known as a candidate to satisfy these challenges. MIMO technology provides higher spectral potency and improves the reliableness of communication systems [2]. Communication through the cooperative sequence improves speed and expands the coverage space [3]. It conjointly reduces the requirement to use high transmit power, that successively reduces interference with alternative nodes. each technologies can even be wont to win abstraction diversity. Recent studies have aroused increasing interest in MIMO relay, which may use key resources to optimize wireless color amendment and gain the benefits of each technology [4].

With the development of era, wireless conversation has spawned its new modern technique for distinct packages in diverse fields. Interest in better statistics costs and the growing range of wireless gadgets are using growing interest in information transmission. This required such type of conversation gadget having better ability and overall performance. The mixture of orthogonal frequency division multiplexing with more than one inputs and more than one outputs is one technique which could fulfill this requirement. It is taken into consideration as a primary approach in numerous structures with excessive information rate, as example IEEE standards like 802.16, which leads to first rate overall performance and excessive frame efficiency. In addition, there may be no want to enlarge the bandwidth or transmit power. Due to this combinatorial technique, there can be a first

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rate revolution within side the subject of conversation [5]. MIMO and OFDM can characteristic as bodily layers of key improvements for the destiny flexible communications framework. These are LTE and WIMAX. For most use of the spectrum to be had within side the frame and to enhance the capacity of the frame, the water filling set of rules mixed with the SVD technique became used. This study is likewise devoted to studying the feature parameters that have an effect on the overall performance of the approaching Massive MIMO era for 5G networks.

2. MIMO COMMUNICATIONS

MIMO has been produced for a long time for wireless frameworks. One of the primary uses of MIMO to wireless correspondences happened during the 1980s with the progressive headways of Jack Winters and Jack Saltz of Bell Laboratories [6]. They attempted to send information from multiple clients on a similar recurrence/time channel utilizing multiple receiving wires on both the transmitter and beneficiary. From that point forward, a few scholastics and designers have made noteworthy commitments to the field of MIMO. Today, MIMO innovation has started enthusiasm for its likely applications in computerized TV, wireless LANs, metro organizations and portable correspondences. The MIMO system uses multiple antennas in each the transmitter and receiver to enhance the performance of the communication system victimization varied technologies and multiplexing. The MIMO system provides higher spectral potency, improves responsibility, weakening reduction, and higher interference resistance [2].

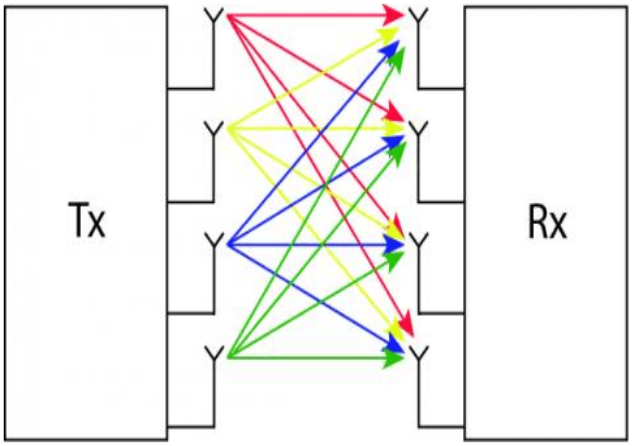

Fig 1: A 4x4 MIMO System

3. ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING (OFDM)

In OFDM, a fast information stream is isolated into an assortment of low speed streams. These streams are sent at the same time through some smaller sub channels. OFDM isn't just a regulation method; it is additionally a multiplexing strategy. A realistic portrayal will encourage the comprehension of the working of OFDM since its first letters in order is "O", ie orthogonal. Because of this property, orthogonal frequency division multiplexing contrasts from frequency division multiplexing. The idea of bit rate assumes a significant function on account of frequency area. These communicated bits characterize the otherworldly effectiveness cycle of any edge. In a multi-transporter transmission, the casing will be data transfer capacity effective if the dispersing between the sub-transporters is satisfactory.

Orthogonal Frequency Division Multiplexing (OFDM) is an advanced adjustment measure in which the information stream is isolated into N equal surges of diminished information rate and each stream is communicated on

autonomous subcarriers. To put it plainly, it is a sort of multi-transporter advanced specialized technique. OFDM has been around for around 40 years and was first planned during the 1960s and 1970s during exploration to limit impedance between neighboring frequency channels [7]. OFDM has showed up in places as different as wideband topsy-turvy DSL (ADSL) and advanced sound video communicates. OFDM is likewise effectively applied to a wide assortment of remote interchanges because of its high information bandwidth with high transfer speed proficiency and power to multipath delay [8].

