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The Impact of EVA & EPA Parameters on LTE-MIMO System under Fading Environment

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Abstract: As a part of Third Generation Partnership Project (3GPP) project, LTE allows the operator to use spectrum more efficiently to deliver high speed data. This paper describes the features of the downlink performance of LTE. As characterized in the LTE standard, the prerequisite for high data rate applications requested a framework to provide users with the MIMO technology which constitutes a breakthrough in wireless communication. There are many metrics to characterize the performance of LTE and one of the most convenient and informative metric is the BER (Bit Error Rate). The parameters that are given more focus is the EVA and EPA, for QPSK modulation for 2×2 and 4x4 LTE considering Rayleigh fading environment. The system is modeled and simulated using MATLAB and the values of BER are obtained against different values of SNR with low correlation.
Keywords: EVA, EPA, LTE, MIMO, QPSK

I. INTRODUCTION

LTE can be considered as an evolution of UMTS (Universal Mobile Telecommunication System) and HSPA (High Speed Packet Access). LTE began in 2004 and was completed in 2008 by a telecommunication body. It is the 3GPP project Release 8. Many works are designed in LTE as it gives the benefit of faster data speed as well as the high capacity voice support. [1] theoretically describes LTE which uses two downlink air interface technologies known as OFDMA and MIMO. MIMO is a key component of next generation wireless technologies and is said to be one of the major technology innovations used to improve the performance of the system. Four different types of MIMO algorithms are defined in LTE standard and they are: receiver-combing, transmit diversity, beam-forming and spatial-multiplexing. Modulation schemes should achieve low bit error rate in the presence of fading, interference, Doppler spread and thermal noise. In QPSK modulation, the constellation diagram has four different positions and each modulation symbols are mapped to different positions. Thus QPSK needs 2 bits to encode different modulation symbols. QPSK gives best results with weak signals[2]-[4].

In [13]-[16] the system performance of MIMO for different modulation schemes is presented. In [13], the BER vs. SNR for 2x2 and 4x4 MIMO using QPSK and 16 QAM modulation and MMSE equalizer is plotted using MATLAB. In [14] the work is extended by using QPSK modulation for Rayleigh fading channel and the BER vs. SNR values are plotted for 2x2 and 4x4 MIMO-LTE and are compared. This work is further extended for MQAM considering Rayleigh fading in [15], where the BER vs. SNR plots for 16QAM 2x2 MIMO-LTE and 4x4 MIMO-LTE using LTE PHY transceiver model for Rayleigh fading environment are plotted and also the BER values for 2x2 MIMO-LTE and 4x4 MIMO-LTE for different values of SNR for 64QAM are plotted. In [16], the BER vs. SNR plots for 2x2 and 4x4 LTE for both 16QAM and 64QAM are considered.

At the point when more technology advances and compared to older technologies, MIMO gives the main part of LTE's peak throughput gains. However, MIMO gains must be acknowledged on a fully optimized network. In reference to [12], MIMO optimization requires a different approach to traditional network optimization with assessment of multipath conditions, playing a key role in determining the potential throughput provided by a MIMO-enabled LTE network. The most important challenge related to wider band transmission is the effect of multipath fading of the radio channel[1]. Rayleigh fading is described in [1,6,11] as the name given to the form of fading that is often experienced in an environment where there are a large number of reflections present. The Rayleigh fading model is normally viewed as a suitable approach to take when analysing and predicting radio wave propagation performance for areas such as cellular communications in a well built up urban environment where there are many reflections from buildings and a line of sight path is not found.

