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Efficient Mobile Uplink LTE System Using Scfdma and Biorthogonal Wavelets

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Abstract— Mobile communications is one of the evolutionary technology in now a days. In this paper the proposed system is widely focused on to increase the efficiency of the mobile communications system in terms of decreasing the power utilization at mobile unit when message is transmitted from mobile unit to base station and also decreasing the bit error rate during uplink transmission. Here Single carrier frequency division multiple access (SCFDMA) used instead of OFDMA to decrease the power consumption and various types of wavelets are used instead of Discrete Fourier Transforms (DFT) to minimize the bit error rate at receiver during uplink transmission. Thus the efficiency of the system is increased by using (SCFDMA) with wavelets.
Keywords: PAPR, BER, OFDMA, SCFDMA, DFT, WAVELETS.

I. INTRODUCTION

The evolution of technologies got started from 1970s. For the improvement of wireless communication technologies first generation(1G) to fourth generation (4G).The predessor of (1G) known as zero generation was used in cars before the invention of mobile phone.(1G) includes analog wireless network the widely used technology in (1G) is AMPS which supports data rate(voice only) of about 9.6kbps to 12 kbps. (2G) includes digital wireless network. The widely used technologies in (2G) are DAMPS,GSM and IS 95. These systems use digital circuit switching technique for data transmission. The data rate(voice and data) supported by these systems are about 9.6kbps to 14.2kbps.(2.5G) is developed to increase the data rate of the system which uses GPRS and EDGE as the techniques for data transmission. The data rate (voice, data and limited web browsing) supported by these systems are about 56kbps to 144kbps.Here (2.5G) used digital packet switching technique for data transmission. The next evolved technology is (3G) here UMTS and CDMA are widely used to increase the data rate which is about 384kbps to 2mbps.Now (4G) is the emerging technology in mobile communications which uses OFDMA for downlink data transmission (base station to mobile unit) and SCFDMA for uplink data transmission (mobile unit to base station).The (4G) is also known as LTE.

LTE has adopted the OFDMA for downlink transmission and SCFDMA for uplink transmission. OFDMA is the multi user version of OFDM. SCFDMA combines the OFDMA advantages such as high spectral efficiency, less sensitivity to the carrier frequency offsets with the lower peak to average power ratio (PAPR).

In this paper PAPR for OFDMA and SCFDMA are compared and BER of SCFDMA is compared with DFT and DWT .The wavelet transforms posses better orthogonality. It reconstructs the signal effectively. It is less prone to Inter Channel Interference (ICI) and Inter Symbol Interference (ISI).As there occurs no loss of orthogonality.

II. SCFDMA

For the LTE uplink, a different concept is used for the access technique. Although still using a form of OFDMA technology, the implementation is called Single Carrier Frequency Division Multiple Access (SC-FDMA).

One of the key parameters that affects all mobiles is that of battery life. Even though battery performance is improving all the time, it is still necessary to ensure that the mobiles use as little battery power as possible. With the RF power amplifier that transmits the radio frequency signal via the antenna to the base station being the highest power item within the mobile, it is necessary that it operates in as efficient mode as possible. This can be significantly affected by the form of radio frequency modulation and signal format. Signals that have a high peak to average ratio and require linear amplification do not lend themselves to the use of efficient RF power amplifiers. As a result it is necessary to employ a mode of transmission that has as near a constant power level when operating. Unfortunately OFDM has a high peak to average ratio. While this is not a problem for the base station where power is not a particular problem, it is unacceptable for the mobile. As a result, LTE uses a modulation scheme known as SC-FDMA - Single Carrier Frequency Division Multiplex which is a hybrid format. This combines the low peak to average ratio offered by single-

