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# Error Rate Performance of OFDMA and MIMO Technology Over Rayleigh Fading Channel in 4G Networks

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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. In this research paper we are analyzing the performance of OFDMA and MIMO using BPSK, QPSK and 16 QAM modulation over Rayleigh fading channels by using BER (Bit error Rate) and schemes $E_b$/No (db).

**Keywords:** LTE, OFDMA, MIMO, BPSK, QPSK,16QAM, BER.

## INTRODUCTION

The modern wireless communication systems place increasing demands on high speed, high data rate and bandwidth efficiency. Various factors are degrading the successful transmission performance of data stream such as propagation loss, interference, limited bandwidth and fading due to multipath propagation [1]. Multiple numbers of antennas are decreasing the fading effects at the transmitter end and receiver end and increasing the capacity through diversity techniques [2]. OFDMA and MIMO techniques should provide high data rates in wireless systems. OFDMA and MIMO have become an experimental interesting research wing in wireless communications performance [3]. The communication technologies initially started at first generation (1G) thereby gradually increases and it attained to the fourth generation. The multiple access technologies are used in fourth generation (4G) communication systems. It is a new technology known as Long Term Evolution (LTE). OFDMA and MIMO technologies are used on the downlink (DL) in LTE. The fourth generation provides different qualities such as [4, 5].

- Good bandwidth efficiency
- High data rate
- Immunity to multipath
- High area coverage
- Extreme High quality audio/video
- Cost reduction

A diverse features are associated with each technology [4, 5,6].

## LTE TECHNOLOGIES

### *A. OFDMA (Orthogonal Frequency Division Multiple Access)*

It is a paramount of multi access technique used in LTE system especially at downlink of the channel. Also for the accessing it bears high quality of service (QOS). OFDMA has diverse attributes such as, Sturdiness to channel fading, high litheness, high spectral efficiency and simple equalization [7, 6]. All these striking attributes made OFDMA become more precious for high speed transmission of data and more fascinating for other data transmission techniques. In this technique, the entire frequency band is alienated into a numeral of orthogonal subcarriers [4].

A general architecture of an OFDMA system is as shown in figure 1. At the transmitter end of OFDMA, the available bandwidth is partitioned into frequency subcarriers, which are said to be orthogonal and firstly the series of data is transformed into parallel data streams. This Parallel data is then modulated by using modulation schemes like (BPSK/QPSK/16 QAM) thereby the modulated signal passes through transform stage i.e., Fast Fourier transform can be inversed (FFTI). FFTI stage transforms the frequency domain symbol into the time domain symbol [9] and generates OFDM symbols. The Time domain symbol may create Inter Symbol Interference (ISI) problem. The data are converted into a serial data. A guard band is added between orthogonal symbols in order to eliminate the Inter Symbol Interference (ISI). The resultant data is transmitted through the channel.

At the receiver end of OFDMA, the reversible processes occur at the transmitter end. The guard band is then removed and data stream is converted from Serial to Parallel data streams. The resultant data stream is passed through Fast Fourier Transform (FFT) [9]. In FFT stage orthogonal symbol converts from time domain into a frequency domain followed by demodulated subcarrier. The demodulated signal converts Parallel data streams into serial data streams [9].

