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Performance Evolution of M2M Networks with Improved Particle Swarm Optimization Algorithm

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Abstract: Due to heavy M2M traffic, congestion occurs in the network. To solve this problem, an efficient clustering protocol is used called an improved particle swarm optimization (IPSO) algorithm. An improved PSO algorithm is proposed to achieve the optimum solution. First the optimization problem and algorithm parameters are initialized. The fitness value is calculated and each step influences the velocity of each particle towards its pbest and gbest positions. To avoid the algorithm falling into a local optimum, improved particle swarm optimization algorithm is used which modifies the inertial weight so as to avoid particles being trapped in local optima. Finally, the proposed method will be shown in simulations by improving energy efficiency and also by minimizing the overall energy consumption and balancing energy consumption among the nodes during the network lifetime.

Keywords: M2M traffic, IPSO Algorithm.

I. INTRODUCTION

Wireless Sensor Networks (WSNs) can be defined as a self-configured and infrastructure less wireless networks to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location or sink where the data can be observed and analyzed. A sink or base station acts like an interface between users and the network.

Energy consumption is the most important factor to determine the life of a sensor network because usually sensor nodes are driven by battery. Sometimes energy optimization is more complicated in sensor networks because it involved not only reduction of energy consumption but also prolonging the life of the network as much as possible. The optimization can be done by having energy awareness in every aspect of design and operation. This ensures that energy awareness is also incorporated into groups of communicating sensor nodes and the entire network and not only in the individual nodes.

A. Sensor Node Usually Consists of Three Sub-Systems

1) *Computing subsystem:* It consists of a microprocessor (microcontroller unit, MCU) which is responsible for the control of the sensors and implementation of communication protocols. MCUs usually operate under various modes for power management purposes. As these operating modes involve consumption of power, the energy consumption levels of the various modes should be considered while looking at the battery lifetime of each node.
2) *Communication subsystem:* It consists of a short range radio which communicates with neighboring nodes and the outside world. Radios can operate under the different modes. It is important to completely shut down the radio rather than putting it in the idle mode when it is not transmitting or receiving for saving power.
3) *Power supply subsystem*: It consists of a battery which supplies power to the node. It should be seen that the amount of power drawn from a battery is checked because if high current is drawn from a battery for a long time, the battery will die faster even though it could have gone on for a longer time.

An Application-Specific Protocol Architecture for Wireless Micro sensor Networks developed Wendi B. Heinzelman *et al.* [1].These networks require robust wireless communication protocols that are energy efficient and provide low latency. Node Clustering in Wireless Sensor Networks: Recent Developments and Deployment Challenges by Ossama Younis *et al.* [2].A Survey on Distributed Topology Control Techniques for Extending the Lifetime of Battery Powered Wireless Sensor Network developed by Azrina Abd Aziz *et al.* [3]. Mahbubul Alam *et al.* [4] investigated the fundamental differences of M2M and IoT by starting out with surveying some of the drivers and moving into an analysis. The performance of the AODV (Ad-hoc On-demand Distance Vector) routing protocol was evaluated with respect to the variation in node concentration Galzarano *et al.* [5].Maria Rita Palattella *et al.* [6] implemented Standardized Protocol Stack for the Internet of (Important) Things which introduces in a timely manner and for the first time the wireless communications stack the industry believes to meet the important criteria of power-efficiency.Different types of the Rank attacks can be used to intentionally downgrade specific QoS parameters implemented by Anhtuan Le *et al.*[7]. A global-coverage M2M healthcare system was successfully implemented Sang-Joong Jung *et al.* [8] by using wearable physiological sensors based on the 6LoWPAN protocol. Ieryung Park et *al.* [9] deals with MAC protocol for hierarchical M2M networks with clustered nodes. A stable and energy efficient clustering (SEEC) protocol developed by Fifi farouk *et al.* [10] for heterogeneous WSNs depends on the network structure that was divided into clusters. Multicast for 6LoWPAN developed by Xiaonan Wang [11] presents the handover algorithm to ensure that the multicast communication can be properly performed when the group members move. Furqan Ahmed *et al.* [12] improved broadcast signals to multiple beams simultaneously can be used to reduce the amount of resources needed for cell search, or to reduce the latency in finding neighboring cells.

