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Analysis of Trade-Offs Between Performance and Energy Consumption Due to Execution of Software on Multiple Platforms and Hardware

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Abstract: ***With the rapidly developing and evolving technology, we are moving towards tech-goals which offer more freedom of data accession and operation through shared platforms. From basic web computing to advanced cloud computing, everything shares data, software or hardware over the network. But this sharing can result in inefficient utilization of available resources and reduction in quality of service provided as well. The point of inefficient energy usage is where Green Technology comes into picture. Data analysts all around the world are trying to come up with more optimized solutions to make the experience of working on shared platforms much better.***
Keywords: technology, cloud computing, multi-platform software, energy utilization, green computing

I. INTRODUCTION

Green computing or green IT, refers to environmentally sustainable computing. Green computing is defined as "the study and practice of designing, manufacturing, using, disposing of computers, servers, and associated subsystems- such as monitors, printers, storage devices, and networking and communication systems- efficiently and effectively with minimal or no impact on the environment.

The goals of green computing are to reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, promote the recyclability or biodegradability of defunct products and factory waste. Research continues into key areas such as making the use of computers as energy efficient as possible, and designing algorithms and systems for efficiency- related computer technologies.

Whilst the performance and the breadth of application of computers is increasing, so too is our awareness of the cost and scarcity of the energy required to power them, as well as the materials needed to make them in the first place. However, because computing developments can enable individuals and businesses to adopt greener lifestyles and work styles, in terms of the environmental debate computing is definitely both part of the problem and part of the solution. The computing industry is more prepared and far more competent than almost any other industry when it comes to facing and responding to rapid change. Environmentally it is not a good thing that most PCs -- especially in companies -- have typically entered a landfill after only a few years in service. However, this reality does at least mean that a widespread mindset already exists for both adapting to and paying money for new computer hardware on a regular basis. Hence, whereas it took decades to get more energy efficient cars on the roads, it will hopefully only take a matter of years to reach a state of affairs where most computers are using far less power than they needlessly waste today.

II. LITERATURE REVIEW

Long back in 2001 Huang et al in their simulation environment, showed that the global optimization allows the reduction of the energy consumption of a set of diverse applications by an average rate of 12% and 16% with almost negligible slowdown.

Chatzigeorgiou and Stephanides explained in 2002 that the rapidly increasing use of programmable processor cores in embedded systems are mainly used in portable devices create a vital need for low power operation. Illustration of the effect of several software decisions on the consumption of energy of the underlying hardware and to take into account power in software design.

After them, in 2007 Freeh et al said that users of high-performance computing are mostly interested in raw performance, but both energy and power consumption are the critical concerns. One approach to reducing energy and power is to use high-performance cluster nodes which have several power-performance states. As a result the energy-time trade-off can be dynamically adjusted.

In 2010 Aqeel et al ventured upon optimising a processor for energy- efficiency and came to the conclusion that it requires an inspection of energy-performance compromises in all fields of processor design space, including both circuit and architectural design. He applied an blended architecture-circuit optimization framework so as to map energy-performance trade-offs of various high-level

processor architectures.

In 2011 Guenter et al presented a paper that predicts demand in the near future to turn on servers gradually before they are needed and avoids turning on of unnecessary servers to handle transient load spikes and formulated an optimization problem that minimizes the linear combination of unmet demand and total energy and reliability costs, and solves the problem efficiently by using the program structure and constructs an execution plan based on the optimization plans to transition servers between different power states.

Year 2012 had a paper by Garg et al which discusses various elements in Clouds contributing to the total energy consumption and the implication of these solutions for directions into future research to enable green Cloud computing.

In 2012 Korthikanti and Agha showed how performance and energy cost of a parallel algorithm that are executing on a multi- core architecture have different trade-offs, depending on the number of cores the algorithm uses, the frequencies in which these cores operate, and the structure of the algorithm.

Beloglazov in total fulfillment of the requirements of the degree of Doctor of Philosophy in February 2013 presented in his thesis novel techniques, models, algorithms, and software for distributed dynamic consolidation of Virtual Machines (VMs) in Cloud data centers. The aim is to improve the utilization of computing resources and lower energy consumption under workload independent quality of service limits.

