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A Review on Black Hole Attack Detection in Wireless Sensor Networks

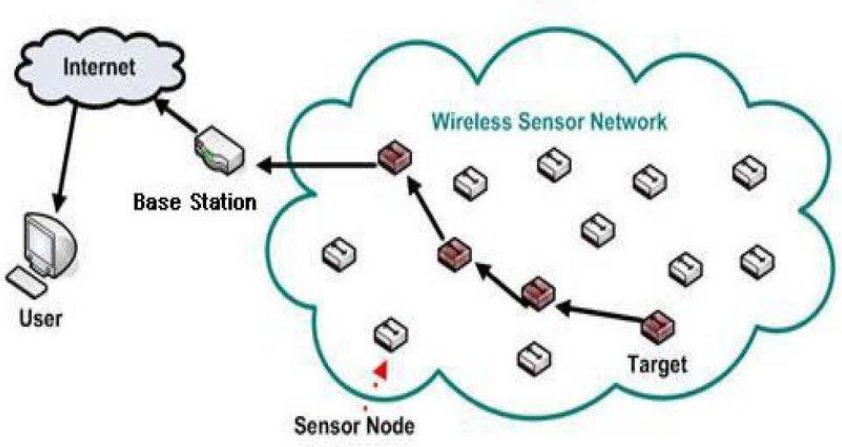
K. Sutha[1], S. Srividhya[2]
[1]*Assistant Professor , Department of Information Technology, Sri Krishna Arts and Science College,*
[2]*Assistant Professor, Department of Computer Science, Sri Ramakrishna College of Arts and Science for women*

Abstract— Wireless Sensor Networks (WSN) is a trending technology within the current era and contains a big selection of applications such as battlefield surveillance, traffic surveillance, forest fire detection, flood detection etc. Several researchers have conducted totally different detection techniques and algorithms to proposed differing kinds of detection schemes. Wireless sensor turn out to be such a great amount of prevalent in many fields because of its usefulness in military, modern territory etc. The blackhole nodes will launch black hole attack to conserve its resource or to perform attacks that reduce the network. In this paper, surveyed the existing solutions and discuss the state-of-the-art routing methods. This paper reviews the existing state of art methods to detect the black hole attack in Wireless Sensor Networks.

Keywords—Mobile Ad-hoc networks, Blackhole attacks, machine learning, pre-processing, classification

I. INTRODUCTION

The wireless sensor networks are formed by the collection of nodes which are geographically distributed. Sensor node consists of three things such as communication component, sensing component and computation or data processing component. These device nodes collect the information, method the information and transmit to sink node or base station by operating along. Basic unit of a wireless sensor network is device node that consists of aboard sensors, power offer, memory, processor, and wireless electronic equipment. A device converts a natural phenomenon like sound, light, heat etc into electrical or different signals that acts as an electrical device. A WSN is assortment of numbers of device nodes that unit of measurement distributed in atmosphere. It's extremely a special form of Ad-hoc network. The key feature of WSN includes its use things as a result of it's self-organizing and self-maintaining. As a results of infrastructure less atmosphere and wireless nature of WSN, they are a heap of laid low with many types of security attacks.



Basic Structure of Wireless Sensor Network

There are several types of attacks can be done by malicious nodes to damage the network and make that network unreliable for communication and proper working. Some of such kinds of attacks are:

A. Wormhole Attack

In wormhole attack attacker records packets at one place and tunnels those to another place in network. Due to this itcreates False scenario that main sender is neighbor of remote location. Wormhole forms by tunneling procedure in sensor network.

B. Tempering

its tempers hardware configuration of sensor and gain physical access for making node as adversary node. Tempering can be done at physical layer.

C. Jamming

this attack is related with troublemaking or interfering radio frequencies which are used by sensor nodes. By gating physical access of some nodes attacker can create jam in network to disturb the network.

D. Sybil Attack

In Sybil attack a malicious node illegally take multiple identities. In this an adversary can appear in multiple places at the same time. A node presents multiple identities to other nodes in network by stealing or fabricating the identities of authenticated nodes. This attack is done on network layer.

E. Hello Flood Attack

Its uses HELLO packets as a weapon to convince the sensors in WSN. In this attack an attacker have high radio transmission range and processing power. They send HELLO packets to number of sensor nodes which are in a large area within a WSN.

F. Black Hole Attack

In the black-hole attack, advertises of the wrong paths as good paths to the source node by a malicious node during the path finding process as in reactive routing protocols or in the route updating messages as in proactive routing protocols.

