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Group Caching For Effective Data Transmission in Disruption Tolerant Networks

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Abstract— ***Network environment where the nodes are characterized by opportunistic connectivity are referred as Disruption /Delay Tolerant Network (DTN). In DTNs, it is difficult to maintain end-to-end connection because density of node is low, mobility of node is unpredictable and lack of global network information. It is possible to predict when the contact of nodes will occur and how long it will last, using Semi-Markov Chain process. But this process has a drawback with time complexity. So the concept of group caching is introduced, in which data is cached in group of central nodes which are frequently contacted by others. Here the data are cached at set of nodes located at the centre of the network. Without any loss of data and time delay the requested data is forwarded from source to destination. In this paper we explore some of the popular techniques for secure data transmission in DTNs.***

Keywords— ***Disruption Tolerant Networks, Semi-Markov Chain, Group caching, Single Data Multicasting (SDM), Max Prop Technique***

I. INTRODUCTION

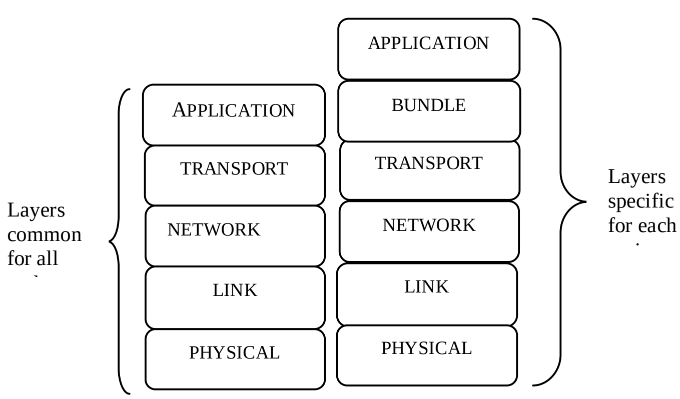
A Delay Tolerant Network (DTN) is a network of smaller networks. It is an overlay on top of networks which are of special-purpose, this also includes the Internet. By accommodating long disruptions and delays between and within those networks DTNs support interoperability of other networks, and by translating between the communications protocols of those networks. DTN opportunistically contact each other which consists of mobile nodes [6]. In DTN, mobile devices are only intermittently connected, because mobility of node is unpredictable and density of node is low [1, 5]. While in motion of communicating nodes, intervening bodies can obstruct the links. These events cause intermittent connectivity to occur. So there is a loss of data on the Internet. So it is difficult to provide end-to-end connection [5].

To overcome the difficulties in providing continuous end-to-end connectivity in DTNs several techniques have been proposed. This paper presents the background to understand the techniques, in section 2. An elaborate survey of the techniques available in recent literatures is presented in section 3 along with their merits and demerits. The Simulation of the Proposed System to overcome some of the demerits of the existing techniques is presented in section 4 and the conclusion is presented in section 5.

II. BACKGROUND

A. Delay - Tolerant Network Architecture

DTN is a network of regional networks: it is an overlay on top of regional networks, including the internet. The communication characteristics are relatively homogeneous in a communication region. Each region has a unique region ID which is knowable among all regions of DTN.



Original Five Layer TCP/IP Stack DTN Stack with bundle layer

Figure 1: DTN Specific Stack

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III. LITERATURE SURVEY

Epidemic routing is the base for all data forwarding techniques in DTNs [1]. Epidemic routing is a flooding based protocol relying upon the distribution of messages through the network to deliver information to their destination. It adopts a so-called ''store-carry-forward''[4] paradigm – when a node receives a packet buffers and while moving it carries that packet then pass that packet on to new nodes that it encounters. Epidemic routing is able to achieve minimum delivery delay at the expense of increased use of resources such as buffer space, bandwidth, and transmission power[7].To overcome the problem of increased resource utilization other techniques were proposed which are discussed in the following subsections.