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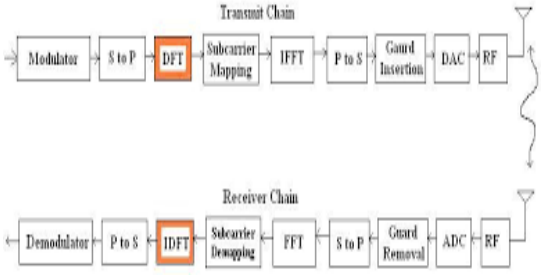
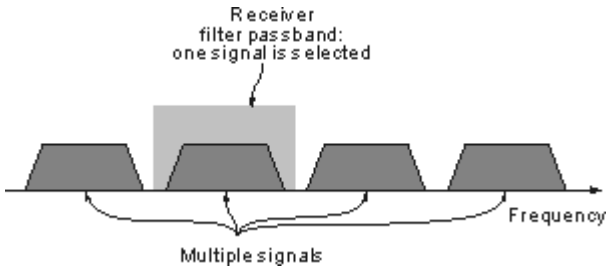
carrier systems with the multipath interference resilience and flexible subcarrier frequency allocation that OFDM provides.



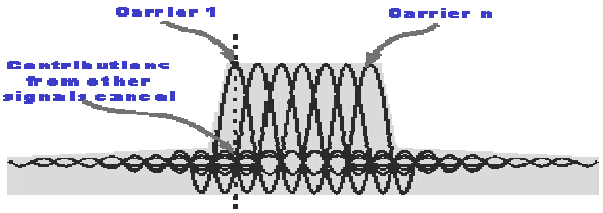
SCFDMA USING DFT BLOCK DIAGRAM

III. OFDMA

OFDM is a form of multicarrier modulation. An OFDM signal consists of a number of closely spaced modulated carriers. When modulation of any form - voice, data, etc. is applied to a carrier, then sidebands spread out either side. It is necessary for a receiver to be able to receive the whole signal to be able to successfully demodulate the data. As a result when signals are transmitted close to one another they must be spaced so that the receiver can separate them using a filter and there must be a guard band between them. This is not the case with OFDM. Although the sidebands from each carrier overlap, they can still be received without the interference that might be expected because they are orthogonal to each another. This is achieved by having the carrier spacing equal to the reciprocal of the symbol period.



To see how OFDM works, it is necessary to look at the receiver. This acts as a bank of demodulators, translating each carrier down to DC. The resulting signal is integrated over the symbol period to regenerate the data from that carrier. The same demodulator also demodulates the other carriers. As the carrier spacing equal to the reciprocal of the symbol period means that they will have a whole number of cycles in the symbol period and their contribution will sum to zero - in other words there is no interference contribution.



OFDMA SPECTURM

One requirement of the OFDM transmitting and receiving systems is that they must be linear. Any non-linearity will cause interference between the carriers as a result of inter-modulation distortion. This will introduce unwanted signals that would cause interference and impair the orthogonality of the transmission.

In terms of the equipment to be used the high peak to average ratio of multi-carrier systems such as OFDM requires the RF final amplifier on the output of the transmitter to be able to handle the peaks whilst the average power is much lower and this leads to inefficiency. In some systems the peaks are limited. Although this introduces distortion that results in a higher level of data errors, the system can rely on the error correction to remove them.

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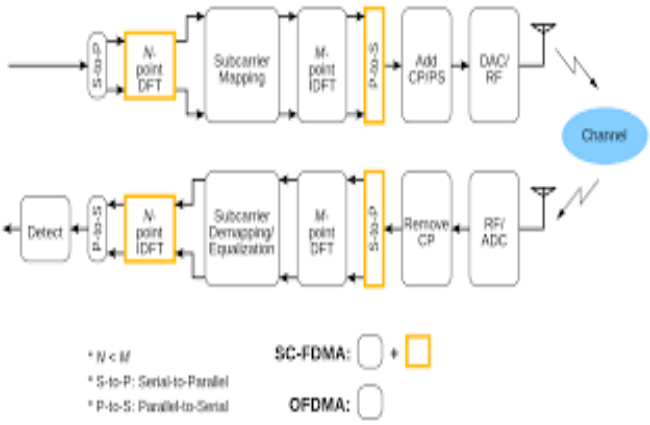
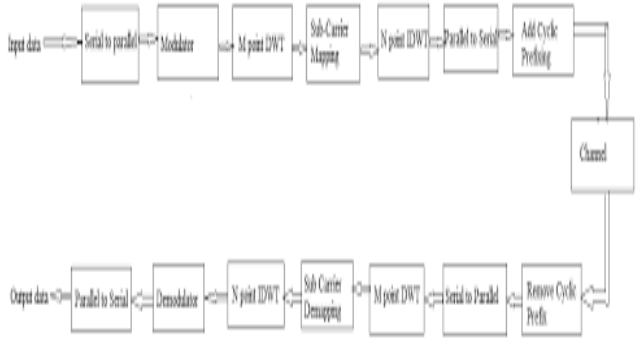