II. PROPOSED METHOD

Network Simulator (Version 2), widely known as NS2, is simply an event-driven simulation tool that has proved useful in studying the dynamic nature of communication networks. Simulation of wired as well as wireless network functions and protocols (e.g., routing algorithms, TCP, UDP) can be done using NS2.In general, NS2 provides users with a way of specifying such network protocols and simulating their corresponding behaviors. NS2 Version 2.34 is implemented. NAM trace records simulation detail in a text file and uses the text file to play back the simulation using animation. NAM trace is activated by the command "$ns namtrace-all $file," where "ns" is the Simulator handle and "file" is a handle associated with the file (e.g., "out.nam" in the above example) which stores the NAM trace information.A routing agent creates, transmits, and receives routing control packets, and commands routing protocols to act accordingly. Connecting an application to a low level network, a transport-layer agent controls the congestion and reliability of a data flow based on an underlying transport layer protocol (e.g., UDP or TCP). Based on the user demand provided by an application, a sending agent constructs packets and transmits them to a receiving agent through a low-level network. An agent acts as a bridge which connects an application and a low-level network. Based on the user demand provided by an application, a sending agent constructs packets and transmits them to a receiving agent through a low-level network. An agent can be used as a sending agent (e.g., a UDP agent) or a receiving agent (e.g., a Null agent). A sending agent has connections to both an application and a low-level network, while a receiving agent may not have a connection to an application (because it does not need any).An application (e.g., CBR) uses its variable "agent_" as a reference to an agent (e.g., UDP and Null agents), while an agent uses its variable "app_" as a reference to an application.

III. SOFTWARE IMPLEMENTATION

In the standard PSO algorithm, the convergence speed of particles is fast, but the adjustments of cognition component and social component make particles search around P_{gd} and P_{id} .According to velocity and position renewal formula, once the best individual in the swarm is trapped into a local optimum, the information sharing mechanism in PSO will attract other particles to approach this local optimum gradually, and in the end the whole swarm will be converged at this position**.**

But according to velocity and position once the whole swarm is trapped into a local optimum, its cognition component and social component will become zero in the end; still, because $0 < \omega < 1$ and with the number of iteration increase, the velocity of particles will become zero in the end, thus the whole swarm is hard to jump out of the local optimum and has no way to achieve the global optimum. A fatal weakness may result from this characteristic.

When a particle is searching in the solution space, it doesn't know the exact position of the optimum solution. Individual particles move in the direction of evading the worst positions an individual particle and the whole flocks have experienced, this will surely enlarge the global searching space of particles and enable them to avoid being trapped into a local optimum too early, in the same time, it will improve the possibility of finding gbest in the searching space. In the new strategy, the particle velocity and position renewal formula are as follows:

$$V'_{id} = \eta 1rand()\,(X_{id} - P_{id\omega}) + \eta 2rand()(X'_{id} - P_{gd\omega})$$

$$X'_{id} = X_{id} + V'_{id}$$

$P_{id\omega}$, $P_{gd\omega}$ represent the worst position particle id has found and the worst positions of the whole swarm has found.

In standard PSO algorithm, the next flying direction of each particle is nearly determined; it can fly to the best individual and the best individuals for the whole swarm. From the above conclusion we may easily to know it will be the danger for being trapped into a local optimum. In order to decrease the possibility of being trapped into the local optimum, the new PSO introduces genetic selection strategy. To set particle number in the swarm as m, father population and son population add up to 2m. To select randomly q pairs from m, as to each individual particle i, if the fitness value of i is smaller than its opponents finally select those particles which have the maximum mark value into the next generation. The experiments conducted show that this strategy greatly reduces the possibility of being trapped into a local optimum when solving certain functions.

A. Flowchart of IPSO Algorithm

The algorithm keeps track of three global variables:

1) Target value or condition
2) Global best (gBest) value indicating which particle's data is currently closest to the Target.
3) Stopping value indicating when the algorithm should stop if the Target isn't found.

