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Performance Analysis of Long Term Evolution using MATLAB Simulink

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Abstract

Long Term Evolution (LTE) as a 4G wireless communication aims to cover long distance with high data rate. The signal is paired by different parameters such as AWGN, Multiple Access User Interference and Mobile Fading; which reduce the system performance in terms of QOS against capacity. This paper aims to study the degradation parameters for LTE system. The values that were taken in consideration for the evaluation process are (**AWGN**) Additive White Gaussian Noise in the downlink, Fading, Bandwidth, Maximum Doppler Shift, and Cyclic Prefix to perform the LTE system in term of QOS such as SNR and BER.
The analysis of the different conditions was made by using MATLAB Simulink software to evaluate and analysis the performance.

Keywords: *LTE, QOS, AWGN, BER, SNR.*

1. Introduction

LTE (Long Term Evolution) referred as a new high performance air interface for cellular mobile communication systems. It is considered as the last step of radio technologies toward the 4th generation (4G) and designed to enhance the capacity and speed of mobile telephone networks. The current generations of mobile telecommunication networks are collectively known as 3G and LTE. The latter is marketed as 4G. (figure1).

According to 3GPP, a set of high level requirements are characterized by:

- Reduced cost per bit
- Increased service provisioning – more services at lower cost with better user experience
- Flexibility of use of existing and new frequency bands
- Simplified architecture, Open interfaces

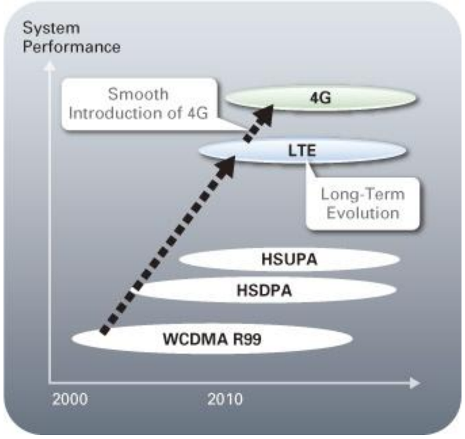

Figure (1): Roadmap to 4G

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Although there are major differences between LTE and its 3G predecessors, it is however regarded as an evolution of the UMTS / 3GPP 3G standards. Despite it uses a different form of radio interface, using OFDMA / SC-FDMA instead of CDMA, there are many similarities in the different earlier forms of 3G architecture and there is scope for much re-use. LTE can be seen for providing a further evolution of functionality, increased speeds and general improved performance.

Table (1): LTE and 3G/3.5G Specification

erm	**3G WCDMA (R99)**	**3.5G HSPA**	**LTE**
Frequency	Common frequency assigned for 3G		
Bandwidth	5MHz		5/10/20MHz
Radio Access	DS-CDMA**T**		DL: OFDMA
			UL: SC-FDMA
Uplink Peak Rate	384kbps	5.7Mbps	>50Mbps
Downlink Peak Rate	384kbps	14Mbps	>100Mbps

LTE has introduced a number of new technologies when compared to the previous cellular systems (**table1).** They enable LTE to be able to operate more efficiently with respect to the use of spectrum, and also to provide the much higher data rates that are being required. [1][2].

In addition, LTE architecture comprises Evolved Packet Cores (EPCs) and Evolved UMTS Terrestrial Radio Access Networks (E-UTRAN) EPCs communicate with each other and with E-UTRANs. EPC contains a Mobile Management Entity (MME) and a System Architecture Evolution Gateway (SGW) along with a Packet Data Network Gateway (PDN GW). E-UTRAN only contains Evolved Universal Terrestrial Radio Access Network Base Stations (eNodeB or eNB) where the User Equipment (UE) communicates with eNB and eNBs communicate with each other and with the EPCs. There is one-to-one communication between UE and eNB but there is one-to-many communication among eNB, MME, and SGW [3][4].

