# Bit Error Rate Performance of Long Term Evolution (LTE) Network

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# Bit Error Rate Performance of Long Term Evolution (LTE) Network

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**Abstract**

In this paper we monitored the bit error rate (BER) performance of LTE network system under adaptive modulations and OFDM system over an additive white Gaussian noise (AWGN) and multi path fading (selective fading & flat fading) channels. Using Mat lab based simulation software program. the parameter which were taken into consideration of the performance are AWGN selective, flat fading channels, cycle prefix, and the bandwidth .the results were obtained in terms of chart for bit error rate against signal to noise rate.

***Keywords:*** *LTE, BER, OFDM, AWGN, Fading.*

## I. Introduction

Mobile broadband is a reality today and is growing fast, as members of the internet generation grow accustomed to having broadband access wherever they go, and not just at home or in the office and the Demand for this high speed in wireless communication systems, a new wireless data networks has been emerged and standardized by the 3rd Generation Partnership Project (3GPP). This new standard is marketed as 4G Long Term Evolution (LTE){1}. In LTE, the wireless data speed and data throughput are increased by using a combination of a number of novel technologies namely Multiple-Input Multiple-Output (MIMO) antennas, The baseline antenna configuration consists of two transmit antennas at the base station and two receive antennas at the Mobile Terminal (MT). The possibilities for higher-order schemes are considered up to a maximum of four transmit and four receive antennas [2]. Orthogonal Frequency Division Multiplexing (OFDM) and Orthogonal Frequency Division Multiple Access (OFDMA) at the downlink, Single Carrier Frequency Division Multiple Access (SCFDMA) at the uplink, support for the (16QAM), 64QAM,(QPSK) The performance of a MIMO-OFDM communication system significantly depends upon the estimation of channel{3}. MIMO technology involves the use of multiple antennas at the transmitter, receiver or both. The diversity and multiplexing modes are the two main modes of operation of multiple antenna systems. On the other hand, OFDM is a modulation technique which transforms frequency selective channel into a set of parallel flat fading channel [4]. Hence LTE will be very convincing for network operators that already have HSPA networks running [5]. Comparing the performance of 3G and its evolution to LTE, LTE does not offer anything unique to improve spectral efficiency, i.e. bps/Hz. LTE improves system performance by using wider bandwidths if the spectrum is available [6]. LTE downlink transmission scheme is based on Orthogonal Frequency Division Multiple Access (OFDMA), while the uplink transmission is based on Single Carrier Frequency Division Multiple Access (SC-FDMA). The main drawback of OFDMA over SC–FDMA is its high Peak to Average Power Ratio (PAPR) [7]. OFDMA allocates individual users in the time and the frequency domain and its signal generation in the transmitter is based on the Inverse Fast Fourier Transform (IFFT) [8]. LTE is focusing on an optimum support of Packet Switched (PS) services [9]. This paper is organized as follows: In Section II the mathematical models and Section III the Descriptive Analysis, implementation in section IV and simulation results are shown in Section V. Finally, conclusions are given in Section. VI

