iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** III **Month of publication:** March 2018

DOI: http://doi.org/10.22214/ijraset.2018.3472

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

A survey on Integration of Smart-grid with Home-automation System in Rural areas of Bangladesh

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Abstract: Smart grid is a concept by which the existing electrical grid infrastructure is being upgraded with integration of multiple technologies as like that two-way power flow, two-way communication, automated sensors, advanced automated controls and forecasting system. Smart grid enables interaction between the consumer and utility which allow the optimal usage of energy based on environmental, price preferences and system technical issues. This enables the grid to be more reliable, efficient and secure, while reducing greenhouse gases. This paper presents a survey of the recent literature on integrating renewable energy sources into smart grid system. Various management objectives, such as improving energy efficiency, maximizing utilization, reducing cost, and controlling emission have been explored normally. Not only that, Smart Home Automation System in Rural Area is a modern thinking for a country. This is a concept of developing. We call our country as "Digital Bangladesh." For digitalized our full country, Government should concern to rural area of our country. Day by day Smart Home Automation System is integrating in the rural area of our country.

Keywords: Smart grids, Renewable energy sources, Pricing, Optimization, Real-time systems,Load modeling, Bangladesh, Smart buildings, Zero energy buildings, Smart communities, Network, Government, Automated, Bangladesh, Rural Area, Digital, Electricity, Power, Investment.

I. INTRODUCTION

Smart grid is dynamically an interactive real-time infrastructure concept that encompasses the many visions of the stakeholders of diverse energy systems. [1]. Smart grids are electrical power grids that are more efficient and more resilient and therefore, "smarter" than the existing conventional power grids. The smartness is focused not only on the elimination of black-outs, but also on making the grid greener, more efficient, adaptable to customers' needs, and therefore, less costly [1]. Smart grids incorporate the innovative IT technology that allows for two-way communication between the utility and its customers/users. As a result the sensing along the transmission lines and the sensing from the customer's side is what makes the grid "smart". Smart Grids open the door to new applications with far-reaching inter-disciplinary impacts: providing the capacity to safely integrate more renewable energy sources (RES), smart buildings and distributed generators into the network; delivering power more efficiently and reliably through demand response and comprehensive control and monitoring capabilities; using automatic grid reconfiguration to prevent or restore outages (self-healing capabilities); enabling consumers to have greater control over their electricity consumption and to actively participate in the electricity market. Smart Grids can create a revolution in the building sector. The accumulated experience of the last decades has shown that the hierarchical, centrally controlled grid of the 20th Century is ill-suited to the needs of the 21st Century. The smart grid can be considered as a modern electric power grid infrastructure for enhanced efficiency and reliability through automated control, high-power converters, modern communications infrastructure, sensing and metering technologies, and modern energy management techniques based on the optimization of demand, energy and network availability. The role of buildings in this framework is very crucial. This paper addresses critical issues on smart grid technologies and the integration of buildings in this new power grid framework [2]. The main objective of this paper is to provide a contemporary look at the current state of the art in the potential of buildings and communities to be integrated in smart grids as well as to discuss the still-open research issues in this field. Since the vast majority of smart grids' potential customers are buildings (residential, commercial, retail and industrial) and communities, the paper addresses the challenges posed by smart grids on building and community level. However being a country of republican, we don't always follow the given quotation. So only for doing something helpful that could ease the trouble of our countries people, the idea of building an application have crossed on our mind. Such as integration of smart home automation system in rural area of Bangladesh. The world of home automation is changing and converging. As the internet of things is increasingly being used for smart home use cases and there has been quite some – increasing – hype around all sorts of smart home labeled products and future home scenarios, the concept of the real smart and connected home is more popular than ever. Yet, as always beyond hype there is also a reality. We know that Bangladesh is a digitalized country and the touch of digitalized are integrating in the city area of our

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country. But day by day it is also integrating in the rural area. Home automation enables to configure and automate how various devices inside and outside/nearby the home work together in an automated way in the context of a connected home. You can compare it with building automation in larger, often commercial, buildings. And, in a sense, a smart home automation system can be compared with an Internet Of Things-enabled building management system *(BMS)* for smaller buildings, although in most homes you won't find those high-end BMS systems but more limited home automation systems whereby the functions and look and feel are different, depending on what functions are needed. [6] Yet, in the world of building and home automation, which really brings together several specializations, not all is black or white – it rarely is in general. So, you might certainly encounter mini-systems for home automation that are pretty sophisticated and look more like an integrated small building management system.