If the data is a pattern or sequence, then individual pieces of the data would be manipulated until the pattern matches the target pattern. The velocity value is calculated according to how far an individual's data is from the target. The further it is, the larger the velocity value. If the data is a pattern or sequence, the velocity would describe how different the pattern is from the target, and thus, how much it needs to be changed to match the target. Each particle's pBest value only indicates the closest the data has ever come to the target since the algorithm started. The gBest value only changes when any particle's pBest value comes closer to the target than gBest. Through each iteration of the algorithm, gBest gradually moves closer and closer to the target until one of the particles reaches the target. The flowchart of the IPSO algorithm is shown in Fig. 1

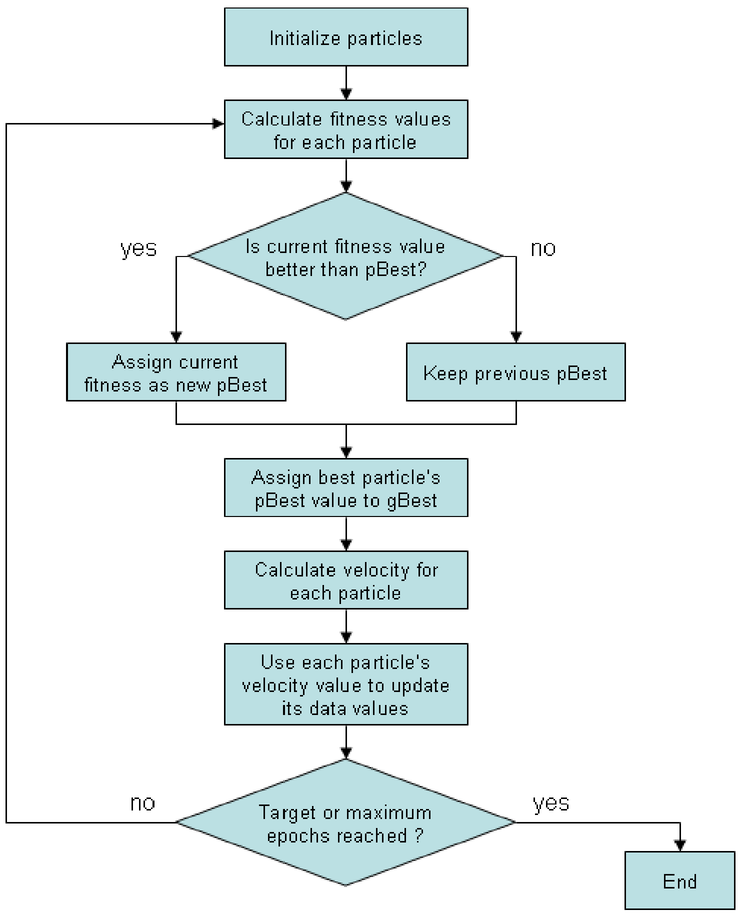

Fig. 1. Flowchart of the IPSO Algorithm

Step 1: to initialize randomly the velocity and position of particles;
Step 2: to evaluate the fitness value of each particle
Step 3: as to each particle, if its fitness value is smaller than the best fitness value P_{idb} , renew the best position P_{idb} of particle i_d , or else if its fitness value is bigger than the worst fitness value $P_{id\omega}$, renew $P_{id\omega}$.
Step 4: as to each particle, if its fitness value is smaller than the best whole swarm fitness value P_{gdb} , renew the best fitness value P_{gdb} of particle i_d ; or else if bigger than the worst whole swarm fitness value $P_{gd\omega}$, renew $P_{gd\omega}$.

Step 5: as to each particle,
1) To produce new particle t by applying formula (1) (2),
2) To produce new particle 't by applying formula (3) (4),
3) To make a comparison between t and't .select the better one into the next generation.
Step 6: to produce next generation particles according to the above genetic selection strategy;
Step 7: if all the above steps satisfy suspension needs, suspend it; or turn to Step 3.

