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MINIMIZING TRAFFIC CONGESTION COST IN INTER-DOMAIN TRAFFIC ENGINEERING

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Abstract: The propagation in the routing table sizes resulted in the optimum flows across the Internet which leads to the significant divergences in the Internet scalability and resiliency. The Internet traffic engineering distribute to the evolution from Internet routing to hierarchical routing with respect to transit and edge networks. The transit-edge hierarchical routing is performed by unraveling the locator from identifier by substituting the dimensions that ensures load balancing scheme which aims at path and locator ranking costs. High traffic congestion and less packet delivery ratio are the challenges faced in edge-to-edge load balancing. The destination rate vector inter-domain traffic engineering approach is introduced in order to ensure how much traffic the autonomous system want to send or receive across an inter-domain link. The inter-domain traffic engineering allows the intra-domain routing methods by protecting the intra-autonomous state information and their topology. The inter-domain traffic flow rates are yielded which minimizes the traffic routing cost across the Internet in the intra-domain traffic engineering policies.The network reliability and the inter-domain traffic engineering technique together constitute the augmented interconnectivity of the network. The traffic routing cost throughautonomous system depends on inter-domain traffic engineering and the aim is to reduce the traffic routing as well as the congestion cost. The outgoing traffic load balancing is constrained by inter-domain traffic engineering techniques. The destination based traffic engineering or point to point traffic engineering has better efficiency of network resource usage.

Keywords:Autonomous System, Destination Rate Vector, Load balancing, Resiliency,Routing game, Scalability, Traffic Engineering

1.INTRODUCTION

The Internet scale applications and research have inferences by the substantial variations in the inter-domain inter connection strategies. In the research and commercial literature[1] the internet inter-domain traffic engineering pattern has significant fluctuations. The secondary gauges of Internet traffic are being focused by the research literature. Now a day the Internet inter-domain traffic is being extended to the protocols such as TCP/UDP and the traffic growth is migrated between the cloud and content providers. The Internet traffic engineering is the key aspect of commercial strategies and network engineering that can be used for performance taxation of operational networks that oversees the packet flow. The network integrity and the survivability can be improved with inter-domain routing that leads to consistent network operation and traffic engineering policy. In inter-domain traffic engineering the traffic flow is being controlled within the network itself by dynamic provisioning [2] and optimizing the cost of routing protocol. The Border Gateway Protocol (BGP) routing decisions is affected by the Internet traffic engineering during the regulation of the flow of ingress traffic.

The IP packets and the decisions are being routed and exchanged with respect to stub domains and the transit domains. The BGP decision processes are talented by BGP and the

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locators and identifiers splits up through the Locator/Identifier Separation Protocol (LISP). The Internet scalability and resiliency is achieved and the routing table size is minimized with respect to the LISP context. This can also be termed as transit-edge hierarchical routing [3]. The factors such as multi-homing and the inter-domain traffic engineering along with the growth of Internet resulted in the indiscriminate growth of BGP routing tables. The traffic can be balanced as well as the cost of traffic can be reduced by the inter-domain traffic engineering and the same is the intention too. The incoming and the outgoing traffic are being regulated with respect to the corresponding destination. For this purpose the route advertisements [4] are introduced. The control of internet traffic, its modeling and characterization comprises the traffic engineering performances which in turn lead to addressing of traffic performance requirements and economic utilization of networks. The routing table maintains the record of routes that reach into various destinations which is an important part of efficient routing.

In this paper, we study the techniques that are helpful for the transit-edge hierarchical routing. In section 2, we show the inter-domain traffic engineering context. Section 3 describes the various methodologies by which the transit-edge hierarchical routing can be achieved based on the traffic engineering aspect. In section 4, the performance is evaluated based on the performance metrics and section 5 contains the implementation details with respect to LISP context. Section 6 concludes the paper.

2.BACKGROUND

There were several literatures devoted on the basis of internet inter-domain traffic engineering. In 2005, it was reported that the lack of scalability was the main threat in the traffic engineering aspect. The autonomous systems were interconnected and the routing information [7] was exchanged through BGP. The BGP talker wholes the decision process for generating the efficient path for transit networks that are facing the scalability issues. The incredible amount of routes is a compromise between path diversity and routing overhead. The path diversity is not modified knowingly by the stability of the routes. When it comes to 2008, the report shows that the Generalized Multiprotocol Label Switching (GMPLS) [5] technology was introduced for traffic engineering purpose and it deals with the inter-autonomous system that provide support for inter-domain services. The GMPLS traffic engineering [6] expertise empowers automatic provisioning of inter-domain traffic engineering amenities.

