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Review: Security Mechanism of Mobile Ipv6 Threats against Binding Update

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Abstract: ***In the last few years there is tremendous development in the area of wireless and mobile network has been observed. Internet Engineering Task Force (IETF) proposed Mobile IPv6 to provide mobility in wireless networks. In MIPv6, Every time when Mobile node (MN) moves, it sends binding update message to the home agent (HA) for telling its current location. However, in this case there may be chances of spoofing of a Binding update (BU)message by an attacker and pretending to be another mobile node. And then the attacker redirects all the traffic destined for the original node to another node or to itself. This paper analyzes and also compares some of the existing mechanisms that are used for reducing threats related to binding update messages in the current mobile IPv6 environment and gives the overview of this area.***
Keywords: MIPv6 Binding Update, False Binding Update, Session Hijacking, Deniel of Sevice, Man in the Middle attack

I. INTRODUCTION

Now a day's mobile and wireless communication have become increasingly popular; we can say that almost every person uses mobile devices to access all kinds of services of internet , such as web-browsing, video conferencing, VoIP, and multimedia applications, anytime and anywhere. As the rising demand observed for wireless connectivity in mobile devices, there is need to develop IP-based mobility protocols. With such protocols, Mobile Nodes (MNs) are remained connected to other correspondent nodes even while roaming the Internet. The Internet Engineering Task Force (IETF) proposed a new host-based mobility management protocol; called Mobile IPv6 (MIPv6) protocol [1]. The important benefit of Mobile IPv6 [2] is that even though the mobile node changes its locations and addresses, existing connections are maintained. In Mobile IPv6 there are 3 node types, namely the Home Agent (HA), Mobile Node (MN) and the Corresponding Node (CN). A mobile node (MN) has a home IP address as the primary identifier, regardless of the current location in the Internet. When a mobile node is away from home, its mobility is detected by a router advertisement message including an MN able to make a router send its advertisement message by request, if needed. Following mobility detection, the Mobile Node (MN) gets a care of address (CoA), which shows the current location of the mobile node. It is necessary for the Mobile Node to tell its current care-of address to the Home agent (HA) and the communicated correspondent node (a node wishing to connect to, or is communicating with MN) by sending the binding update (BU) message. The Home Agent (HA) and correspondent node (CN) update the binding list and send acknowledgement messages [3], meaning that the Mobile IPv6 allows an MN to alter its attachment point to the internet while maintaining established communications [4]. As BU message is most important types of message for sending a CoA to the HA and Correspondent Node(CN), there may be chances of BU vulnerability problems that are usually related to authentication and authorization. These issues are in the form of data packet interception, through which an attacker may eavesdrop on data packets, breaching user data confidentiality or modifying transmitted packets to suit the attacker's malicious purposes. Other forms of attacks that capitalize on mobile IP vulnerability are the Man-in-the-Middle, Session Hijacking, Denial-of-Service(DoS) and Return- to-Home spoofing attacks. A summary of necessary security issues includes authentication between sender and receiver with each other before creating any connection (addressing as trust), protection of communication between senders and receivers against eavesdropping and tampering (addressing as confidentiality), and how authenticated users follow private communication (authorization).

Such security threats are one of the primary considerations that need to be addressing. Protecting mobile IPv6 from such binding update threats is one of the most challenging tasks now days. General improvement in MIPv6 may offer enhanced security; however, there are areas still prone to attacks. And the MobileIPv6 security standardization is still ongoing. A number of research works have been done to enhance the security of current MIPv6 .In this paper, we have analyzed some mechanisms, which aim to minimize the threats of binding update by providing preauthentication of nodes, by sharing secrete key and by encrypting the BU message. And then compare the performance among each method and their features and drawbacks. Also discuss on how to extend

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performance of existing methods, so that it will provide best solution for reducing Binding Update threats of MIPv6. The rest of the paper is organized as follows. Section II introduces the purpose of security mechanism. In Section III describes various types of Binding Update threats. In section IV studied various existing security mechanism. The discussion regarding the performance of each existing mechanisms and the comparison of the performance between each method will also be brought up in Section V; and finally section VI gives the conclusion.

II. PURPOSE OF SECURITY MECHANISM

Security mechanism provides a number of security goals [5] to ensure the privacy of data, non-alteration of data and so on. Following are the various goals of security:

A. Confidentiality

Information in computer is transmitted and has to be accessed only by the authorized party and not by anyone else.

