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Smart Village: An IOE based approach

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Abstract: ***Kevin Ashton put forward the concept of giving observational power to computers which can enhance information collection mechanism. Recent advances in sensory technology and Cisco's famous forecast of huge interconnected network [1] in near future encourage us to plan a better habitat harnessing the potential of these developments. This paper analyses the basic structure of IoE and also distinguishes it with IoT and tries to standardize an ecosystem for its implementation. It further investigates the possible areas of village where it can be served and finally proposes a Smart Village Model (SVM) which can be used as reference for further modelling based on this concept.***
Keywords: IoE, IoT, Internet, Smart Village.

I. INTRODUCTION

We are living in an incessantly expanding universe and continuously evolving world and specifically in the era of electronic miniaturization. We at present witness many amazing technologies. We can now communicate with each other from anywhere in world but what if can communicate with our surroundings in a manner in which we share information with each other. What if we can give intelligence to most mundane things around us and modify them as smart things. We will definitely be living in one of the most interesting times of our civilisation. This concept is possible and the basis of this was laid in 1999 by Kevin Ashton who coined the phrase "Internet of Things" in one his presentation for linking RFID technology in the existing system. According to him the existing computer network or the internet is dependent on humans for information. He proposed that the computers can be given observational power through sensor technology which is a much accurate source for information [2]. The system having these capabilities can be honoured as a smart system. And years after the Cisco's prediction of 500 billion internet connected devices and objects by 2030 attracted many researchers to harness the potential of this technology toward a smart future. Cisco also put forward the concept IoE which promises these technological innovations integrating more layers to the IoT system.

In this paper we will try to use technological innovations of IoE for the betterment of villages. For implementation of this technology we first need to understand the basic architecture of this technology and the conceptual difference between IoE and IoT which are often confused as same. We will then try to analyse the possible sectors of village where we can serve IoE for not just to implement but to enhance the efficiency of existing mechanism. Moving forward we will then propose IoE solutions in respective sectors. At the end we will conclude our discussion and propose an IoE model for smart village.

The rest of the paper is arranged in the following manner. Section II comprises of explanation of IoE and distinguishes it with IoT. Section III discusses the IoE ecosystem and Section IV investigates the areas where IoE solutions can be deployed. Section V suggests IoE solution in possible areas and finally section VI proposes a Smart Village Model (SVM). Conclusion is made in section VII.

II. IOE: SMART IOT

IoT and IoE have become the synonym for future technology of enhanced user experience with interconnected things or at least they will serve as fundamentals for technologies to evolve in this genre. These promising traits have made them so popular that these are often confused with each other and are often considered as same. However according to [3] there is a conceptual difference between these two terms.

According to Cisco IoE is a combination of people, process, data, and things. Doing this will make the information more interactive and this according to Cisco will create new capabilities, richer experiences, and unprecedented economic opportunity for businesses, individuals, and countries. [4]

IoT is explained as "Sensors and actuators embedded in physical objects are linked through wired and wireless networks, often using the same Internet Protocol (IP) that connects the Internet."[5]

Considering both the definitions it can concluded that IoE adds process and people to the things with every possible connection imaginable. Moreover, this also is superior in sense of connection and coverage. It is also often referred to as the superset of IoT [6]. For nutshell understanding, IoE involves connection over every possible medium to every possible user with a processing mechanism in addition to IoT (i.e., just connecting things with each other for sharing information). This conclusion justifies the title of this section that *"IoE is just a Smart IoT."*

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III. ELEMENTS OF AN IOE ECOSYSTEM

Based on understanding of IoE in section II the basic ecosystem of IoE for smart village can be proposed by just using three basic elements which are: Smart Things, Smart Processing and Smart People and it is represented in figure 1.