A. User Centric Data Dissemination

In [4] Gao et al. have proposed a user centric data dissemination technique. When data are disseminated based on network centric approach data are forwarded to all the nodes and hence network resources are wasted. Also, in network centric approach relays are selected based on the scope of network information maintained at individual node forcing every node to maintain network information. To overcome these drawbacks of network centric approach, the data is disseminated based on user centric approach using the technique called social-based data forwarding. Here the data is forwarded to only interested nodes by splitting data dissemination into two parts:

1) Uncontrollable part, where the Data is disseminated among interesters automatically without help of additional relays.

2) Controllable part, where the relays are intentionally selected among the non-interested nodes.

In the controllable part, relays C and D are intentionally selected among the non-interester nodes, according to their capabilities of forwarding data to interesters, which is shown in figure 3.1[4]. This model implicitly assumes the consistency of user interests over all the data items in the same channel, and simplifies relay selection by using data dissemination history in the past as prior knowledge. But there is a delay in delivery of data.

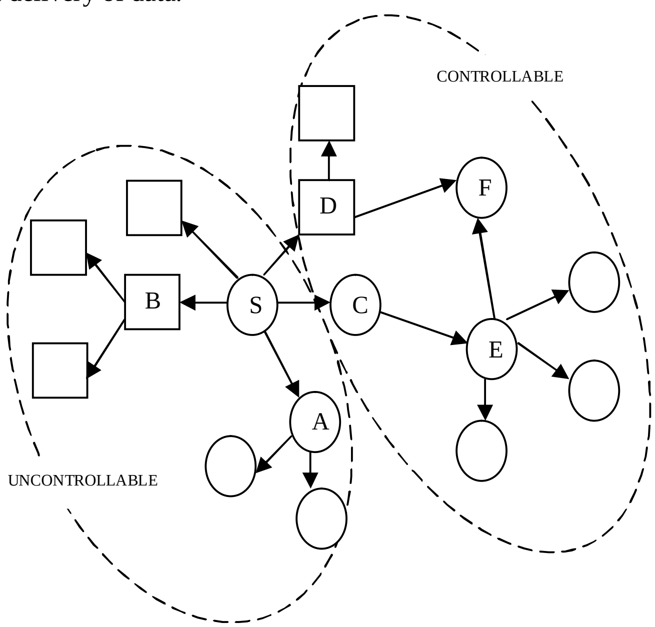

Figure 2: User-Centric Data Dissemination

B. Multicasting in DTNs

Centrality-based heuristic for Single Data Multicasting (SDM) has been developed in [6]. This technique is based on the local knowledge of the data source. The different nodes presented here have heterogeneity in their contact patterns, and such heterogeneity validates the use of Social Network Analysis (SNA) for data forwarding in DTNs. There are two key concepts in SNA methods:

1) Communities, which are naturally formed according to people's social relations. Social communities are derived from the "small-world" phenomenon, which is first investigated by Milgram's experiment, and is later formalized as a random graph problem.

2) Centrality, which shows that some nodes in a community are the common acquaintances of other nodes and act as communication hubs.

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The relays are selected among the contacted neighbors of the data source based on their centrality, to ensure that the required delivery ratio can be achieved within the time constraint. Relays among these nodes are selected by consider the time needed for them to contact the data source. Multicasting in DTNs was introduced, in which even multiple data can be forwarded based on the technique called weighted social network model

