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OFDM-IDMA Uplink Multi-user System with Scalable Latency for Next Generation WLAN

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Abstract: Compared to OFDM-CDMA, the OFDM-IDMA method has several advantages, including a lower ISI and more efficient cross-cell interference mitigation. Furthermore, IDMA supports a turbo-type iterative MUD algorithm that is easy to use and efficient for systems with a high user count. This gives us a high throughput system. In this paper, we examine how variations in SNR during wireless communication affect bit error rate (BER) in a combined IDMA-OFDMA framework. By using IDMA for iterative discovery, the cyclic prefixing approach in OFDM can minimize ISI. Flexible rate adaptation, frequency diversity, low-cost iterative multi-user detection, and notable improvements in spectrum and power efficiency are all advantages of OFDM-IDMA.
Keywords: IDMA, OFDMA, QOS, WLAN

I. INTRODUCTION

The modern world has transformed due to advancements in wireless communication. Twenty years ago, the only devices with Wireless Local Area Networks (WLAN) connectivity for wireless broadband internet access were high-tech notebooks. However, as consumer demand grows, WLAN connectivity is already a standard feature of many contemporary communication gadgets. New applications like multimedia streaming and video-on-demand have been made possible by this increase. The emergence of this phenomenon has given rise to a novel area of research on "wireless broadband access everywhere." The fact that mobile environments can also be used for internet browsing or watching live video streams is evidence of the effectiveness of WLAN-based wireless broadband.

Existing 2G cellular technologies, such as GSM, perform poorly for data-based applications since they are intended for voice-centric networks. Data-centric network transmission is better suited for 3G cellular technologies like HSDPA and UMTS. However, existing standards are unable to meet future prospects' demands for high quality of service (QoS) and large data rates.

Upcoming systems are planned with high-capacity fields in mind. Interleave division multiple access (IDMA) systems have been discovered to be more capable of transferring information than orthogonal frequency division multiplexing (OFDM) [1, 2]. Two significant impairments Wireless communication systems are susceptible to transmission performance degradation due to the presence of multiple access interference (MAI) as well as inter-symbol interference (ISI). While there are other suggested methods, such as time domain equalization, they are quite expensive. By converting frequency-selective channels into parallel flat fading channels, OFDM may effectively combat ISI. By integrating elementary signals and decoding in an iterative manner, IDMA [3] offers advantages over MAI minimization. The characteristics of both technologies will be covered in detail in the following section, after which we will assess how an IDMA-OFDMA system performs in terms of bit error rate (BER) performance in relation to changes in SNR.

II. LITERATURE REVIEW

In 2015, W. Belaoura proposed an interleaver that utilizes elliptic curves in cryptography to generate permutation manage keys. The interleaved series' degree of randomness is scalable through the application of multiple rounds as well as a unique subkey in each spherical. According to simulation results, the final structure with the suggested interleaver offers a certain degree of information security along with a workable bit errors fee performance. It was noted how resilient the nontraditional scheme was against multi-person interference and multi-direction fading [8].

Panagiotis Botsini's 2015 inventions have made it simple to integrate low-complexity tender-enter tender-output quantum-assisted multi-consumer detectors (QMUD) into modern iterative receivers. Extrinsic statistics transfer charts are the foundation of our design.

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QMUDs have been used in multi-provider interleave-department multiple access (MC-IDMA) architectures. These architectures can be studied in the context of varying channel coding fees and dispersing item pairs, in addition to resolving the overall bandwidth demand. It is noted that one QMUD operates within zero. After three rounds between the MUD and the decoders, the conventional maximum a posteriori possibility inside five dB MUD is accomplished with only half of its complexity. [9].

A low-cost code shift division multiple-access (CSDMA) method was examined by Yang Hu et al. (2018), [10]. In this scheme, user-specific shifting is employed in place of user-specific interleaving in IDMA. We also present an efficient "Gaussian approximation-based linear least mean square error message passing detection approach for CSDMA. We show that CSDMA can achieve about the same performance as the original IDMA at a much lower implementation cost in low-density parity-check or turbo-coded" systems.

