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PERFORMANCE ENHANCEMENT OF MULTIPATH FADING INLTE-ADVANCE (5G) NETWORK

Majzoub Hassan Abdelwahab Khairi*, Mortada M. Abdulwahab and Abdalla Akode O. Mohammed

Telecommunication Engineering - Faculty of Engineering and Technology - University of Gezira – Sudan.

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***Corresponding Author**
Majzoub Hassan Abdelwahab Khairi
Telecommunication Engineering - Faculty of Engineering and Technology - University of Gezira – Sudan.

ABSTRACT

The objective of this paper is to study, analyze and improve the performance evaluation MIMO technique of LTE-Advance (5G) network by using MATLAB simulink software program. The parameters which were taken into consideration for the performance evaluation are: Type of the fading (RICIAN & RAYLEIGH), signal to noise ratio (SNR), bandwidth (BW), cyclic prefix (CP) and AWGN noise (N). After execution of software program the results were obtained in terms tables and charts for bit error rate (BER) versus signal to noise ratio (SNR) before and after MIMO technique. The results show that the bit error rate (BER) decrease as the signal to noise ratio (SNR), cyclic prefix (CP) values increase and the bandwidth (BW) value decrease, Also, the RICIAN fading was better when used than the RAYLEIGH fading.

KEYWORDS: LTE-Advance (5G), AWGN, RICIAN, RAYLIGH, MIMO.

I. INTRODUCTION

For the sake of increasing 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).[11]This new standard comes as a natural evolution to the existing second generation (2G) and third generation (3G)and (4G) wireless networks in order to respond to the growing demand in terms of extended data rates andspeed and is marketed as the Long Term Evolution Advance (LTE-Advance) network.[11] To achieve the target data rate of LTE-Advance, many new techniques are necessary, Multiple-Input Multiple-Output (MIMO) is onekey 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.[15]

Through the previous studies there are many problems when using MIMO technique such as in S.Shenoy study the feedback is applicable in real system and the cost of feedback overhead is far largest. In this study did not face any problem whether in block diagram or in the simulation before and after using of the MIMO & adaptivetechniques or when calculating the bit error rate in the different environments and different values of bandwidth and cyclic prefix and signal noise to ratio or when extracting the results. MIMO (multiple input multiple output) antennas increases sector throughput and capacity density using large numbers of antennae and Multi- user MIMO (MU-MIMO). MIMO, on the other hand, is a MIMO system with an especially high number of antennas. There's no set figure for what constitutes a MIMO set-up, but the description tends to be applied to systems with tens or even hundreds of antennas.[17] For example, Huawei, ZTE, and Facebook have demonstrated MIMO systems with as many as 96 to 128 antennas. Each antenna is individually-controlled and may embed radio transceiver components. Nokia claimed a five-fold increase in the capacity increase for a 64-Tx/64-Rx antenna system. The term MIMO was first coined by Nokia bell labs researcher Dr.thomas L.marzetta in 2010, and has been launched in 4G networks, such as softbank in japan.[17]

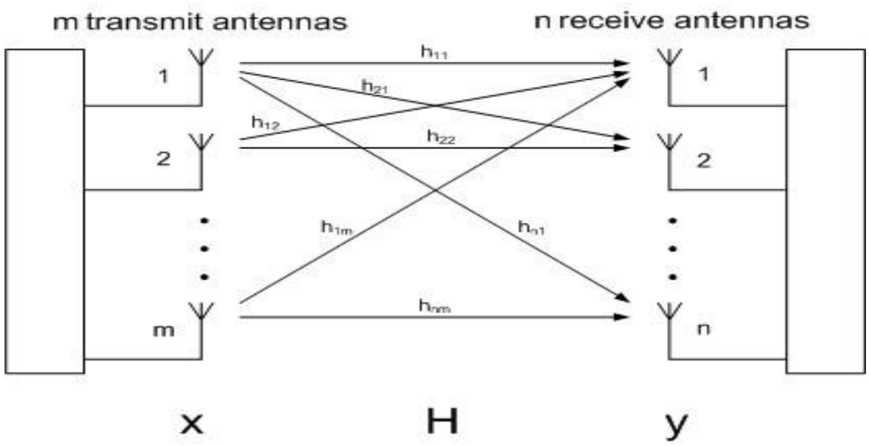

Figure 1: MIMO - Multiple Input Multiple Output.[19]