4. MIMO-OFDM

MIMO is an advanced antenna strategy for next-generation remote access that can carry significantly more data traffic than today's more advanced third-generation networks. OFDM is another famous radio innovation that gives the answer for range difficulties. Yet, these advancements independently don't yield higher data rates [9]. With OFDM, a solitary direct in an unearthly band can be part into a few littler sub-flags that communicate data all the while without obstruction. Because MIMO technology is able to bring together many smaller antennas to function as one, it can receive and send these multiple OFDM sub-signals in a way that significantly increases the bandwidth for each user as needed. The development of OFDM in mix with MIMO offers an attractive interface and gives the suitable reaction to [10]:

- New-era remote networks
- Next era remote metropolitan zone networks
- Fourth-era portable cell remote frameworks.

MIMO-OFDM innovations are critical in current wireless communication frameworks, as they can significantly increment unearthly proficiency. As of late, monstrous MIMO frameworks, furnished with tens or even many receiving wires, have developed as an improved MIMO procedure to fulfill the expanding traffic needs of fifth era (5G) wireless communication organizations [11].

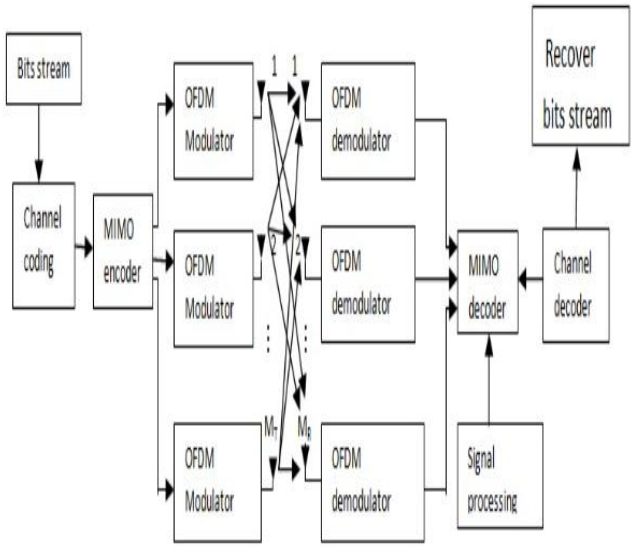

Fig 2: Architecture of OFDM with MIMO

5. SYSTEM CONFIGURATION AND SIMULATION OF THE PROPOSED WORK

So as to have the option to evaluate arrange execution, use LTE as a correspondence convention and answer investigate inquiries right now, must form a model that reproduces LTE usefulness and system conditions. This recreation is the primary apparatus right now gives the important data on the exhibition of the framework. Sadly, because of the incredible multifaceted nature of LTE systems and PC confinements, work restrains the extent of research and settles on significant decisions with respect to parts of these frameworks that are structured in the

test system. Right now, decisions and suspicions are clarified, the displaying made disentangled, and a full portrayal of the model is given. Right now, plan and model principle highlights are examined. LTE physical layer execution, that is, the word BER code regarding SNR plans, is performed considering the FDD playback of different advanced balance plans, for example, QPSK, 16-QAM and 64-QAM under MIMO disappearing channels reenacted utilizing MATLAB.

The simulation model designed for the evaluation of the speed of the LTE system and to find the bit error rate is shown below. The model is designed in Matlab software version R2015a. 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	20MHz
Duplex mode	FDD
Transmit Channel Modulation	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	4×4 MIMO

6. RESULT

Table 2: BER and Speed of Rayleigh Fading Channel

Configuration	Speed in Mbps	Bit Error Rate (CW1, CW2)
16QAM, 4x4, EPA 0Hz	61.664	0.4585, 0.4644
64QAM, 4x4, EPA 0HZ	149.776	0.4726, 0.4766
QPSK, 4x4, EPA 0Hz	31.704	0.438, 0.4513
16QAM, 4x4, EPA 5Hz	61.664	0.4585, 0.4844
64QAM, 4x4, EPA 5Hz	149.776	0.4726, 0.4766
QPSK, 4x4, EPA 5Hz	31.704	0.438, 0.4513
16QAM, 4x4, EVA 5Hz	61.664	0.4585, 0.4844
64QAM, 4x4, EVA 5Hz	149.776	0.4726, 0.4766
QPSK, 4x4, EVA 5Hz	31.704	0.438, 0.4513
16QAM, 4x4, EVA 70Hz	61.664	0.4585, 0.4844
64QAM, 4x4, EVA70Hz	149.776	0.4726, 0.4766

QPSK, 4x4, EVA 70Hz	31.704	0.438, 0.4513
16QAM, 4x4, flat static MIMO	61.664	0.4585, 0.4844
64QAM, 4x4, flat static MIMO	149.776	0.4726, 0.4766
QPSK, 4x4, flat static MIMO	31.704	0.438, 0.4513

In Fig 3 shown the BER Analysis in Different Modulation Scheme using different channel type in Rayleigh Fading Channel, in which we get the in QPSK modulation scheme low value of bit error rate(BER) and In Fig 4 shown the Speed Analysis in Different Modulation Scheme using different channel type in Rayleigh Fading Channel.