B. Simulation Parameters

Table. 1 Simulation Parameters

Parameters	Value
Simulation area	150x300
Number of nodes	100
Channel type	Wireless channel
Energy of node	2J
Packet size	512 bytes
Initial energy of sensor node	0.5J

The proposed algorithm is simulated for the project is done by using network simulator version 2.34. For our simulation, 100 nodes are created in the wireless sensor network. Multi-level sink nodes are present in this scenario. Idle nodes are represented in black color. After creating nodes, the sink node broadcast the hello packet to sensor node. Then, the nodes start to calculate the energy of it nodes. Energy for each node will be calculated. Energy calculation is shown in Fig. 3. The nodes will start to select the primary cluster head among the nodes. Cluster members are formed from the cluster head groups. From each sink node ,the transmission and reception of packets are processed from cluster head to sink node ,cluster head to cluster head and vice versa. It is shown in Fig. 2.

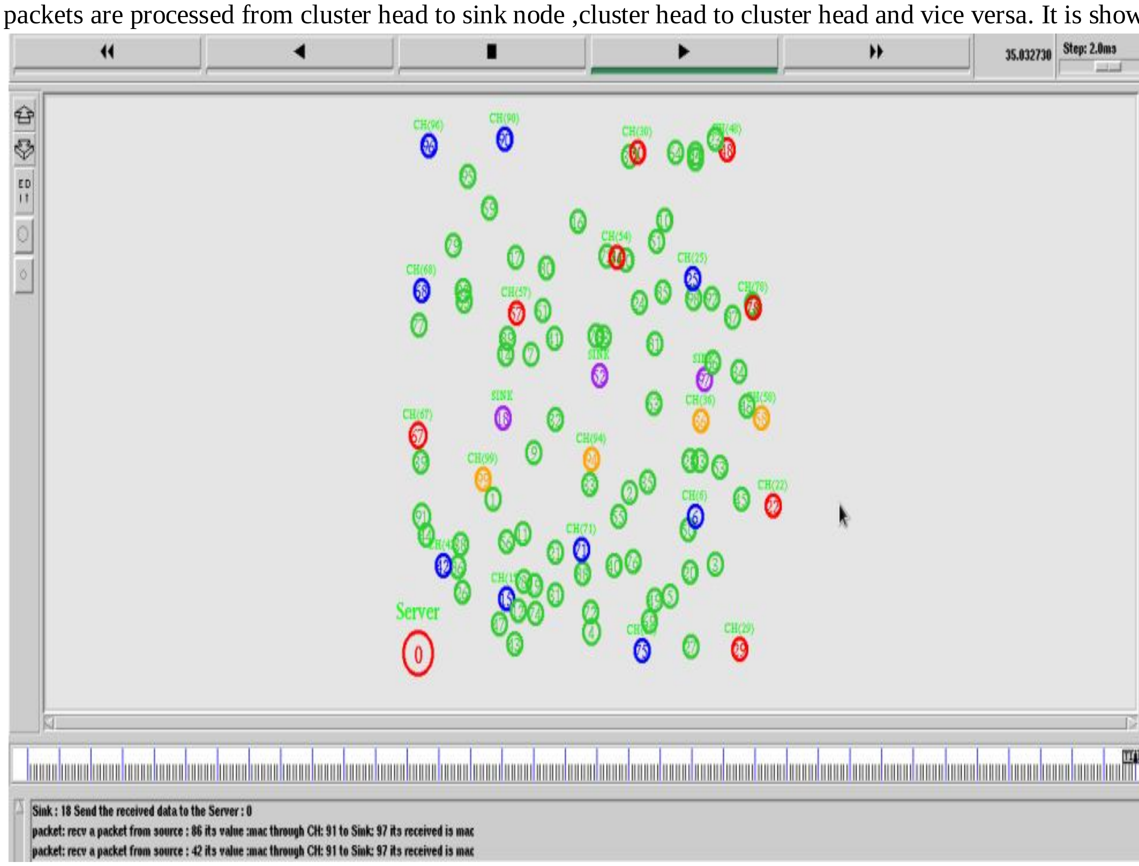

Fig. 2. Transmission and Reception of Packets

C. Graphical Representation

It is necessary to check the network life time, energy consumption, packet delivery ratio and end to end delay. A comparison is made with the existing system. The energy consumption may be defined as designing and analyzing a mathematical representation of a WSN to study the effect of changing the system parameters. MAC layer energy models are models that take into account the parameters of energy consumption at physical layer and parameters of energy consumption at MAC layer. Fig. 3 shows the graph for energy consumption.