II. EASE OF USE

A. *Smart And Zero Energy Buildings*

The energy consumption for buildings accounts for 40% of the energy used worldwide. It has become a widely-accepted fact that measures and changes in the building modus operandi can yield substantial energy savings minimizing the buildings' carbon footprint. Moreover, buildings in the near future should be able to produce the amount of energy they consume, i.e., become zero or nearly zero energy buildings (ZEBs). This is a mandatory requirement based on the fact that by 31 December 2020, all new buildings shall be nearly zero-energy consumption buildings. New buildings occupied and owned by public authorities shall comply with the same criteria by 31 December 2018 [3].

ZEBs are buildings that work in synergy with the grid, avoiding putting additional stress on the power infrastructure Achieving a ZEB includes apart from minimizing the required energy through efficient measures and covering the minimized energy needs by adopting renewable sources, a series of optimised and well balanced operations between consumption and production coupled with successful grid integration. Information and Computer enabled Technologies (ICT) and smart grids implementation are the keys to achieve the aforementioned zero energy goals. ICT for energy management in buildings has evolved considerably the last decades leading to a better understanding and penetration of the term "smart buildings". Advances in the design, operation optimization and control of energy-influencing building elements (e.g., HVAC, solar, fuel cells, CHP, shading, natural ventilation, etc.) unleashed the potential for realization of significant energy savings and efficiencies in the operation of both new and existing dwellings worldwide. Smart buildings ready to be interconnected with smart grids should comply with the following requirements:

1) Incorporation of smart metering
2) Demand response capabilities
3) Distributed architecture.
4) Interoperability.

B. *Smart Metering*

Smart metering is a prerequisite and starting point for effective implementation of smart grids and zero energy buildings' perspective. In Finland, the usage of smart metering encouraged consumers to increase energy efficiency by 7%. In order for electricity providers to deliver intelligent services for customers, bidirectional metering interfaces should be used to obtain customers' energy demand information. Moreover through the advances of smart metering, sensors based approaches can be exploited to provide energy load forecasting. Data collected from smart meters, building management systems and weather stations can be used by advanced artificial intelligent techniques and machine learning algorithms to infer the complex relationships between the energy consumption and various variables such as temperature, solar radiation, time of day and occupancy. Due to the fast development and application of low cost options for energy metering in recent years, energy load prediction is becoming increasingly relevant and cost effective. [4]

C. *The Potential of The Internet of Things in Bangladesh*

The Internet of Things is essentially a network connecting things all over the world. The Internet of Things being any electronic devices, not just computers and mobile phones. It would connect electronics with embedded computers in them, be it an air conditioner, or a light bulb or a refrigerator, or even a door lock, to each other. The idea is for all these "things' to communicate with each other and get things done more efficiently. Think of your car communicating directly with your garage door to open it or close it without any human intervention, or the machinery in your factory automatically requesting maintenance service based on sensor data. Imagine your fridge creating a shopping list and sending it to you on the way home from work, or your front door automatically unlocking when your phone lets your door lock know that you're right in front of the door. This direct integration of

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the world around us with the cyberspace will pave the way for smarter industries, smarter homes, smarter transportation and therefore smarter grids.

Although there are security concerns about how these devices could be hacked once online, measures are being taken to make it more secure and viable for the masses. The Internet of Things has the potential to streamline not only personal lives but industries all together and can thus tremendously impact the productivity and strength of economies worldwide. It might appear to be a first world technology, but it has tremendous potential in developing countries too. It therefore can impact Bangladesh.

D. Is It Viable for Bangladesh?

Yes. Absolutely yes. The Internet of Things depends on "smart" things and some sort of a network over which they can communicate to each other. Bangladesh can offer the following:

1) *Strong Telecommunications:* Although Bangladesh has only 5 telecom operators, together, they have almost complete network coverage of the country. 3G connectivity is also widely available with 4G connectivity set to make its debut very soon. Thus, people in even the most remote parts of the country have access to basic telecommunications which can be used to support the Internet of Things
2) *Government Support:* The Government's focus on utilizing Information and Communication Technologies (ICT) for overall development has resulted in lots of developmental works being undertaken in this arena. This has led to the spread of broadband internet all over the nation. Moreover, the government is making the internet even more accessible to the masses by reducing the price of internet, particularly the rates of the major telecom companies. Thus, even if we are a developing country with relatively low income per capita, everyone can access the internet
3) *Affordable "Things":* The more traditional "smart" things to be used in the Internet of Things, such as smart phones and computers are quite affordable in the country. Smart phones of local and cheap Chinese brands are extremely economical and can be accessed by the masses. Things such as sensors to be used in the Internet of Things are also becoming more and more available and affordable on a global scale.