II. BLACKHOLE ATTACK

Blackhole attacks are one of the attack in WSNs. It is an attack which is mounted by an external adversary on a subset of the sensor nodes (SNs) in the network. In the blackhole attack, a malicious node advertises the wrong paths as good paths to the source node during the path finding process as in reactive routing protocols or in the route updating messages as in proactive routing protocols. Good path means the shortest path from source node to the destination node or the most stable path through the sensor network[7].

Fig. 1 to illustrate these terms. In the figure, are black hole node is represented by red border and the black hole region is represented by dotted lines. When the source node selects the path which includes the attacker node, the traffic starts passing through the adversary node and this nodes starts dropping the packets selectively or in whole. Black hole region is that the entry purpose to an outsized variety of harmful attacks.

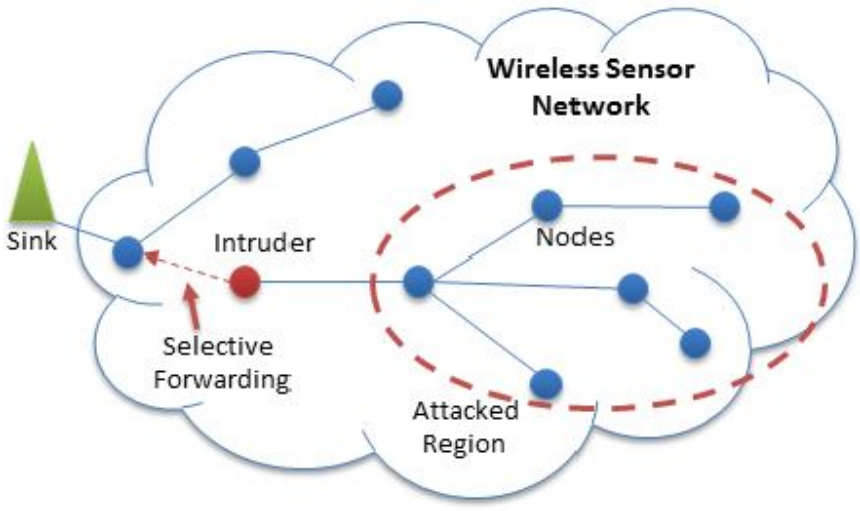


Fig.1. Black hole attack in Wireless Sensor Netwworks

Security against this attack is challenging problem which can be detect and prevents by various techniques. Several researchers have proposed different detection and prevention techniques.

Blackhole attack is also known as packet drop attacks. There are two protocols used in wireless sensor networks and they are Ad-hoc On Demand Distance Vector (AODV) and Dynamic Source Routing (DSR). For finding the routes DSR uses two types of routing packets and they are Route Request packets (RREQ) and Route Response Packets (RREP). An RREQ has the address of the destination node and it goes to all the nodes attached to that network. When it receive the destination address, it creates an RREP in response and sends it back to the original sender

III. REVIEW OF LITERATURE

Taylor Vincent F, Fokum Daniel T [1] discussed Wireless sensor networks comprise of autonomous, self organizing, low-power nodes which cooperatively measure data in an environment and cooperate to route this data to its intended destination. Black hole attacks are potentially devastating attacks on wireless sensor networks in which a malicious node utilizes spurious route updates to attract network movement that it then drops. We propose a robust and flexible attack detection scheme that uses a watchdog mechanism and lightweight expert system on every node to detect anomalies in the behavior of neighboring nodes. Utilizing this scheme, regardless of the possibility that malicious nodes are inserted into the network, great nodes will have the capacity to identify them based on their behavior as inferred from their network activity. We examine the resource-preserving mechanisms of our system utilizing simulations and demonstrate that we can allow groups of nodes to all in all evaluate network activity and identify attacks while regarding the limited hardware resources (handling, memory and capacity) that are typically accessible on wireless sensor network nodes.

R. Lakhwani, et., al., [1] proposed a new approach called Agent based method to detect and eliminate black hole attack. Agent based mostly technique won't solely expeditiously notice the parts however utterly overcome the matter by eliminating the black hole from taking part in painter so rising the protection of the AODV. In simulation victimisation NS - a pair of.33, the Agent based AODV has shown outstanding results as compared to AODV in presence of black holes. Results obtained from simulation have shown that Agent based mostly technique doesn't introduce high overhead for the period of secure time (no attacks) and supply higher performance throughout attack time (presence of Black hole) in the network.