Quality of Service for Mobile Communication

The **quality of service** (**QoS**) refers to several related aspects of telephony and computer networks that allow the transport of traffic with special requirements. In particular, much technology has been developed to allow computer networks to become as useful as telephone networks for audio conversations, as well as supporting new applications with even stricter service demands. Mobile cellular service providers may offer mobile QoS to customers just as the fixed line PSTN services providers and Internet Service Provider (ISP) may offer QoS. QoS mechanisms are always provided for circuit switched services, and are essential for non-elastic services, for example streaming multimedia. [5]

Bit Error Rate:

Bit error occurs when one or more bits of data travelling across a network fail to reach their destination. It's also affected by Signal-to-noise ratio and distance between the transmitter and receiver.

Signal to Noise Ratio:

Signal-to-noise ratio is defined as the power ratio between a signal (meaningful information) and the background noise (unwanted signal). [6]

2. Methodology

The computer model implemented with MATLAB software Simulink which characterize with a library function for transmitters module and channel and receiver which is powerful for communication, and it have built LTE system module.

Table 2: Simulation Environment

Parameter	Value
Signal to noise Ratio SNR (dB)	-10,-8,-6,-4,-2,0,2,4,6,8,10
Bandwidth (MHz)	5,10,15
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, 1, 2
K Factor	0.5

Mathematical Models:

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

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

$$P(4QAM)=0.5\ (1-\sqrt{SNR/(2-SNR))} \quad (2)$$

$$P(16QAM)= =0.5\ (1-\sqrt{SNR/(10-SNR))} + 0.5\ (1-\sqrt{9SNR/(10-0SNR}} \quad (3)$$

The simulator block diagram of LTE using MATLAB is shown in figure (2) below:

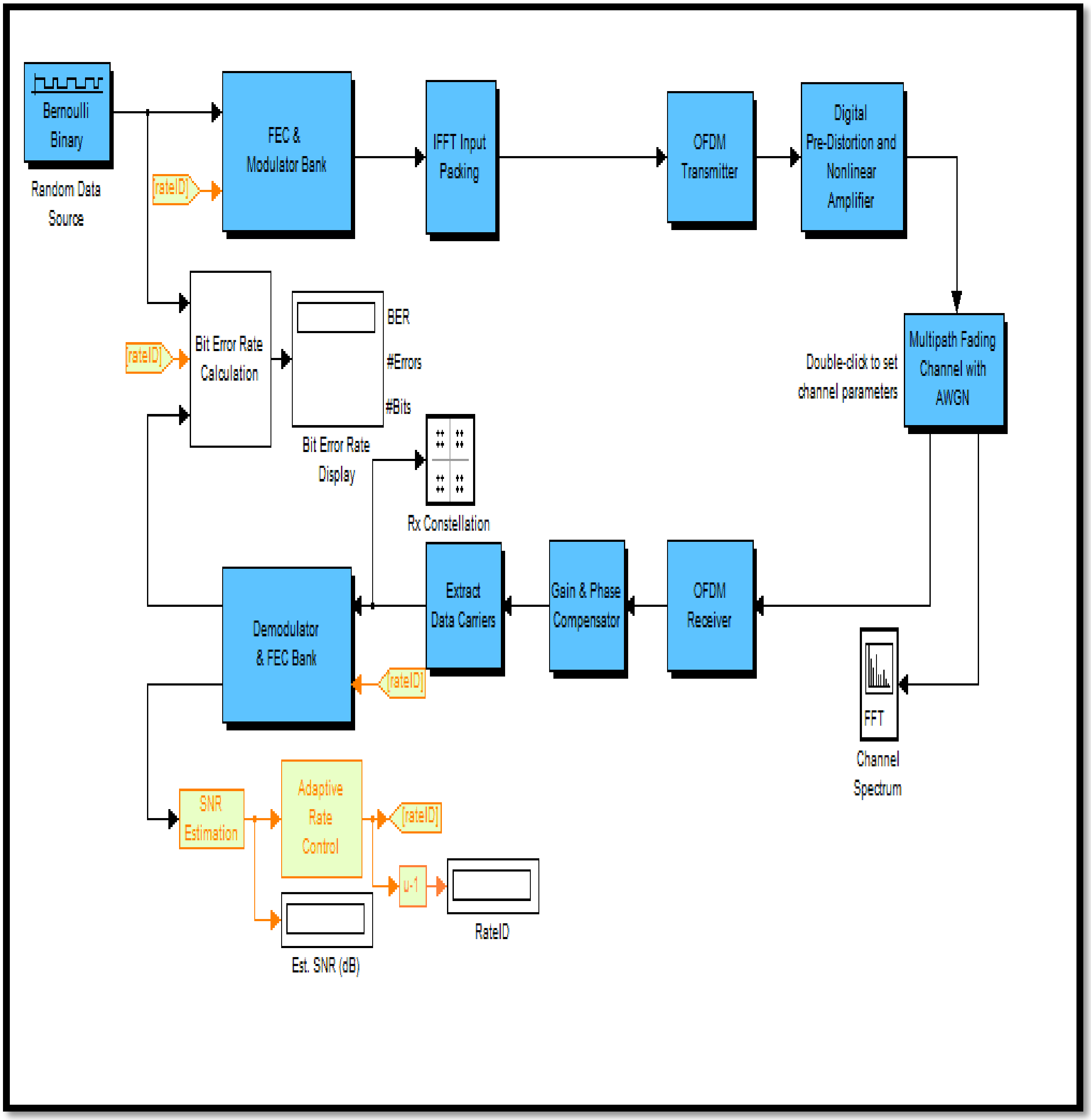

Figure (2): Performance Analysis of LTE

Computer Model:

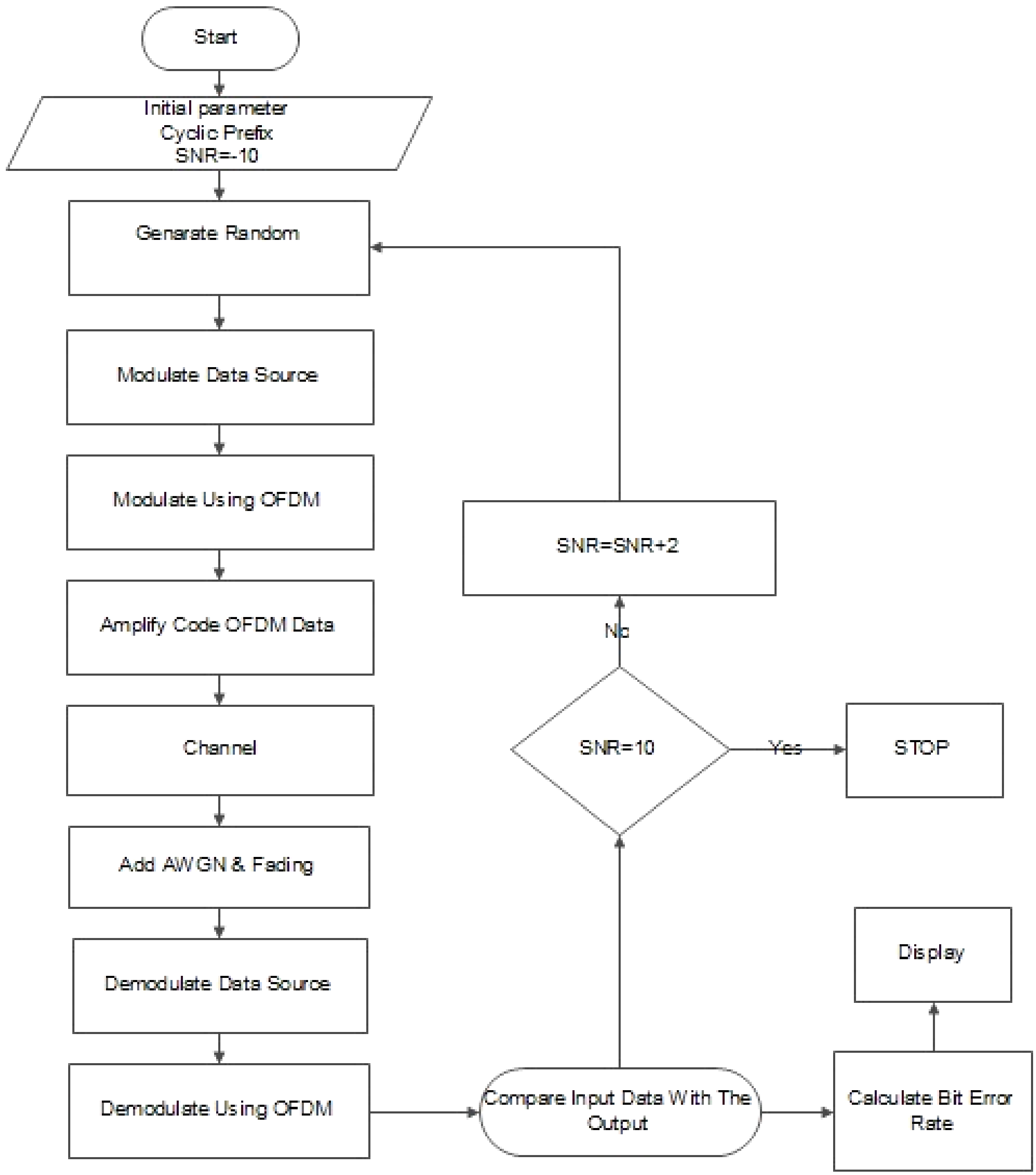

Figure (3): The computer model

3. Results

For Number of Symbols per burst=4, Cyclic Prefix=1/4, No Fading.

Table (3)

SNR (dB)	BER (BW=5)	BER (BW=10)	BER (BW=15)
-10	0.499	0.499	0.499
-8	0.574	0.501	0.500
-6	0.494	0.494	0.493
-4	0.481	0.479	0.478
-2	0.359	0.367	0.368
0	0.067	0.062	0.062
2	0.001	0.0008	0.0009
4	0	0	0
6	0	0	0
8	0	0	0
10	0	0	0

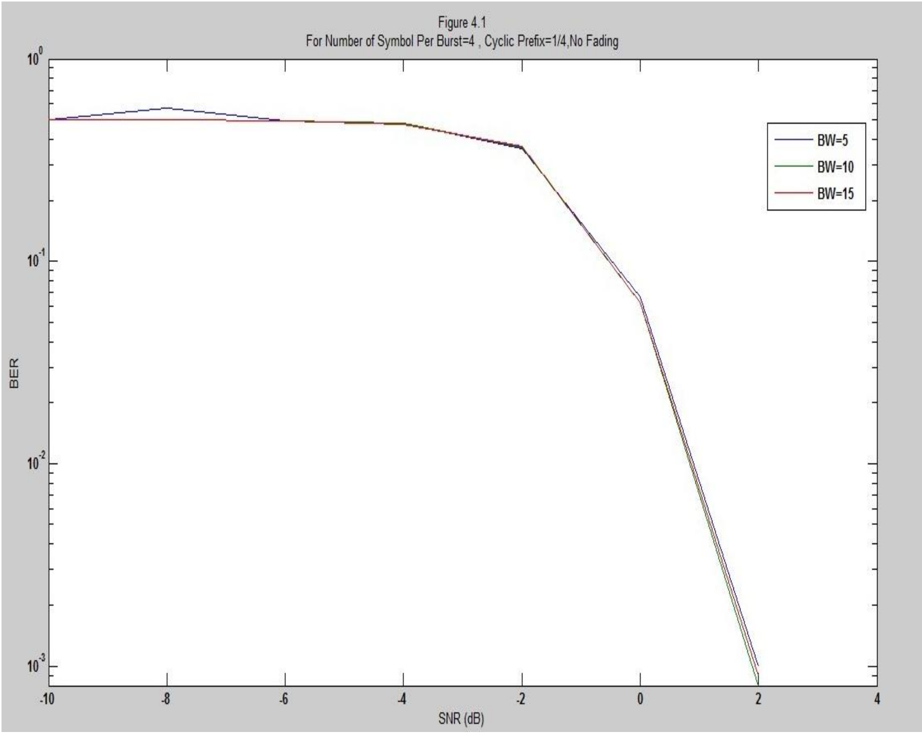

Figure (4)

For Bandwidth=5MHz, Number of Symbols per burst=4, No Fading.