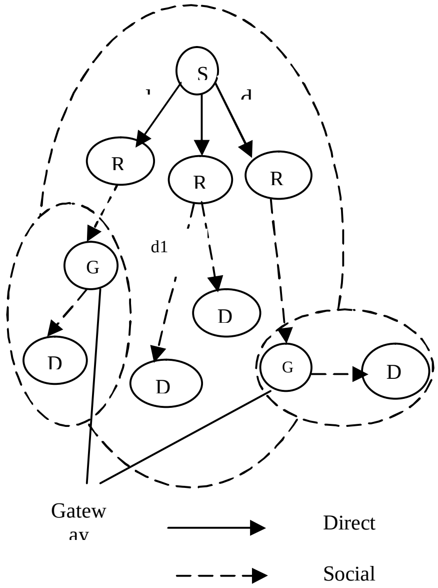

Figure 3: MGM data forwarding process

In figure 3.2 [6] source *S* multicasts three data items *d*1, *d*2, *d*3 to destination sets *{D*1*}*, *{D*2*}*, *{D*3, *D*4*}*, respectively. For destinations *D*1 and *D*2 with relay *R*1 belongs to the same community, *R*1 forwards data *d*1 and *d*2 to the destinations according to its local destination-awareness about *D*1 and *D*2, in the form of social forwarding paths. For destinations *D*3 and *D*4 which reside in other Communities, data forwarding is conducted through the "gateway" nodes *G*1 and *G*2, which belong to multiple communities. Therefore it greatly reduces the forwarding cost. When the time constraints are short then the selected relays may not contact destination. The delivery ratio of Multiple Data Multicasting (MDM) is only – 60%.

C. Data Transmission based on Social Contact Pattern

Some schemes develop data forwarding metrics by exploiting the stochastic node contact process based on experimental and theoretical analysis. Metrics based on the prediction of node mobility and its probability of contacting the destination was developed by some others. However the performance of these schemes is limited due to the randomness of human mobility and thus the low prediction accuracy. So the best relay choices could not be achieved within short period due to heterogeneity of transient node contact characteristics.

Gao et al. have suggested that this can be done by exploiting the transient social contact pattern [5]. Social contact pattern has 2 perspectives.

1) Centrality, which indicates that some nodes are the common acquaintances of other nodes and thus have better capabilities of contacting others.

2) Community, this indicates that people are naturally organized into groups according to their social relations.

In both stages, most of the current social-aware data forwarding schemes evaluate the centrality of mobile nodes based on their cumulative social contact patterns over a long period of time. Data forwarding decision is then made based on these metrics and the specific forwarding strategy being used. The authors have found that forwarding cost has reduced over 20% when compared to other processes and also time constraint is short. But the delivery ratio is decreased.

D. Effective Routing in DTNs using MaxProp Technique

Routing in DTNs environments is difficult because peers have little information about the state of the partitioned network and transfer opportunities between peers are of limited duration. In prioritizing both schedule of packets transmitted to other peers and schedule of packets to be dropped can be done using the technique MaxProp [3], a protocol for effective routing of DTN messages.

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These priorities are based on the path likelihoods to peers according to historical data. The MaxProp is used to increase the delivery rate and lower the latency of delivered packets.

MaxProp unifies the problem of scheduling packets for transmission to other peers and determining which packets should be deleted when buffers are low on space which is shown in figure 3.3 [3]. Also improving the performance of path-likelihood based routing, including: system-wide acknowledgments, hop lists denoting previous intermediate recipients, and priority for new packets using an adaptive threshold. MaxProp uses acknowledgments that are propagated network wide, and not just to the source. Finally, MaxProp stores a list of previous intermediaries to prevent data from propagating twice to the same node. The MaxProp is used to increase the delivery rate and lower the latency of delivered packets.

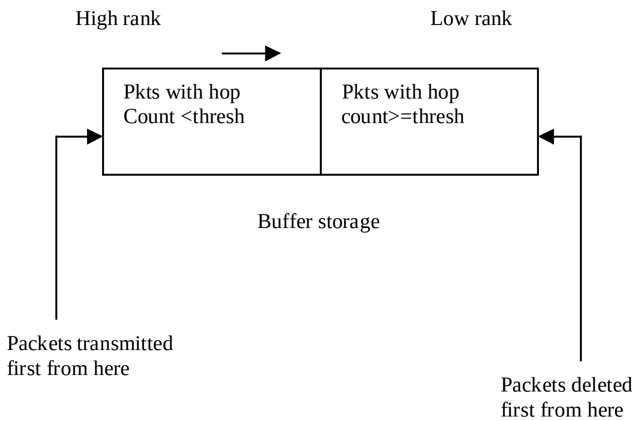

Figure 4: The MaxProp Routing Strategy

The authors found that it performs well in varied DTN environments and it does not send group of data from source to destination at a time. But the downside of this technique is that it maximizes the time delay.

