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Performance Analysis of MIMO LTE Network

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Abstract

The objective of this project is to study, analyze, simulate and evaluate the performance of MIMO LTE network using MATLAB software program. The parameters which were taken into consideration of the evaluation are: bit error rate, signal to noise ratio, cyclic prefix. After the execution of the simulation the results were obtained in terms of tables and charts. From the results we observed that best MIMO performance decreases as cyclic prefix and bandwidth increased.

Keywords: LTE; MIMO**;** Network

1. Introduction

To increase the capacity and speed of wireless communication systems, a new type of wireless data networks has recently emerged and been standardized by the 3rd Generation Partnership Project (3GPP). This new standard comes as a natural evolution to the existing second (2G) and third (3G) generation wireless networks in order to respond to the growing demand in terms of extended data rates and speed and is marketed as the 4G Long Term Evolution (LTE) network [1].

To achieve the target data rate of LTE and eventually 4G, many new techniques are necessary. Multiple-Input Multiple-Output (MIMO) is one key technique among them because of its ability to enhance the radio channel capacity of cellular systems at no extra cost of spectrum. The performance showed that the capacity of MIMO can be up to many (Nt,Nr) times larger than the single-antenna capacity where Nt and Nr is the number of antenna elements at transmitter and receiver respectively[2].

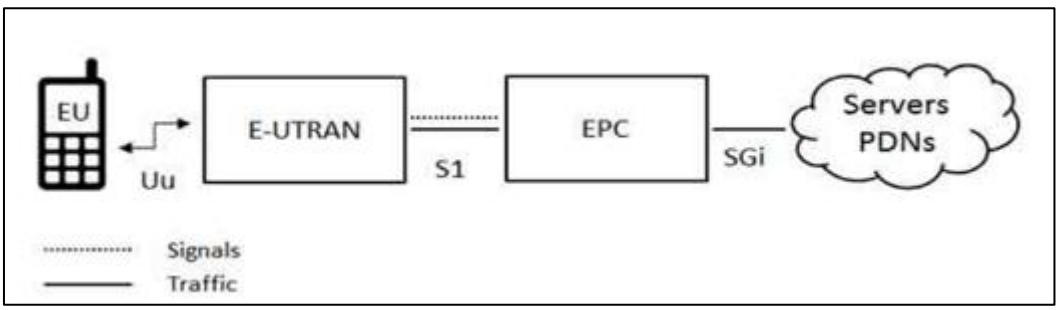

Figure 1 LTE architecture

1.1. Objectives

The objective of this research to study to study LTE network, analysis MIMO, simulate MIMO in LTE network, evaluate the performance of LTE network before and after using MIMO to over comes the problems that LTE network faced and

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evaluate the performance according to bit error, SNR, CP before and after MIMO then to see the improvement and enhancement.

2. Descriptive analysis

LTE network was created by using MATLAB software program by the following structure:

A random signal (base band signal) was generated by using data source then it passes through an adaptive modulation to change it to band pass signal (narrow band) then it's converted to wide band signal by using OFDM spread spectrum, then the signal would become LTE signal according to specific parameter such as BW, CP. After that the signal transmitted through the channel and it would be corrupted by AWGN, and RICIAN or Rayleigh Fading. At the receiver a reverse operation would be applied to detect the received signal then it's compared with the transmitted signal to calculate the BER. The same circuit used to create LTE MIMO network after adding MIMO before sending the signal.