The multipath fading channel is defined by a combination of a multipath delay profile and a maximum Doppler frequency which can be 5, 70 or 300Hz. In the 3GPP LTE standard three different multipath fading models are defined. They are EPA (Extended Pedestrian A), EVA (Extended Vehicular A), ETU (Extended Typical Urban). The delay profiles of these three models are shown in Table I. In this paper two parameters are used i.e. EPA 5Hz and EVA 5Hz. In MIMO actually refers to sending and receiving multiple data on the same radio channel at the same time via multipath propagation and therefore there may be correlation between antenna port at both the transmitter and the receiver. It is always desirable to minimize this correlation. In LTE standard three different correlation level are specified and they are shown in Table II.[1]

TABLE I

DELAY PROFILES FOR E-UTRAN CHANNEL MODELS

Channel model	Excess tap delay (ns)	Relative power (dB)
EPA	[0 30 70 90 110 190 410]	[0 -1 -2 -3 -8 -17.2 -20.8]
EVA	[0 30 150 310 370 710 1090 1730 2510]	[0 -1.5 -1.4 -3.6 -0.6 -9.1 -7 -12 -16.9]
ETU	[0 50 120 200 230 500 1600 2300 5000]	[-1 -1 -1 0 0 0 -3 -5 -7]

TABLE IIi

CORRELATION MATRICES FOR HIGH, MEDIUM AND LOW CORRELATION

LTE MIMO channel correlation levels	α	β
Low correlation	0	0
Medium correlation	0.3	0.9
High correlation	0.9	0.9

In this paper focus is mainly on the downlink LTE in Rayleigh fading environments for the two different multipath models EVA and EPA using the modulation scheme QPSK. So for the transmission of the data a better understanding of the LTE PHY radio interface is important.