## II. Mathematical Models

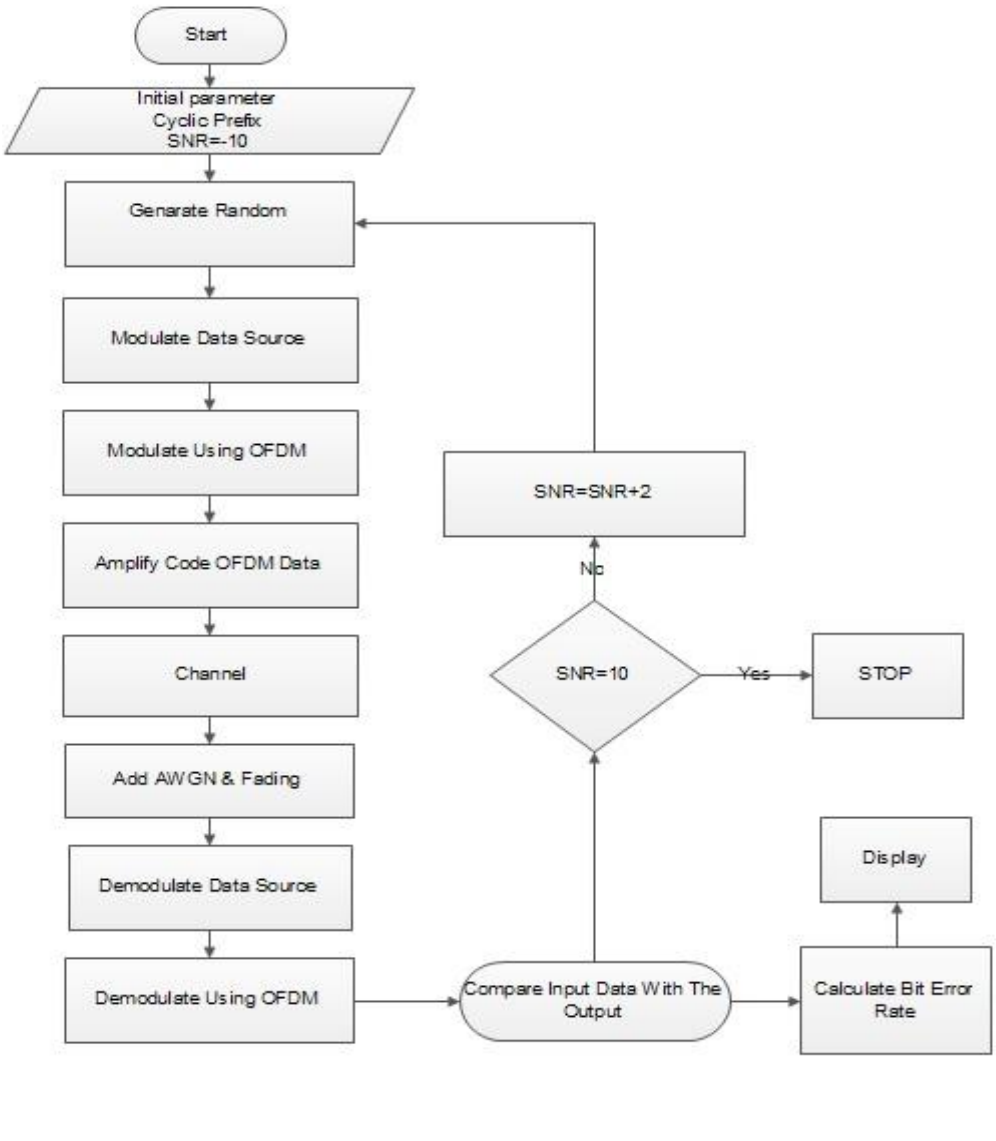
The theoretical bit error rate performance with SNR for different types of digital modulation such as BPSK, 4QAM and 16QAM for Rayleigh flat fading environment is given by:

$$P(BPSK)=0.5\ (1-\sqrt{SNR/(1-SNR)}) \quad (1)$$

P(4QAM)=0.5 (1-√SNR/(2-SNR)) (2)

P(16QAM)==0.5 (1-√SNR/(10-SNR)) + 0.5 (1-√9SNR/(10-0SNR)) (3)

## III. Descriptive Analysis




To design and implementation of LTE network with 5 and 10 MHZ capacities, The random data source had been data Modulated, using one of the BPSK, QPSK, 16-QAM or 64-QAM constellations specified and the Orthogonal Frequency Division Multiplexed (OFDM) transmission and a variable cyclic prefix length with the addition of cyclic prefix(1/4,1/8,1/16 and 1/32) and starting with a signal to noise ratio 0 to

25 stepped with 5 , then the data will be encoded using OFDM to transmit the signal . At the channel side the kinds of the multipath fading used were No Fading, flat fading and selective fading. The Additive White Gaussian Noise (AWGN) was added. Then in the receiver side the OFDM signal transmitted will be demodulated and decoded, The signal is received and processed at the receiver with inverse order of blocks, comparing with the transmitter, If the signal is received correctly, the receiver used (FEC) will send an acknowledgment to the transmitter and calculates the available bit error rate.