OFDMA BLOCK DIAGRAM

IV. WAVELETS IN SCFDMA

Recent research has shown that the Single Carrier Frequency Division Multiple Access (SC-FDMA) is an attractive technology for uplink broadband wireless communications, because it does not have the problems of Orthogonal Frequency Division Multiple Access (OFDMA) such as the large Peak-to-Average Power Ratio (PAPR). In this paper, an efficient transceiver scheme for the SC-FDMA system, using the wavelet transforms is proposed. In the proposed scheme, the Fast Fourier Transform (FFT) and its inverse (IFFT) are replaced by the Discrete Wavelet Transform (DWT) and its inverse (IDWT). Wavelet filter banks at the transmitter and the receiver have the ability to reduce distortion in the reconstructed signals, while retaining all the significant features present in the signals.



SCFDMA BLOCK DIAGRAM WITH DWT

V. PROPOSED PROJECT

In this paper the efficiency of mobile LTE uplink data transmission is increased with the help of SCFDMA technique and WAVELETS. The OFDMA is used for mobile LTE downlink data transmission which requires large amount of power because of change in the phase of sub-carriers.Which creates no problem at the base station because of abundant availability of power.Where as the problem arises in mobile unit hence to decrease the power comsunption we use SCFDMA technique.This technique uses only one carrier the absence of sub carriers will lead to less amount of power utilization. The data rate of OFDMA is more than the data rate of SCFDMA hence the BER of SCFDMA is more than the OFDMA. In order to decrease the BER we use DWT the frequency of the signal is increased with the help of wavelets so the signal propagates fastely through the channel by which interference of the noise will be low. The biorthogonal wavelets are used to still decrease the BER and to increase the data rate of the SCFDMA down link data transmission.

A. Biorthogonal Wavelets

A biorthogonal wavelet is a wavelet where the associated wavelet transform is invertible but not necessarily orthogonal. Designing

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biorthogonal wavelets allows more degrees of freedom than orthogonal wavelets. One additional degree of freedom is the possibility to construct symmetric wavelet functions. It is well known that bases that span a space do not have to be orthogonal. In order to gain greater flexibility in the construction of wavelet bases, the orthogonality condition is relaxed allowing semi-orthogonal, biorthogonal or non-orthogonal wavelet bases. Biorthogonal Wavelets are families of compactly supported symmetric wavelets. The symmetry of the filter coefficients is often desirable since it results in linear phase of the transfer function In the biorthogonal case, there are two scaling functions ϕ, $\tilde{\phi}$ which may generate different multi resolution analyses, and accordingly two different wavelet functions ψ, $\tilde{\psi}$ So the numbers M and N of coefficients in the scaling sequences a, $\tilde{a}$ may differ. The scaling sequences must satisfy the following biorthogonality condition

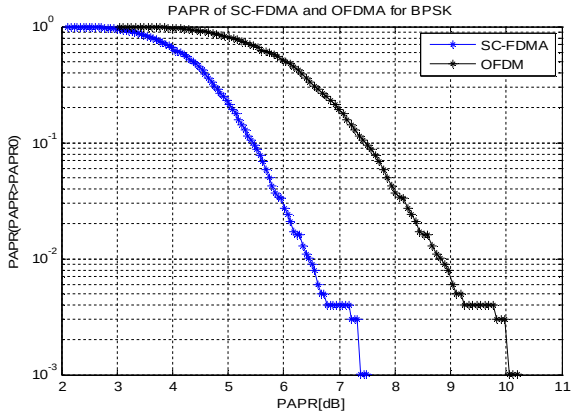
$$\sum_{n\in\mathbb{Z}} a_n \tilde{a}_{n+2m} = 2\cdot\delta_{m,0}$$

$$b_n = (-1)^n \tilde{a}_{M-1-n} \qquad (n=0,\ldots,N-1)$$
$$\tilde{b}_n = (-1)^n a_{M-1-n} \qquad (n=0,\ldots,N-1)$$