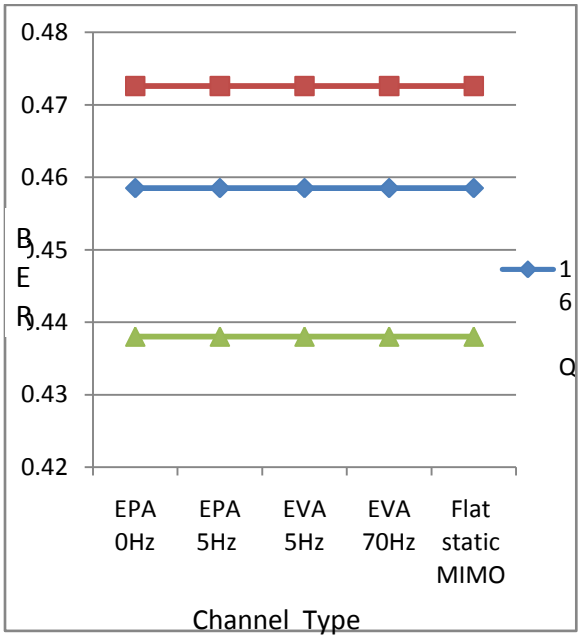

Fig 3: BER Analysis in Different Modulation Scheme using different channel type in Rayleigh Fading Channel

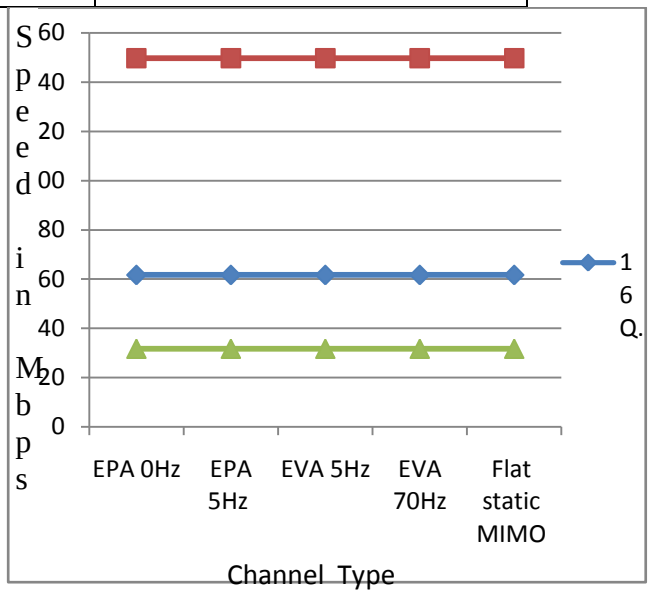

Fig 4: Speed Analysis in Different Modulation Scheme using different channel type in Rayleigh Fading Channel

In table 3 shown the Bit Error Rate (BER) and Speed of the Rician Fading channel in different Modulation (QPSK, 16-QAM, 64-QAM) schemes and different channel type (Flat Static MIMO, EPA 0Hz, EVA 5Hz, EVA 70Hz).

Table 3: BER and Speed of Rician Fading channel

Configuration	Speed in Mbps	Bit Error Rate (CW1, CW2)
16QAM, 4x4, EPA 0Hz	61.664	0.3983, 0.3992
64QAM, 4x4, EPA 0HZ	149.776	0.4349, 0.4352
QPSK, 4x4, EPA 0Hz	31.704	0.3367, 0.3397
16QAM, 4x4, EPA 5Hz	61.664	0.3983, 0.3992
64QAM, 4x4, EPA 5Hz	149.776	0.4349, 0.4352
QPSK, 4x4, EPA 5Hz	31.704	0.3367, 0.3397
16QAM, 4x4, EVA 5Hz	61.664	0.3983, 0.3992
64QAM, 4x4, EVA 5Hz	149.776	0.4349, 0.4352
QPSK, 4x4, EVA 5Hz	31.704	0.3367, 0.3397
16QAM, 4x4, EVA 70Hz	61.664	0.3983, 0.3992
64QAM, 4x4, EVA70Hz	149.776	0.4349, 0.4352
QPSK, 4x4, EVA 70Hz	31.704	0.3367, 0.3397
16QAM, 4x4, flat static MIMO	61.664	0.3983, 0.3992
64QAM, 4x4, flat static MIMO	149.776	0.4349, 0.4352
QPSK, 4x4, flat static MIMO	31.704	0.3367, 0.3397

In Fig 5 shown the BER Analysis in Different Modulation Scheme using different channel type in Rician Fading channel and Fig 6 Shown the Speed Analysis in Different Modulation Scheme using different channel type in Rician Fading channel.