N. Sharma and A. Sharma [2] The first proposal is to find more than one route to the destination (redundant routes, at least three different routes). Then, the source node unicast a ping packet to the destination using these three routes (we should assign different packet IDs and sequence number, so any node who receive the first packet will not drop the second one if it exists in both paths). The receiver and the malicious in addition to any intermediate node might have a route to the destination will reply to this ping request. The supply can check those acknowledgements, and process them in order to figure out which one is not safe and might have the malicious node. The second proposed solution exploits the packet sequence number included in any packet header. The node in this situation needs to have two extra tables; the first table consists of the sequence numbers of the last packet sent to every node in the network, and the second table for the sequence number received from every sender. During the RREP phase, the intermediate or the destination node must include the sequence number of last packets received from the source that initiates RREQ. Once the source receives this RREP, it will extract the last sequence number and then compare it with the value saved in its table. If it matches the transmission will take place. If not, this replied node could be a malicious node, so an alarm message will be broadcast to warn the network about this node.

N. R. Yerneni and A. K. Sarje [3] found an algorithm that is based on how the malicious node behaves in order to perform the black hole attacks. To attract traffic towards it, malicious node sends false RREP packet as a response RREQ packet. It sends RRE P even if it does not have the path towards the destination as requested by the source of RREQ. It does not broadcast RREQ, instead sends RREP without checking its routing table. So, for the malicious node the ratio of number of RREQs transmitted to the number of RREPs transmitted is very less. Modified algorithm makes use of this fact to detect the black hole attack. Two extra fields are used in the proposed algorithm OAODV (opinion AODV) - request weight and reply weight. Request weight in routing table indicates the quantity of RREQs that area unit forwarded by the corresponding node. Similarly Reply weight indicates the number of RREPs forwarded. Proposed method has two modules-updating request/reply weights and collecting feedback.

R. K. Bar, et., al., [4] In the proposed work a new parameter known as ‘trust value’ is calculated against all the intermediate nodes. This trust price is calculated relying upon the flexibility to forward packets and therefore the RREQ forwarding ability of a node. To obtain this ability the number of packets received and the number of packets sent is counted. Two weight factor W1 and W2 are introduced. W1 is the ratio of number of packets sent from a node to the number of packets received to that node. A high price of this magnitude relation indicates that, the node has a greater ability to forward the packets. Thus, the chance of loss of packets is a

smaller amount. The maximum value of W1 may be 1, where all the received packets are forwarded and no packet is dropped. From this value we can also detect the untrusted nodes in the network. The other weight vector W2 is the ratio of number of RREQ received to number of RREP sent. This magnitude relation detects the nodes that incessantly receive the RREQ from its neighbor nodes however ne'er reply to that request by causation the reply i.e. the silent node. Thus, the upper price of this quantitative relation implies that, the nodes can frequently respond to the route request of its neighbor node. Then this two-weight factor is multiplied to get the trust value of that node. Here we check if any nodes have the W1 value greater than the threshold value. If it will send a packet then the trust price is enlarged otherwise it's reduced. This trust price is saved within the routing table of that node. And within the route discovery step of AODV routing protocol the trail is established per that trust price instead of the shortest path. Thus, the less trusty node may be avoided throughout the route institution in AODV routing protocol.

S. Biswas, el., al., [5] black-hole attack is one of the most severe routing attacks that is often encountered in MANET. In this attack, a malicious node sends fake RREP to a source node that initiates route discovery, and consequently deprives data packets from the source node. Many researchers have proposed different solutions for preventing black-hole attack. In MANET network topology changes continuously. But most of the solutions do not consider the mobility of nodes that is an important characteristic of nodes in MANET. In this paper, we have analyzed black-hole attack and proposed a solution based on trust of the individual nodes to detect and prevent black-hole attack in MANET. Trust has been calculated based on a few important parameters of a node such as rank, mobility, available battery power, etc.

R. Kumar and R. Chadha [6] the effects of black hole attack in the performance of fuzzy and GA are analyzed. The simulation results show that when the black hole node exists in the network, it can be affected and decreased the performance of network and it can be optimized by using fuzzy and GA algorithm. A theoretical network was made for the simulation purpose then monitored for variety of parameters. The model for various nodes is simulated. Initial position for the node is specified in a movement scenario file created for the simulation using a MATLAB. The nodes move randomly among the simulation area. So, the detection and interference of part attack within the network exists as a difficult task.