In a study conducted by D. Sony et al. (2021) [11], the IDMA system was implemented in MATLAB and its performance was compared with that of code division multiple access (CDMA). Because MATLAB is more recognizable to engineers and scientists, we may use it to analyze data, construct algorithms, and generate models, and applications. FourG uses a technology called CDMA. Multiple access communication possibilities are offered by this technology. With CDMA, performance quality generally declines as the user count rises. Thus, with the development of CDMA and its inheritance, a new technique called IDMA was created in order to address its shortcomings. IDMA technology is being investigated globally for use in 5G communication systems. IDMA is a multiuser method in which distinct interleaver sequences are used to keep users apart.

III. METHODOLOGY

In ISI channels, random interleaving makes detection easier [11] and reduces MAI. Below is a discussion of how IDMA technology functions in wireless communication.

A. Basic IDMA System

Equation (1) provides the updated model of a received signal for an IDMA system with an ISI channel:

$$r = \sum_{k=1}^{K} \sqrt{p_k}\, h_k \otimes x_k + z \qquad (1)$$

r: received signal vector,

x_k: the "transmitted signal vector for user k,

h_k:$\{h_{k,0}, \ldots, h_{k,L-1}\}$ a fading coefficients vector for user k,

z: sample vector of AWGN noise and

$\otimes$: signifies convolution operation.

Considering the transmitter for user k, the data is first encoded by the encoder ENC_k (refer to" figure 1) and subsequently fed into a chip sequence {xk(j)} by an interleaver πk. A power control factor √pk is also utilized in certain instances. Although the conventional CDMA spreading operation is employed, user separation is additionally achieved by the user-specific interleavers $\{\pi_k\}$, therefore it is not required.

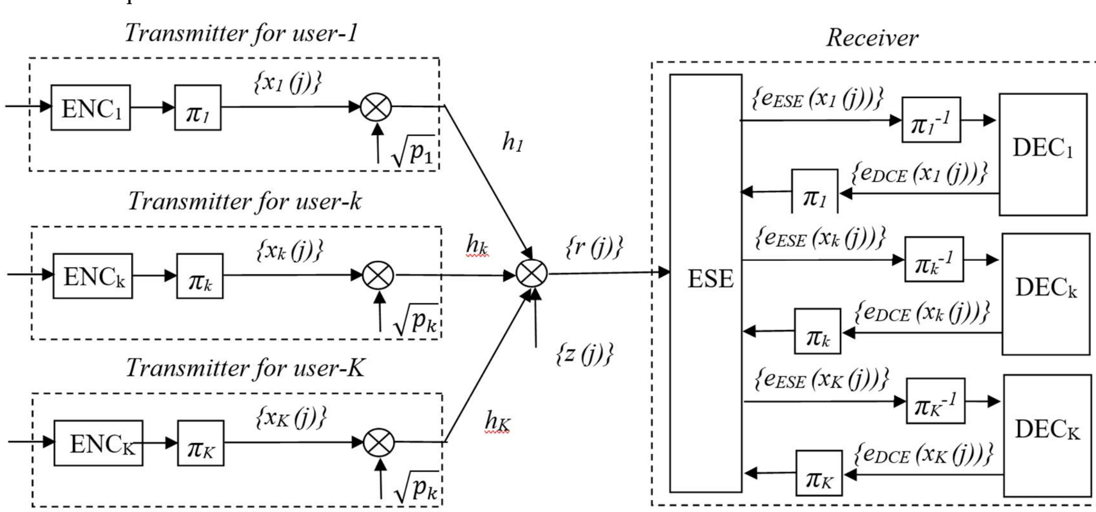

Figure 1: The system model of an IDMA multiple access scheme

Equation (1) is expressed for the k[th] user as follows:

$$r(j) = \sqrt{p_k} h_k x_k(j) + \xi_k(j)$$

where, with regard to *xk(j), ξk(j)* is the noise-plus-interference component in *r(j)*. Despite being rather basic and uncomplicated, the aforementioned detection technique is highly effective, typically achieving sufficient results after a few "iterations.

B. OFDMA Transmission System

The transmitted signal in OFDMA is calculated as the sum of independent, equal-bandwidth Nc sub-symbols with a frequency separating of $1/T_s$ (T_s being the duration" of an OFDMA symbol). Given that one user's data is carried by all *K* sub carriers. If several users wish to transmit using OFDM, they must each take a turn at the appropriate time [4]. In Figure 1, the OFDMA transmission system is displayed.