Fig.1: Ecosystem of IoE based smart village

In this proposal smart things will constitute the sensors which are used to collect data from subject. The data generated by these sensors are sent to Internet for processing. The processing of data can be understood as the generation of useful information from data sent by sensors. This useful information is generated by interpreting the possible factors through which raw data may get affected. This interpretation system can be made more resourceful by combining two or more raw data (if possible) i.e., we can use multiple sensors for a particular subject for more detailed insight information. Since this whole process is proposed on Internet the efficiency can be further increased by adding a feedback mechanism using previous observations of that particular information. By feedback mechanism it is meant that the processed information is now coupled with the previous experiences and hence a better information and control system can be offered. This data flow is illustrated in fig.2. Smart people are the end node of this ecosystem and can access the data directly through internet platforms or can receive as notification in their smartphones or computers. Smart people are not different from the normal folk but they are compatible with IoE ecosystem i.e., they are aware of how they can use the information delivered to enhance the effectiveness of the subject which is processed and get benefitted with that. And they really are the important element of this ecosystem in terms of establishing a virtual to real communication and also in terms of the decision-making entity. Moreover, people can also trigger the required things through internet but since this communication is majorly low range

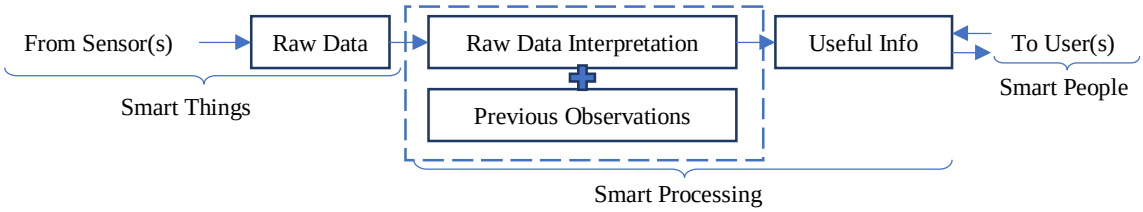

Fig.2: Data Flow in IoE Ecosystem

so we should prefer to use low range communicating device for this purpose. In this regard we can also explore the possibility of triggering the devices on certain conditions with acknowledging user using internet but this may fall under IoT and also if communication between devices without human acknowledgment, which will be considered as Machine to Machine (M2M) communication system. And since IoE is the superset of these type of systems we can design an IoE system having both IoT and M2M.

IV. AREAS OF IOE SERVICE

Farmers, shepherd, crops, cattle, etc., are the elements of instantaneous frame when we think of village. This is because these are their basic livelihood sources. So, for a smart village these dominant occupational choices should be of prime focus. In addition to regular shops weekly markets are also observed in villages. We can have IoE solutions for these also which can increase the adaptability of our model.

Education and health-care services are necessary for a better and progressive community. These value based services are usually offered by government but there may be private firms also. Talking of government, it facilitates community development with many of its other services also like supporting farmers by buying their yields, simplified banking solutions, providing natural resources, etc.

Resources like water and electricity are also an important aspect. Water apart from being essential for life is necessary for irrigation also and electricity is necessary for driving modern irrigation equipment. These two resources have become a necessity in contemporary IoE ready world and hence their management is also significant.

So, for ease of implementation understanding and on the basis of above discussion the areas where IoE can be served are categorised as: (i) Unit (ii) Union and (iii) Universal. Flow chart for this classification is depicted as figure 3. In Unit, we can list the services specific to occupational choices. And in this regard agriculture dominates all other business choices in our villages. Union will cover the necessary aspects of better life i.e., education, healthcare and similar government services. Basic resources like water, electricity will fall under third sector i.e., universal sector.

V. IOE SOLUTIONS

Having discussed the elements of IoE and are as where it can be served in villages, we can now discuss the methods through which IoE will make our villages smart. The methods will be based on basic concept of making physical things smart i.e., linking physical things through embedded sensors and actuators and connect them with internet.

A. The Unit

1) Smart Agriculture: The first sector of our service division is of occupational choices of which agriculture is the main element. The possible solution for this can cover:

a) Soil Profiling: The primary object of agriculture is soil. So, soil profiling can help a lot in efficient farming. Various aspects of soil profile viz., pH and moisture level can be calculated using electrochemical sensors which basically works by detecting specific ions in the soil. For delivering the useful information from these sensors the raw data is sent to the internet for data processing. [7]

b) Smart Irrigation Techniques: The soil irrigation can be made smart by controlling the irrigation with only the required amount of water which is determined on the basis of soil profile, atmosphere and crop. The required moisture level of soil is different for different crops. Smart water management can be done by using the data of standard requirement of water based on the crop and available area.