Sonia and H. Kaur [7] The protocol used to enhance the security is Enhance AODV (Ad-hoc on-demand distance Vector), the key concept used in the procedure is that of multipoint relays. MPRs are selected nodes which advancing broadcast messages during the flooding process. This technique considerably reduces the message overhead as associated to a classical flooding instrumentality, where every node retransmits each message when it receives the first copy of the message. In mobile spontanepous networks, the movement of the network nodes may quickly change the topology resulting in the surged overhead message in topology maintenance that is why clustering techniques are used. In one of the recent researches works performed, to prevent Black hole attack. Aims and objectives of this thesis work are to design and implement IMPROVED BACTERIA FORAGINING OPTIMIZATION protocol with smartest hole attack and prevent the system for threat using this hybridization. At last evaluate the parameter explain in problem statement.

I. Woungang, et., al., an improved version of a dynamic source routing (DSR) protocol (so-called detecting blackhole attack based on DSR (DBA-DSR)) is proposed to combat against blackhole attacks in mobile ad hoc networks. Unlike other solutions, which adopt a reactive approach in which blackhole nodes are identified only after the attack has been carried out on the network, our DBADSR scheme detects and isolates the blackhole nodes prior to the actual routing process. This is achieved by mistreatment faux route request packets.

M. B. M. Kamel, el., al., [10] Mobile accidental networks (MANET) could be a sort of networks that consists of autonomous nodes connecting directly while not a top-down specification or central controller. Absence of base stations in MANET force the nodes to rely on their adjacent nodes in transmitting messages. The dynamic nature of Edouard Manet makes the connection between nodes untrusted because of quality of nodes. A malicious node might begin denial of service attack at network layer to discard the packets rather than forwarding them to destination that is thought as region attack. In this paper a secure and trust-based approach supported spontanepous on demand distance vector (STAODV) has been planned to enhance the safety of AODV routing protocol. The approach isolates the malicious nodes that attempt to attack the network betting on their previous data. A trust level is connected to every taking part node to find the extent of trust of that node. Each incoming packet are going to be examined to forestall the region attack.

J. M. Chang, et., al., [11] a mechanism [cooperative bait detection theme (CBDS)] is providing effectively detects the malicious nodes that attempt to launch grayhole/collaborative blackhole attacks. In our theme, the address of Associate in Nursing adjacent node is employed as bait destination address to bait malicious nodes to send a reply RREP message, and malicious nodes square measure detected using a reverse tracing technique. Any detected malicious node is kept in a blackhole list so that all other nodes

that participate to the routing of the message are alerted to stop communicating with any node in that list. Unlike previous works, the merit of CBDS lies in the fact that it integrates the proactive and reactive defense architectures to achieve the aforementioned goal.

A. A. Bhosle et., al., [12] AODV is an important on-demand reactive routing protocol for mobile ad hoc networks. There is no any security provision against a "Black Hole" and "Wormhole" attacks in existing AODV protocol. Black hole nodes are those malicious nodes that conform to forward packet to destination. But they do not forward packet intentionally to the destination node. The black hole nodes degrade the performance of network eventually by participating in the network actively. The propose watchdog mechanism detect the black hole nodes in a WSN. This method first detects a black hole attack in the network and then provide a new route to this node. In this, the performance of original AODV and modified AODV in the presence of multiple black hole nodes is find out on the basis of throughput and packet delivery ratio. In a wormhole attack, intruders tunnel the data from one end of the network to the other, leading distant network nodes to trust they are neighbors' and making them communicate through the wormhole link.

I. Woungang, el., al., [13] A blackhole is a malicious node that can falsely reply for any route requests without having an active route to a specified destination and drop all the receiving data packets. The attack might even cause a lot of devastating injury if 2 or a lot of blackhole nodes work with one to launch an attack. This type of attack is known as collaborative blackhole attack. In this paper, a novel scheme Detecting Collaborative Blackhole Attacks (so-called DCBA) for detecting collaborative blackhole attacks in WSN is introduced. Simulation results unit of measurement provided, demonstrating the superiority of DCBA compared to Dynamic Source Routing (DSR) and the Bait DSR scheme (so-called BDSR) [1] - a recently proposed scheme for detecting and avoiding cooperative blackhole attacks in MANETs - in terms of network output rate and minimum packet loss proportion, when collaborative blackhole nodes are present in the network.