VI. RESULTS & CONCLUSION

The all simulations are based on below assumed parameters

PARAMETER	SPECIFICATION
Simulation tools used	MATLAB
Wavelets	Haar,Daubchies,Biorthogonal
Channel	AWGN
Sub carrier mapping	Localized
Input block size	1024
System bandwidth	6MHz
Cyclic prefix	2 bits per symbol
Modulation schemes	BPSK,QPSK,16-QAM ,64-QAM
DFT/DWT (Size)	256
IDFT/IDWT(Size)	256



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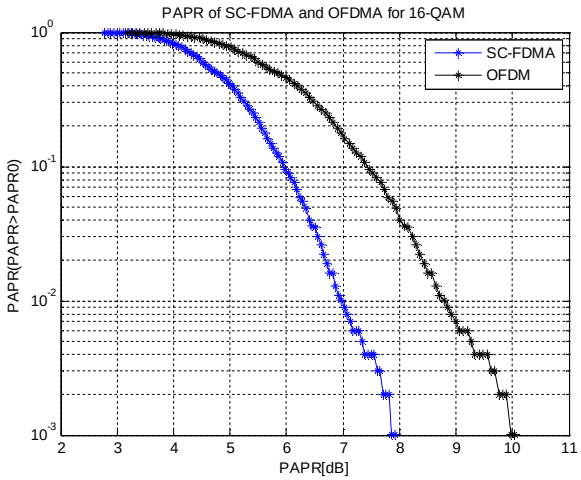
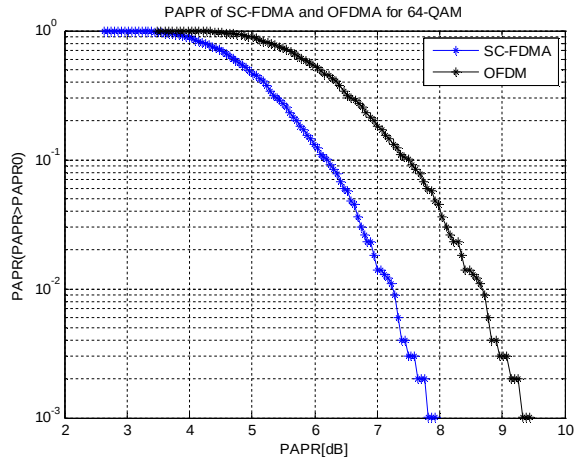
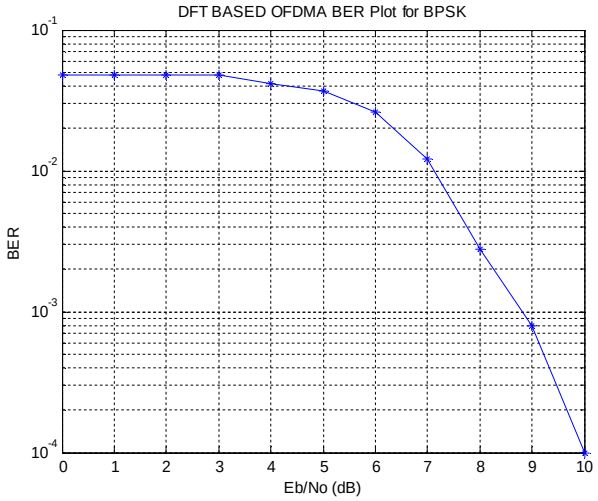




The above graphs shows us that the SCFDMA uses less amount of power than that of OFDMA and as the order of modulation increases the power utilized by SCFDMA will approach to OFDMA.Hence is adviceble to use lower order modulation techniques for reduction of utilization of power through SCFDMA.