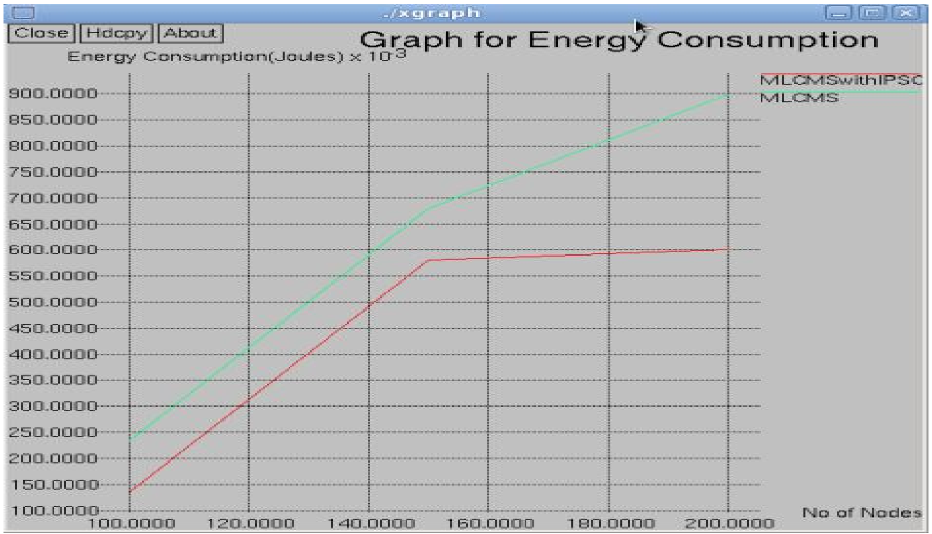

Fig. 3. Energy Consumption

Network lifetime is the amount of time that a Wireless Sensor Network would be fully operative. One of the most used definitions of network lifetime is the time at which the first network node runs out of energy to send a packet, because to lose a node could mean that the network could lose some functionalities. It is possible to use a different definition, in which some nodes could die or run out of battery power, whenever other network nodes could be used to capture desired information or to route information messages to their destination. The Fig. 4 shows the graph for network lifetime.

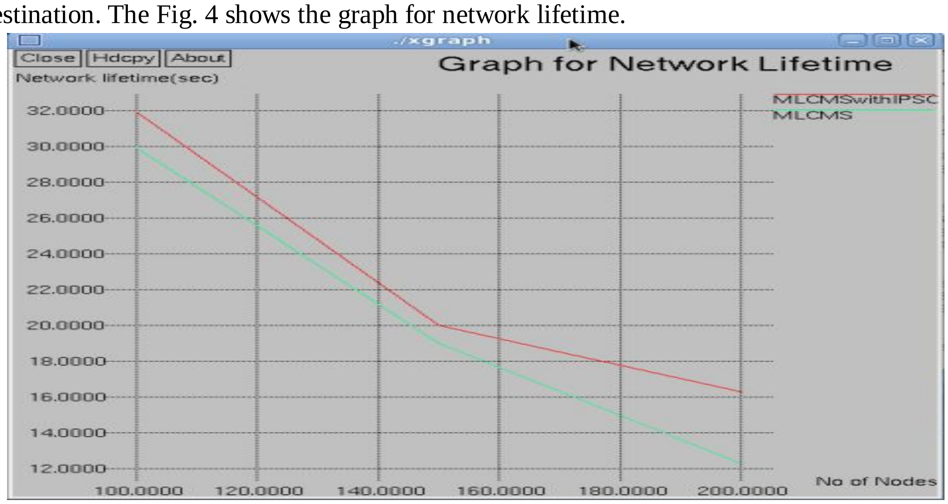

Fig. 4. Network Lifetime

The ratio of packets that are successfully delivered to a destination compared to the number of packets that have been sent out by the sender or the Proportion of number of packets delivered against the number of packets sent called packet delivery ratio. The Fig. 5 shows the graph for packet delivery ratio. End-to-end delay or one-way delay (OWD) refers to the time taken for a packet to be transmitted across a network from source to destination. It is a common term in IP network monitoring, and differs from round-trip time (RTT) in that only path in the one direction from source to destination is measured.The Fig. 6 shows the graph for end to end delay.