In 2010, the internet routing is affected by the routing deviations which in turn resulted in the routing protocol stability and the diversity in the internet core. The IP networks discourses from its neighbors towards the same destination network by receiving multiple announces from BGP router. The configuration of service elements such as edge sender, edge destination and the transit provides the outcome of inter autonomous system traffic engineering which proclaim routing from access router towards the end router of the next autonomous system. The identification of service elements is done based on the inter-AS multiprotocol label switching service which was followed by the instantiation of service that authenticates the accessibility of service elements and triggers the service establishment. In 2011, the traffic engineering is considered as the separation of the locators and identifiers that is based on the Locator/Identifier Separation Protocol (LISP). The locator is talented for providing the different path between two identifiers in which the locators are globally routable. During this period the transit edge hierarchical routing [3] came into existence. In 2012, the factors such as deployability, non-disruptive namespace and core network transit [4] put forward in order to achieve the principles such as address role separation, encapsulation and mapping are measured. The address role separation is the process of separating the IP addresses into Routing Locators and Endpoint Identifiers. Encapsulation is the packaging of the data into several packets which is done by the packet source site of the destination border routers.

In extension to LISP, the BGP also became popular for swapping the information of routes within the interconnected ASes. The mapping within the ISP was managed for guaranteeing the path diversity, scalability and robustness [10] between the autonomous systems. The verification of availability of resources, capability of switching and possibility of protection depends upon Label Switched Paths (LSPs) [9]. In 2013, the concept of separation of locators and identifiers again came into existence.It is observed that the internet topology [15] of endpoint identifiers (EID) is being noted by the routing locators. The packet is send and the traffic flow is from source EID to the destination EID. The communication is done by EIDs. The LISP mapping comprises of tuples such as priority,

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RLOC and weight. The highest priority RLOC is taken and the corresponding weight is used for load balancing.

3.METHODOLOGY

For attaining the inter-domain traffic engineering with respect to transit-edge hierarchical routing some of the techniques are being used.

3.1.Routing Game

The Internet is the composition of several smaller networks that can be termed as the Autonomous Systems (ASes). The route is being established in between the ASes is considered as the main task of the inter-domainrouting. The ASes are not directly connected so that the packets have to traverse through several ASes which enable them to express preferences over routes.The routing technique is performed across the edge networks and the transit networks where two edge networks and five autonomous systems (AS) providers are considered in which edge networks are positioned in the two culminations and autonomous systems (AS) providers are assembled within the edge networks that are considered as an Internet core. The edge networks interchange a pertinent volume of traffic for humanizing the routing phenomenon by proclaiming routing locator preferences which are applicable to inward traffic. The edge router has the routing select for the terminus network and the source network can receive the prevailing locators for the terminus with the locator preferences. The locator preferences are done with the help of BGP's local preferences. The differential factor between the local and locator preference is relied in the aspect of traffic flow.

The BGP local preference is affected by the outgoing traffic and the locator preference is affected by inbound traffic. Both inbound traffic and outbound traffic are measured with respect to the locator preferences. The available locators for a given destination are received by the source network with respect to locator cost preference. So the routing locator cost is impacted by source network as well as the destination network. The routing game is performed by two parallel routes which can be considered as the single edges where there is a source node and sink node. The single edges are having a cost which is capable of providing a large amount of traffic. The players in the routing game are well known as selfish players and each player have an objective to minimize the cost.

3.2.Coordinated joint routing

The introduction of locators for edge networks fetches grander path diversity in Internet routing [11] which is trailed by increment in the overall resiliency. The locator priorities and the locator weights are considered as the dynamics for locator preferences in the transit-edge hierarchical routing mechanism. The main aim of routing game is to minimize the routing cost.The strategic calculation can be done for getting the best known path by considering the gateway and the locator cost.The traffic flows can be jointly routed by two networks which is followed by the implicit coordination equilibria [11] of the joint routing game. The routing cost is similar for both upstream and downstream flows and the cost is impacted on the network depending upon the player's decision. The locator identifier separation is deployable in the transit-edge hierarchical routing mechanism where the border routers of edge networks are the BGP peers of the border routers of the transit networks. Therefore, the border routers of the edge networks increase the path diversity by receiving several AS paths which permits the evaluation of gateway-locator route independently. The backward paths are not received by the border routers of the edge networks from the destination locators towards its network. The ingress and egress edge links are being modeled by the ingress and the egress costs with distorted properties.