G. S. Bindra, el., al., [14] proposed a mechanism to detect and remove the blackhole and grayhole attacks. The solution we tend to square measure proposing tackles these attacks by maintaining AN Extended information Routing data (EDRI) Table at every node additionally to the Routing Table of the AODV protocol. The mechanism is capable of detecting a malicious node. It also maintains a history of the node's previous malicious instances to account for the gray behavior. Refresh packet, Renew Packet, BHID Packet, Further request and Further reply packets are also used in addition to the existing packets (RREQ and RREP). Our technique is capable of finding chain of cooperating malicious nodes which drop a significant fraction of packets.

A. Mishra, el., al., [15] proposed a mechanism to identify multiple black hole nodes cooperating as a group in ad hoc network. the proposed mechanism work with slightly modified AODV protocol and make use of the data routing information table (DRI) with 'check bit' in addition to cached and current routing table. We have found out misbehavior nodes in mobile ad hoc environment, and also find secure route to the destination. And enhance the performance of network by eliminating cooperative black hole attack. This type of attack is thought as Cooperative region attack. We projected a mechanism to mitigate single region attack likewise as cooperative region attack to get a secure route to the destination by avoiding attacks. In this paper we proposed an approach for better analysis and improve security of AODV, which is one of the popular routing protocols for WSN. Our theme is predicated on AODV protocol that is improved by deploying Advanced DRI table with extra bit. The Simulation on NS2 is dispensed and therefore the planned theme has created results that demonstrate the effectiveness of the mechanism in detection and elimination of the attack and maximizing network performance by reducing the packet dropping magnitude relation in network.

S. K. Dhurandher, el., al., [16] we therefore analyses MANETs under single and collaborative Black Hole attack and prevent it by diverting traffic from the Black Hole. The WSN therefore mentioned use the AODV routing protocol and also the technique therefore projected is predicated on causing confirmation packets that square measure verified by the destination to visualize for Black Hole presence in the GAODV routing protocol so proposed. The GAODV algorithm was then simulated in both static as well as mobile node environment and it was observed that its data delivery ratio is significantly better than the conventional AODV.

R. J. Cai, el., al., [17] A proactive security-routing protocol, SCS, and its enhanced version were proposed with the necessary assumption that internal attackers have the knowledge about how the prevention mechanism works in WSN. Our scheme could be applied on top of conventional routing protocols as a complimentary security measure. The key idea is that every node is required to exchange neighbor information before route discovery and then uses previously collected neighboring information to verify each received RREP. As the attackers do not know who will be the requested destination in the next RREQ message, they have no idea what neighbor information they need to fake in order to avoid being caught. If they randomly add many faked neighbors into broadcast Hello messages, they can be easily identified. If certain node refuses to exchange neighbor information, definitely, it will be caught if it behaves as an active black hole attacker in the next second. If attackers provide faked neighbor information after they

know the requested destination, liar-checking operation will function. By utilizing previously collected neighboring information, we can greatly increase the robustness of our prevention system.

N. Arya, el., al., [18] A mobile ad-hoc network is a wireless network such that nodes are move dynamically in network. In OSI network layer there's heap of attack however introduce solely cooperative part and worm hole attack. A group of black hole node easily employed against routing in mobile ad-hock networks called collaborative black hole attack. When two malicious nodes are creating a tunnel is called worm hole attack. This paper instigates to detect and avoided of worm hole attack and collaborative black hole attack using trusted AODV routing algorithm.

K. S. Arathy and C. N. Sminesh [19] To shield AODV from single and collaborative black hole attacks, it is essential to discover noxious nodes amid the route discovery process, when they send malicious RREPs to attract the source node. We propose 2 algorithms for mitigating single and cooperative part attacks. Three additional elements are used in the proposed algorithms specifically, a fake RREQ with nonexistent target address, a list of black hole nodes (BH list) and a list of collaborative black hole nodes (CBH list). The proposed Detection of Multiple Black Hole attack (D-MBH) algorithm detects single and multiple black hole nodes, computes a threshold for DSN (ADSN), creates BH list and invokes the proposed Detection of Collaborative Black Hole attack (D-CBH) algorithm. Using ADSN, BH list and next hop information extracted from RREP, the proposed D-CBH algorithm creates the CBH list.

S. Sharma and S. Gambhir [20] The CRCMD&R scheme is an on demand AODV like protocol that avoids malicious node attacks during route setup between source and destination. CRCMD&R scheme uses AODV to form path during path discovery. In CRCMD&R scheme, every CH node maintains the Neighbor Table, Legitimacy Value Table and Reputation Level Table which are used to keep information about all the nodes. In the route discovery phase of CRCMD&R scheme, an intermediate node will attempt to create a route that does not go through a node whose replied information is wrong or Prime Product Term is not fully divisible or reputation value of that node crosses the lower threshold value (level 1 or level 2) or reputation value greater than 1. Compared with AODV, the proposed CRCMD&R scheme has the following differences in message format and type.