II. SYSTEM MODEL

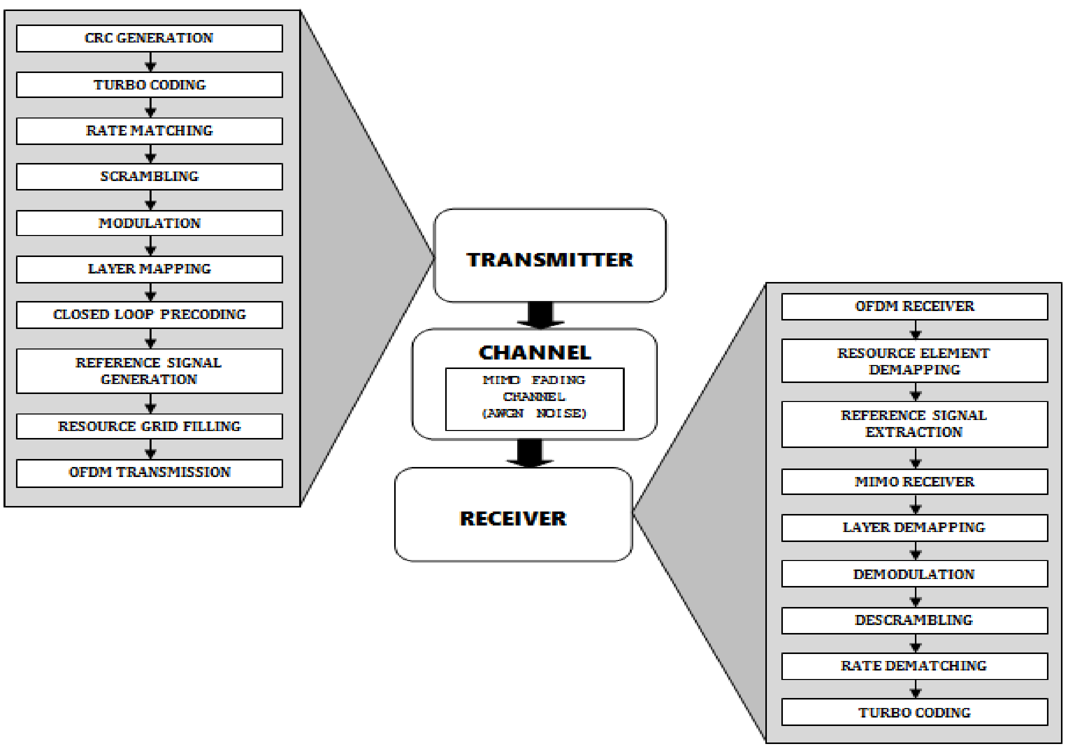

Fig. 1 System Model of LTE Downlink

Fig. 1 shows the structure of the LTE downlink transceiver which composed of a transmitter, a channel model and a receiver. The LTE Physical layer which is interfaced by the MAC layer is connected by the transport channels. In the transmitter side the transport channel performs CRC (Cyclic Redundancy Code) generation, turbo coding based on 1/3 rate and rate matching of the coded transport channel to handle any requested coding rates[12]-[16]. The coded bits are then scrambled resulting in a block of scrambled bits. The blocks of scrambled bits are then modulated using modulation mapper, which produces complex valued modulation symbols. To properly decode the data the terminal in LTE needs Reference Signals. After Precoding reference signals are generated, the coded bits are then mapped to the physical resource blocks. Then OFDM (Orthogonal Frequency Division Multiplexing) transmission is applied to the resource grid which produces the transmitted symbols. The transmitted symbols are then passed through a MIMO fading channel which is distorted by AWGN noise.

After the symbols are passed through the channel it will be received at the receiver and in the receiver the symbols will be recovered based on the reverse operations as on the transmitter side.

The receiver will receive the OFDM signals processed by the channel, an estimate of the noise variance per received channel, the transmitted reference signals and demodulate the OFDM symbols to generate the best estimate of the transmitted symbols.[12]-[16]

III.EXPERIMENTAL RESULTS

This section discusses the results obtained by performing the desired experiment using the system model as discussed in the previous section. In the transmitter side the information bits are generated and these bits are then modulated using the modulation scheme QPSK. The modulated bits are transmitted using two transmitting antennas and sent to the receiver through MIMO Fading Channel where AWGN noise is added. The transmitted signal is received by two receiving antennas at the front end of the receiver. This signal is then demodulated to get the desired signal which is sent to the user. Bit-error rate (BER) is plotted against different SNR (Signal to Noise ratio) values

A. Parameters Used

The parameters used in our work are listed in Table III, Table IV and Table V.

TABLE IIIII

CELL WIDTH CONFIGURATION

Parameters	Values
No of Frames	1024
No of resource blocks	50
No of Transmit antennas	2
Cell ID	0
Cyclic prefix	Normal (7)
Duplex mode	FDD(Frequency Division Duplex)
SNR Range	0:8 (QPSK)

TABLE IVV

CHANNEL MODEL CONFIGURATION

Parameters	Values
No of received antennas	2
Downlink channel	PDSCH (Physical downlink shared channel)
Channel bandwidth	20 MHz
Channel model	EVA 5Hz/ EPA 5Hz
Doppler shift	5
Fading type	Rayleigh
Noise type	AWGN
MIMO correlation	Low
Normalize path gain	On
Normalize for transmission antennas	On

TABLE V
MODULATION AND EQUALIZATION

Parameters	Values
Transmission mode	4 (Spatial multiplexing)
Modulation	QPSK
Mode type	QPSK
Coding rate	1/3
Equalization mode	MMSE
Demodulation	QPSK

B. BER vs. SNR Plots

BER and SNR are briefly defined in [13]-[16]. This section presents the plots that are obtained in the work process. The BER vs. SNR plots for QPSK, 2×2 LTE and 4x4 LTE using LTE PHY transceiver model for Rayleigh fading environment for EVA 5Hz and EPA 5Hz are shown in Fig. 2 and Fig. 3. BER values for 2×2 and 4x4 LTE EVA-EPA for different values of SNR for QPSK Rayleigh fading are listed in Table VI and Table VII respectively.