3.3.Forward Cost Function

The forward cost can be established by calculating the locator preference cost and the gateway cost in which both costs are equal. The edge router receives several paths towards the destination locator which allows the evaluation of forward costs. The more number of paths are available for the destination locators, the more buoyant the transit route is. The failure of one path provides a platform for selecting the alternative paths that are available in the routers. The forward costs are different for different players by examining the cost function. The forward cost is only considered since the backward paths are not deliberated. The edge AS networks performs the multi-homing in the traffic engineering scenario for improving the overall Internet resiliency. The level of path diversity of transit route is being considered for the forward cost function along with the performance criteria of the existing paths.

The routing metric can be calculated as follows.

$$c_{j,k} = [T.L_{cp}] = [T(\sum_{\alpha\epsilon\Omega_{j,k}} \frac{1}{L(\alpha)})^{-1}] \quad (1)$$

In the above equation, the j and k corresponds to the border routers and T is an arbitrary constant. L_{cp}isthe comparable length of an equivalent network. It can be computed as follows.

$$\frac{1}{L_{cp}} = \sum_{\alpha\epsilon\Omega_{j,k}} \frac{1}{L(\alpha)} \quad (2)$$

From the above equation it can be conclude that $\Omega_{j,k}$be the set of available AS-level paths between a Gateway j and a locator k and let L(α) be the AS hop count of the path$\alpha\epsilon\Omega_{ij}$.

3.4.Load Balancing

The load-balancing equilibrium solution is purely based on the edge-to-edge load balancing where non-cooperative game theory is taken into account. The potential function can be minimized by considering the equilibria by decreasing the time density.The potential function can be calculated with respect to the edge-to-edge interaction with forward path costs. The Internet path diversity is dramatically increased due to the presence of multiple locators. The load balancing technique provides a platform for eliminating the possible routing oscillations. The routing oscillations are occurred due to the traffic overhead and the performance loss of the single path routing. The percentage weight is allocated at the source of the edge network and along that route egress traffic distribution is made possible for implementing the load balancing.

3.5.Destination Rate Vector Framework

The minimization of the traffic congestion cost over all ASes is the main objective of the inter-domain traffic engineering approach. By considering the physical link capacity constraints the network flow conservation can be preserved. The traffic congestion cost across each AS is reduced depending upon the traffic rate that it wants to send and receive. The process across an inter-domain link for each destination is termed as the destination-rate vector inter-domain traffic engineering approach [14].The destination-based traffic engineering is the most efficient and flexible technique in the usage of network resource. For achieving scalability the traffic engineering is designed in a fully distributed manner for attaining the message exchanges between domains. The traffic rate across an inter-domain link for each destination is declared and it is known as destination-rate vector inter-domain traffic engineering approach. The aim of the approach is to minimize the totality of inter-domain congestion cost and intra-domain congestion cost.

Where $\sum_{i\epsilon N} C\,(S)$the inter-domain congestion is cost and $\sum_{j\epsilon N} C\,(T)$ is the intra-domain congestion cost. The destination-rate vector traffic engineering can be demonstrated as:

To minimize $\sum_{i\epsilon N} C\,(S) + \sum_{j\epsilon N} C\,(T)$(3)

4.PERFORMANCE EVALUATION

An edge-to-edge interaction is made possible between the autonomous system providers in order to perform Internet traffic engineering more effectively. The number of locators is taken as the input parameter and the performance factors are the output parameters itself.

4.1.Routing Stability

The routing stability [13] is being examined by the Internet routing dynamics for achieving the Internet routing stability. The compositions of huge number of independent networks called autonomous systems constitute the routing infrastructure. The instability of the routing results in the packet dropping and the routing stability provide better knowledge in the limitations of Internet routing. The graphic representation of routing stability is shown in the Fig. 1. This shows that edge-to-edge traffic engineering mechanism is having higher stability with respect to than the LISP and BGP.

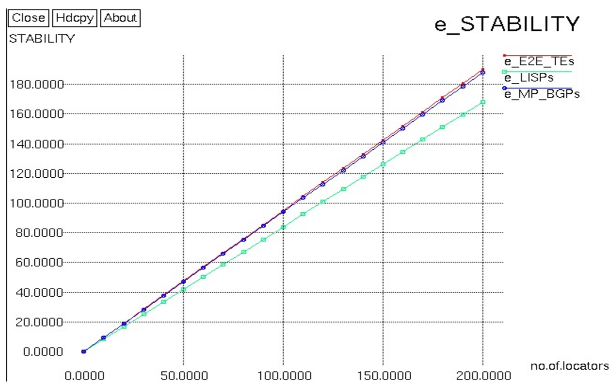

Fig.1. X-graph showing the routing stability

4.2.Percentage of used locators

Fig.2 shows the graphic representation of the percentage of used locators. Here two sample autonomous systems are considered say, AS12182 and AS4685. Both autonomous systems actively participate in the Internet traffic engineering process and it can be examined that AS12182 shows higher usage of locators than the other one.