Table (4)

SNR (dB)	BER (Cyclic Prefix=1/4)	BER (Cyclic Prefix=1/8)	BER (Cyclic Prefix=1/16)	BER (Cyclic Prefix=1/32)
-10	0.499	0.506	0.498	0.503
-8	0.507	0.501	0.500	0.498
-6	0.494	0.493	0.498	0.492
-4	0.481	0.480	0.482	0.483
-2	0.359	0.360	0.358	0.350
0	0.067	0.070	0.063	0.058
2	0.001	0.001	0.001	0.0008
4	0	0	0	0
6	0	0	0	0
8	0	0	0	0
10	0	0	0	0

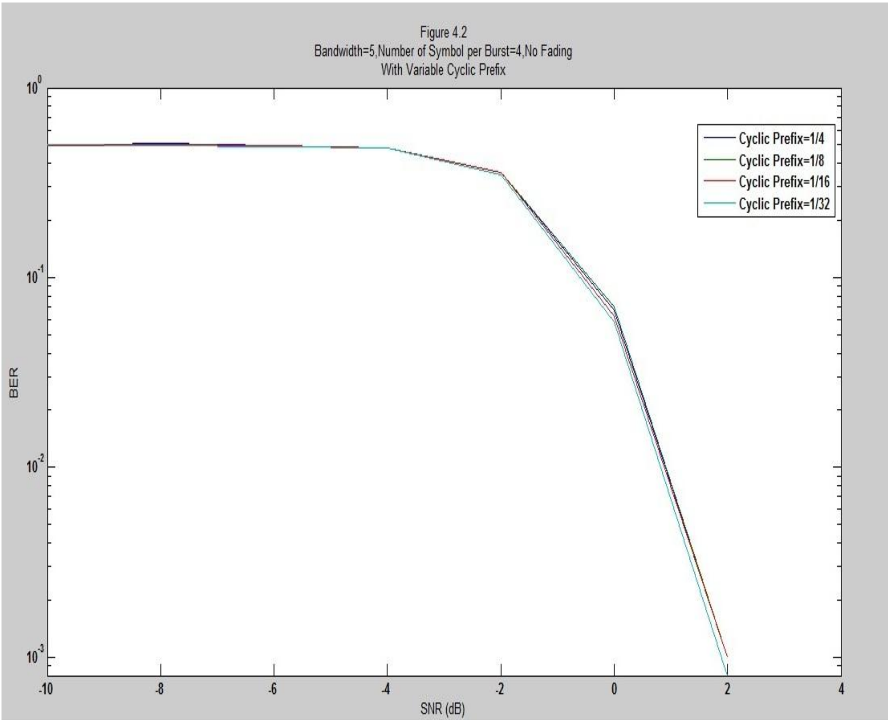

Figure (5)

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For Bandwidth=5MHz, Number of Symbols per burst=4, Cyclic Prefix=1/4.

Table (5)

SNR (dB)	BER (No Fading)	BER (Flat Fading)	BER (Selective Fading)
-10	0.499	0.498	0.498
-8	0.507	0.497	0.496
-6	0.494	0.496	0.490
-4	0.481	0.481	0.489
-2	0.359	0.347	0.418
0	0.067	0.077	0.175
2	0.001	0.001	0.010
4	0	0	0
6	0	0	0
8	0	0	0
10	0	0	0