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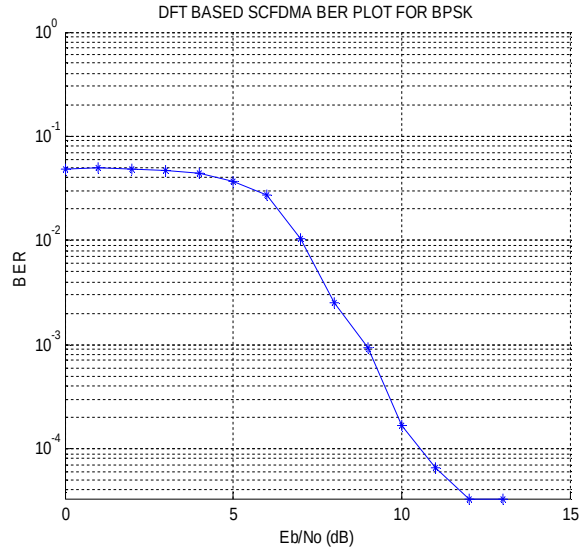

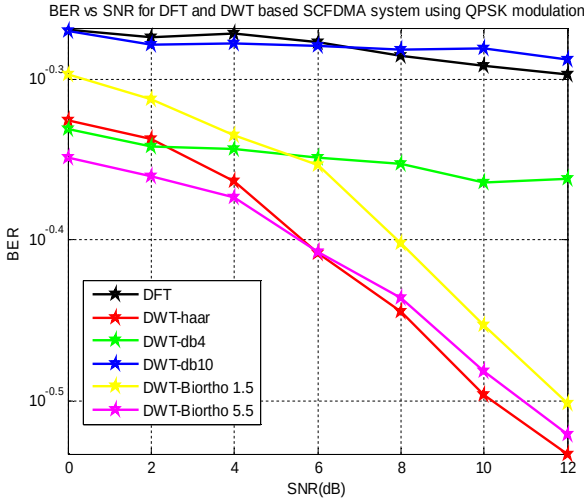

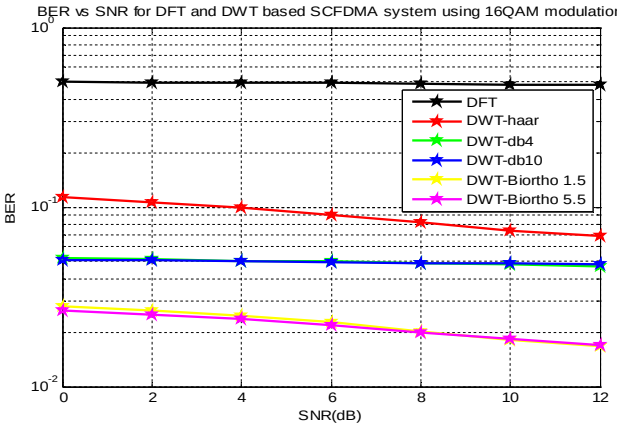

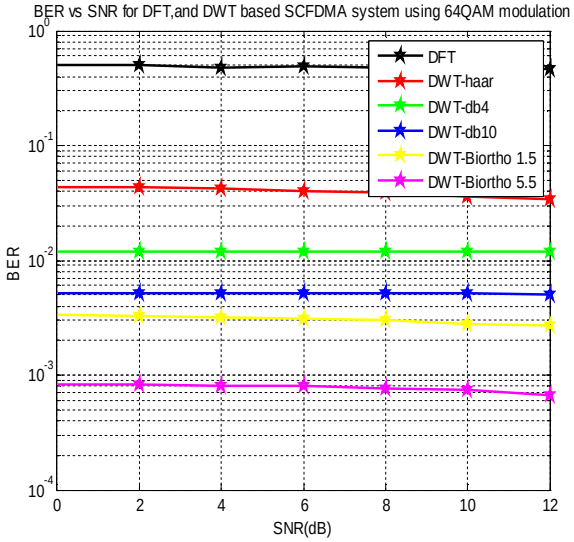

The above graphs shows us that the BER for SCFDMA is more than that of OFDMA.The next graphs shows us the various types of wavelets with different modulation techniques and finally we observe that Biorthogonal wavelet usage will decrease the BER of SCFDMA system