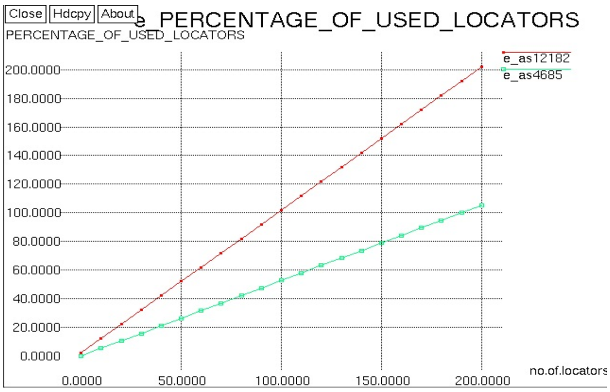

Fig.2. X-graph demonstrating the usage of locators

4.3.Nashequilibria

Fig.3 shows that the nashequilibria dynamics with respect to the number of locators. Here the optimal outcome is taken as the best result while considering the players and after receiving the opponent's choice where there is no need of changing the player's strategy. The nashequilibria is used to determine the traffic flow over a network.

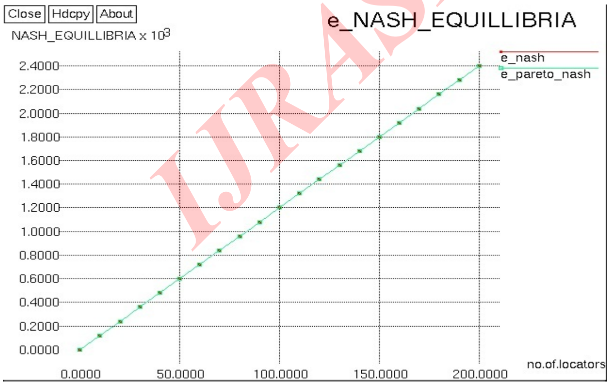

Fig.3. Nash equilibria dynamics.

4.4.Routing Cost

Fig.4 shows the routing cost of LISP, BGP and edge-to-edge traffic engineering technique. The path is being analyzed, selected and directed with respect to the outbound traffic and inbound traffic that is based on cost which depends on the path that transport the best rate. It is being observed that the edge-to-edge traffic engineering technique is having the lower routing cost as well as congestion cost.

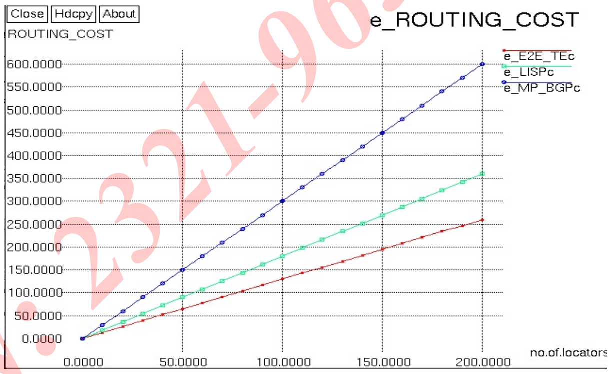

Fig.4. X-graph statistics of the routing cost

4.5.Path Diversity

The number of paths within the autonomous system network for a packet to transit between two points can be termed as the path diversity. It is having multiple routes to reach the destination. Fig.5 shows that the edge-to-edge traffic engineering techniques have higher path diversity and is resilient to failures that occur in the network.

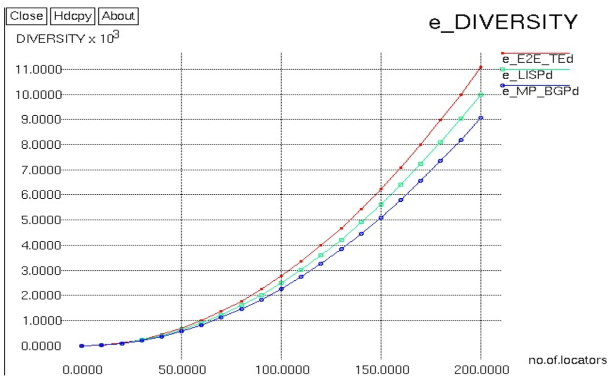

Fig.5. X-graph showing the path diversity.