IV. CONCLUSION

Wireless sensor networks have gained much popularity over past few years. Security is the biggest threat in WSNs. In this paper we describe Attacks which degrade performance of wireless sensor network. The black hole attack is the active type of attack which reduce network performance in terms of various parameters. This paper reviews various techniques which are used for detection of malicious nodes and discussed in terms of various parameters. This paper mainly focuses on the working of various related techniques, different steps involve in detection of attacks in WSN.

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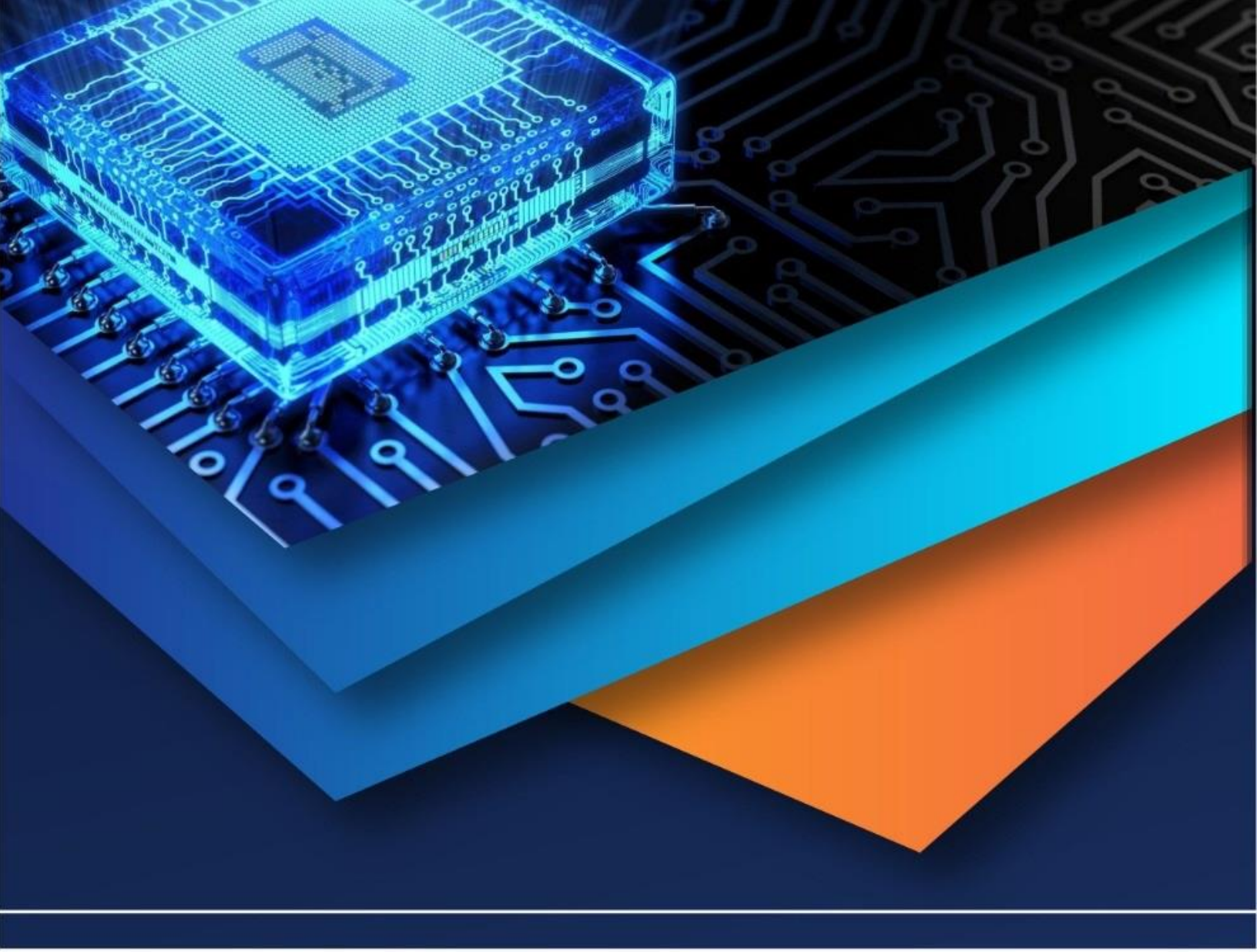

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