3. Mathmatical model

The mathematical model is evaluated in term of BER equation to evaluate the performance of the network, which is given by:

$$\text{BER} = \frac{NUMBER\ OF\ BIT\ ERROR}{TOTAL\ NUMBER\ OF\ BIT\ TRANSMITTED} \ldots\ldots (3.1)$$

4. Simulation environments

The following table showing the consider parameter:

Table 1 Simulation environments

Parameter	Value
Network	LTE
Noise	Additive White Gaussian Noise (AWGN)
Fading	RICIAN & RAYLEIGH
SNR	0 to 30 dB
Cyclic prefix	1/4 , 1/8 , 1/16 , 1/32
Bandwidth	1.4 , 5 , 10 , 20 MHz
Modulation	Adaptive Modulation
Diversity technique	MIMO

5. Simulation

The LTE network was implemented by using Mat lap software program as shown:

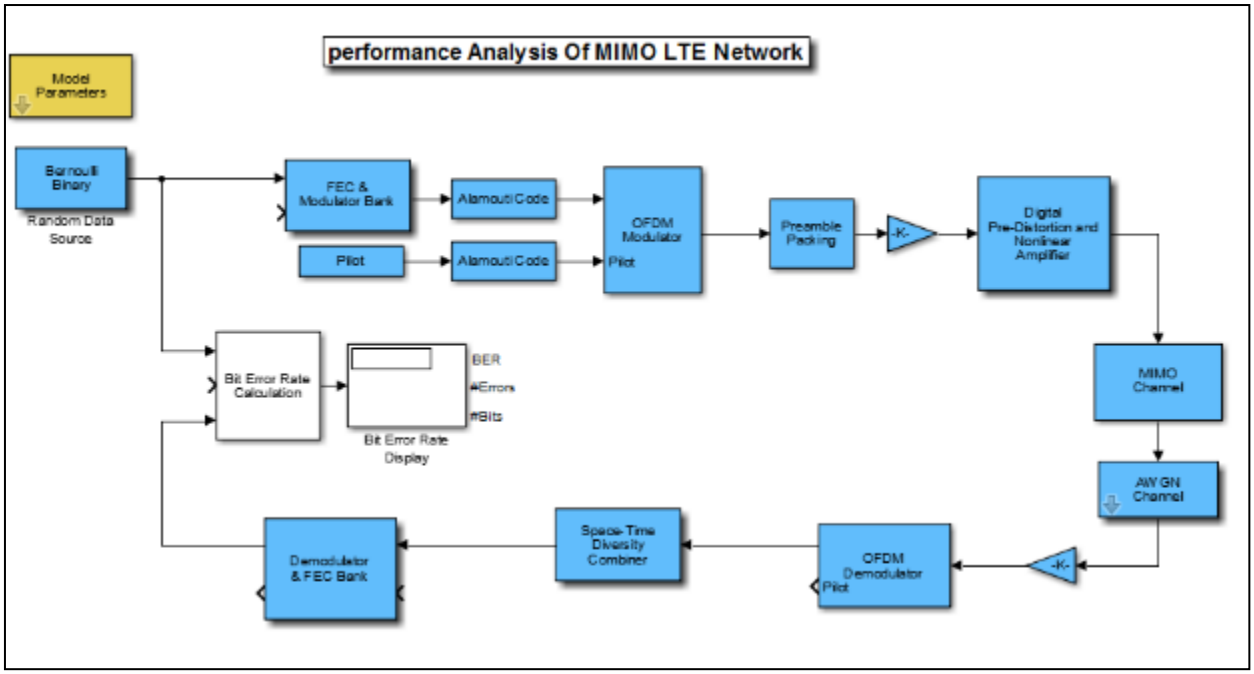

Figure 2 Performance Analysis of MIMO LTE Network

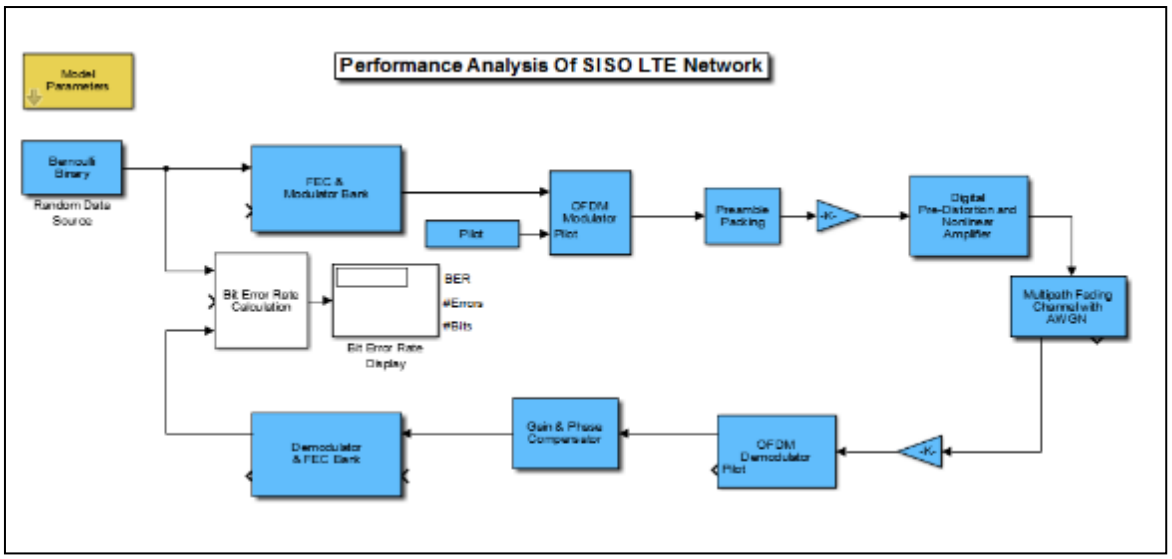