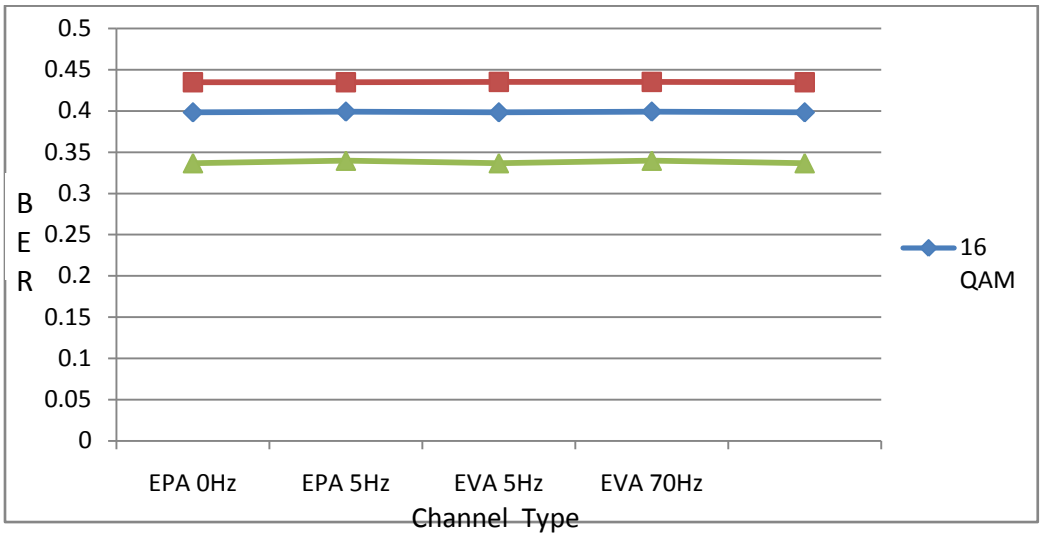

Fig 5: BER Analysis in Different Modulation Scheme using different channel type in Rician Fading channel