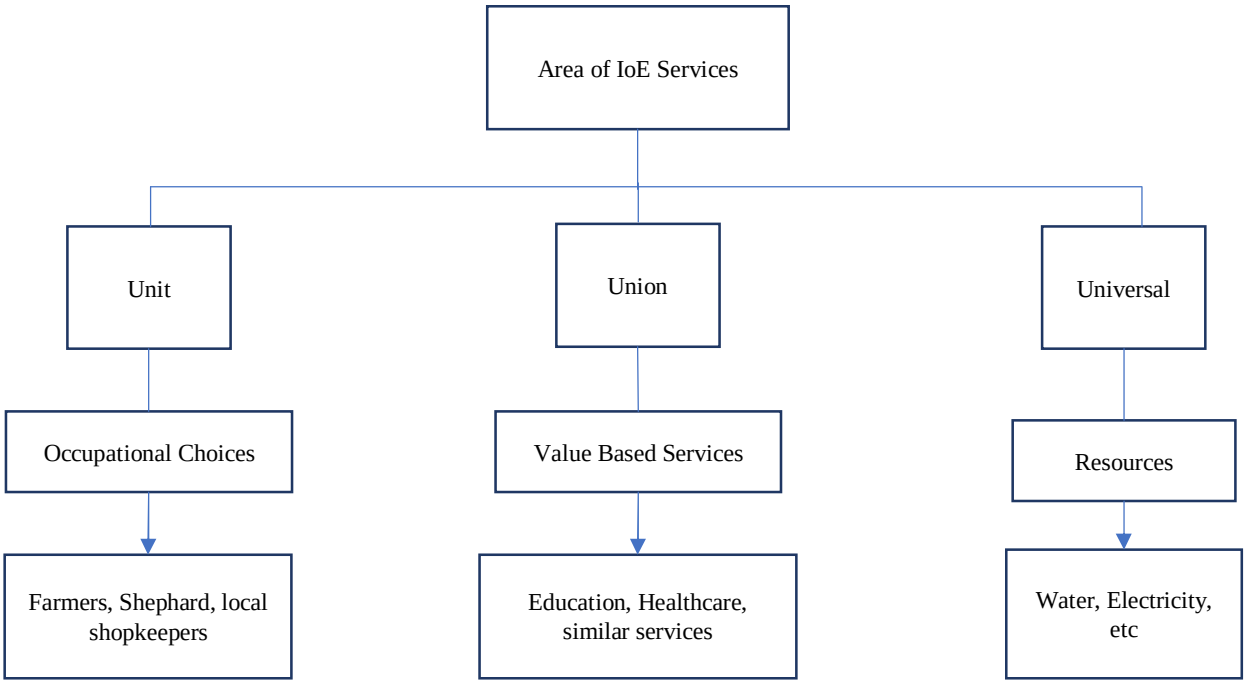

Fig.3: Flow Chart of IoE Service areas

B. Smart Weather Reports

Weather is also a significant factor for agriculture. So, facilitating with exact weather readings will be beneficial. Moreover, there are times when unfavourable weather conditions destroy the crop. The efficient remedy for this is that we can use the expected weather readings i.e., the weather forecast reading and can process them with the current weather conditions of our subject field. This can help in alarming farmers to take necessary actions for protecting crops.

1) *Smart Cattle Management:* Livestock monitoring enables us to gather data regarding the health, well-being and location of cattle. Hence, we can easily identify sick animals, keep track of their location. Moreover, in case of virus hazard the flu-alerts of particular area can be directly notified to the farmers which can help a lot to prevent spreading of diseases. [8]
2) *Smart Local Shopkeepers:* We also have local shopkeepers in first sector. The main thing at a shop is transaction which we can make smart by doing them in digital mode. In addition to this we can facilitate the shopkeeper with the data of purchase percentage of items. This can help in maintaining stocks of items in demand. We can also update him with product quality reports which will help in choice of brand.

