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An Analysis of Block Chain Applications In Bitcoin And Smart Grid Technologies

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Abstract: ***Blockchain is the nascent technology which has the capability of incorruptible future in making. The blockchain mechanism is regarded for its security. In recent years, many have adopted for Blockchain. This paper tries to analyze some of the game changing technologies using blockchain mechanism. The paper has been framed by using secondary research and the authors' opinion is also voiced.Blockchain-based application are springing up, covering numerous fields including financial services, Internet of Things (IoT), and Energy distribution systems Smart Grids uses blockchain to control the flow of energy. Blockchain, the foundation of Bitcoin, has received extensive attentions recently. Blockchain serves as an immutable ledger which allows transactions take place in a decentralized manner. Blockchain-Based Smart Grids presents emerging applications of blockchain in electrical system. As, Rapid growth of renewable energy resources in power systems we require a system through which we can monitor the consumption and supply of the electricity. This is sustainable and eco-friendly alternative. This paper is tailored to analyze the blockchain applications in Bitcoin and Smart Grid.***
Keywords: Blockchain, Bitcoin, Smart Grid, Distributed ledger, Consensus Algorithm, Microgrid monitoring and Control.

I. INTRODUCTION

The Blockchain is a chain of blocks that contains records of data or information. The data exchange related to the block is recorded in an open Distributed ledger. The ledger records the time-stamps of the data exchanged, once recorded it cannot be back-dated. As, it uses an open ledger it is prone to theft or misuse of the data. To tackle this issue blockchain uses Asymmetric Cryptography. In a blockchain every block consists of cryptographic hash of previous block its current hash and data and is linked with other blocks (generally represented as MERKLE TREE). Once the block is added to the chain, modification or tampering the data becomes next to impossible as each block is linked with the hash of the previous block and any ill-activities will be portrayed in the ledger.This feature has become greatest asset and many applications used blockchain as their Fundamental Mechanism.

A. Characteristics Of Blockchain

Figure 1: Characteristics Of A Blockchain

1) *Decentralized Network:* The blockchain is an ungoverned network, so that there is additional payment for services and it works faster compared to the traditional systems.
2) *Immutability:* Immutability means something which cannot be altered. Once a block is published into chain its actions cannot be altered.
3) *Auditability:* Every action in the network is easily traceable. Therefore, misuse of data is not possible.
4) *Consensus:* It is a Fault-tolerance mechanism. That is used to achieve the necessary agreement on a single data or value among the networks. It makes sure that the block added is trustful and true to its own in a peer- to-peer network all the members must verify in order to add the block into chain.
5) *Fastest Settlement:* The transactions are processed quick the invoices are attached to the block. Hence, reducing in tiresome paperwork
6) *Security:* The blockchain provides an impeccable security standard. It uses Asymmetric Cryptography by which everything in the system is secured.