B. Authentication

The process of verifying a user's or device's identity for the purpose of communication is called the authentication process. Authentication provides security assurance to all BU messages coming from nodes with original MNs and CoAs. Authenticating the CoA ensures that the entity is indeed located at that address.

C. Integrity

This service ensures that sent BU messages contain the same binding data upon arrival. Only the authorized party is allowed to modify the transmitted information. No one in between the sender and receiver are allowed to alter the given message.

D. Non Repudiation

Ensures that neither the sender, nor the receiver of message should be able to deny the transmission.

E. Access Control

Only the authorized parties are able to access the given information.

III. FALSE BINDING UPDATE ATTACKS IN A MOBILE IPV6

In MIPv6, Every time when Mobile node (MN) moves, it sends binding update message to the home agent (HA) for telling its current location. In this case there may be chance of spoofing of a Binding update (BU)message by an attacker and pretending to be another mobile node. And then the attacker redirects all the traffic destined for the original node to another node or to itself. This process is summarized is as follows

A. Session hijacking attacks

In the session hijacking it is assumed that Mobile Node 1(MN1) is communicating with the CN. A false BU message is sent to the CN, and claiming that the MN has moved to a new CoA that belongs to Mobile Node 2 (MN2). If the Correspondent node (CN) accepts this false Binding Update (BU) notice, it will begin communication with MN2 instead of MN1.Due to such type attack there may be chances of information leakage, mobile node impersonation or MN2 flooding.

B. Denial-of-Service (DoS)attacks

In a DoS type attack, the attacker uses a BU message to stop any service from being transmitted from the CN to the MN. A false BU may be sent, requesting a CN to forward packets which is destined for the MN to a fake address that is not the real MN's CoA. By utilizing such a spoofed BU, an attacker can send a large amount of unwanted traffic to overwhelm the resources of a single node one to work. First, the attacker locates a website with streaming video or a different heavy data stream and connects to it. It then sends a BU to the CN, requesting traffic redirection to the attackers' new arbitrary location. This arbitrary node will thus be bombarded by constant unwanted traffic. Attackers may also employ a target network's prefix to pass on a spoofed BU message, redirecting a great deal of streaming traffic to the intended network and flooding it with unwanted data. A variation of a DoS attack entails saturating the CN's memory (meant for storing binding cache entries) with fake BUs filled with false HAs. Therefore, no real message from any genuine node can be processed because the CN's memory is already full.

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Yet another type of DoS attack can hijack or cause the malfunctioning of a router on the path between the MN and CN or its HA. The attacker can refuse service to the MN's packet by actively dropping it, though it is not common within Mobile IPv6.

C. Man-in-the-middle (MITM) attacks

Man-in the Middle (MITM) attacks occur when a device man- ages to insert itself into the communication path between two hosts. In other words, an attacker sends a spoofed BU message to hosts A (MN) and B (CN) and proceeds to insert itself into the communication path between both hosts. When the attacker is located on the path between a MN and can modify the BU message, potentially hijacking ongoing connections or creating a reflection attack between the MN and CN. Even if host A (MN) is able to prove address ownership, the attacker can still situate itself on the MN– CN path. Because the attacker can modify the content of the BU message and its IPv6 header for own purposes, the CN needs to authenticate the MN's message to determine whether it was modified during the communication.

IV. MECHANISMS FOR SOLVING BINDING UPDATE ATTACKS

A. Review: A survey of secure protocol in MIPv6

As MIPv6 offers mobility support & allows MN to remain connected with CN even when moving through foreign networks. Such type of uninterrupted connection possible by managing address variations. But in this case security remains a fundamental concern. In order to design a security solution that will avoid all associated security risks, need to integrate advantages of all existing mechanism. In 2014, H. Modares et al [6] analyzed some of the previously developed security solution and presented overview of the MIPv6 Protocol. It is concluded that for new security solution the BU message should be designed on the case by case basis and it should avoid the repetition as well as enhanced the efficiency. Also it should complete the registration procedure with CN and minimize the computing cost of the CN.