In this case, where "one sub-carrier is allotted to each user and additive white Gaussian noise (AWGN) is the source of disturbance, the nth of decoded bits is translated into the complex valued OFDMA vector [5] of QPSK constellation points. Next, the following is a single multi carrier sign in the continuous time representation:

$$X_k(n) = \frac{1}{\sqrt{N_c}} \sum_{k=0}^{N_c} d_k(n) e^{j2\pi kn/N_c}$$

The QPSK value of the k[th] user with K= 0, 1,..., K-1 at the receiver is represented by $X_k(m)$, where m is the symbol index. In this case, all user channels to the base station are constant for each OFDMA" symbol.

Below is the demodulated receiving signal written:

$$d_k(m) = \frac{1}{\sqrt{N_c}} \sum_{k=0}^{N_c} r_k(m)\, e^{j2\pi km/N_c}$$

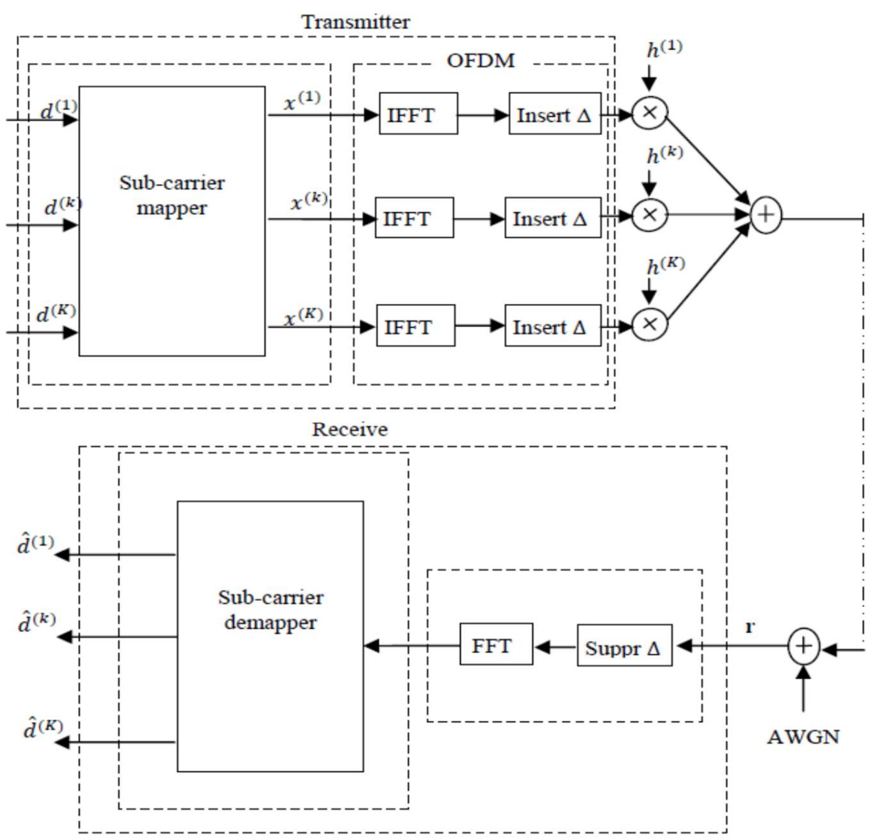

Figure 2: The transmitter and receiver structure of an OFDMA system, where Δ denote the cyclic prefix.