B. History

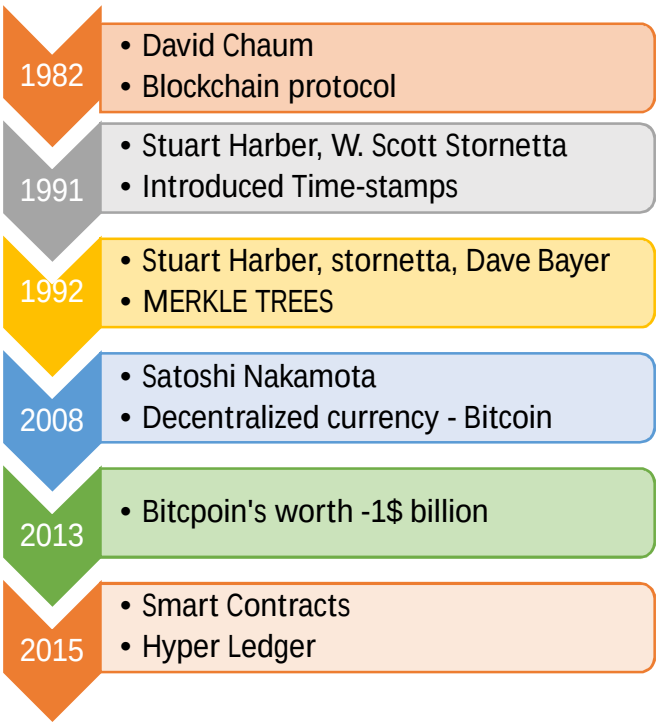

Figure 2: Timeline Of Blockchain

1) *1982*–Cryptographer David Chaum proposed the blockchain protocol in his dissertation"Computer Systems Established, Maintained, and Trusted by Mutually Suspicious groups".
2) 1991- Stuart Harber, W.Scott Stornetta worked on implementing a system wherein the document time stamps couldn't be mortified.
3) *1992* – Along with Harber, Stornetta and Dave Bayer introduced to *MERKLE TREES* which provided efficiency to inculcate more transactions into a block.
4) *2008* –This is considered as the pivotal year for the blockchain, as a group of people named Satoshi Nakamoto invented the decentralized currency called "Bitcoin" and adapted blockchain as a fundamental mechanism.
5) *2013*- In a span of 5 years, Bitcoin surpassed 1$ billion and growing still in spite of other competitors.
6) *2015*-Smart contracts have evolved and Linux foundation unveils ***HYPERLEDGER*** to enhance blockchain efficiency.

From then, blockchain adaptations grew exponentially into various fields. Many experts believe that this technology is a "game-changer".

a) Advantages

The two main pillars of a blockchain are to provide a transparent network with an enhanced security.

- The data is an open source and anyone can trace the transaction or the exchange of the data.
- Being an open ledger, it provides an enhanced security and all moments are tracked and recorded with at most transparency.
- Blockchain provides a high-level security using Asymmetric cryptographic mechanism and Hashing techniques.
- The transactions in a blockchain can be completed faster and efficiently. Documentation along with the details are stored in the block. Further eliminating paper exchanges.
- The transactions are not governed by a single body. Hence, it forms a Decentralized network.

b) Applications

The applications of the blockchain are far-spread expanding its wings in every possible sectors. The below are some of the examples of the blockchain adaption mechanisms.

- *Supply Chain Management:* The blockchain provides the required visibility that is needed to track down raw materials. This is used in highly regulated industries where tracking down is difficult to manage.
- *Banking And Financial Industries:* The blockchain is used to handle order to cash, trade, finance, intercompany transactions and reconciliation. It is also used in Streamline banking and lending services, insurances etc.
- *Healthcare and Pharmaceticals:* The ledger technology facilitates the hold of patient's records manages the supply of medicines and other confidentiality is maintained in the blockchain. The blockchain is also used in the various medical researchers.
- *Voting Ballot:* The blockchain is composed on a fault proof mechanism in which there is no chance for corruption. By implementing Blockchain in Ballots, only a genuine vote will be casted. This brings transparency to the System.
- *Managing Internet of Things Network:* The Internet of things describes wireless connected devices that sends and receives the data. They are in need of an application to promote trustworthiness and blockchain exactly comes into the picture. It is used in all smart devices like watch, phone car etc.

II. OBJECTIVES

1) Understanding the Concept of Blockchain and its structure.
2) To scrutinize the Blockchain Mechanism served in Bitcoins.
3) To analyze the Blockchain Applications in Smart Grid.

III. RESEARCHMETHODOLOGY

This paper has been formulated by referring to various research articles, expert's opinion as well as reliable internet sources. Also, our own analysis has been provided in the paper

IV. SOURCES OF DATA

The present study mainly uses Secondary data. As, a nature of the data is explicit, so various books, magazines, web-sources has been used for the research work.

V. LIMITATIONS OF THESTUDY

a)Although, bitcoin is used in various applications and adopted into several mechanisms, the study is only being focused on Bitcoins and Smart grid Technologies.

b) This paper gives a pragmatic approach to inculcate blockchain into smart Grids. But, it stillneeds some polishes to work for real-life problems.