C. The Union

Union is the next sector which basically deals with the value based services. As discussed these are primarily managed by government but since education and healthcare are two important aspects we will discuss solution regarding to these separately. The rest of the services will be covered in smart governance section.

1) *Smart Education:* Smart education system should obviously focus on quality education which can delivered by good literature. And since we are talking about smartness we can facilitate our students with lots of great relevant literature digitally. Teachers can map their student's progress and can plan teaching methods accordingly. This mapping may involve presence, response, problem solving ability and psychological trends. There are many suggestions regarding quality teaching and it would be really valuable if we can deliver all those to our teachers in villages and can strengthen our primary education system.
2) *Smart Healthcare :*Healthcare services are aimed for value medication and treatment. This is done by monitoring various factors of body specific to every disease. The proposed IoT solution in this regard is wireless monitoring of patients. We are much familiar about the wearable electronics in this regard which intend to keep track of various activities. But in recent studies patient monitoring has gone to a new level. Healthcare sector now has ingestible sensors and they are known as ingestibles. Proteus Digital Health is offering the same ingestible pill. It works with a sensor patch and a smartphone. Each pill contains a one-square-millimetre sensor that is coated in two digestible metals: copper and magnesium. Due to presence in our diet and multivitamins these are not harmful for digestion. Electrolytes within the body is used to activate the sensor. Hence upon swallowing, pill gets activated and then transmits a signal to a small, battery-powered patch worn on the user's torso and sends the data via Bluetooth to the desired smartphone. [9] [10]. However apart from these advanced sensors we also great medical products like My Signals which comes with 15 sensors all of which can be connected for analysis through the touch screen module. These can help a lot for resolving limited bed issues in hospitals as through this the patient can also be monitored from home [11]. Apart from these if one wants to keep check his health issues at a personal level, a personalized cost-effective kit can also be offered.
3) *Smart Governance:* Smart governance can be provided by transparent, immediate and effective services. Some of the suggestions for this are as follows:
4) *Smart Cold Storage :*A very common issue which our farmers face is the storage for their yields and selling it. For the remedy of selling issue government declares a minimum support price at which it buys their yields. Here we can design a smart cold storage system where they can store their yields and what this system does is it maps the yields submitted for quantitative evaluation against the profile of farmer and the farmer is immediately paid digitally. The government can use storage data for efficiently supplying this yield to market.
5) *Smart Cards:* As in India we have our unique IDs which can be an Aadhar Card or a voter card or any other valid card. Two things can be done for smart usage of cards. We can either upgrade them to digital cards which carries the credential in digital form and can be easily swiped with the compatible devices or, we can install a scanning system which scans the credentials of existing cards and matches it with the information in relevant database.

D. The Universal

The last sector of our classification is of universal things which has natural resources in it. We can have IoE solution for them as their efficient management.

1) *Smart Electricity Management:* Electricity can be efficiently managed by minimizing its useless consumption. In this, lights especially street lights can be managed according to the atmospheric brightness by using light dependent resistors. Piezo sensor can also be used to detect the presence and then switching lights accordingly.