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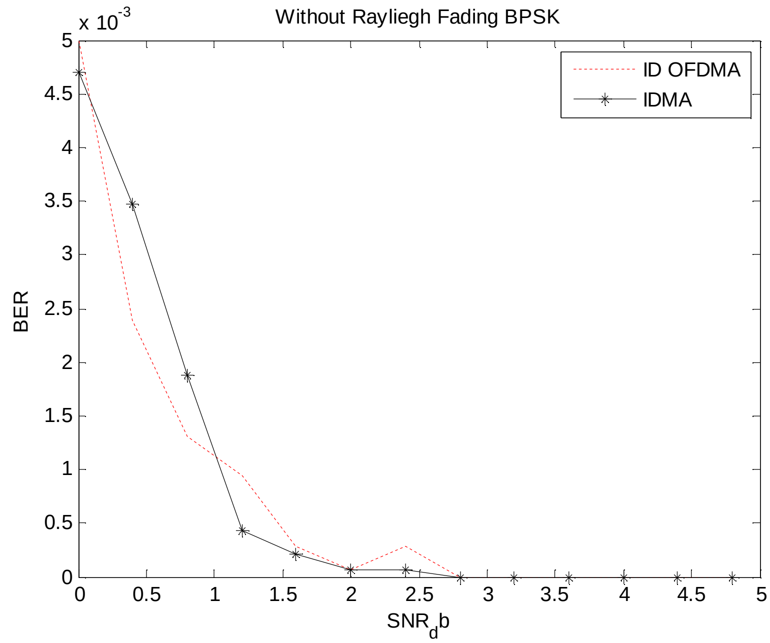
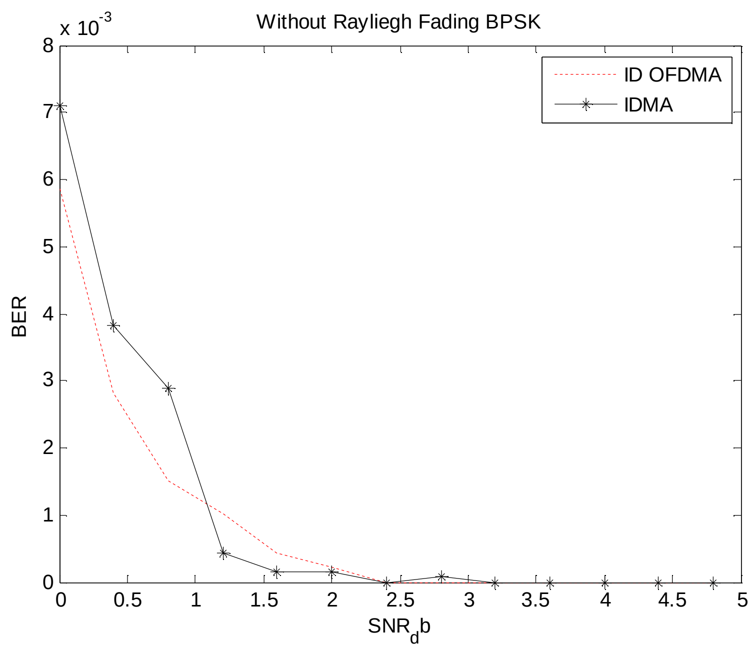
IV. RESULT AND DISCUSSION

For writing the method, we used a Matlab platform. We created a script file for wireless transmission in AWGN noise with various SNR levels.



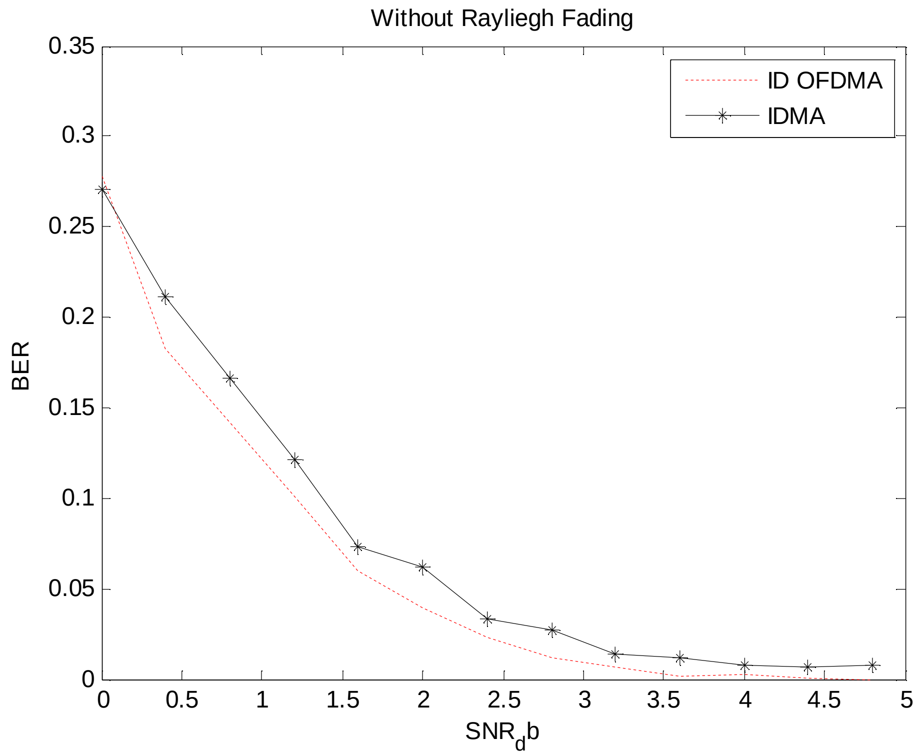
(a)