VI. VI.BLOCKCHAIN ARCHITECTURE

Every block links with other blocks forming a **BLOCKCHAIN.** A single block consists of data structure that aggregates the transactions in the public ledger. The block is made of a **header**, containing **metadata (**stores the transaction data**)**, followed by the thousands of the transactions. A block can hold up to 1MB size. The initial block is called **Genesis block** and the block that exists outside of the main chain is called an **Orphan block.**

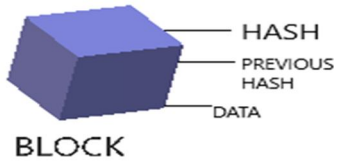

Figure 3: Structure Of A Block

A. Block Header

The block header differentiates between various other blocks. It consists of three parts of metadata,

1) *The Previous Hash Data:* The block contains the value of previous block's **hash** connecting the current and following blocks. The value of the hash is computed using software like Message Digest and Secure Hash Algorithm (SHA2) built by NSA. This is creating a unique id for every transaction making it so complex to modify. Even the minute changes made will be recorded in the ledger.
2) *Timestamp and Nonce:* Timestamp records the time of the transaction and Nonce is used in verification of block before publishing
3) *MerkleRoot*

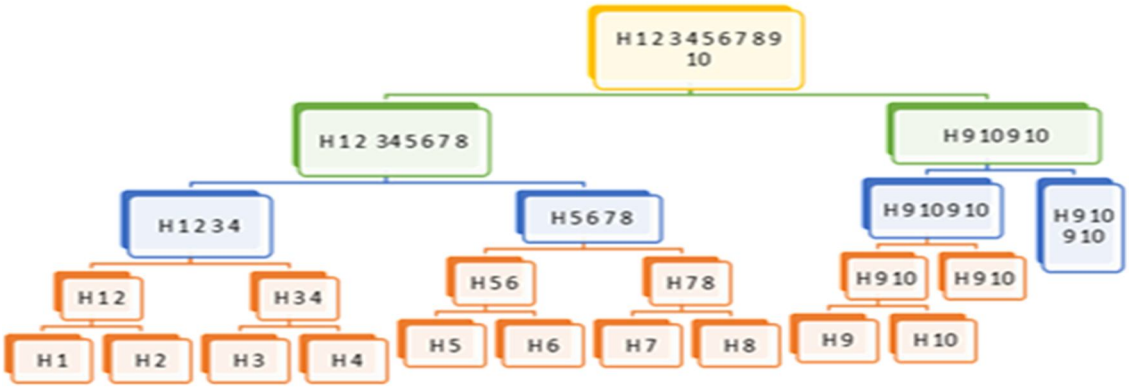

Figure 4: Merkle Tree

The Merkle Tree gives the hash of each transaction. The primary transaction is called Merkle root. For example, A block consists of 10 transactions. To find the hash of a single transaction is very difficult. So, the Merkle tree stores the hash values of each transaction.

B. Consensus Algorithm

The Consensus process takes place in predefined discrete time intervals. These intervals represent the time from the initiation of the transactions to the time of its additional to the blockchain.

The confirmation depends on the blockchain size, transactions, and the consensus algorithm is utilized.

1) *Proof-Of-Work:* In order to save from a malicious block entering the chain, Blockchain uses proof-of- work. It slows down the creation of new block. After a block is being published in a blockchain, it is very difficult to modify, if the modification is necessary 50% of the people in the network must approve for the change.
2) *Proof-OF-Stake:* In this consensus, whoever owns the reward in the process of mining becomes the validator of the transactions. Comparatively, it uses less power and time in consensus process
3) *Proof Of Authority:* Using this consensus only authorized and approved users can add new blocks thus, eliminating the risk of malicious activity.
4) *Byzantine Faulttolerance:* In this approach, primary and secondary replicas are utilized in the consensus process. The secondary will evaluate if the primary is compromised.