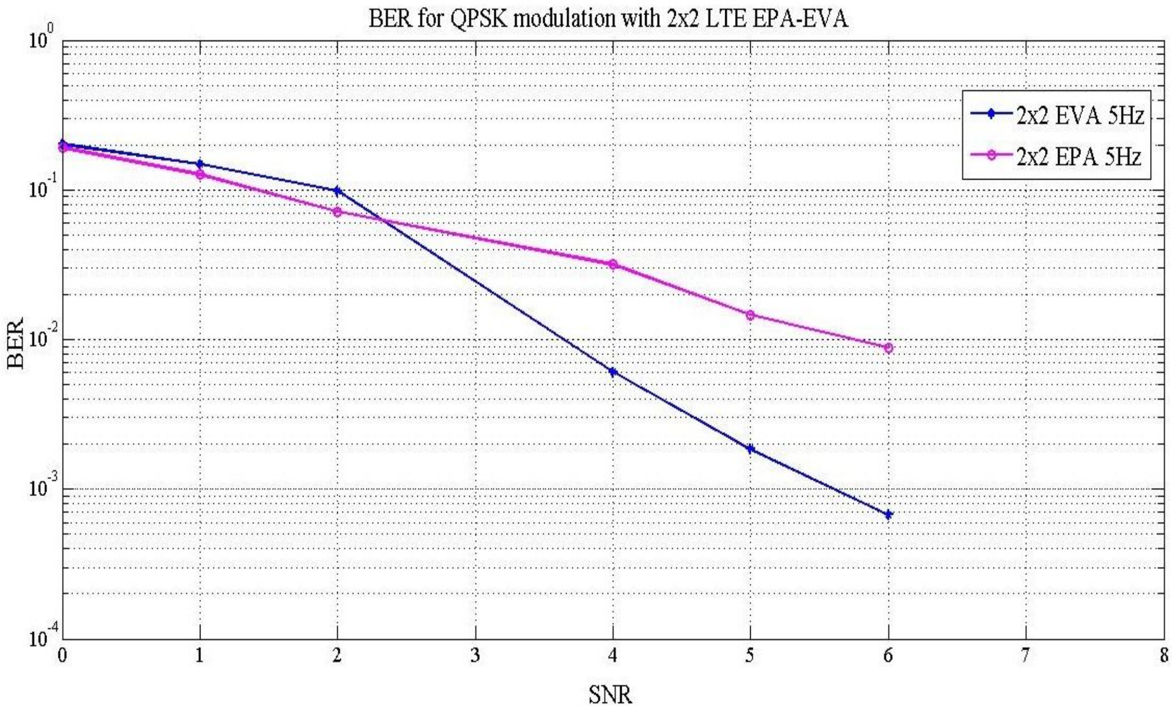

Fig. 2 BER vs. SNR for 2×2 LTE with QPSK modulation for EVA 5Hz and EPA 5Hz

TABLE. VI
BER VS. SNR PLOT FOR 2X2 LTE WITH QPSK MODULATION FOR EVA 5HZ AND EPA 5HZ

Sl. No	SNR (db)	BER QPSK 2x2 LTE EPA-EVA	
		EPA	EVA
1	0	0.190600	0.2019000
2	1	0.126800	0.1485000
3	2	0.071270	0.0984800
4	4	0.031690	0.0060660
5	5	0.014590	0.0018560
6	6	0.008856	0.0006744