The performance degradation due to the interchange interference (ICI) becomes significant as the carrier frequency, block size, and vehicle velocity increase. The time-domain compensation technique, which can reduce the fading distortion in a flat (not frequency selective) Rayleigh fading channel by correcting gain and phase distortions of the received time-domain signal using a pilot symbol, is proposed. The frequency domain equalization technique is proposed to compensate for the fading distortion with less noise enhancement in a flat Rayleigh fading channel. This latter approach is based on the assumption that the pattern of ICI, corresponding to the fading distortion in the time domain is invariant for all sub channels due to the frequency no selectivity assumption, which is not the case in a multipath fading channel. In this paper, a new frequency-domain equalizer which can compensate for the effects of channel variation in a multipath fading channel is described by assuming that the channel impulse response (CIR) varies in a linear fashion during a block period.[13] The ICI terms significantly affecting the loss of sub channel orthogonally are then compensated for by a frequency-domain equalizer with a minimum computational complexity.[13]

The conventional frequency-domain equalizer with one tap in an OFDM system compensates for the frequency-selectivity of a multipath fading channel, assuming that the channel is stationary over the period of an FFT block. In this paper, a new frequency-domain adaptive technique to reduce the time- variation effect of a multipath fading channel is described by assuming that CIR varies in linear fashion during a block period. It is shown through simulation that the loss of orthogonally caused by the time- variation of a multipath fading channel can be compensated effectively by the proposed equalizer if the relative doppler frequency change is in the range of.[13]

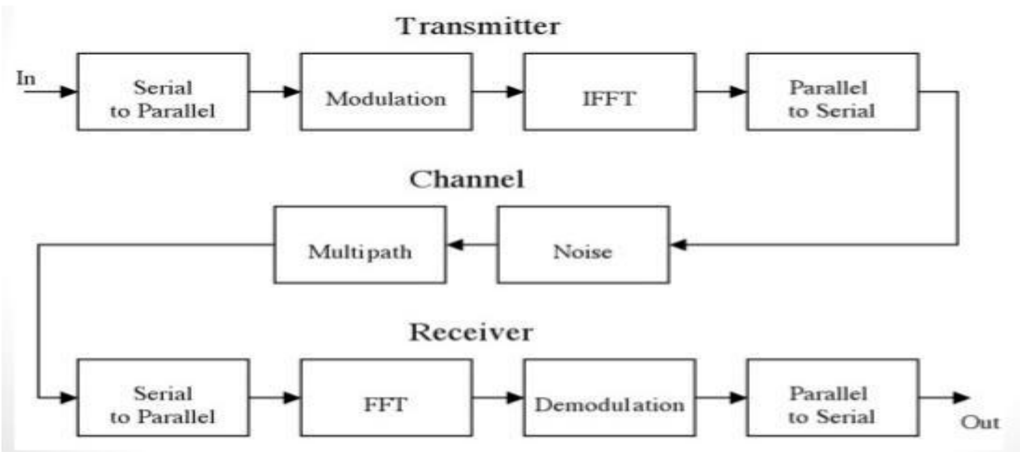

Figure 2: Baseband block diagram for adaptive technique of OFDM system.

II. OBJECTIVES

The objective of this research to study LTE-Advance (5G) network, analyze multipath fading and MIMO technique, simulate MIMO technique for enhancing the performance for LTE-Advance (5G) network and evaluate the performance enhancement of the proposed system in this study against the conventional LTE-Advance (5G) network.

III. DESCRIPTIVE ANALYSIS

LTE-Advance (5G) 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 pass 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 became LTE-Advance (5G) signal according to specific parameter such as BW and 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-Advance (5G) network after adding MIMO before sending the signal.