E. Data Access using Rapid Protocol

Increasing the likelihood of finding a path with limited information is incidental effect. The major drawbacks of this effect are average delay, missed deadlines and maximum delay. So, resource allocation protocol for intentional DTN (rapid) is introduced in [2]. This uses the technique namely distribution control channel where the expected intermeeting time, expected transfer size and replica location are known.

RAPID nodes use the control channel to exchange additional metadata that includes the number and location of replicas of a packet and the average size of past transfers. Balasubramanian et al. have developed a protocol namely RAPID for data transmission in DTNs by modeling a DTN as a set of mobile nodes. Two nodes transfer data packets to each other when within communication range. During a transfer, the sender replicates packets while retaining a copy. A node can deliver packets to a destination node directly or via intermediate nodes, but packets may not be fragmented. There is limited storage and transfer bandwidth available to nodes. Destination nodes are assumed to have sufficient capacity to store delivered packets, so only storage for in-transit data is limited. Node meetings are assumed to be short-lived. This approach is heuristic. But the major disadvantage is that performance is not guaranteed.

IV. PROPOSED SYSTEM

To deliver data to the requester in DTNs without any loss and time delay a technique is proposed in this section based on group caching. In this technique the requester/destination sends query about requesting data to the network, then the data source responds to the query by sending the requested data. Here the data are intentionally cached at central locations of the network. If a central node's buffer is full, then the data is cached by another node near the central node.

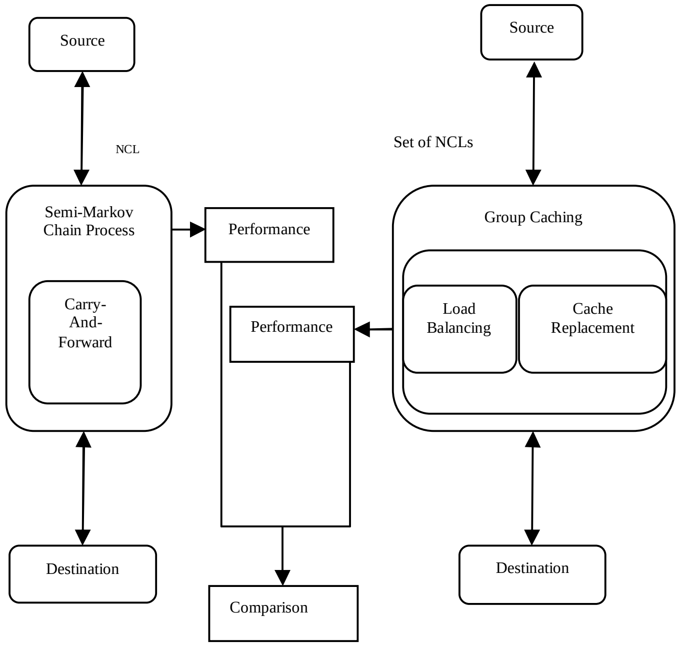

Figure 5: System architecture diagram

A new central node is selected when the central node fails. For each data item in the network, the locations where it is cached are dynamically adjusted via cache replacement. This replacement is based on data popularity, and generally places popular data nearer to the central nodes. Probabilistic cache replacement strategy is introduced, which appropriately selects the data to be cached and heuristically balances between the cumulative data accessibility and access delay. Figure 4.1 shows the system architecture diagram.

A. Simulation of the Proposed System

The proposed system is simulated in TCL (Tool Command language) and the screen shots are presented in this sub-section. Figure 4.2 shows the Creation of Disruption Tolerant Network which consist of collection of nodes forms the disruption tolerant network. This network is created with 13 nodes.