B. Light Weight MIPv6 with IPsec Support.

In 2014, Anotonia j et al [7] presented and analyzed the requirements and desirable features for the mobility support and Proposed efficient solution based on IPSec for mobility constraint environment. In this solution for major requirements for scalable and inter domain solution, compatibility with IPv6 existing protocols and security support based on IPSec has been considered. This solution of lightweight MIPv6 with IPSec is aware of requirements of the LOT devices and also presents the best solution for dynamic ecosystems in terms of efficiency and security. This mechanism is Feasible.

C. IPSec ESP Transport mode

In 2012 Hero Modares et al [8] used the standard IPSec method for BU protection in transport mode as well as the Encapsulation Security Payload (ESP) is used for securing the connection for control message sent during home registration method .IPSec encrypt any packets with just their IP headers. The IKE protocol can control the mutual authentication and cryptographic algorithm negotiations as well as dynamic key management. Additionally, authentication method such as shared secrete, Extensible Authentication Protocol (EAP). Unfortunately, IPSec needs to be configured with various settings thus making it complicated. This method minimizes any damages caused by bombing attacks where packets are sent to the MN by malicious nodes. Cryptography Generated Address (CGA)can also be use to make spoofing type attacks harder .Private keys can be use to signed the message as well.

D. Enhance IPv6 Dynamic Host Configuration with Cryptographically Generated Addresses

In 2011Sean Shen et al. proposed in “Enhance IPv6 Dynamic Host Configuration with Cryptographically Generated Addresses” [9] analyses the security issues of the IPv6 DHCP. It then proposes a security solution using the Cryptographically Generated Address (CGA) along with DHCPv6 interaction. It also discusses some further extensions to this mechanism and the security issue for downgrade attacks.

E. IKEv2 Authentication Exchange Model.

To avoid BU spoofing we need to do share some secrete key between MN and CN. It is the responsibility of Internet key exchange version 2 to management and distribution of reliable authentication key. In 2012, Do Hyeon Lee [10] designed & constructed the network which is based on real mobile node and result analyzed by simulation. In this design authors analyzed the resetting of authentication key and re-exchange problem. It is observed that key exchange is affected by limited band width. To overcome the

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delay time authors proposed multi interface of nodes. The result of simulation shows because of limited bandwidth of network re-authentication of key is impossible to reset. This multi interface can minimize key exchange latency.

F. Anonymous Home binding Update Scheme for MIPv6 wireless networking

As the anonymity and location privacy are critical problems in seamless roaming environments. In 2011Sana Taha et al proposed an anonymous home binding update scheme (AHBU) for mobile IPv6 networks to achieve both anonymity and location privacy for mobile nodes [11]. In addition, a mutual authentication mechanism and construct a shared secret key between the mobile node and the foreign gateway is implemented. Unlike existing anonymity and location privacy schemes, AHBU works efficiently in scalable, real-time, and highly mobile environments. Besides, it achieves reasonable degree of anonymity and high level of mobile node's location privacy. Compared to the mix-based scheme, AHBU has less computation overhead because it requires only two public key encryption operations.

G. Security Analysis of Binding Update Protocols in Route Optimization of MIPv6

To make BU message Secure , In 2010 D.Kavitha et al [12] analyzed Return Rout ability (RR), Certificate-based Binding Update (CBU),Hierarchical Certificate based Binding Update protocol (HCBU), Child-proof Authentication for MIPv6 (CAM) , CAM with a digitally signed Diffie-Hellman key (CAMDH), Cryptographically Generated Address-based to Optimize MIPv6 (CGA-OMIPv6) protocols and have categorized them into two types where one is based n Return Routability and Cryptographically Generated Addresses(CGA) and the others are based on Certificate based Binding Update Protocols. A comparison of security threat protection of all these BU protocols is observed. This shows that all the RR protocols are providing security but are prone to session hijacking and man in the middle attacks. These attacks are overcome by the CGA protocols but with the introduction of cryptographically generated addresses, these protocols are susceptible to flooding and DoS attacks. Another type of protocols is based on certification from a central authority. Of these, Certificate based Binding Update(CBU) is prone to flooding attack. Hierarchical Certificate Based Binding Update protocol is designed in such a way that its security strength is too high, but its computation and communication efficiency should be improved.

H. Binding update Authentication Scheme for MIPv6

As MIPv6 provide route optimization facility by which mobile node and correspondent node can directly communicated with each other. To make route optimization more effective and reliable, need good authentication scheme. In 2007 , Ahmed I [13] proposed a new binding update authentication scheme. This mechanism validates the care of address and integrity of the binding update message in terms of latency and computation. This mechanism also resolves reflection and amplification, intensive computation problem.