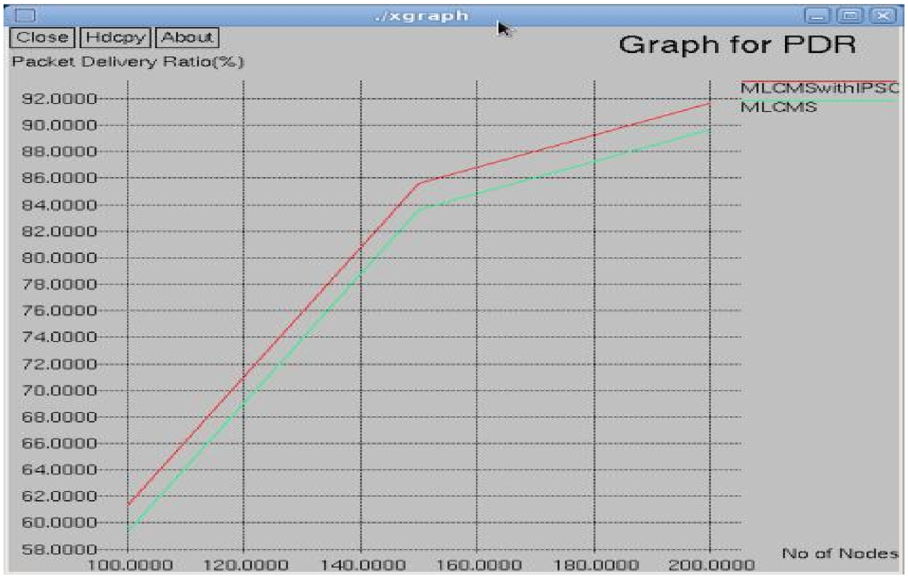

Fig. 5. Packet Delivery Ratio

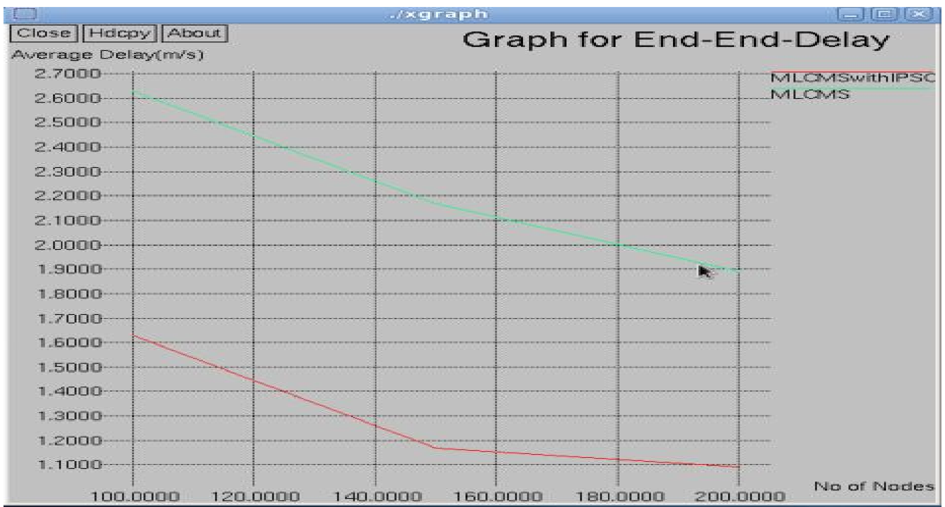

Fig. 6. End to End Delay

IV. CONCLUSION AND FUTURE IMPROVEMENT

Generally, every cluster head has a corresponding relay node. By using IPSO algorithm, the cluster heads do not need to consume additional energy to choose their next-hop node. Channel contention which arises when choosing relay nodes by the cluster heads can be avoided. In addition, the selection of the relay nodes is based on not only the residual energy, but also the distance to the corresponding cluster head and the BS. Then, two fitness functions are generated which determine whether a node is selected as a cluster head or a relay node, in consideration of both their location and residual energy. The simulation result shows that the proposed method improves the energy efficiency by minimizing the overall energy consumption and also energy consumption is balanced among the nodes during the network lifetime.The Future scope of this project is to securely transfer the packet against various types of attacks by using Elliptic Curve Cryptography (ECC).