## IV. Implementation

We implemented the BER performance of LTE model with MATLAB which characterized with a library function for transmitters module, channel and receiver which is powerful for communication, and it have built LTE system module.

**The simulation environment is shown in Table (1) as follows:**

| Parameter | Value |
|---|---|
| Signal to noise Ratio SNR (dB) | 0,5,10,15,20,25 |
| Bandwidth (MHz) | 5,10 |
| Number of symbols per burst | 4 |
| Cyclic Prefix | 1/4,1/8,/1/16,1/32 |
| Fading Mode | No Fading, Flat Fading, Selective Fading |
| Maximum Doppler Shift (Hz) | 0.5 |
| K Factor | 0.5 |

**Table 1: Environment Parameters**

The simulator block diagram of BER Performance of LTE using MATLAB is shown in figure 1 below:

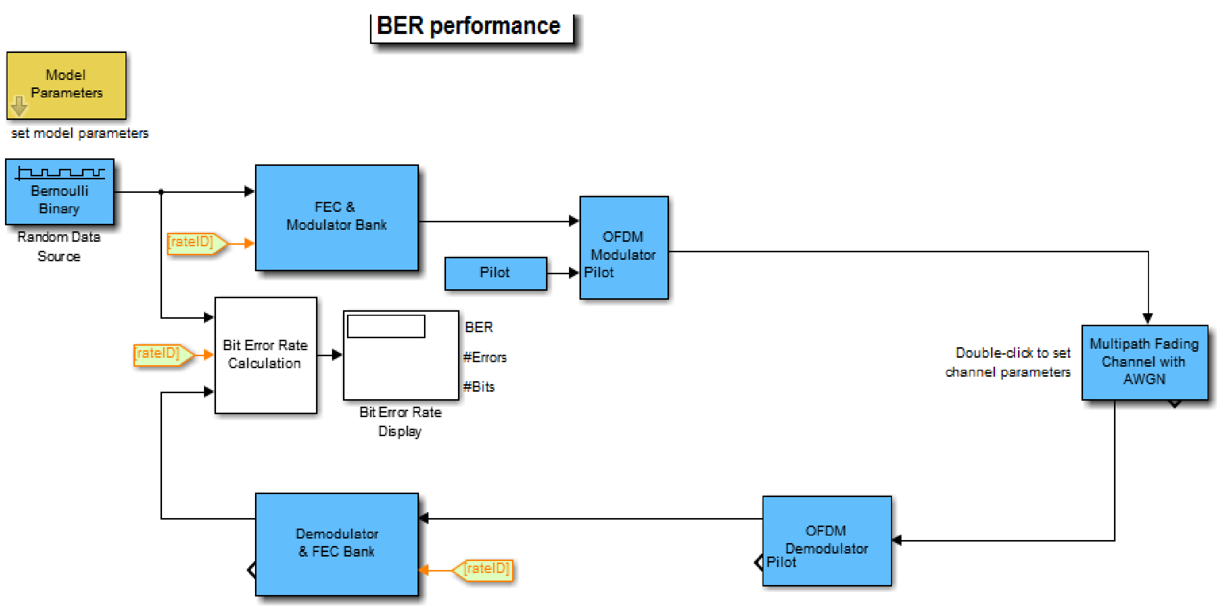



**Figure (1) BER Performance Analysis of LTE**

## V. Result

**-BER for different fading**

| SNR(dB) | Sum of BER(No Fading) | Sum of BER(Flat Fading) | Sum of BER(Selective Fading) |
|---|---|---|---|
| 0 | 0.1906 | 0.1951 | 0.2431 |
| 5 | 0.00316 | 0.003623 | 0.0025 |
| 10 | 0 | 4.75E-07 | 6.87E-06 |
| 15 | 0 | 4.63E-06 | 1.42E-05 |
| 20 | 0 | 0 | 0 |
| 25 | 0 | 0 | 0 |
| | | | |