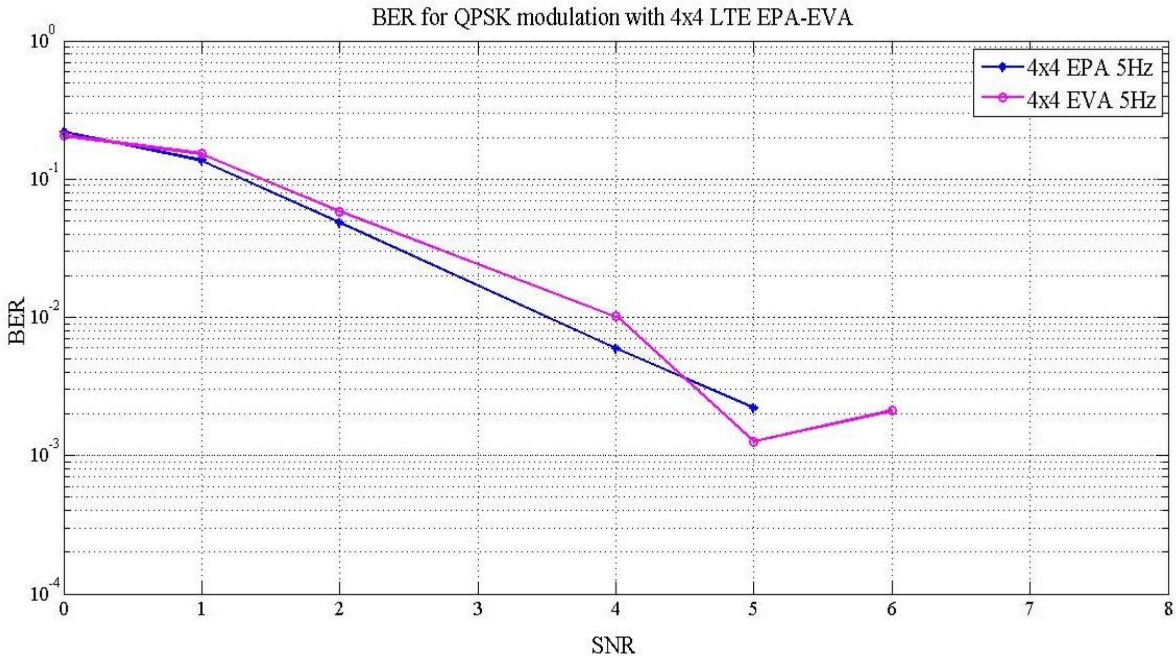

Fig. 3 BER vs. SNR for 4×4 LTE with QPSK modulation for EVA 5Hz and EPA 5Hz

TABLE VII
BER VS. SNR PLOT FOR 4X4 LTE WITH QPSK MODULATION FOR EVA 5HZ AND EPA 5HZ

Sl. No	SNR (db)	BER QPSK 4x4 LTE EPA-EVA	
		EPA	EVA
1	0	0.218800	0.205600
2	1	0.136600	0.152700
3	2	0.048410	0.058080
4	4	0.005965	0.010170
5	5	0.002216	0.001265
6	6		0.002104

IV. RESULT ANALYSIS

In this paper the BER vs. SNR for OPSK 2×2 and 4×4 LTE using LTE PHY transceiver model for Rayleigh fading environment for EVA 5Hz and EPA 5Hz are plotted and the BER values for Rayleigh fading channel are compared for 2x2 LTE and 4x4 LTE for the modulation scheme QPSK.

From Fig. 2 and Table VI, it is seen that with increase in SNR, the BER value for EVA 2×2 decreases eventually more than that of EPA 2×2. As also it is seen that for low SNR value the BER value for EPA is lower than that of EVA. With increase in the SNR value the performance of EVA becomes better than EPA.

Now from Fig. 3 and Table VII, it is seen that the performance of EVA 4×4 and EPA 4×4 is almost same for low SNR . With increase in the SNR values, BER values for EPA is lower than that of EVA.

V. CONCLUSION

In this paper the concept of 3GPP LTE has been demonstrated using the standard LTE model with transmission mode 4 with severely faded EVA 5Hz and EPA 5Hz fading channel. The signal is transmitted through Rayleigh faded environment. BER curves play a very important role in the performance of the system. In this paper the BER vs. SNR values are plotted comparing EVA 5Hz and EPA 5Hz for both 2x2 and 4x4 MIMO using QPSK modulation. With the increasing value of SNR, the BER values must decrease for a better performance of the system. From the analysis this can be concluded that the BER reduces in LTE significantly when the SNR is increased. Further the work can be extended using a different equalizer for better performance and also the number of antenna can be increased.