III. SMART AND ZERO ENERGY COMMUNITIES

Moving from the building to the community level, the requests of the future communities are very demanding. They should be places of advanced social progress and environmental regeneration, as well as places of attraction and engines of economic growth based on a holistic integrated approach in which all aspects of sustainability are taken into account.

Smart Grids can be the basis of smart zero energy communities offering:

A. Reliability and security as the prominence of information technology
B. Optimal operation thus contributing to a generation–consumption matching through the full exploitation of Low Zero Carbon (LZC) emissions' technologies.
C. Adaptation to the rapidly evolving ICT technologies, as well as exploitation of the internet capabilities and smart devices and applications.
D. The necessary balance between the energy demand and energy production on community, neighbourhood and district level contributing to the smart and sustainable urban environment.

Effective management of the intermittency of Renewable Energy Sources power generation as well as of operational and capacity reserve in conjunction with the buildings' energy demand profiles. In order to understand more clearly the role of smart grids in zero energy communities, some examples are presented in the next paragraphs. More details on the Smart Grids penetration worldwide can be found in.

The role of net energy metering and the time of use rate in the electricity demand of a zero energy apartment community are investigated. The apartments' community is placed in West Village in Davis, California. Smart scheduling is applied in order to achieve peak load shaving by using the various household appliances during off-peak hours. [5] The peak demand is reduced by 18%, the part-peak demand by 32% and the off-peak demand is increased by 12%. Since the apartments are using photovoltaics for electricity, the community occupants can benefit significantly if the surplus generation by the photovoltaics is maximized and sold to the grid during peak hours (Fig. 1).

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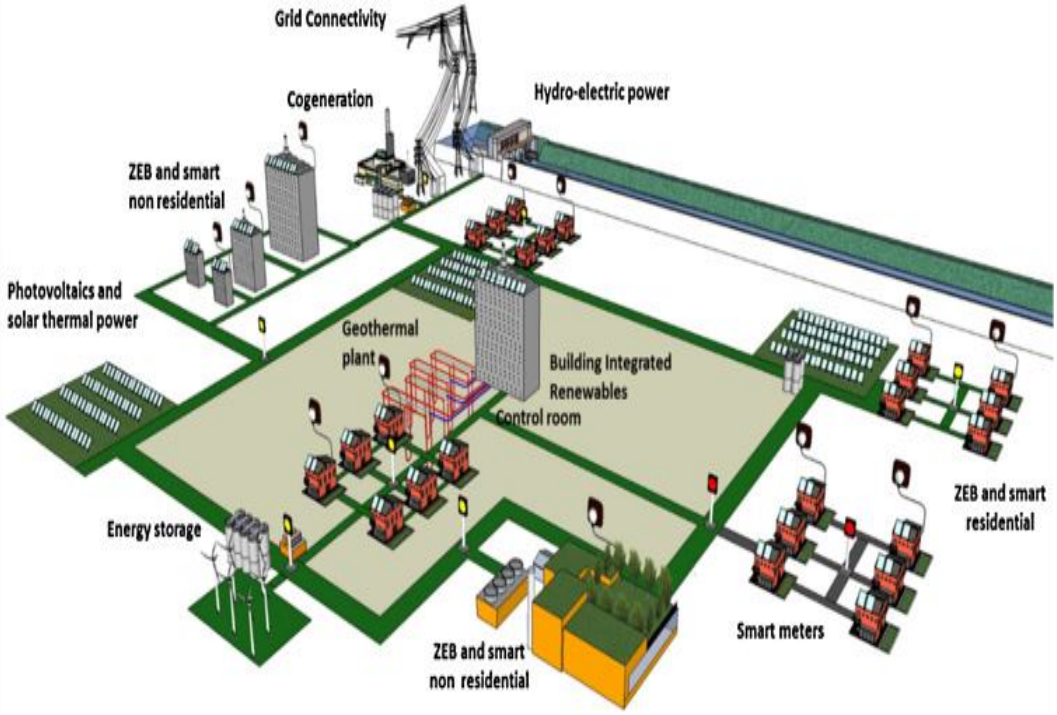