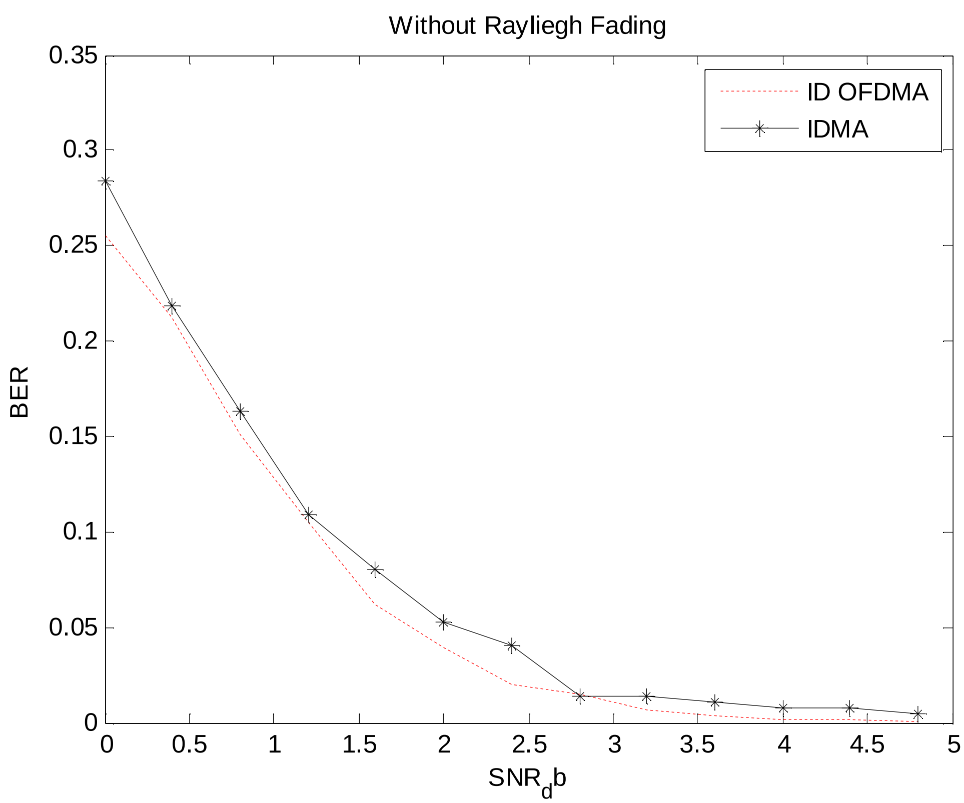
(b)

Figure 3: BER vs SNR plot for BPSK modulation using IDMA(solid) & IDMA-OFDMA(dash) transmission.

We tested BER at SNR levels ranging from 0 to 5 after applying IDMA to our message signal. Figure 3. (a & b) shows a plot of BER versus SNR for BPSK modulation, with a solid line for IDMA and a dashed line for IDMA-OFDMA transmission. We can see that OFDMA-IDMA transmission has a lower BER than IDMA transmission. The outcomes of two different random messages are shown in Figure 3 (a) and (b).



(a)



(b)

Figure 4: BER vs SNR plot for QPSK modulation using IDMA (solid) & IDMA-OFDMA (dash) transmission.

For QPSK modulation, a similar technique is used. Figure 4(a & b) shows the BER for OFDMA-IDMA (dashed) and IDMA only for two different random signals, and we can see that the BER for OFDMA-IDMA (dashed) is lower than IDMA just (solid).
We used standard coding prior to interleaving.

V. CONCLUSION

We have planned an IDMA-OFDMA framework to check its exhibition and vigor against the AWGN commotion. Three unique plans are utilized for regulation known as BPSK; QPSK and 8PSK the BER esteems are determined by utilizing Matlab based recreation calculation. It has been observed that for various irregular age of twofold signals we get lower BER on account of OFDMA0–IDMA framework. Henceforth IDMA framework alone can perform great execution against multiuser access impedance yet alongside OFDMA IDMA we can battle with0ISI and get decreased piece blunder rate. At higher SNR execution of both IDMA and IDMA-OFDMA become same yet at lower SNR OFDMA-IDMA helps in bring down the BER. For various adjustment the most minimal BER is gotten for BPSK in the scope of 5 x10-3 to 7x10-3 henceforth the exhibition is best for BPSK. However, on account of 8PSL our IDMA-OFDMA beats to IDMA as it were.