I. Multiple Home Agent

In MIPV6 if there is some trouble with home agent, then the correspondent nodes cannot communicate with the mobile nodes. Also in MIPv6 route optimization, Mobile Node and correspondent node can communicate directly and so mobile node contacts with home agent frequently and cannot know if the home agent is down in short time. In 2007, Hongboshi; Goto S [14] proposed multiple home agent mechanism for mobile node when it is away from the home link. If there is anything wrong with any one of the home agent at that time by using multiple home agent mechanism , other working home agents can keep on forwarding packets to the mobile node by detecting the problem in short time and then other home agents inform the mobile node by using ICMP home agent unreachable error message.

To protect the location privacy of Binding Update message Takahashi H. et al.[15] employed multiple home agent method. In this method both Mobile Node (MN) and correspondent Node (CN) select one of multiple Home Agents(HA) independently and only selected HA know the location of MN .To conduct some experiments authors have implemented a prototype system by extending the UMIP (USAGI-patched Mobile IPv6 for Linux). The Result showed that communication delay observed due to message traverse on the additional path.

J. Ticket based binding update protocol for MIPv6

In 2006 ,Sangjin Kim[16] proposed a new ticket based binding update protocol in which CGA method is used to provide mutual authentication between nodes. In Ticket based binding update protocol there is no need of mobile node at the time to generate signature , when it acquire a new IP address and requires similar computational cost compared to existing protocols.

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In 2007,Mieso k et al.[17] proposed ticket based pre-established trust mechanism that employed a HA as a ticket issue server. In this Method in order to reducing the management cost of CN , instead of making trust relationship with MN , CN require relationship with the HA. And to optimize the CoA test, adopts the early binding update and CBA technique.

K. PAK-based binding update Method for MIPv6 Route Optimization

In order to protect the BU message against the attacker who resides on the path between MN and CN , in 2006, Ho-Su- YOON et al [18] proposed efficient and secured password shared binding update authentication method. In PAK-based binding update Method to authenticate the BU message , MN shares the password with the CN and incorporates the PAK protocol and derives the session key. It is observed that PAK based scheme provide more security than previous security methods. Also more computation complexity and the amount of exchanged communication data. The advantage of this mechanism is more efficient than the using public key in terms of computation complexity. Also does not require an external authentication infrastructure.

L. Binding Updates for Mobile Networks by using Multicast mechanism in IPv6 environment

As in moving network there are several active connection may exist and each of them have different correspondent nodes, the procedure of binding update will become complex. In order to keep the binding update procedure same as when MN travels in mobile network, in 2005, Yen- Wen Chen; Ji Min Shin[19] proposed two tier concepts. Also proposed multicast based binding update scheme (MONET). The result analyzed by simulation and it is observed that when the number of mobile nodes in mobile network increases and percentage of directly transmitted packets improved, at that time multicast binding update scheme can effectively reduce the cost of binding update message and packet transmitted in direct state is much higher than other states.

V. DISCUSSION

In Mobile IPv6, Whenever Mobile node change its location, it sends binding update message to HA and CN to tell its current Location. But there may be chances of BU message spoofing by third person. In this paper we have studied various existing security mechanisms that provide solution for reducing the threats against Binding update and improve security of BU message. But these mechanisms have some drawbacks and require some support. From the above study we prepare a table which help to compare features and drawbacks of each Security Mechanism (Table I). In this table various mechanisms are elaborated.

From the table it is observed that some mechanisms enhance security by providing mutual authentication between nodes. So In case of improve security by mutual authentication, the Binding update Authentication Scheme for MIPv6 proposed by Ahmed I in 2007 and PAK-based binding update Method proposed by Ho-Su- YOON et al. in 2006, provide more security than other methods by validating latency and computation of BU message. On the other hand in case of improving security by employing multiple home agent the solution provided by Hongboshi; Goto S ,2007 is more useful because it Keep the connection more smoothly than using single home agent. and also decrease Packet loss problem.

From above discussion it should be clear that not a above single mechanism has all good features. So how can we choose a mechanism in order to provide better performance? We list out some key issues that may help to develop a high performance mechanism.