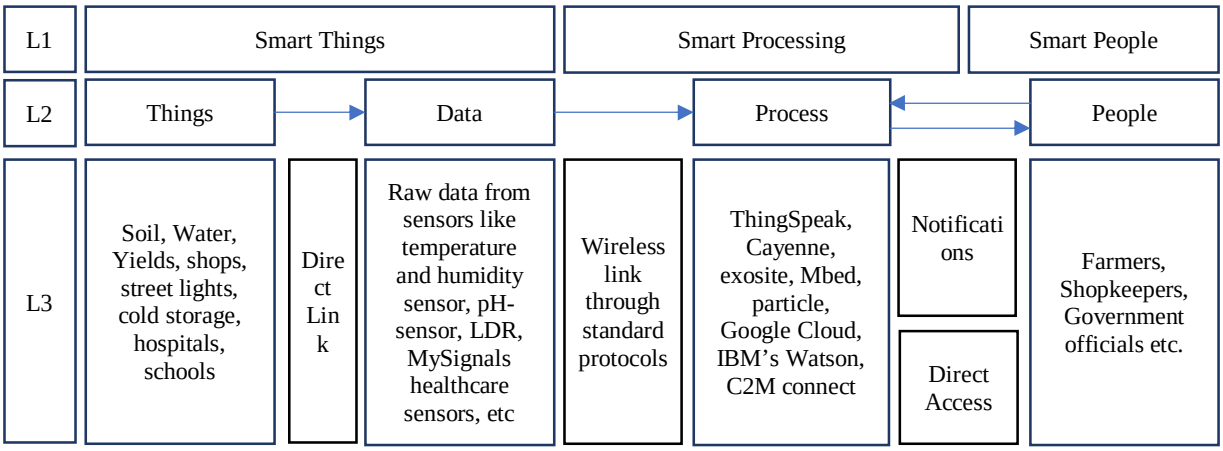

Fig.4: Smart Village Model (SVM) based on IoE approach

E. Smart Water Management

Water is a natural resource. Somewhere it is abundant and somewhere it is rare and there are traditional methods to deal with it. What we can improve in is that we can distribute it in storages according to its use and can notify others about the exact amount left. Specific family and firm resource usage data can be gathered in order to minimalize wastage.

In addition to these IoE techniques can also help us to maintain hygiene in villages. Air quality readings in this regard can be of useful for qualitative analysis of air.

In all the above solutions we have seen the usage of sensors to collect raw data. And according to IoE ecosystem discussed in section III the next step is to send this raw data to internet for processing. Luckily, we have many online platforms to connect our devices. These in addition to data processing provides secure sever encryption. This strengthens our model with data security features. The famous platforms are Things Speak [12] by Math Works which facilitates data processing through Matlab tools and Cayenne [13] by myDevices claims to be first drag and drop platform for connected devices. Similarly, we can use Mbed [14], exosite [15],particle [16], Google Cloud IoT [17], C2M connect tool of plasma [18] and many more.

As the end node smart people can access this useful information through their smartphones, personal computers or any other specifically designed relevant device.

VI. SMART VILLAGE MODEL (SVM) BASED ON IOE APPROACH

A. Smart Village Model (SVM)

Having discuss all the required aspect regarding an IoE ecosystem and its solutions making a village smart and considering model proposed in [19] we now propose a general model based on IoE which is illustrated in fig 4.

The model is distributed in three layers indicated Lx, where L stands for layer and x indicates layer number (for example L1 will mean layer 1). Layer 3 is the main layer which illustrates the solution proposed in section V. Layer 2 is depicts the distribution of solutions according to Cisco's definition mentioned in section II. Layer 3 distinguishes the solutions based on elements of an IoE ecosystem classified in section III. Unlike model proposed in [19] here layer only explains the process in different terms. The model proceeds from left to right as indicated in layer 2 by arrows. Forward and backward arrows between process and people are because of the fact that user either can directly access the online platforms (shown by reverse arrow) or can receive notifications from online platforms. This fact is also highlighted by distributing equal areas of section between process and people for smart processing block and smart people block of layer 1.

B. Technical Aspects of SVM

1) Power Source

Model uses electronic equipment like sensors, communicating devices and smartphones which need constant power source, however small, for proper operation.

2) Choice of sensors

Sensor choice is also very important. Flooding the system with hundreds of sensors will just increase data traffic. So, a single sensor with many capabilities should be preferred. More wisely we can look for a property of system which reflects many details about the subject and then choose the sensor accordingly.

3) Communicating devices

These are necessary for moving data to processing part which is available on internet/cloud services. Selection of communicating device should be based on the appropriate communication protocols required, power consumption and range.

4) Compatibility with folks

We have already discussed this point as smart people. But since it is necessary that the village folk should understand this technology for proper usage. This can be done either by training and encouraging them by spreading awareness about the benefits of this concept for this or by making the user interface as much easier as possible.

VII. CONCLUSION

Internet is the largest data storage, information source and an efficient connecting medium. In our proposal of smart village, we have used all these aspects of internet to provide an efficient interactive model by connecting smart things i.e., physical things integrated with sensors and smart people together backed with a resourceful data processing mechanism. Smart solutions for various sectors are also suggested which should be implemented in accordance with technical challenges discussed in section VI. Based on discussions in this paper, finally a Smart Village Model (SVM) in section VI is proposed which can be taken as reference model for smart village planning.