C. *Types Of Blockchain*

There are four types of blockchain categorized based on their ledger distribution.

1) *Public Blockchain:* A public blockchain as the name suggests is an open ledger. Anyone with the access to the internet can send transactions and become a validator. They require security of proof-of-stake and proof-of-work algorithm.
2) *Private Blockchain:* It is a restricted ledger. One cannot enter the chain without access unless invited by a member in the network.
3) *Hybrid Blockchain:* A hybrid blockchain is the mix of both centralized and decentralized features. Their working model is depended on the feature they use.
4) *Side Chains:* It is a designated for a blockchain that runs parallel to a primary blockchain. Entries from the primary blockchain can be directly linked from the side chain allowing it to operate independently.

VII. BLOCKCHAIN APPLICATION IN BITCOIN

Although, the blockchain protocol was introduced in 1982. Its popularity began after its adaptation into Bitcoin. A group of anonymous scientists in the pseudo name Satoshi Nakamoto invented a decentralized currency called as **Bitcoin**. It uses the Blockchain mechanism for its data storage and security. Let us see the working mechanism of bitcoin. Bitcoin is decentralized, that means it is not controlled by any organization. And this same point increases its security using CONSENSUS.

A. *Bitcoin Mining*

Mining is the backbone of bitcoin network as it provides safety and security and confirms secure transactions. Miners are paid rewards for their securing the blockchain for every 10 minutes in the form of a new bitcoin unit. Mining is the most important part, as the decentralized blockchain is supported or maintain. Without Miners the system will be prone to hacking and total system will be a disaster and collapse entirely.

How Bitcoins are mined?

1) Mining is usually done with the help of specialized computers called **ASIC MINER.**
2) We can mine by joining a Bitcoin mining pool in the mining website, where, the system gives mathematical problem.
3) Solving the problem gives them reward of bitcoins. Miners are also asked to verify the transaction.
4) For example, If A is selling 5bitcoins to B. The miner's role is to check A's balance and verify the transaction.
5) The verified transaction will be added to the **BLOCKCHAIN**.

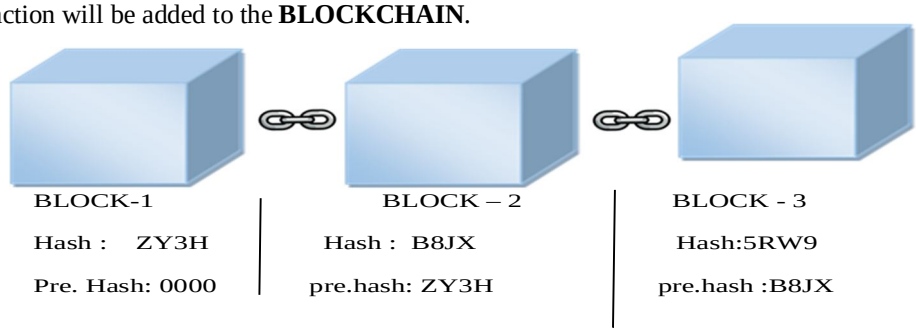

Figure5: Blockchain

B. *Peer-to-Peer Network*

As, the blockchain is an open distributed network, There's existence of insecurity. In order to tackle this, blockchain uses a peer-to-peer network. The network asks for authentication when someone creates a new block a copy of it will be sent to everyone in the network. All the peers in the network checks and verifies each node and then add it to the blockchain. Blockchain uses various security mechanisms to steal proof the data and transactions. This makes the blockchain network so SECURITY and IRREVERSABLE

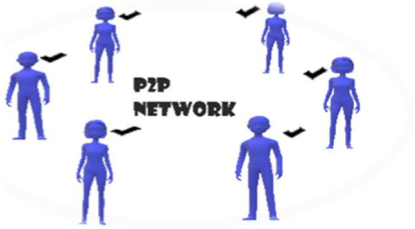

Figure 6: Peer-To-Peer Network

C. Smart Contracts

The Smart Contracts are the Conditions and agreement between the network peers. The contract is written as code and committed in the blockchain. The conditions are publicly available in the ledger. When a transaction or an event occurs the people in the network can observe the changes while maintaining the privacy of individuals.