Fig 01: The smart grid's components

In figure 01, we can see the The smart grid's components diagram as we imagine which is a real in the world. Moreover a low energy community configuration for the Island of Hawaii is proposed. The overall work included energy production using photovoltaics, storage systems using batteries and compressed air systems, demand response of buildings, passive cooling techniques for energy efficiency as well as microclimate and landscape assessment. An advanced energy management and optimization model for the operation of the Leaf Microcrid Community is proposed by Kolokotsa. The aim of the model is to minimize the energy cost of the microgrid by performing a generation–consumption matching using genetic algorithms. The optimization procedure is supported by energy load forecasting and energy production prediction (by the photovoltaics and hydroelectric plant) using artificial neural networks. While the optimization horizon is 24 h ahead, the optimization and management procedure leads to almost 6% reduction of the energy costs for the microgrid and significant cost savings for the community without extra energy investment.

IV. HOW CAN IT HELP BANGLADESH?

The primary goal of Internet of Things is to ramp up efficiency. By integrating everything around us in a network and allowing them to communicate with each other, we can make far more productive and efficient systems. For a country like Bangladesh, that has a massive population of over 160 million and a disproportionately low amount of resources, efficiency is a necessity. Internet of Things has the potential to streamline activities and systems in various sectors of Bangladesh, helping us fully utilize however little resources that we have for maximum development. Below are some ways the Internet of Things can help.

A. Smart Homes

Although targeted more towards rural areas, smart homes can conserve energy and save costs. Energy savings is especially important for Bangladesh which has inadequate electricity supply. Smart thermostats can work with smart air conditioners for optimum cooling, without keeping it arbitrarily switched on for too long. Smart lights can detect the presence of people in a room and turn them off if anyone is absent and forgets to switch them off. Smart refrigerators can automatically create shopping lists and even warn people of food that is about to expire. There plenty of other smart home appliances that not only save energy but also make everything a lot more convenient. In our rural area of our country, the problems of electricity is getting solved day by day. Because of solving electricity problems, people are enjoying to using many kinds of home automated system. CC Camera, Television, Smart phones, Socket, Home Server etc. are the example of the home automated system, which can help and change a person life style and also can make a house as a smart house or home.

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Fig 02: Smart Homes [7]

In figure 02, we can see the smart homes diagram as we imagine which is a real in the world.

B. Agriculture

The internet of things can be used to increase, protect, and optimize crop production. For starters, Bangladeshi farmers have very little access to local weather data. They can't set up local weather stations either. The internet of things can be used to create a system of mini-weather stations, with affordable temperature, soil moisture and water flow sensors in every farm or fields. Not only will the farmers get better real time information about their own farms and carry out irrigation and fertilization accordingly, but the aggregated information of all the farms can help them predict weather patterns and take precautions. Water flow sensors can especially be helpful in dealing with an impending flood. The internet of things can also be used to operate machinery located in far off places. For instance, farmers in India can use their mobile phones to operate irrigation pumps located in far off parts of a huge farm, without much hassles. Application of such technologies will increase agricultural output as Bangladesh faces the problem of decreasing cultivable land.

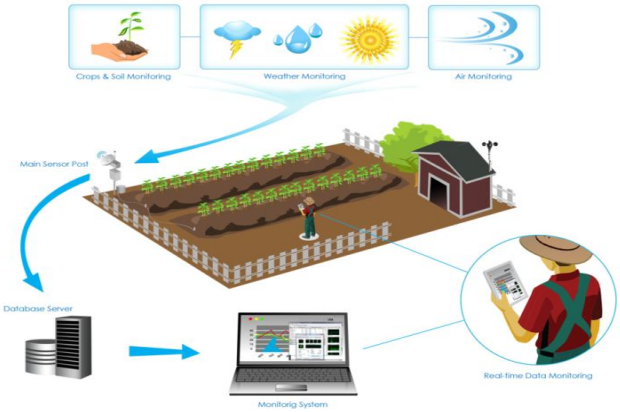

Fig 03: Agriculture [8]

In figure 03, we can see the agricultural diagram of rural area of the world.