Figure 3 Performance Analysis of SISO LTE Network

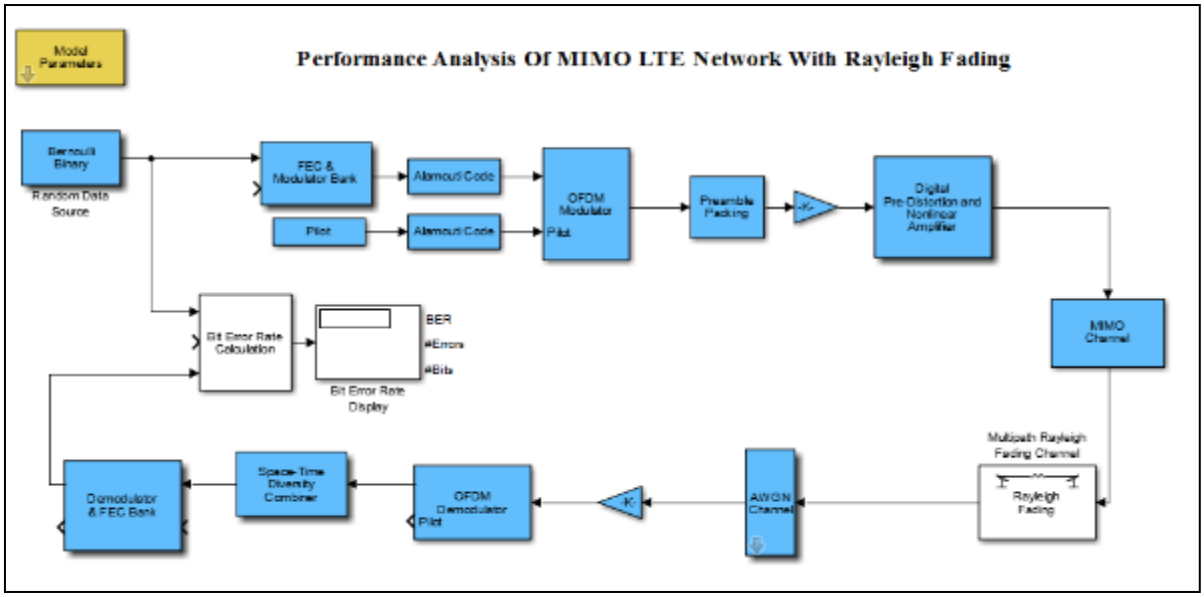

Figure 4 Performance Analysis of MIMO LTE Network With Rayleigh fading

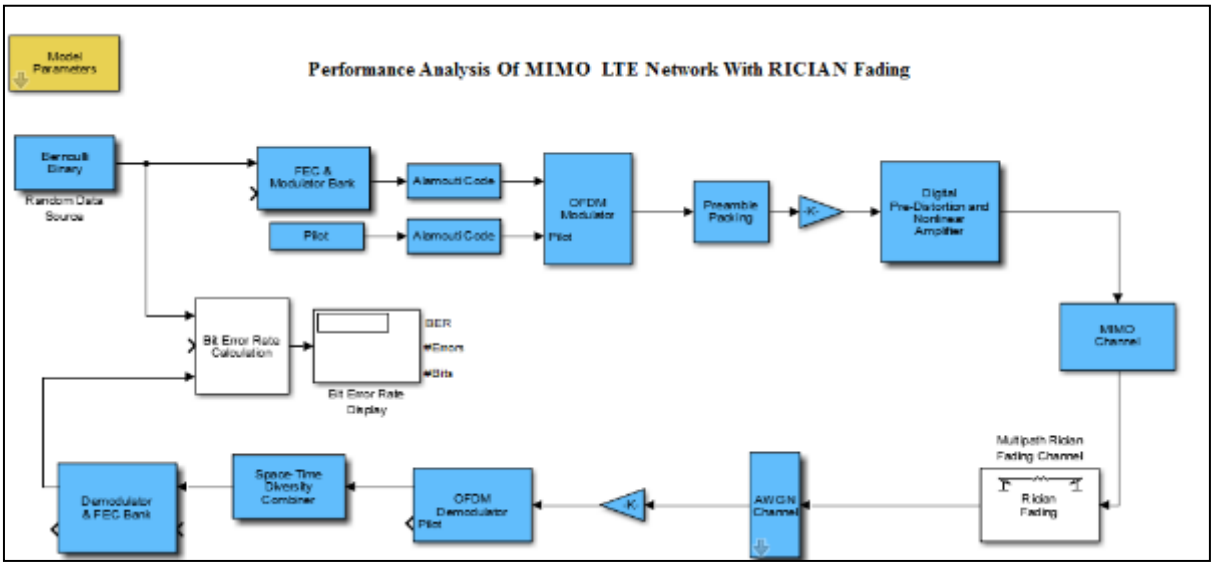

Figure 5 Performance Analysis of MIMO LTE Network With RICIAN Fading

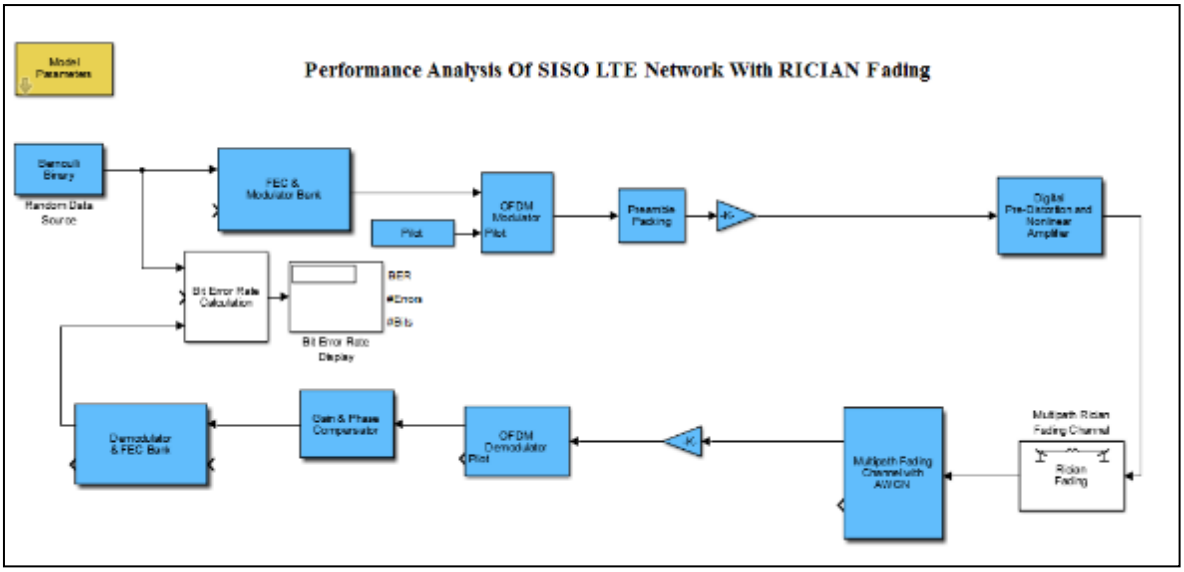

Figure 6 Performance Analysis of SISO LTE Network With RICIAN Fading

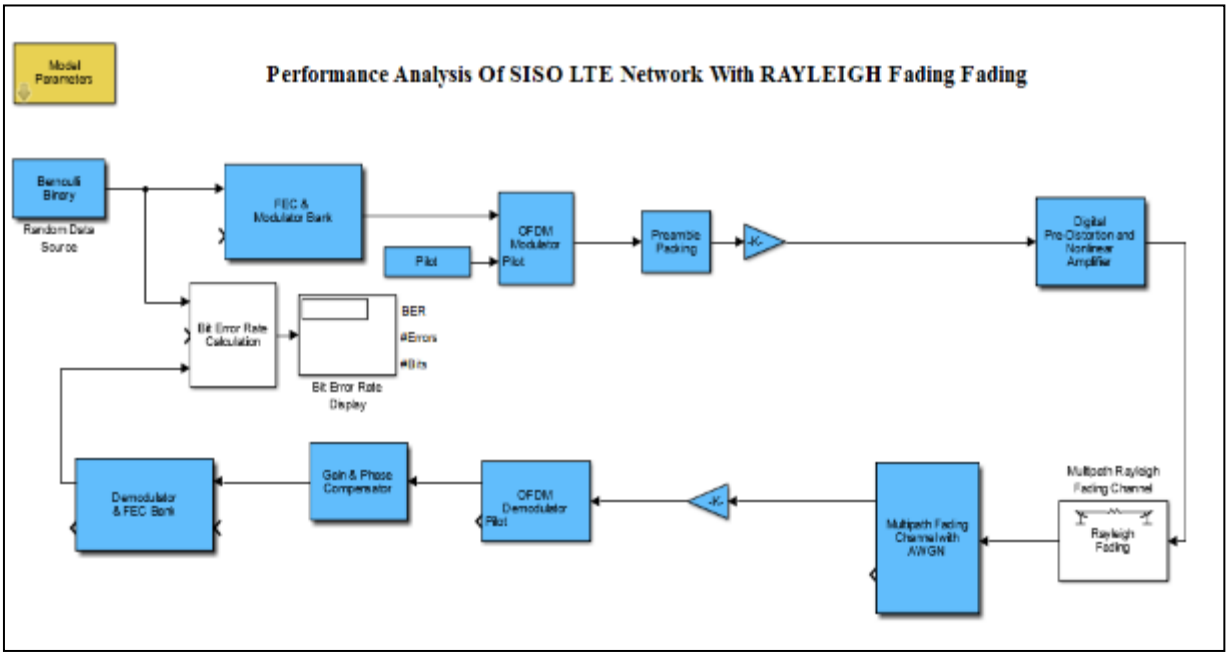

Figure 7 Performance Analysis of SISO LTE Network with Rayleigh Fading

6. Results and discussion

From the results obtained we observe the following:

In the SISO result without Fading and with CP=1/8. when the SNR=0, BW=1.4 MHZ the BER=0.171 and when the BW=20 MHZ the BER=0.1963. Also when the SNR=2, BW=1.4 MHZ the BER=0.003603 and when the BW=20 MHZ the BER=0.01417, When the BW decrease and the SNR increase the BER decrease.