VIII. APPLICATION OF BLOCKCHAIN INTO SMART GRIDS

A. Smart Grids

In recent times, the demand for the energy grew tremendously. Due to sustainability in view, we are shifting towards Renewable Sources of Energy. Of all the renewable resources, Solar and Wind Energy will contribute a large share in the coming future.

The grid is a network of power lines and substations that carry electricity from power plants to the end-users. Today's grid relays on a single power source and does not provide the details which, makes it difficult to manage. To resolve these problems, we use a Smart Grid, A Smart Grid adds sensors and software for the existing grid That will provide the details to solve the problem more quickly and efficiently. As, our motto is to use the resources sustainably and efficiently, Blockchain mechanism can be introduced into the to the smart grid and make it even smarter. Smart grids propose a solution to the integration of distributed energy resources to maintain security and supply of the grid. The focus of the Smart grid is to facilitate local production and consumption by consumers and prosumers. By stimulating local energy production and consumption, transmission losses will be reduced. Prosumers and consumers will be able to trade electricity with each other in a peer-to-peer fashion To manage these transactions between consumer and a prosumer participating within the smart grid in a centralized manner would be very costly and require lots of infrastructure. As, a result decentralized method will be preferred. And this is where blockchain comes into the picture.

B. Enabling Blockchain Application in Smart Grid

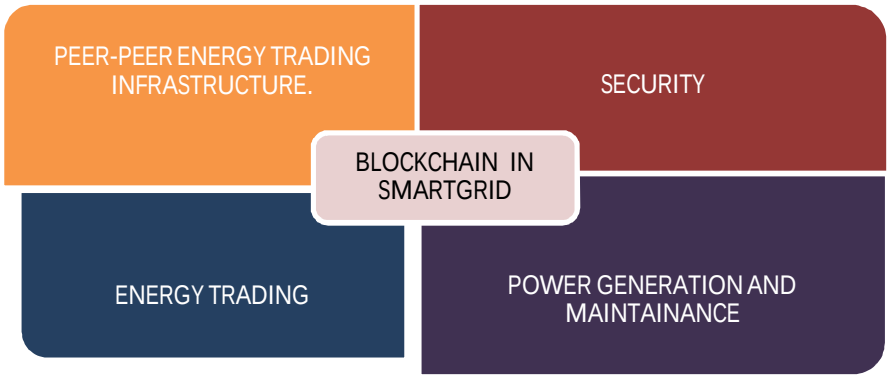

Figure 7: Concept Of Smartgrid

Smart grids rely on automation and remote access. And these bring with them security concerns that are to be dealt with. Therefore, the two security measures that must be are:

1) *Authentication:* The verification that someone "entering" the grid technology
2) *Authorization:* Verifying who does not have the authority to enter into the grid.

Based on proof of authority it differs from standard energy intensives blockchain System

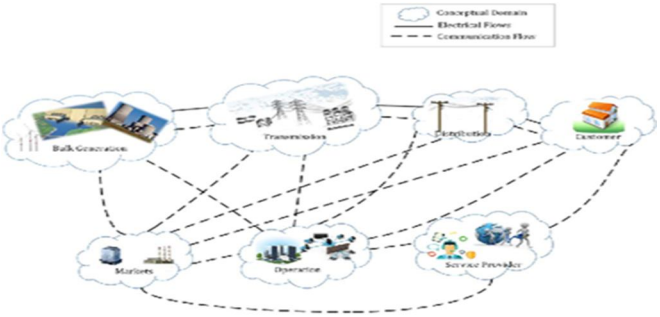

Figure 8: blockchain applications in smart grid.