IV. MATHMATICAL MODEL

Signal at transmitter

Suppose that the user sends a digital adaptive modulation signals with in phase (I) and quadrature (Q) both branches are spread by the respective user code sequence. The signal transmitted for different digital adaptive &digital modulation and the probity of error is given by:

$$\mathbf{S_T(t) = \sqrt{p}\ \sum_{i=-\infty}^{\infty}(C_{p|i|_N}\ d_{p[i]_N}\ + jC_{q|i|_N}\ dq[i]_N\ )g_T\ (t - iT_c)} \qquad \mathbf{(1)}$$

Where: $|i|_N$ = Modulus N, T_c: The chip duration T_s: The symbol duration

T_b: The information bit duration = $T_s/2$ P: The user transmitter power

$c_{p.i}$: The sign of the i_{th} chip for the user inphase spreading sequences

$C_{q.1}$: The sign of the i_{th} chip for the user quadrrature spreadingsequences

$D_{p.i}$: The sign of the k_{th} I symbol, $D_{q.k}$: The sign of the k_{th} Q symbol

$g_t(t)$: The transmit filter impulse response

N: The integer symbol to chip duration ratio N= $^{T_s}/_{T_c}$

Performance Analysis of OFDM signal in additive white gaussian noise channel (AWGN)

The signal at the demodulator input is given by:

$$\mathbf{S_r(t)= P_T}(t) + n(t) \qquad \mathbf{(2)}$$

Where: n(t): A complex qaussian variable

Performance analysis under RAICIAN fading

The probability distribution models describe the effect of the propagation channel on the received signal when the mobile is found in one of the different constant to which the diffuse component can then be added to form a Rician and to obtain the probability of error when (a) is random, must average $P_e(a)$ over the probabilitydensity function(PDF) of (a) which is denoted as P_{Rician}(a) and the probability of error is given by:

$$\mathbf{P_e = \int P_e(\mathit{a})\ \ P_{Rician}(a)\ da} \qquad \mathbf{(3)}$$

Where:P_e: Probability error, P_{Rician}: Rician probability density function

Performance analysis under RAYLEIGH fading

The received signal by a mobile terminal is represented as a Rayleigh distributed multipath component, where the line of sight is totally obstructed by objects and buildings surrounding the vehicle (C=0). The theoretical BER performance assuming perfect carrier phase tracking for coherent detection on a Rayleigh fading channel given by:

$$\mathbf{P_e = \int_0^\infty P(\mathit{r})\ \ P_{Ray}(r)\ dr} \qquad \mathbf{(4)}$$

Where: P_e: Probability error, P_{Ray}: Rayleigh probability density function

a. BER for QAM constellation

The SER for a rectangular M-QAM (16-QAM, 64-QAM, 256-QAM etc.) with size L = M2 can be calculated byconsidering two M-PAM on in-phase and quadrature components. The error probability of QAM symbol is obtained by the error probability of each branch (M-PAM) and is given by:

$$P_q = 1 - (1 - \frac{2(sqrt\ M-1)}{sqrt\ M} J (\sqrt{\frac{3\gamma}{M-1}}))^2 \quad (5)$$

Where: P_q: Probability error for QAM M: Number of QAM

V. SIMULATION ENVIRONMENTS

The following table showing the consider parameter:

Table 1: Simulation environments.

Parameter	Value
Network	LTE-Advance (5G)
Noise	Additive White Gaussian Noise (AWGN)
Fading	RICIAN & RAYLEIGH
SNR	0 to 8 dB
Cyclic prefix	1/4 , 1/8 , 1/16 , 1/32
Bandwidth	3 , 5 , 10 , 20 MHz
Modulation	OFDM Modulation
Diversity technique	2*2 MIMO

VI. COMPUTER MODEL

Each of the flow chart calculates bit error rate (BER) against signal to noise ratio (SNR) for different bandwidth(BW) and different cyclic prefix (CP) depends on particular parameters, these parameters are changed for the purpose of measuring the (BER), that shown in figure below:

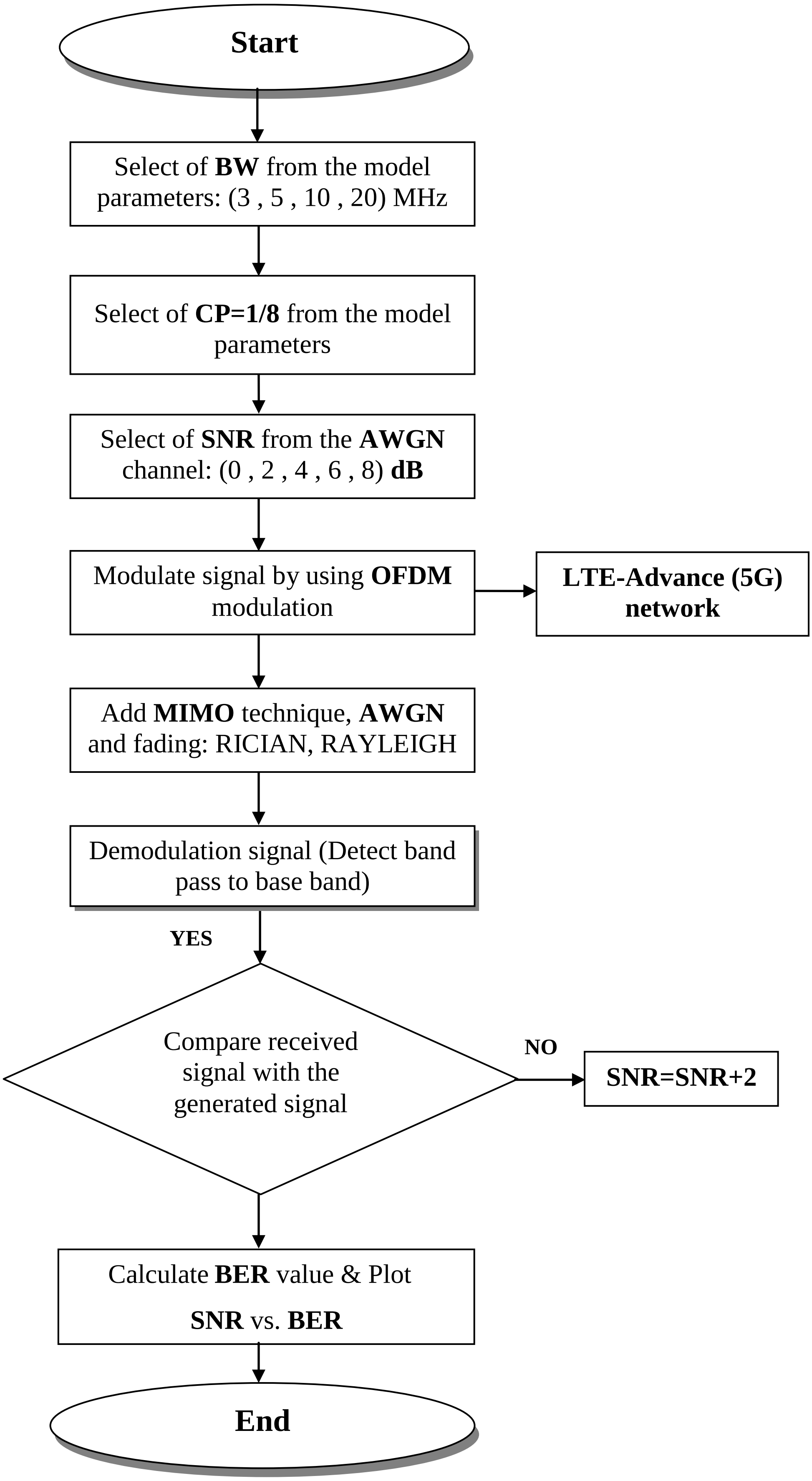

Figure 3: Computer model.