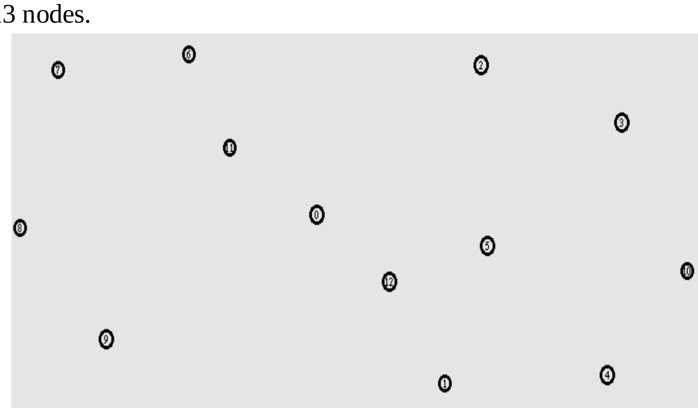

Figure 6: Creation of Disruption Tolerant Network

Figure 4.3 shows the communication of nodes. When the mobile node moves, the nodes which are within the coverage will communicate. In this figure node 11 and node 12 is considered as DTN_Mobile_1 and DTN_Mobile_2 respectively, station (6) and station (1) are coming under the coverage of these 2 DTN_Mobile nodes.

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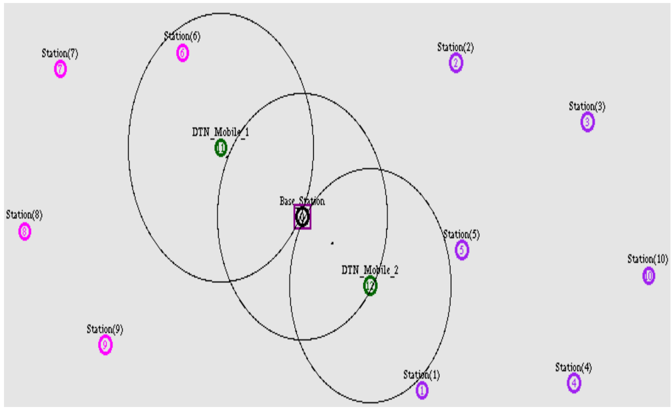

Figure 7: Communication of nodes

In figure 4.4 Station (6), Station (7) and Station (8) are comes under the coverage of DTN_Mobile_1. Station (4) and station (10) which come under the coverage of DTN_Mobile_2. So that data can be transmitted to the nodes which are within the range

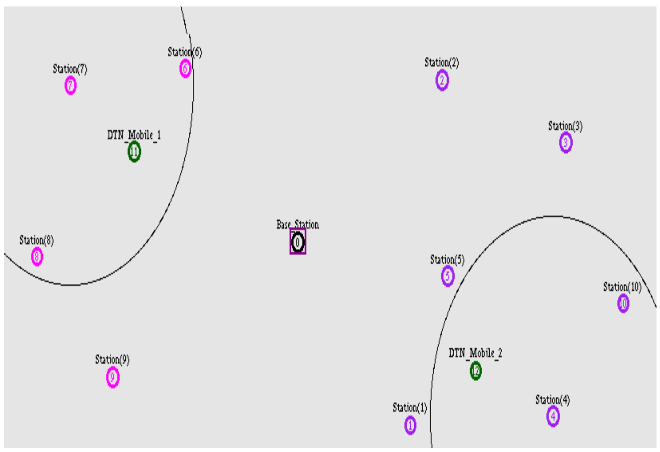

Figure 8: Mobility of nodes

V. CONCLUSION

In this paper the various techniques available for lossless data transmission have been analyzed. A novel scheme to transmit the data efficiently without any loss of data and time delay has been proposed. This scheme supports cooperative caching in DTNs to enhance the chance of data access. The basic idea is to cache the data at set of central nodes in 3G network, which can be easily accessed by other nodes. The number of central nodes present in the network is important for the performance of caching. Here the number of central nodes to be used for data transmission is optimized and central nodes selection is based on a probabilistic metric. We have simulated the proposed technique in TCL (Tool Command Language) and we hope that the data access delay and the data loss will be reduced to a great extent.