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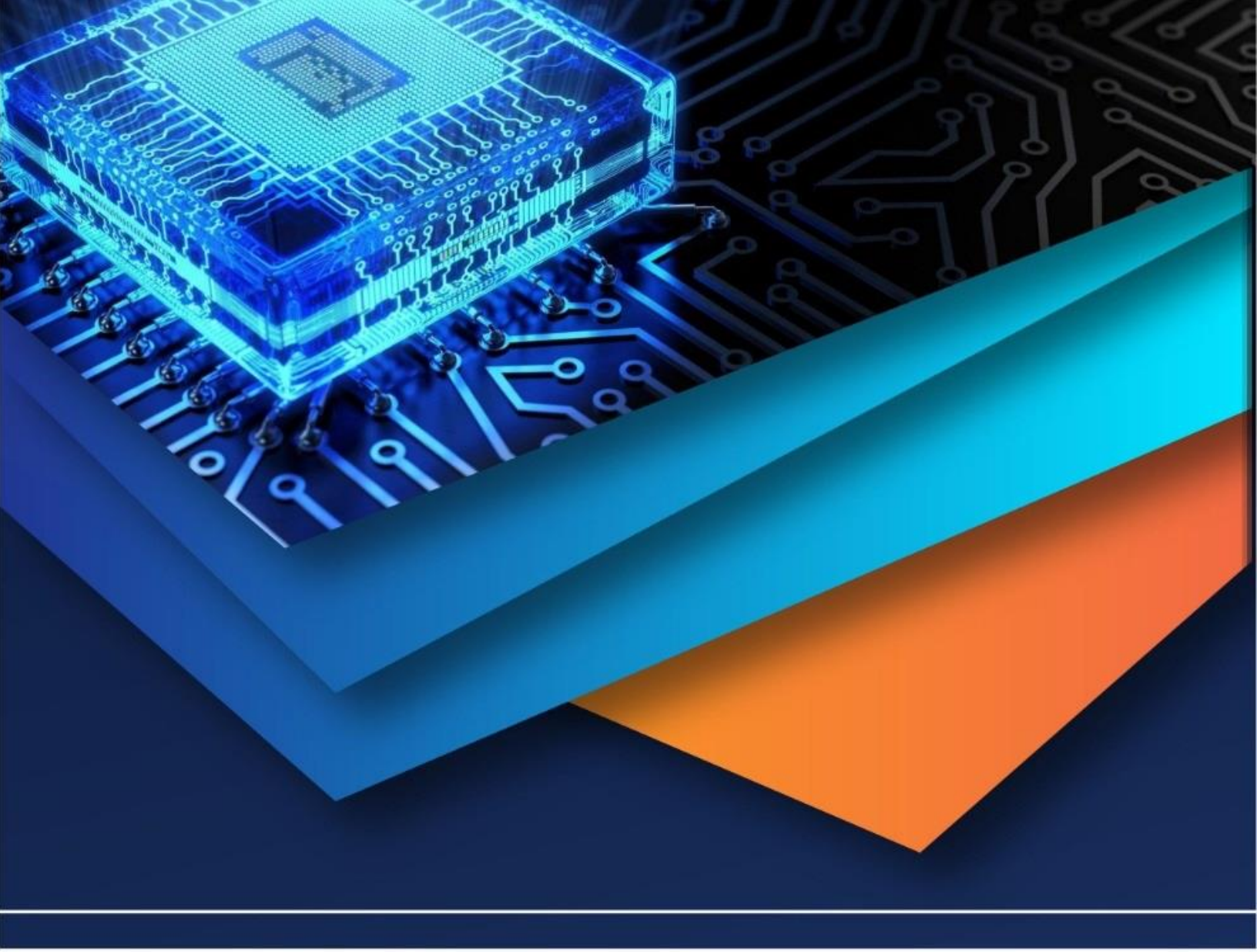

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