C. Water and Sanitation

Access to clean water and sanitation is one of the biggest challenges Bangladesh faces in rural areas. Ensuring basic hygiene is a priority. IoT can help achieve this despite the lack of resources in rural areas. Biosensors placed in wells and manual pumps can be used to monitor water quality. They can detect elements like Arsenic and Iron which pollute the ground water of many areas. It can not only help the people in the immediate vicinity know which sources are safe or unsafe but also the aggregate information can be

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used by local authorities to know exactly which areas are affected and take measures. Using biosensors to detect waste flow and waste levels in soil and water can also help achieve better sanitation. With information available about the areas that are affected by contamination, corrective measures can be taken and adequate healthcare services can be provided.

Fig 04: Water and Sanitation [9]

In figure 04, we can see the Water and Sanitation diagram. These are only some of the ways that show how IoT can help Bangladesh. Industries stand to benefit from smarter equipment, individuals gain to benefit from smarter devices that make life more convenient. At the end of the day, every application reduces waste and boosts efficiency. IoT is not only for the developed world. It has tremendous potential in Bangladesh too.

V. CONCLUSIONS

Smart Grids can be considered very promising for the energy and building environment industry due to the fact that create a physical proximity between consumers and micro energy sources that help increase consumer awareness towards a more rational use of energy. Moreover smart grids can offer new opportunities for the reduction of gas emissions by creating technical conditions that increase the connection of devices and renewable energy resources at the low voltage level. In addition, smart grids in the building sector offer a great opportunity for improving the power quality and reliability of energy sources due to the fact that it offers decentralization of supply, better supply and demand matching, reduction of transmission losses and minimization of downtimes. Thus energy investments can be shifted from the expansion of transmission and large scale generation systems to the energy efficiency in the building sector, i.e., improving building fabric, increasing green infrastructure in the community, improving indoor and outdoor environment interaction by landscape solutions. In addition, widespread application of modular micro generation sources on community level may contribute to the reduction of the energy price in the power market. Further, price reduction may be achieved by optimizing micro-generation operation and performing building load forecasting which is possible due to the available data from the metering process. As a result the smart grids can be viewed as aggregators of buildings, consumers and communities that will be empowered with better prices and valuable opportunities.

VI. ACKNOWLEDGMENT

To integrate intermittent renewables, power companies are adding distribution automation systems to their grids. These distribution automation packages also enable companies to automatically locate and isolate outages, and switch instantaneously to new source feeds to avert system-wide failures. Another significant challenge is related to the increased initial installation cost which constitutes a great disadvantage. Specific policies and incentives should be provided by the governmental bodies to encourage investment in order to reach national carbon reduction goals. On the other hand, as an alternative source of off-grid electric power, solar home systems (SHS) stand out above all other options. The SHS program has been very successful in Bangladesh, where SHS projects are

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managed by a government financial institution (Infrastructure Development Company Limited (IDCOL). The Bangladeshi SHS model could be replicated and launched in other parts of the world. This survey study conducted in rural areas of Tangail district focused on the impacts of SHSs on rural population lives in Bangladesh. Mondal and Klein and Khan and Azad also conducted their study on SHS social impacts of rural people near Dhaka city in October 2004 to January 2005 and 2013, respectively. However, over the years, the basic conditions of SHS technology (e.g., package price, load demands, socio-economic condition, and awareness) have been changed. Evaluation of the social impacts of SHSs on the lives of rural people who are not connected to electricity grids can be assessed after the installation of the SHSs and may help policymakers create SHS policies to improve the living standards of off-grid rural populations world-wide.

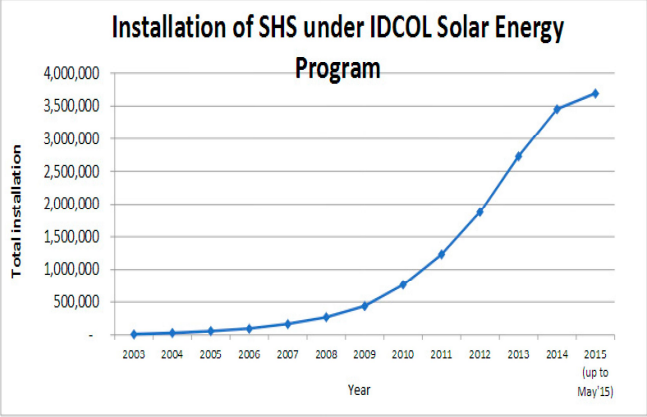

Fig 05. Annual SHS installations in Bangladesh[10]

In figure 05 shows the solar home systems (SHS) installations in Bangladesh, which the program has been very successful in Bangladesh.