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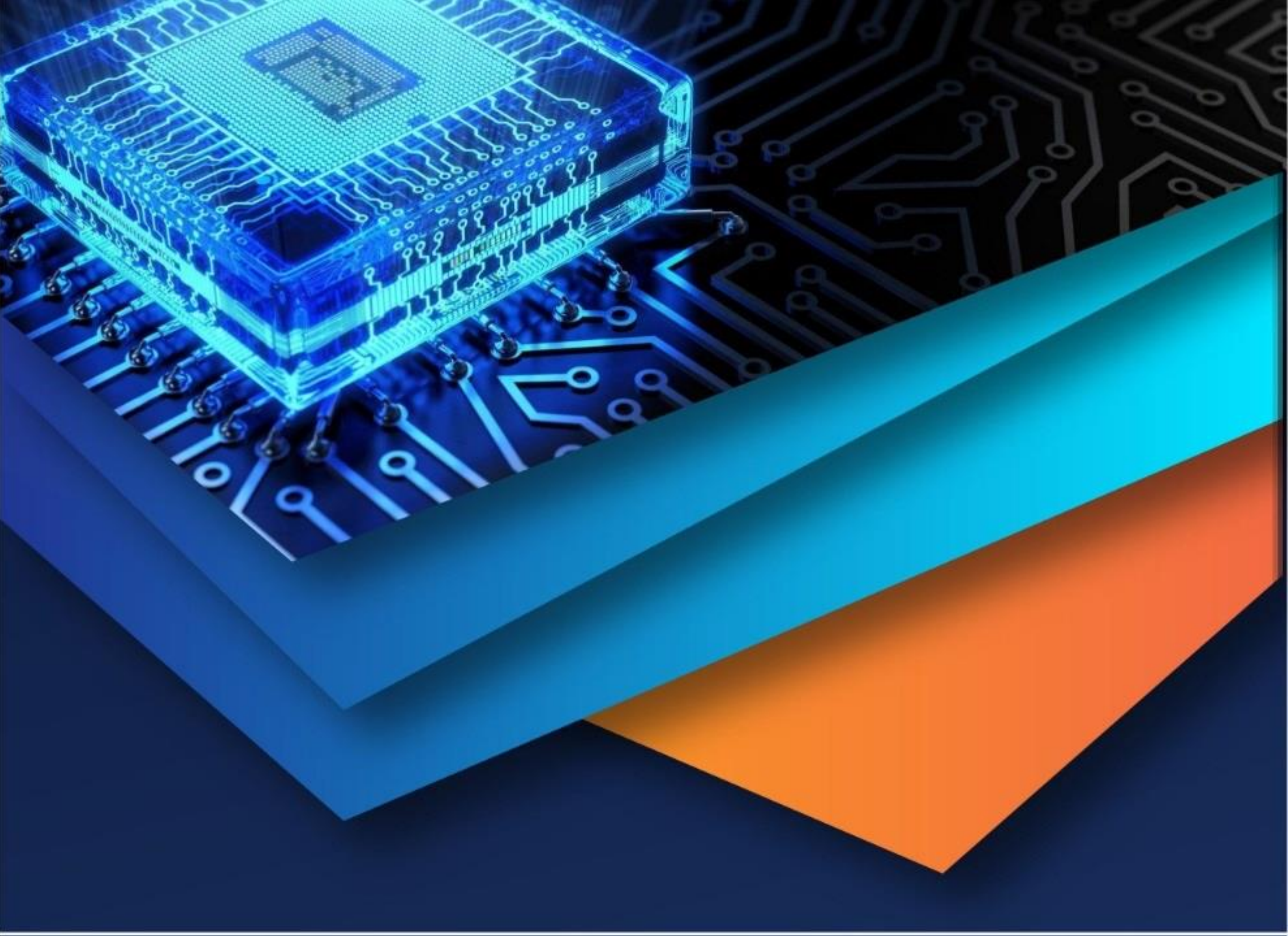

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