1) *Peer-To-Peer Trading:* Energy trading has a huge impact on the distributed energy generation from natural sources . Blockchain has gained more importance on energy trading for eradicating false transactions and assurance of fair trading. Blockchain in the energy trading process doesn't have any third parties. it allows the direct contact between the consumer and producer (P2P) Peer-to-peer
2) *Security:* Blockchain is a subversive innovation of key management of the smart grid system. It is almost impossible for a third party to review private information Each participating user in a blockchain system has its own public and private keys. An exclusive public key is issued to all network users who same encryption or decryption algorithm, while private keys are held by only the users themselves.
3) *Energy Trading:* The Smart grid is to facilitate local production and consumption. By stimulating local energy production and consumption, transmission losses will be reduced. Prosumers and consumers will be able to trade electricity with each other in a peer-to-peer fashion and ensure that those transactions are legitimate and permanently recorded.
4) *Power Grneration And Maintainance:* Numerous cyberattacks on smart grid have been undertaken in the past where the malicious attackers have used various methods such as Denial of Service (DoS), Data Injection attacks (DIA), etc.to manipulate data and gain control in the grid. This has resulted in complications such as regional power outages and even complete blackouts. Incorporating blockchain into the power generations and distribution systems help in the prevention of data manipulation since one of the prime characteristics offered by the blockchain system is its ability to ensure the data immutability.
5) *Electric Vechicles:* Electric vehicles (EVs) play an important role in the smart grid infrastructure for distributed renewable energy transportation. There can be two sources to charge the EVs: using vehicle-to-grid(V2G) and vehicle-to-vehicle(V2V) Trading .In V2V trading ,EVs can trade electricity in the hotspots(charging stations or parking lots)in a P2P manner, where the discharging vehicles(with surplus electricity)discharge their energy to fulfill the electricity demand of the charging vehicles and thus balance the electricity supply demand equilibrium. However, due to privacy concerns, discharging EVs tend to be reluctant to participate in the electricity trading market and consequently the supply and demand equilibrium among EVs become unbalanced. These problems with the traditional centralized electricity trading schemes which rely on intermediary parties are discussed in. hence, there is a need to provide a secure electricity trading systems that is decentralized and preserves privacy for EVs during the electricity trade.

C. *Advantages*
1) The blockchain also help in keeping track of all the potential applications of blockchain technology that could solve data management problems.
2) Blockchain uses less energy to record provenance and track ownership including date, storage type and location.
3) It's fast, secure and efficient.
4) Blockchain provides sustainable use of resources.
5) The Confirmation Certification is provided faster as it is maintained by a decentralized network.

D. *Dis-Advantages*
1) *More Expensive:* Node want greater rewards for accomplishing transactions in a business which work with the code of demand and supply
2) *Smaller Ledger:* This could affect the security and immutability of the block chain, and all data stored in it.
3) *Error Risk:* This risk is always present if the human factor not engaged even though the Blokchain is a highly secured technology

IX. FINDINGS AND SUGGESTIONS

A. Blockchain is the fastest growing technology.
B. As, Bitcoins are completely decentralized. It may be prone to illegal activities.
C. Blockchain needs to upgrade its games with hundreds of players entering the same market trying to do just that.
D. People tend to buy cheaper electricity regardless of it sources. The blockchain records all the transaction history. Hence pricing can be detected based on the condition and performance of the source
E. It creates a secure peer-to-peer energy trade environment
F. As, this adaption is still in beginner stage it needs more polishing to be activated in real-life.

X. CONCLUSION

The Blockchain took a breakneck acceleration in developing into all the sectors of the technology. Blockchain serves as an immutable ledger which allows transactions take place in a decentralized manner. Blockchain, the foundation of Bitcoin, has received extensive attentions recently. Bitcoin uses a Blockchain to store, secure and document the transaction data. Mining is the most important part, as the decentralized blockchain is supported or maintained. Blockchain is also used for improving efficiency and transaction speed.

This paper gives an overview of smart grid and blockchain together with its security. An energy network is explained together with the energy transitions and how smart grids are the solutions to the current trends in the energy and also the advantages and disadvantages of its usage are discussed, however, to successfully implement the Blockchain within the smart grid, significant challenges must be addressed in the coming years.