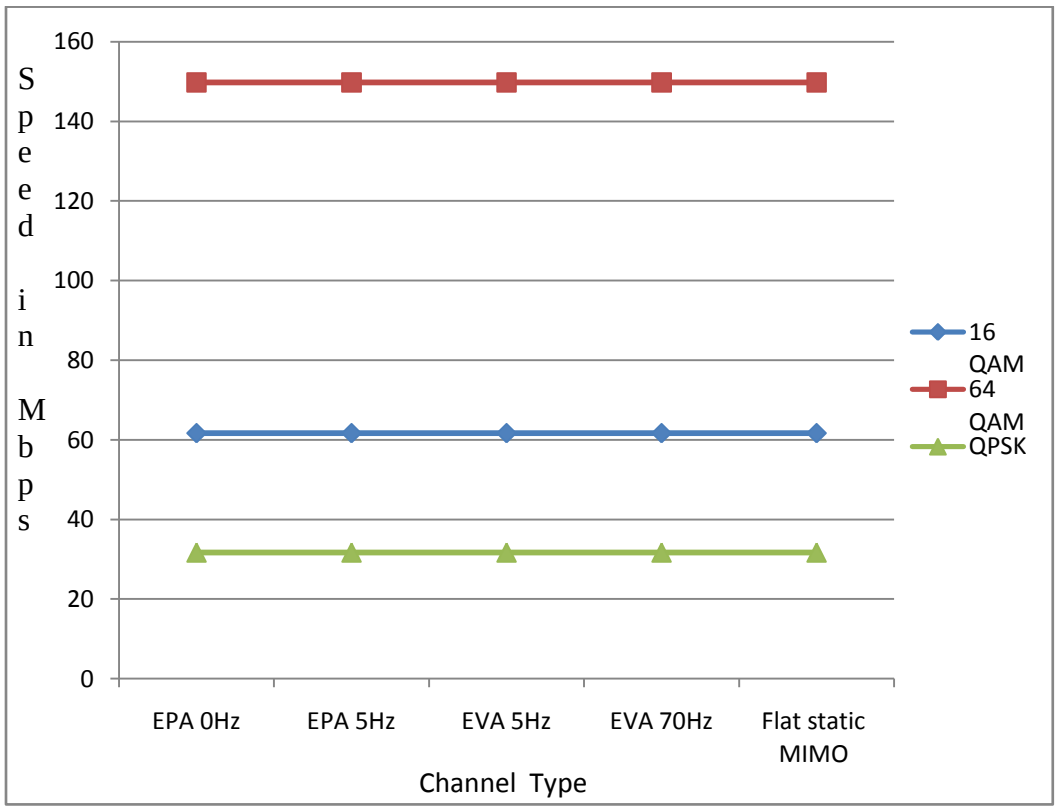

Fig 6: Speed Analysis in Different Modulation Scheme using different channel type in Rician Fading channel

In Fig 7 shown the comparative analysis of BER in different modulation schemes (16QAM, 64QAm, QPSK) using different channel type in Rayleigh and Rician Fading Channel.

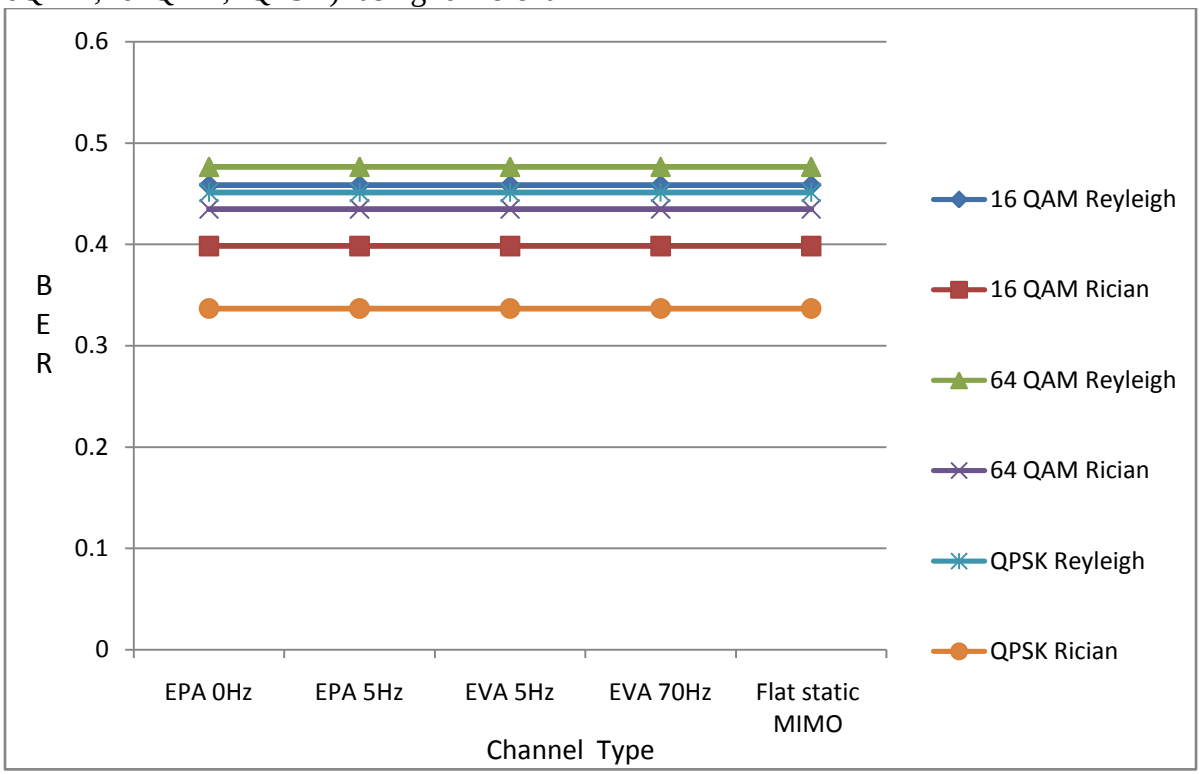

Fig 7: Comparative Analysis of BER in Different Modulation Scheme using different channel type in Rayleigh and Rician Fading Channel

7. 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 thesis 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 Rician Fading channel provides better result as compared to the Rayleigh fading channel in terms of Bit Error Rate for the

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configuration chosen for the system. In QPSK modulation get the low bit error rate in all the Channel type like Flat Static MIMO, EPA 0Hz, EVA 5Hz, EVA 70Hz.

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