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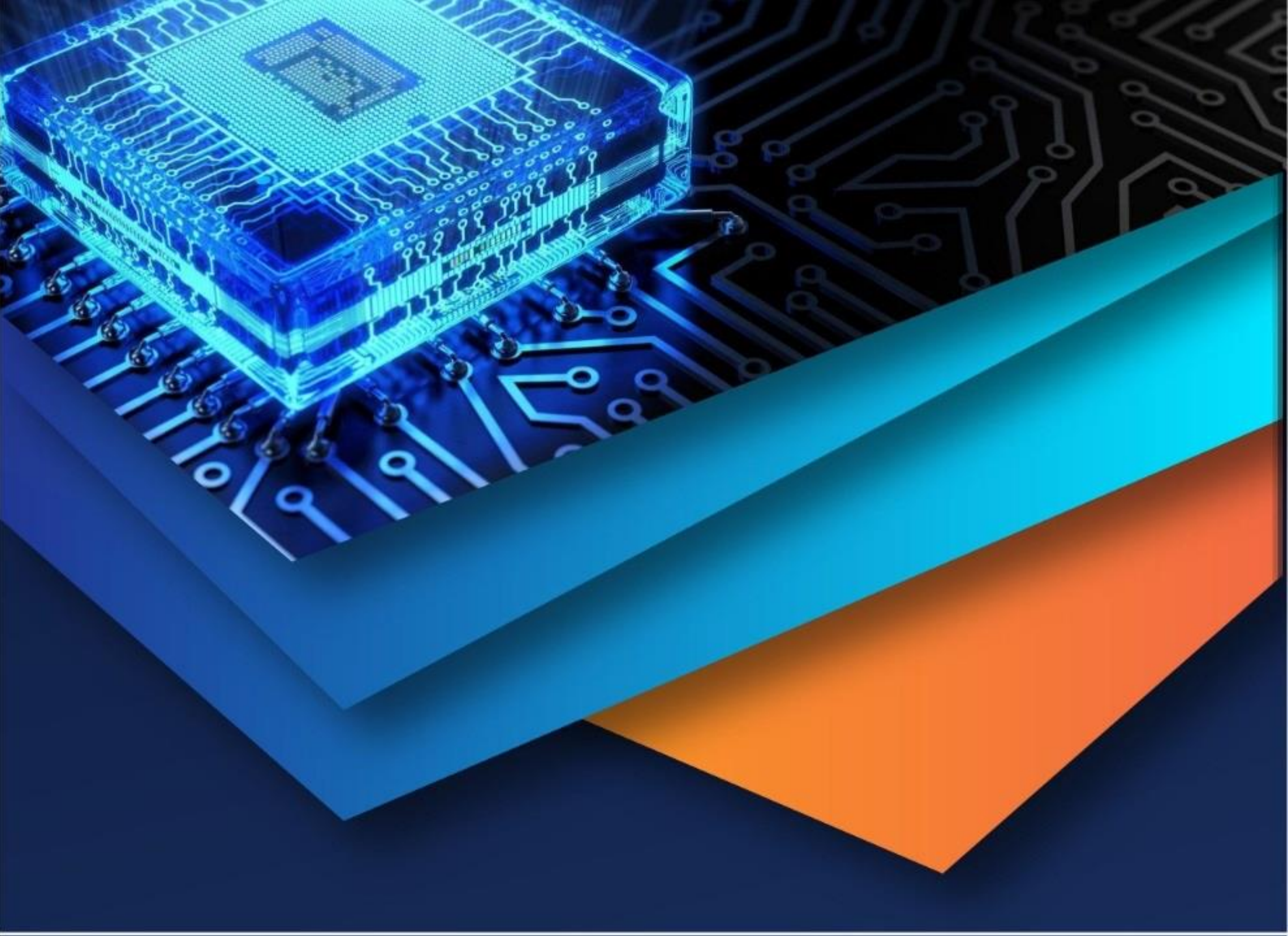

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