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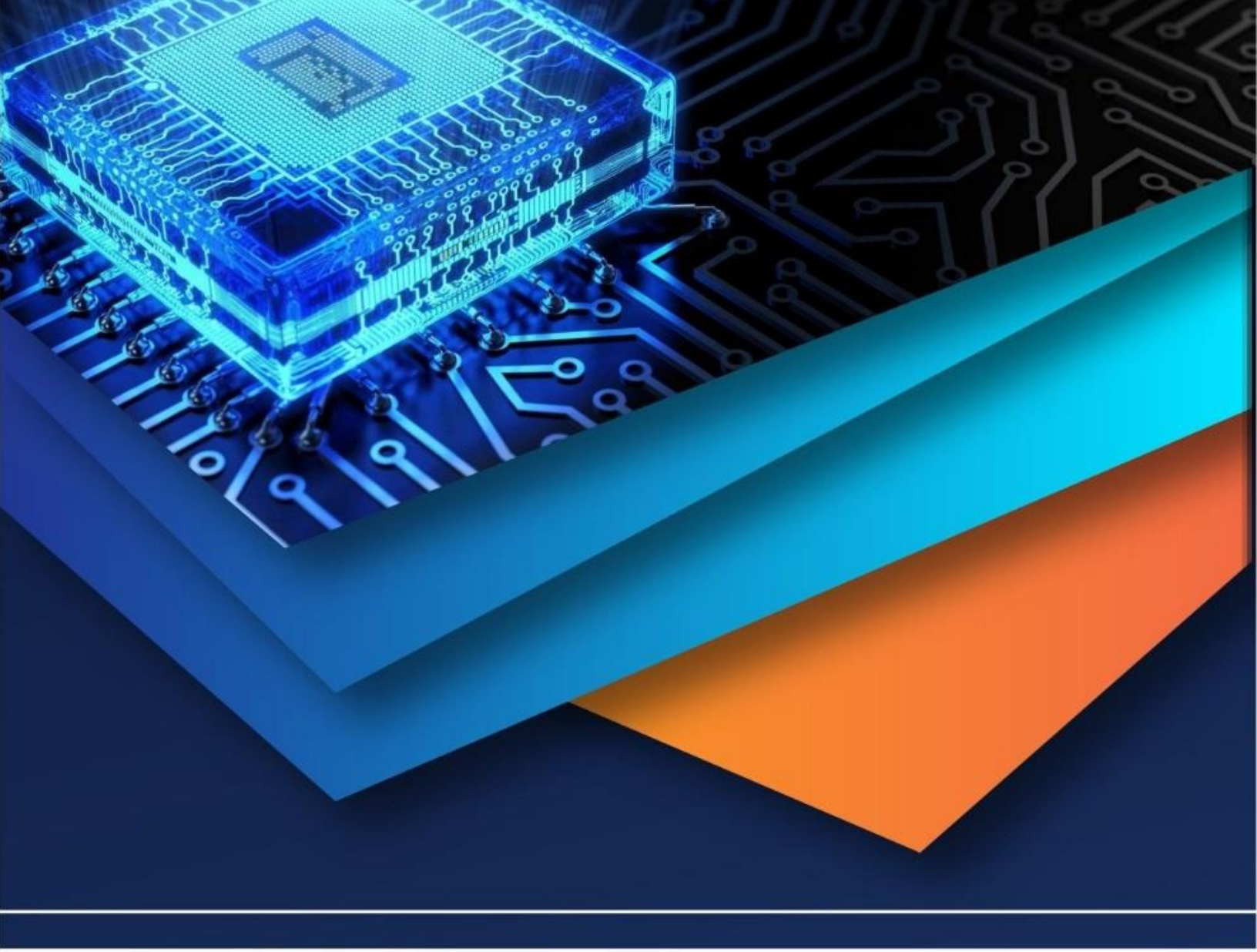

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