Mechanism that should provide pre authentication between nodes by sharing some secretes key or password.
Should provide better authorization method.
Should encrypt the BU message.
Should be reduce Binding registration time .
Should reduce the computation cost.
Should reduce overhead.
Provide Security for threats related to binding Update.

VI. CONCLUSIONS

In MIPv6, when MN moves from one location to another location, it sends BU message to HA and CN to tell its current location .And BU message plays most important role in MIPv6 communication. So there may be chances of spoofing BU by intruder in order to know the current location of MN or hacking messages communicated between MN and CN. And due to this reason Mobile IPv6 suffer from binding update threats like Session hijacking, Denial-of-Service (DoS), Man-in-the-middle (MITM). In this paper, we discuss the reasons and types of threats against binding update. Also give review, analysis of various mechanisms and compared its features and drawbacks.

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TABLE I: COMPARATIVE ANALYSIS OF VARIOUS MECHANISMS FOR REDUCING BINDING UPDATE THREATS

AUTHOR	YEAR	SECURITY MECHANISM	FEATURES	DRAWBACK	SECURITY FUNCTION
H. Modares	2014	Review : A survey of secure protocol in MIPv6	**1**. Concluded that for new security solution the BU message should be designed on the case by case basis . **2**. It should avoid the repetition as well as enhanced the efficiency. **3**. It should complete the registration procedure with CN and minimize the computing cost of the CN.	Not yet completely developed, is in progress.	Try to Provide uninterrupted connection.
Anotonia j et al	2014	Light Weight MIPv6 with IPsec Support	**1**. Aware of requirements of the LOT devices. **2**.Presents the best solution for dynamic ecosystems in terms of efficiency and security. **3**.This mechanism is Feasible.	**1.**Higher memory required. **2.**Higher Overhead.	Based on IPSec
Hero Modares et	2012	IP Sec ESP in transport mode	Any protocol can be encrypted and also encrypt any packets with just their IP	IPSec is complicated.	Encryption , Authentication

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al.		and Extensible Authentication Protocol (EAP).	headers		
Do Hyeon	2012	IKEv2 Authentication Exchange Model	**1**.Reauthentication of key is impossible to reset. **2**.Multi-interface can minimize key exchange latency.	**1.**Keying value was a little faster. **2.** Need to study of key delay time & security transmission between heterogeneous networks.	Multi interface of nodes.
Takahashi H. et al	2012	Multiple Home Agent	**1.** Extension to Mobile IPv6 to protect location privacy. **2.** Make hard to link BUs.	Communication delays.	Authentication, Encryption
Sana Taha	2011	Anonymous Home binding Update Scheme for MIPv6 wireless networking	**1.**Works efficiently in scalable, real-time, and highly mobile environments. **2.**It achieves reasonable degree of anonymity and high level of mobile node's location privacy. **3.**AHBU has less computation overhead.	Require only two public key encryption .	Mutual authentication mechanism and construct a shared secret key.
D.Kavitha et al	2010	Hierarchical Certificate Based Binding Update protocol	**1.**Certificate management in the protocol is relatively simple and efficient. **2.**Computation costs on the protocol participants are significantly reduced, compared to the previous certificate-based protocols; **3.** The latency is fairly low, which ensures fast handovers.	Required improvement in Computation and communication efficiency .	Use early binding update technique.
Ahmed I	2007	Binding update Authentication Scheme for MIPv6	**1.**Validate the care of address and integrity of the binding update message in terms of latency and computation. **2.** Resolve reflection and amplification, intensive computation problem.	Not yet observed any drawback.	Validate latency and computation of BU message.
Hongboshi; Goto S	2007	Multiple Home Agent	**1**. Keep the connection more smoothly than using single home agent. **2.** Decrease Packet loss.	Not provide solution for ICMP home agent unreachable detection.	Using ICMP home agent unreachable error message.
Mieso et al	2007	Ticket based binding update protocol for MIPv6	Efficient in terms of the management cost and security.	Same handover latency as that of static shared key method.	CN require relationship with HA.