**Table 2 SNR VS BER for no fading, flat fading and selective fading**

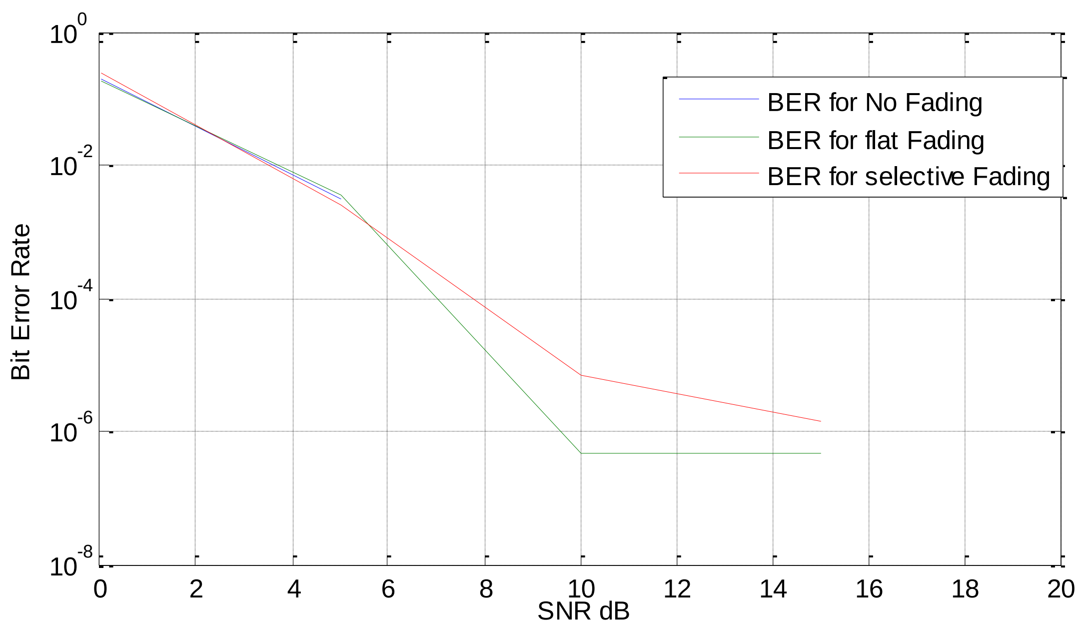



Fig No(2)Comparison of Bit Error Rate Vs SNR for flat fading and selective fading

Fig. 2 shows the plot of table (2) BER against SNR in LTE network with no fading, flat fading and selective fading adding the AWGN variance SNR mode. The result explains the BER decreased when there is no fading and increased when using selective fading and flat fading.

**-BER for different cyclic prefix**

| SNR | cyclic prefix factor1\4 | cyclic prefix factor1\8 | cyclic prefix factor1\16 | cyclic prefix factor1\32 |
|---|---|---|---|---|
| 0 | 0.2431 | 0.2002 | 0.02052 | 0.2027 |
| 5 | 0.0025 | 0.0003079 | 0.00155 | 0.001286 |
| 10 | 6.87E-06 | 0.0005096 | 4.68E-05 | 0.001444 |
| 15 | 1.42E-05 | 0.0001202 | 1.19E-05 | 0.001615 |
| 20 | 0 | 0 | 0 | 0 |
| 25 | 0 | 0 | 0 | 0 |