VII. RESULTS AND DISCUSSION

From the results obtained we observe the following

- In the SISO with RAYLEIGH fading, CP=1/8. When the SNR=0 dB, BW=3MHZ the BER=0.4999 and when the BW=20MHZ the BER=0.5011. Also when the SNR=2 dB, BW=3MHZ the BER=0.4805 and when the BW=20MHZ the BER=0.4938 so when the BW decrease and the SNR increase the BER decrease.
- In the SISO with RAYLEIGH fading, BW=10MHZ. When the SNR=0 dB, CP=1/4 the BER=0.4999and when the CP=1/32 the BER=0.4923. Also when the SNR=2, CP=1/4 the BER=0.4931 and when theCP=1/32 the BER=0.4800 so when the CP increase and the SNR increase the BER decrease.
- In the SISO with RICIAN fading, CP=1/8. When the SNR=0 dB, BW=3 MHZ the BER=0.4999 and when the BW=20 MHZ the BER=0.5007. Also when the SNR=2 dB, BW=3 MHZ the BER=0.4697 andwhen the BW=20 MHZ the BER=0.4993 so when the BW decrease and the SNR increase the BER decrease.
- In the SISO with RICIAN fading, BW=10MHZ. When the SNR=0 dB, CP=1/4 the BER=0.4999 and when the CP=1/32 the BER=0.4907. Also when the SNR=2, CP=1/4 the BER=0.4897 and when the CP=1/32 the BER=0.5015 so when the CP increase and the SNR increase the BER decrease.
- In the MIMO with RAYLEIGH fading, CP=1/8. When the SNR=0 dB, BW=3 MHZ the BER=0.340900and when the BW=20 MHZ the BER=0.390300. Also when the SNR=2 dB, BW=3 MHZ the BER=0.003986 and when the BW=20 MHZ the BER=0.049900 so when the BW decrease and the SNR increase the BER decrease.
- In the MIMO with RAYLEIGH fading, BW=10MHZ. When the SNR=0 dB, CP=1/4 the BER=0.33450 and when the CP=1/32 the BER=0.35930. Also when the SNR=2, CP=1/4 the BER=0.07041 and when the CP=1/32 the BER=0.04348 so when the CP increase and the SNR increase the BER decrease.
- In the MIMO with RICIAN fading, CP=1/8. When the SNR=0 dB, BW=3 MHZ the BER=0.27610 and when the BW=20 MHZ the BER=0.37230. Also when the SNR=2 dB, BW=3 MHZ the BER=0.03804 and when the BW=20 MHZ the BER=0.06304 so when the BW decrease and the SNR increase the BERdecrease.
- In the MIMO with RICIAN fading, BW=10MHZ. When the SNR=0dB, CP=1/4 the BER=0.33510 and when the CP=1/32 the BER=0.22830. Also when the SNR=2, CP=1/4 the BER=0.08696 and when the CP=1/32 the BER=0.04620 so when the CP increase and

the SNR increase the BER decrease.

- The BER in MIMO system is less than BER in SISO system.
- The performance of MIMO is better than performance of SISO system.
- The performance of MIMO is better in RICIAN fading than in RAYLEIGH fading.
- Through a channel with fading the amount of BER is higher in SISO than in MIMO.
- To overcome the problems in LTE-Advance (5G) network such as fading, interference and noise we usethe diversity technique of MIMO system.

VIII. CONCLUSION

The study, analyses, plan and design of the software program to simulate the performance of MIMO technique in LTE-Advance (5G) network and the evaluation performance of the system had been done using MATLAB software program. The parameters which were taken in consideration of the evaluation are: Signal to noise ratio (SNR), cyclic prefix (CP), bandwidth (BW), noise (N) and fading. 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 (CP) increase, bandwidth (BW) decrease and the signal to noise ratio (SNR) increase the bit error rate (BER) decreased, also RICIAN and RAYLEIGH fading effect had been reduced when MIMO used and finally the performance of MIMO is better than the SISO system and the performance of MIMO is better in RICIAN fading than in RAYLEIGH fading.

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