In the SISO result without Fading and with BW=10 MHZ. when the SNR=0, CP=1/4 the BER=0.1923 and when the CP=1/32 the BER=0.1674, Also when the SNR=2, CP=1/4 the BER=0.02027 and when the CP=1/32 the BER=0.01395, When the CP increase and the SNR increase the BER decrease.

In the SISO result with RICIAN Fading and with CP=1/8. when the SNR=12, BW=1.4 MHZ the BER=0.0005411 and when the BW=20 MHZ the BER=0.005612.

In the MIMO result with RICIAN Fading and with CP=1/8. when the SNR=2, BW=1.4 MHZ the BER=0.003986 and when the BW=20 MHZ the BER=0.0499, When the BW decrease and the SNR increase the BER decrease.

In the SISO result with RICIAN Fading and with BW=10 MHZ. when the SNR=12, CP=1/4 the BER=0.008192 and when the CP=1/32 the BER=0.001099.

In the MIMO result with RICIAN Fading and with BW=10 MHZ. when the SNR=2, CP=1/4 the BER=0.07041 and when the CP=1/32 the BER=0.04348, When the CP increase and the SNR increase the BER decrease.

In the SISO result with RAYLEIGH Fading and with CP=1/8. when the SNR=12, BW=1.4 MHZ the BER=0.007576 and when the BW=20 MHZ the BER=0.4259.

In the MIMO result with RAYLEIGH Fading and with CP=1/8. when the SNR=2, BW=1.4 MHZ the BER=0.03804 and when the BW=20 MHZ the BER=0.06304.

In the SISO result with RAYLEIGH Fading and with BW=10 MHZ. when the SNR=26, CP=1/4 the BER=0.01085 and when the CP=1/32 the BER=0.0006143.

In the MIMO result with RAYLEIGH Fading and with BW=10 MHZ. when the SNR=2, CP=1/4 the BER=0.08696 and when the CP=1/32 the BER=0.0462.

The performance of MIMO is better than the SISO for low signal to noise ratio.

The performance of MIMO is better in Rayleigh fading than in RICIAN fading.

Through a channel with fading the amount of BER is higher in SISO than in MIMO.

To over comes problems in LTE network such as fading, interference and noise we use one of the diversity techniques (space diversity – MIMO).

7. Conclusion

The study, analyze, plan, design of the software program to simulate the perform of MIMO LTE network and the evaluation performance of the system had been done using MATLAB software program.

The parameter which were taken in consideration of the evaluation are: Signal to noise ratio, cyclic prefix, fading, Bandwidth and noise.

After the execution of the simulator the results were obtained in terms of tables and charts. From the results we observed the following:

As the cyclic prefix increase, Bandwidth decrease and the signal to noise ratio increase the bit error rate decrease, Also RAYLIGH, RICIAN fading effect had been reduced when MIMO used, Also The performance of MIMO better than the SISO for low signal to noise ratio.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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Authors short biography

	Majzoub Hassan Abdelwahab Khairi received his bachelor of Electronic Engineering degree in Telecommunication Engineering from University of Gezira, Sudan in 2014. He worked in Sudanese Mobile Telephone Co.Ltd. (Zain Sudan) for telecommunication in Sudan at the years 2015 till 2017. Engineer Majzoub has been appointed as purchasing coordinator at DUN Trading Establishment, Riyadh, Saudi Arabia in September 2017 till September 2019. In addition to his experience in the computer and the ability to speak English.