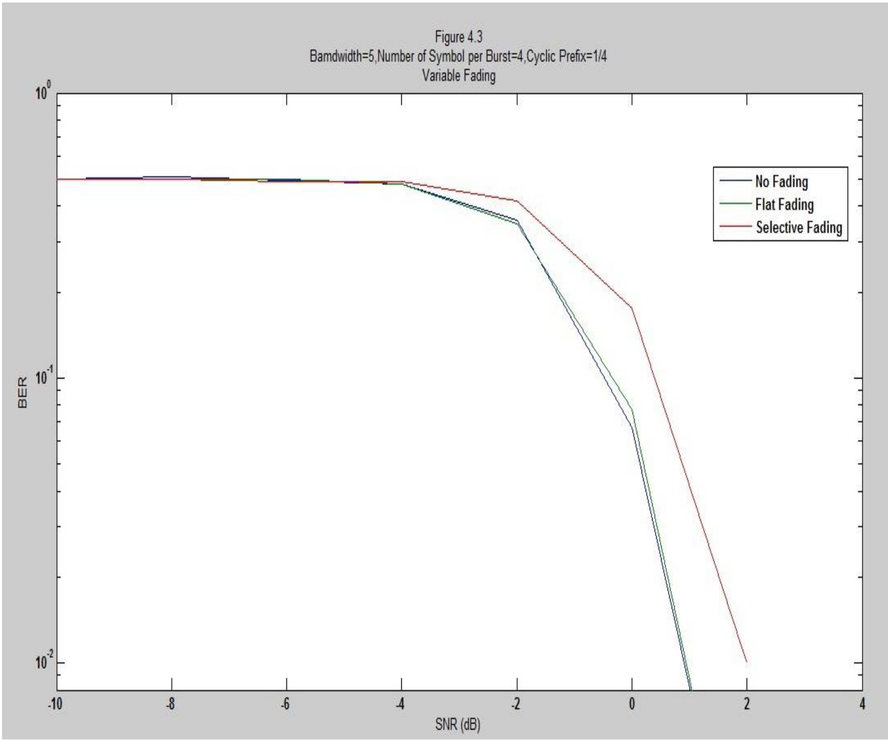

Figure (6)

For Bandwidth=5MHz, Number of Symbols per burst=4, Cyclic Prefix=1/4, Selective Fading

Table (6)

SNR (dB)	BER (Doppler Shift=0.5Hz)	BER (Doppler Shift=1Hz)	BER (Doppler Shift=2Hz)
-10	0.498	0.498	0.498
-8	0.496	0.496	0.498
-6	0.490	0.492	0.495
-4	0.489	0.488	0.481
-2	0.418	0.422	0.411
0	0.175	0.168	0.156
2	0.010	0.010	0.008
4	0	0	0
6	0	0	0
8	0	0	0
10	0	0	0

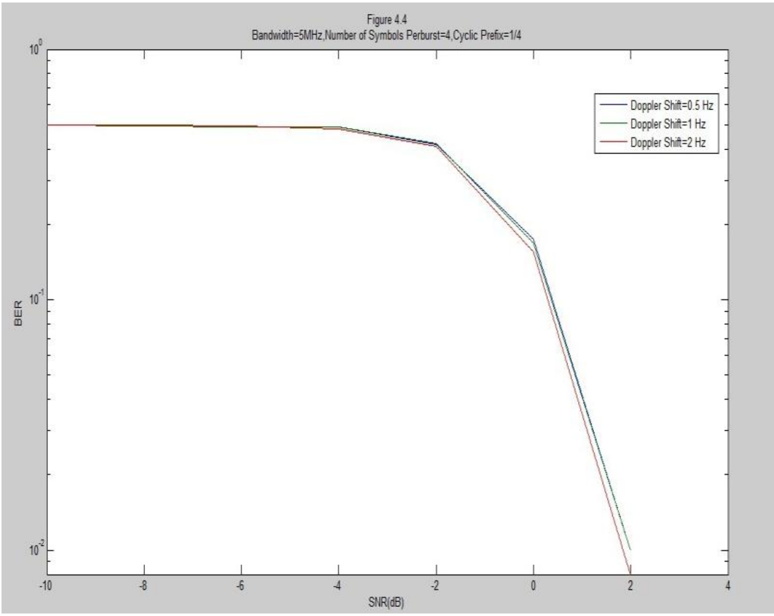

Figure (7)

4. Analysis & Discussion

From the results obtained we observe that:

- As signal to noise increase the bit error rate decrease.
- As the Bandwidth increase the bit error rate decrease.
- When the cyclic prefix decrease the bit error rate decrease.
- When there is selective fading the bit error rate decrease more than it's either no fading or selective fading.
- As Doppler shift increase the bit error rate decrease.

5. Conclusion

The simulation performance analysis of LTE in term of bit error rate against signal to noise ratio have been done using MATLAB Simulink software program. We can conclude that when signal to noise and Bandwidth increase the bit error rate decrease. And the cyclic prefixes decrease the bit error rate decrease. But when the Doppler shift increase the bit error rate decrease. In term of fading, selective fading the bit error rate decrease more than it's either no fading or selective fading.

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