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Sangjin Kim	2006	Ticket based binding update protocol for MIPv6	Outperforms others when a mobile node has valid ticket.	Computational cost is similar as existing mechanism.	Used CGA method for mutual authentication.
Ho-Su-YOON et al	2006	PAK-based binding update Method	1.More efficient in terms of computation complexity. 2.Does not require external authentication infrastructure.	Not yet observed any drawback.	Shared password
Yen- Wen Chen; Ji Min Shin	2005	Multicast mechanism in IPv6 environment	1. Effectively reduce the cost of binding update message. 2. Packet transmitted in direct state is much higher than other states.	Not provide solution for security mechanism of the binding update procedures with multicast, hierarchical handoff of mobile networks.	Two tier concept

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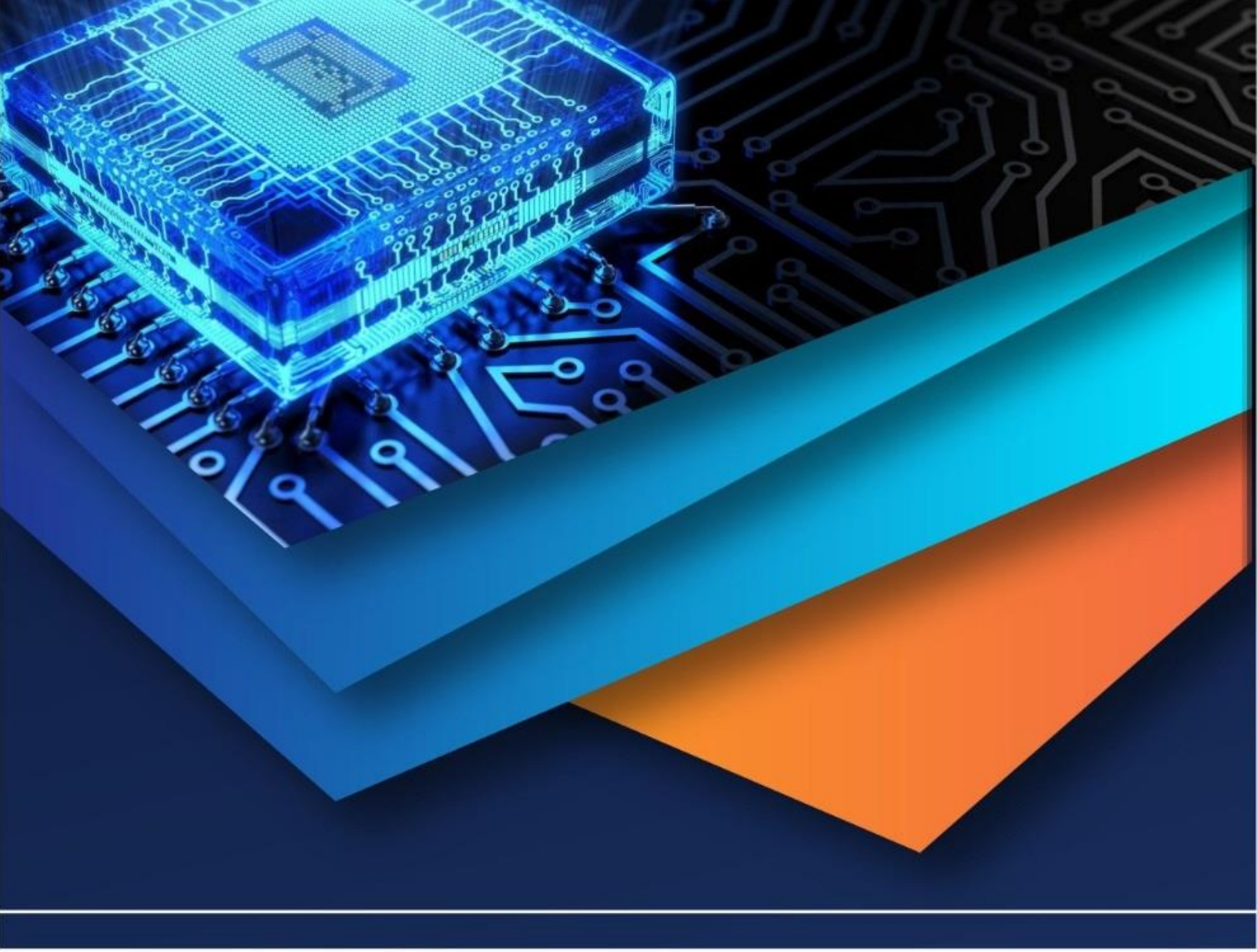

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