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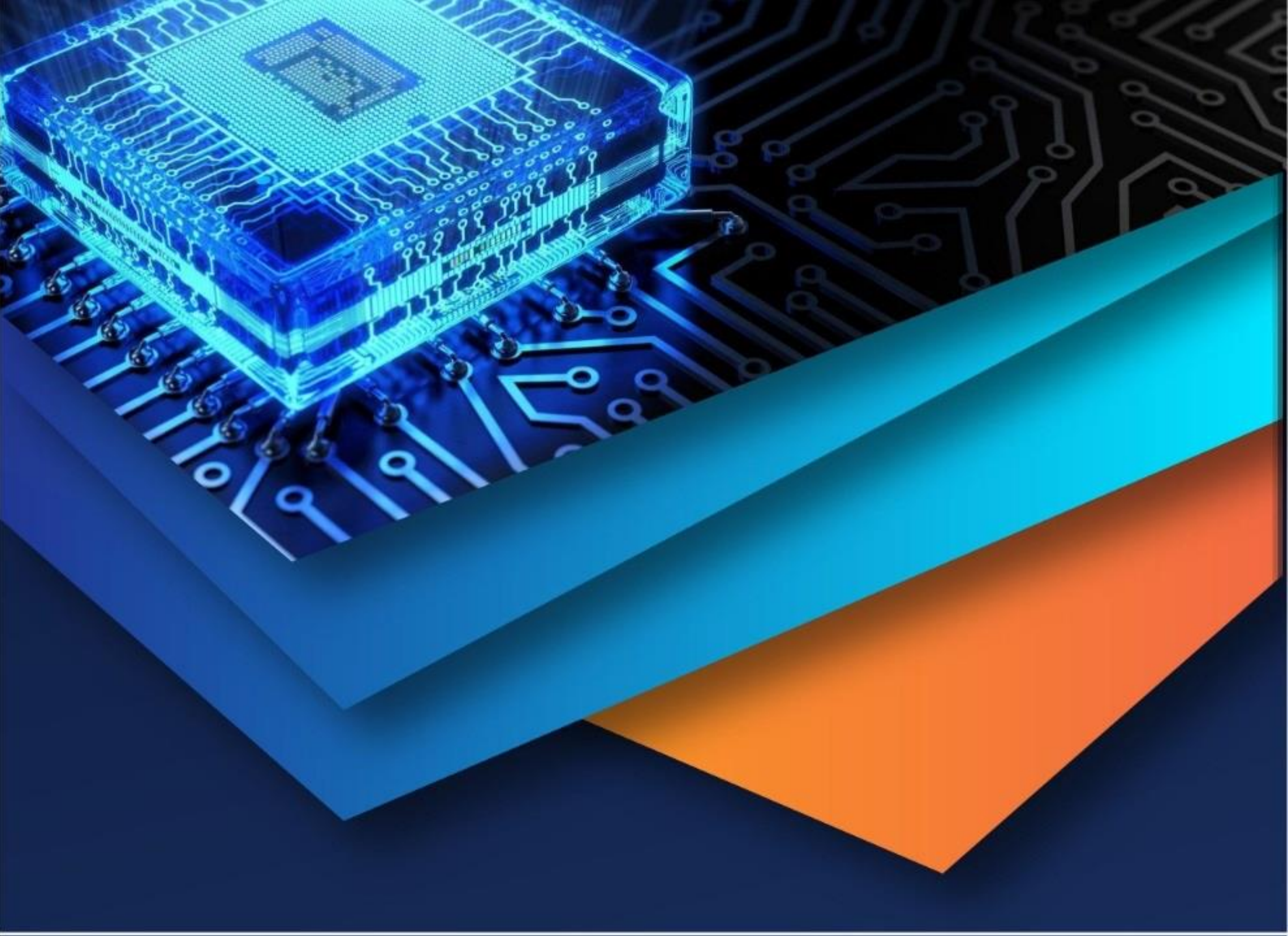

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