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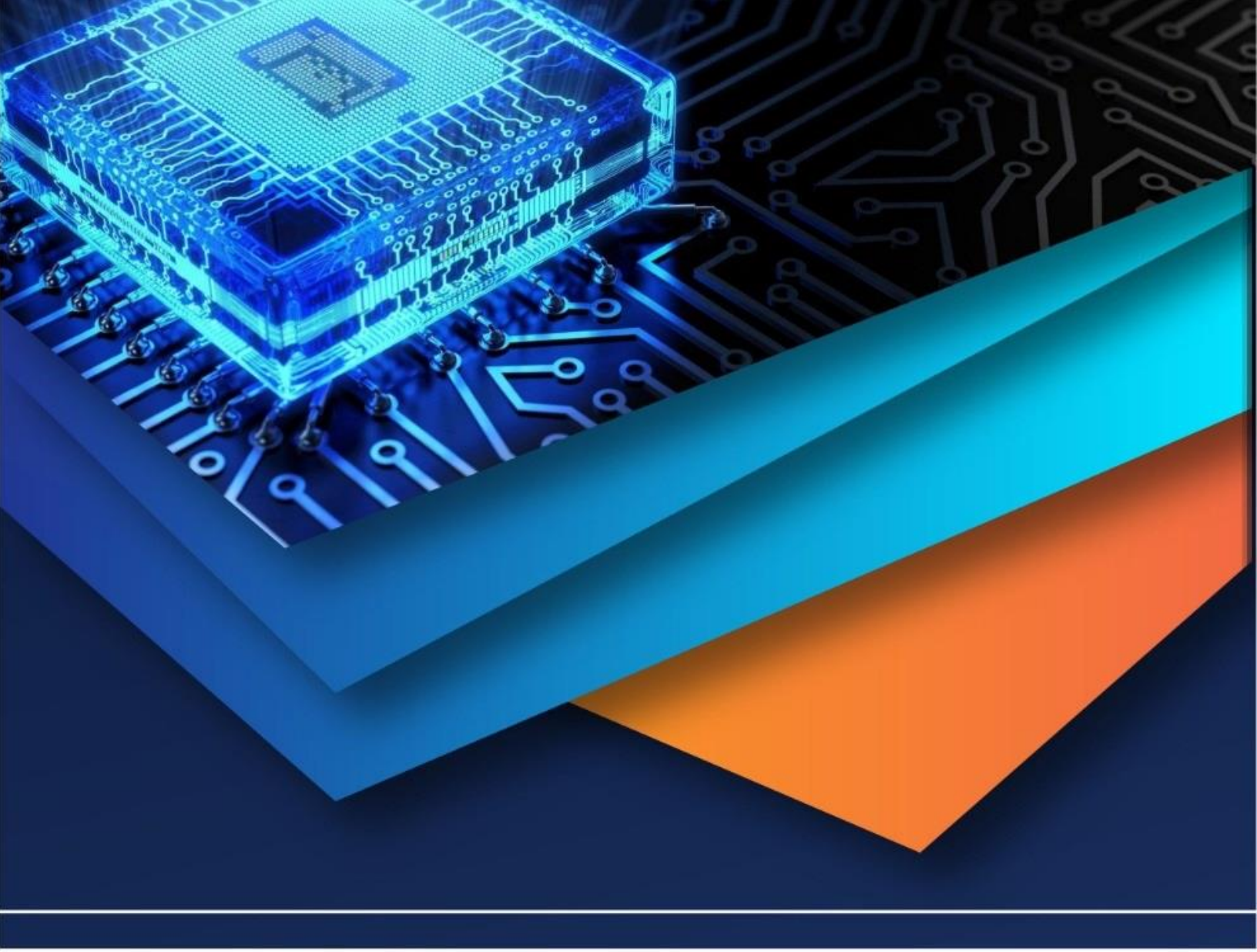

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