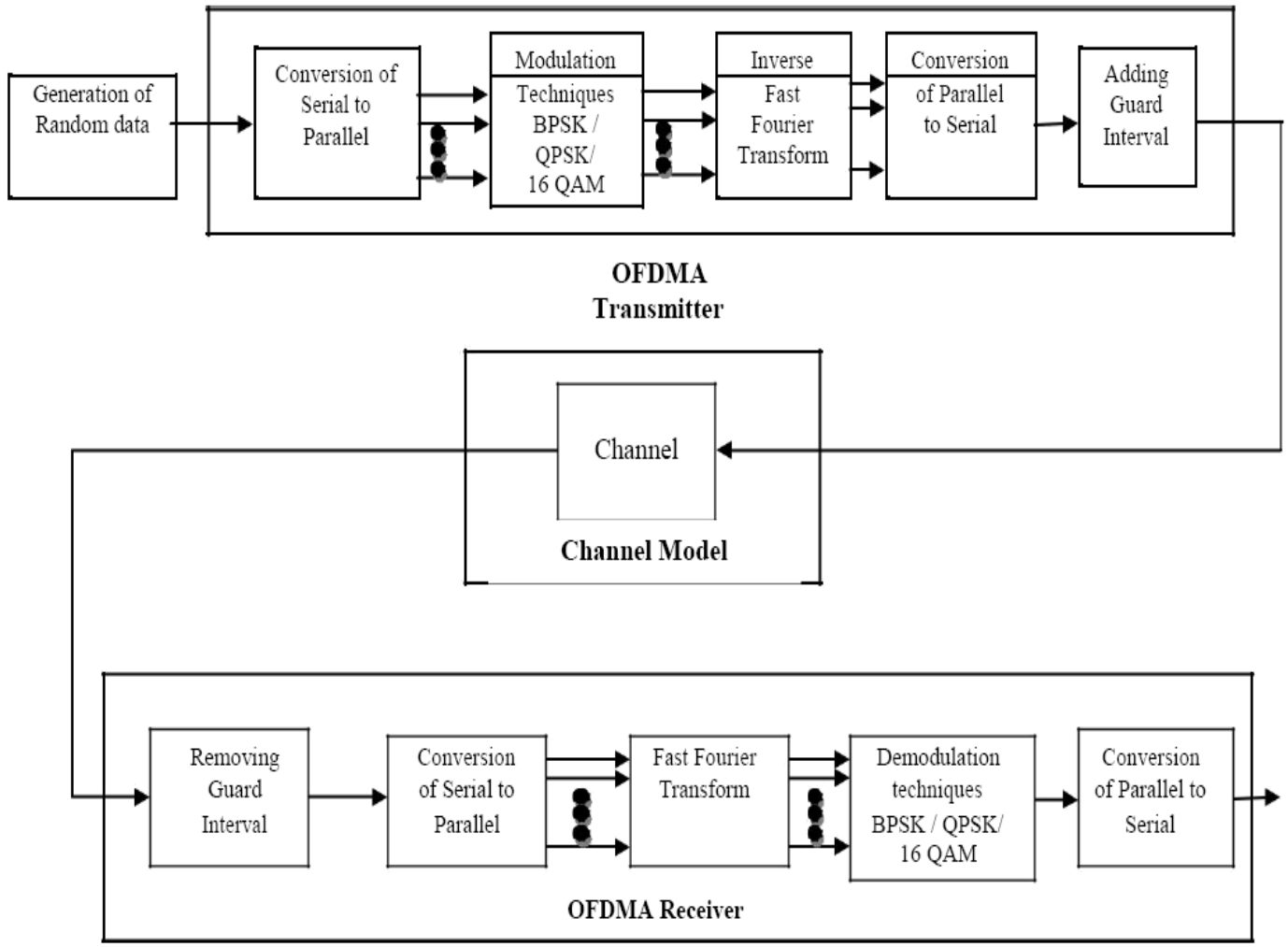


**Figure 1:** Transmitter and Receiver Block Diagram of OFDMA

OFDMA has the following limitations: it seizes a high peak to average power ratio, it is more responsive to carrier frequency offset and Inter carrier Interference (ICI)[4,9,10].

### *B. Multi Input Multi Output (MIMO)*

It stands for Multi Input Multi Output configuration. A general architecture of an OFDM system is shown in figure 2. MIMO system consists of multiple transmit antennas ($N_T$) and receive antennas ($N_R$). Multiple antennas transfer data at the same time. MIMO increases spectral efficiency of the transmitted data, throughput and increasing data rate [4, 11]. At the end of the transmitter the transmitted data streams are alienated into multiple bit streams and passed through multiple antennas [11, 12].The medium such as channel accesses the bit streams and projected to receiver antenna. In the receiver the transmitted original is recovered by a unique pattern matching method. The major limitations of MIMO techniques are poor system performance; more complexity battery power consumption is more.