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5.CONCLUSION

The novel traffic engineering capabilities are arising in a transit-edge hierarchical routing context. A strategically rational approach accounts the reciprocal routing of equivalent traffic volumes culminating in edge-to-edge load-balancing. Due to the indiscriminate growth of the Internet and the increase in the size of routing table the scalability and the resiliency is reduced. The traffic engineering approaches provide solutions for this huge threat. Placing intermediate gateways and locators separating edge networks from transit carrier networks can jointly solve both the routing scalability and connection resiliency issues. Literature survey reveals that the lack of scalability The congestion cost and the network overhead is minimized to a certain extent. The network traffic in the inter-domain approach can be analyzed based on the x-graphs of the metrics that are included in the performance evaluation. The approach shows the routing stability and the path diversity is attained in terms of resiliency. The inter-domain traffic engineering is policy driven and the overall uses of Internet resources are being optimized.

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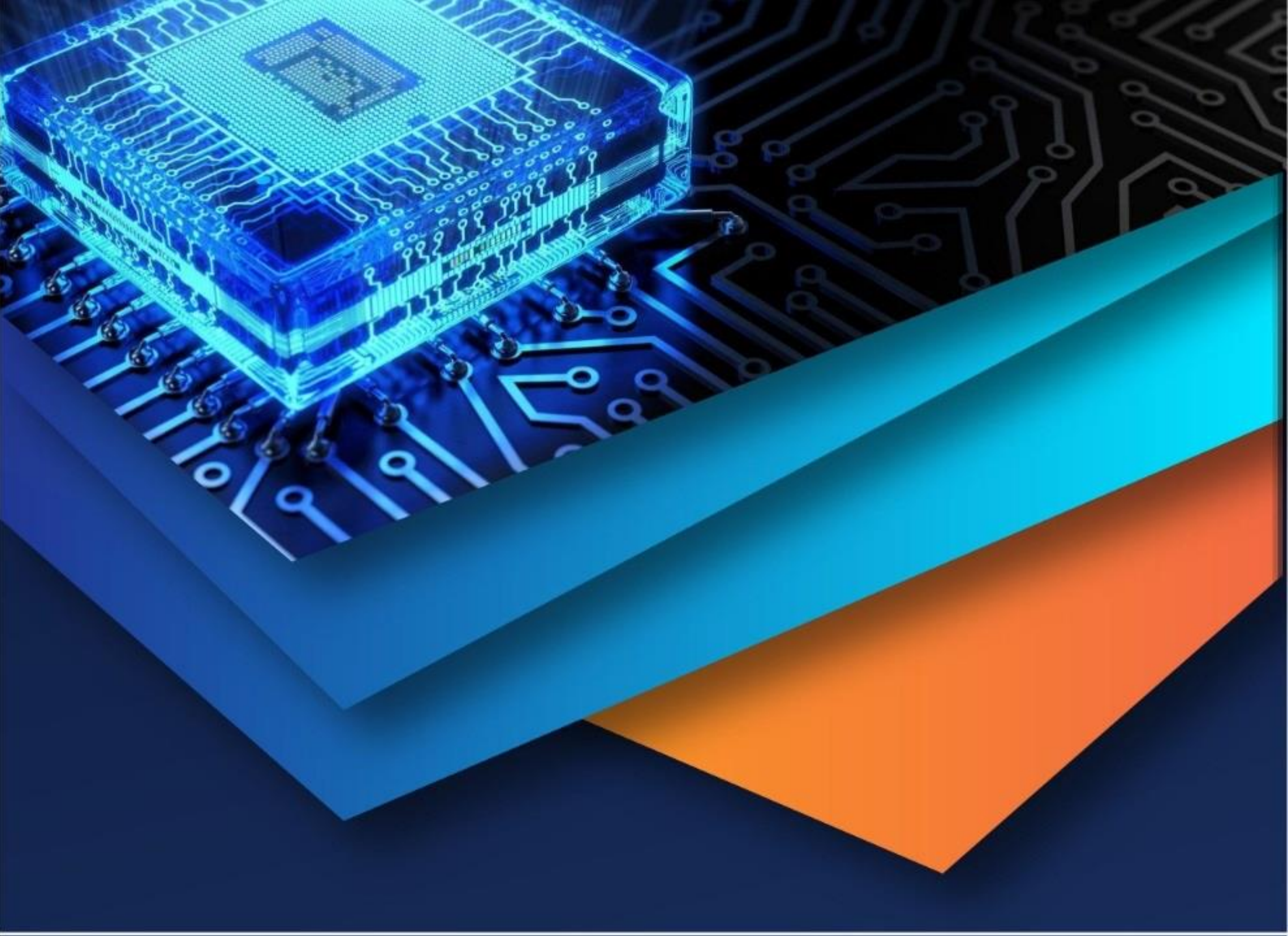

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