Finally, significant effort should be put in the development of standards concerning the operational characteristics, the power quality, real time optimization and overall management.

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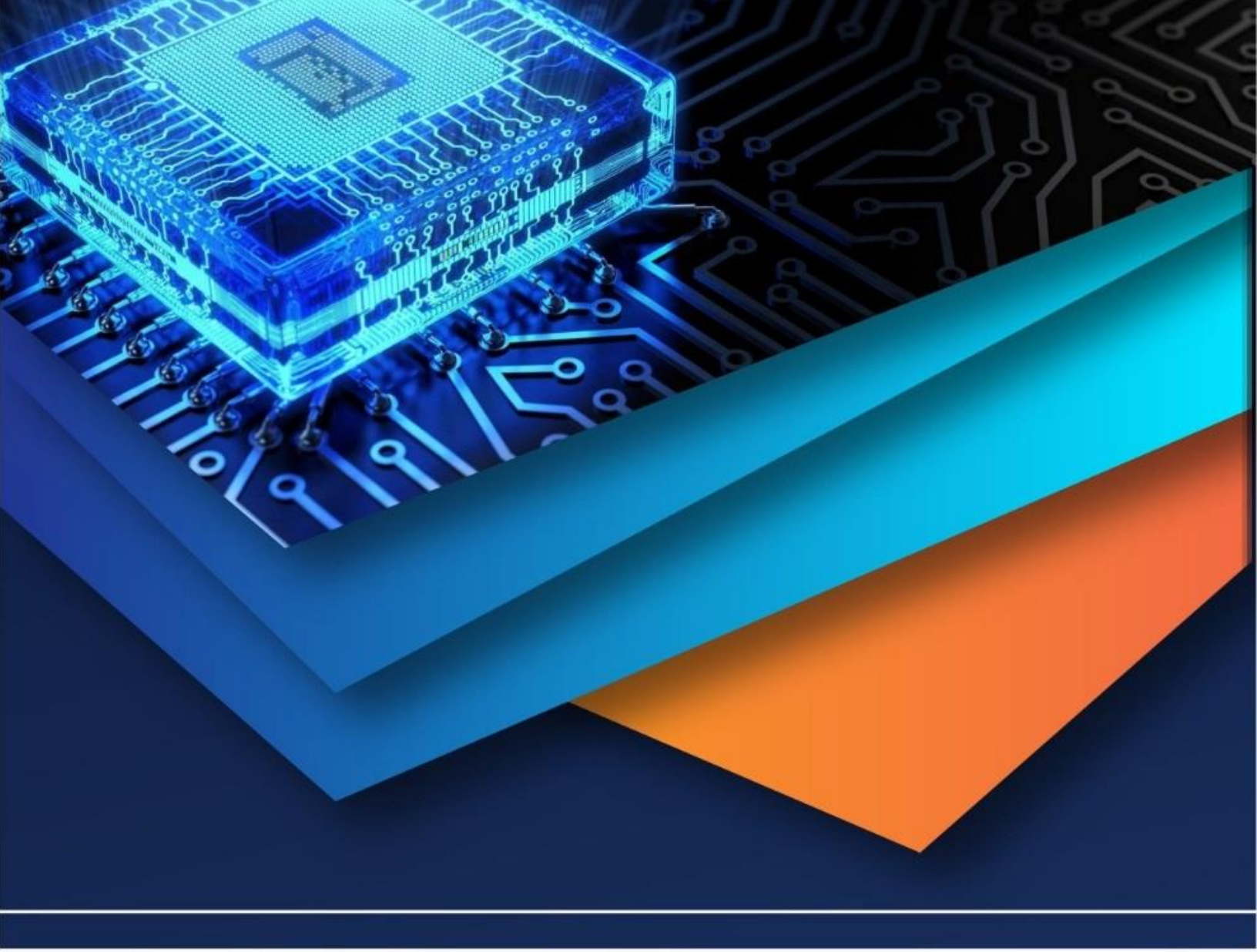

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