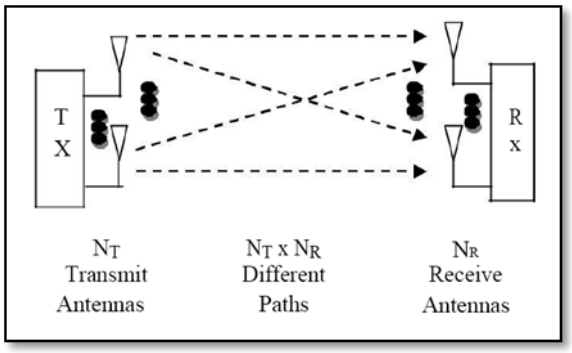


**Figure 2:** 2x2 MIMO

## EXPERIMENTAL RESULTS

Complete simulation work is implemented in MATLAB. We analyzed OFDMA and MIMO multiple access techniques over Rayleigh fading channel in LTE networks. We evaluated the performance of OFDMA and MIMO using Bit error rate (BER) and $E_b/N_o$ as performance metrics.

### *A. Rate of Bit Error (RBER):*

Where RBER can be defined as the division of error bits number to the number of total bits transmitted. It can be represented by using the following expression:

BER = Error Bits Number/ Number of total bits Transmitted.

### *B. $E_b/N_o$ :*

$E_b/N_o$ is defined as the ratio of energy of the bit by bit ($E_b$) to the power spectral density of the noise ($N_0$) and it can be expressed using db.

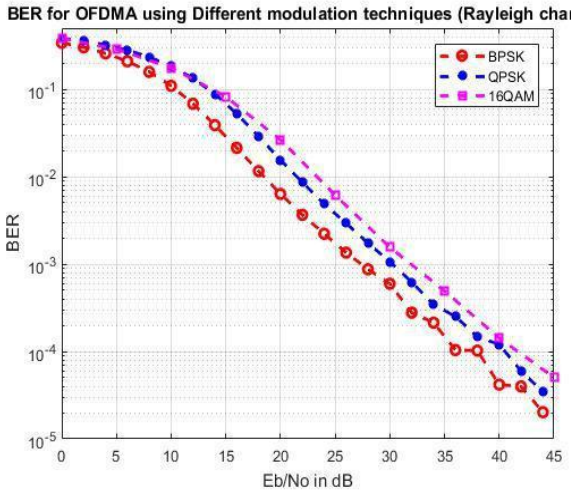


**Figure 3:** Simulated BER Vs Eb / $N_0$ of OFDMA over Rayleigh Fading Channel

Fig.3. portray simulated results of OFDMA system, and comparison of BPSK, QPSK and 16-QAM schemes in Rayleigh fading channel. These results are related to Bit Error Rate (BER) and $E_b/N_o$ values.

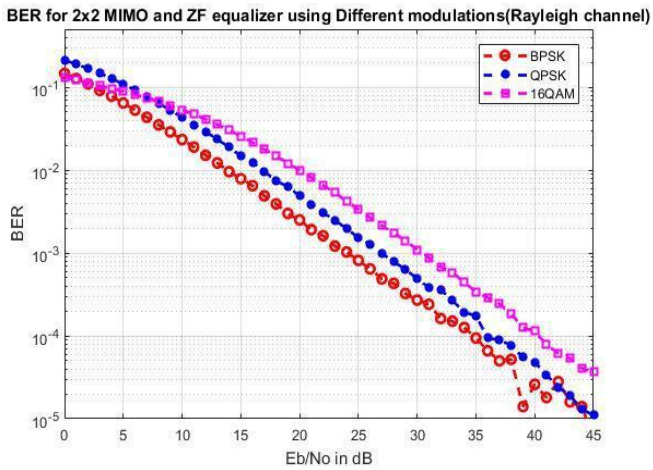


**Figure 4:** Simulated BER Vs Eb / $N_0$ of MIMO over Rayleigh Fading Channel

Fig. 4 shows simulated results of Multiple Input and Multiple Output (MIMO) system and comparison of Binary Phase Shift Keying (BPSK), Quadrature Phase Shift Keying (QPSK) and 16-Quadrature Amplitude Modulation (16QAM) schemes in Rayleigh fading channel. These results are related to Bit Error Rate (BER) and $E_b/N_o$ values.

## CONLUSION

In this paper OFDMA and MIMO are simulated using BPSK, QPSK and 16 QAM modulation techniques in LTE networks. The performance can be evaluated by using error rate of the bit (RBER) and $E_b/N_o$. We analyzed error rate performance of OFDM and MIMO Technology using Rayleigh fading channel in LTE networks. The BER can be further improved by using MIMO with OFDMA system.

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