**Table 3 SNR VS BER for different cyclic prefix**

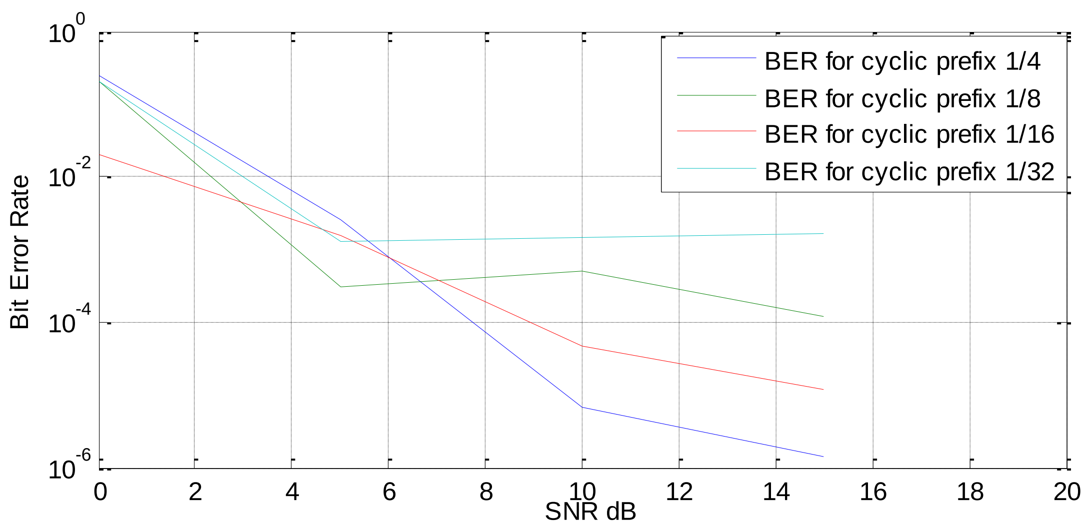



Fig No(3)Comparison of Bit Error Rate Vs SNR of cyclic prefix

Fig. 3 shows the plot of table (3) BER against SNR with Various cyclic prefix (1\4, 1\8, 1\16 and 1\32) and different SNR(0,5,10,15,20 and 25) it is shows the BER decreased when the cyclic prefix increased

**-BER for different bandwidth:**

Error! No text of specified style in document.**TABLE NO(4) BER for different BW**

| SNR(db) | BW 5MHZ | BW 10MHZ |
|---|---|---|
| 0 | 0.2431 | 0.1959 |
| 5 | 0.0025 | 0.08565 |
| 10 | 6.87E-06 | 4.36E-06 |
| 15 | 1.42E-05 | 8.21E-05 |
| 20 | 0 | 5.71E-08 |
| 25 | 0 | |

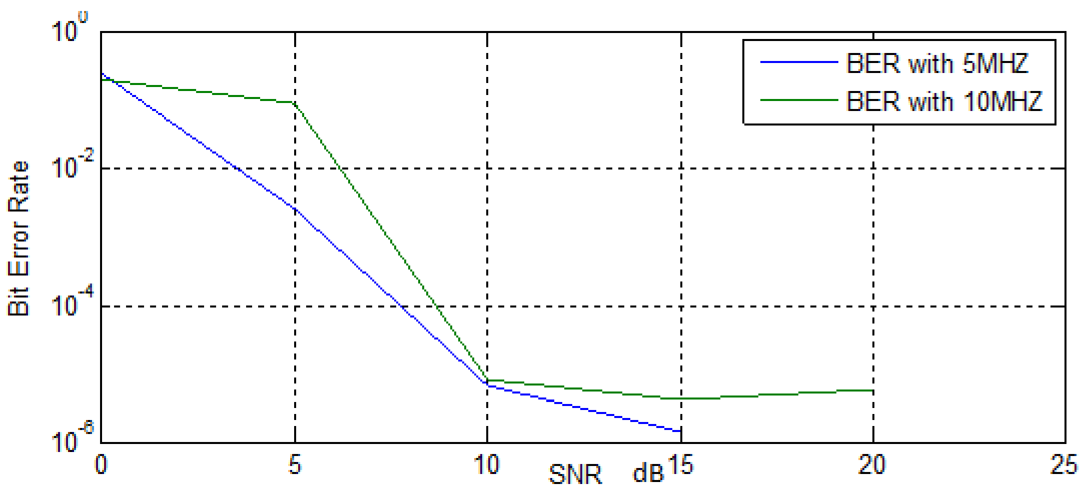



Fig No(4)Comparison of Bit Error Rate Vs SNR For 5MHZ & 10MHZ bandwidth

Fig. 4 shows the plot of table (4) BER against SNR for different bandwidths, the BER decreased when the capacity decreased.

## VI. Conclusion

In this paper we evaluated the BER performance of an OFDM based LTE communication system with the implementation of model under different digital modulations over AWGN were used in the lab to measure the bit error performance (BER) OF Different fading(flat and selective fading channels)at different signal-to-noise ratios (SNR). After this study On the basis of the results obtained in the present Matlab-based simulation we found that BER decrease when to increase SNR, and decrease the fading and bandwidth.

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