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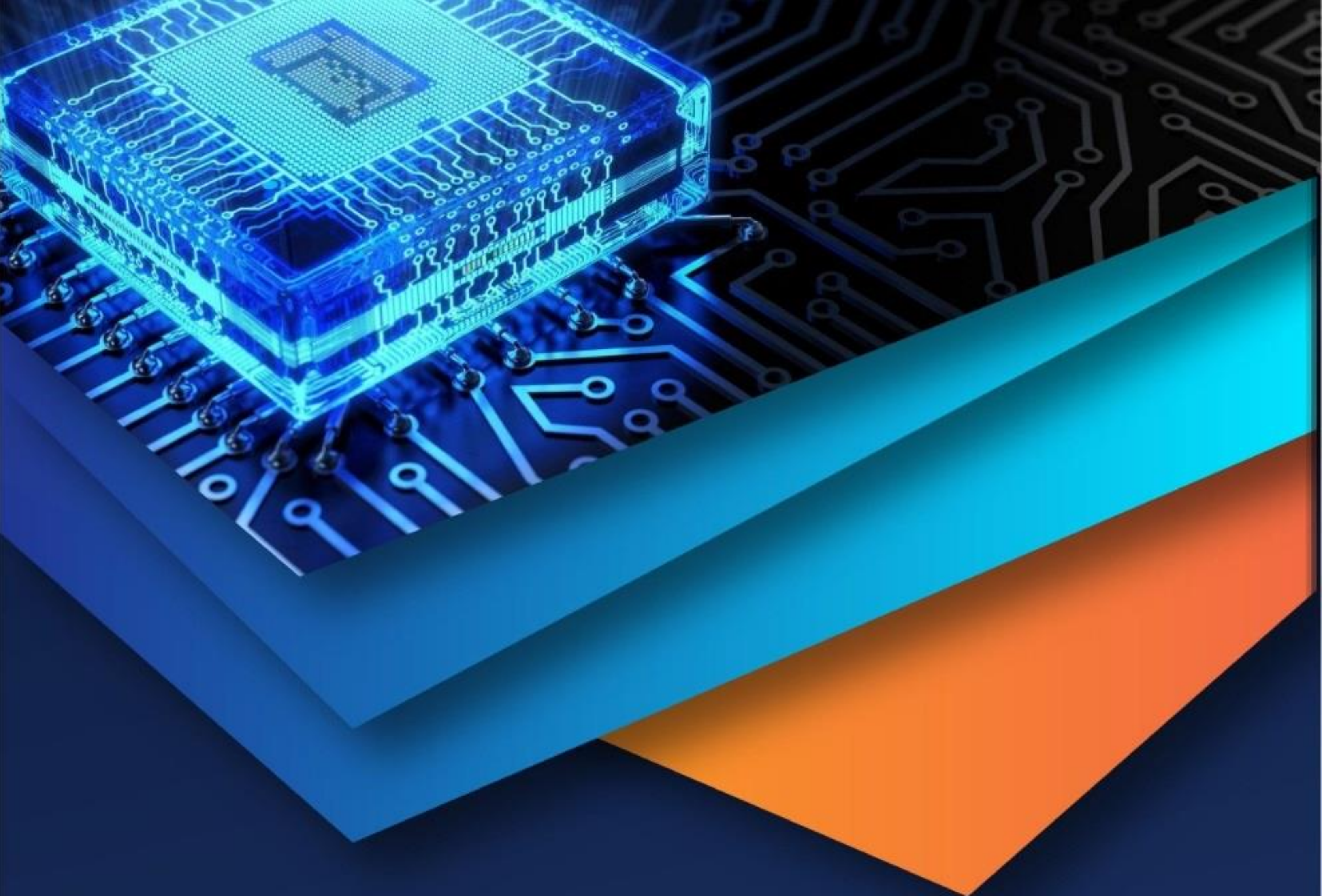

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