Meanwhile, Banerjee et al worked on Energy Efficiency Model for Cloud Computing in 2013 analysed every conceivable range in a generic location cloud foundation that are in charge of prominent measure of energy utilization and addresses the techniques by which power usage can be minimised without trading off Quality of Services (QoS) and usual execution. Kalange Pooja in 2013 in her research work told that high vitality utilization not just means high operational cost, which decreases the overall revenue of Cloud suppliers, additionally prompts high carbon discharges which is not earth well disposed. Subsequently, vitality productive arrangements are required to limit the effect of Cloud figuring on the earth. Keeping in mind the end goal to outline such arrangements, profound investigation of Cloud is required concerning their energy proficiency. We have to address different components of Clouds which add to the aggregate vitality utilization and how it is tended to in the writing. We additionally examine the ramifications of these answers for future research bearings to empower green Cloud processing. This paper likewise clarifies the part of Cloud clients in accomplishing this objective.

The paper proposed in 2013 proposes another approach that is both lightweight as far as its engineer necessities and gives fine-grained appraisals of energy utilization at the code level. It accomplishes this utilizing a novel blend of program examination and per-direction vitality modeling.

Zhu proposed a paper for his PhD on synergistic cross-layer enhancements over the star cessor design, Web runtime, programming dialect, and application layers to boost the entire framework effectiveness. The proposition said to have the capacity to have a long haul affect in light of the fact that the objective application space, the Web, is turning into an all inclusive portable improvement stage, and our answers focus on the crucial calculation layers of the Web area. Many papers were distributed on a similar proposal.

Michanan et al appeared in 2014 live power utilization and execution time information for the projects in the CHStone benchmark suite on an installed processor with configurable reserve parameters is accumulated and a Pareto examination on these information to recognize the ideal store arrangements is performed. It is watched that the ideal arrangements are inadequate in the outline space, are conflicting over the benchmark, and are outlandish at times.

Saad and Nandedkar, in 2014, proposed computational off stacking to show signs of improvement execution and battery life in their paper Energy Efficient Mobile Cloud Computing. It settle the test to build the vitality proficiency and execution improvement of asset obliged gadgets.

The paper by Gschwandtner et al in 2014 talks about outcomes of utilizing a multi-objective search-based auto-tuner to advances for three conflicting measures: execution time, energy intake, and resource utilization.

Ardagna et al in 2014 wrote the paper that targets at supporting research and investigation in this subject by offering a survey of the state of art of QoS modelling approaches relevant for cloud systems. It also audits and assorts their early application to some decision-making problems emerging to cloud QoS management.

Menasce in 2015 was able to discover by studying that dynamic power consumed by a CPU is directly proportional to the product of the square of the CPU clock frequency and the voltage. The CPU execution time of a job gets increased by lowering CPU clock frequencies. This paper focuses on the tradeoffs between system performance and CPU clock frequency. A multiclass investigative lining system model is used to find the optimal CPU clock frequency that understates the relative dynamic power while not surpassing user-established SLAs on response times.

Pallister et al 2015 brought forth a paper that demonstrates an analysis of the energy intake of a huge number of the optimizations a

modern compiler can carry out. Utilizing GCC as a test case, we appraise a set of ten benchmarks, carefully chosen for five different embedded platforms.

Gaudette et al in 2016 suggested for statistical models address both single and multi-stage functions and used in the production of a development problem, the solution to which is a passive, lightweight controller that advances energy efficiency of mobile applications, subject to restraints on the prospect that the application execution time meets a given time.

Cassagne et al in 2016 suggested a raw dynamic and fully universal implementation of a Successive Cancellation (SC) decoder (multi- precision support and intra-/inter- frame strategy support). This universally compatible SC decoder is used to execute comparisons of the different arrangements in terms of throughput, latency and energy intake. A special stress is given on the energy intake on low power embedded processors for software defined radio (SDR) systems.

Ziai in 2016 when taking a gander at energy consumption at the entire building level, similar to the concentration of this paper, one is basically keen on warm execution. Warm execution is normally figured for one of two motivations to measure and select mechanical hardware or to anticipate the yearly vitality utilization of a structure. Draftsmen, engineers, and mechanical contractual workers depend on estimating projects to compute, frequently in view of techniques and calculations set up by ASHRAE (American Culture of Warming, Refrigerating and Ventilating Engineers), the peak warming and cooling season stacks that decide essential HVAC gear. In considering proficiency, originators and designers progressively utilize energy programs that model and foresee yearly building energy utilization regarding energy units (e.g. BTUs), monetary cost, or ecological effect.

Balouek-Thomert in 2016 gave a proposition researches the vitality productivity of Mists by proposing an extensible and multi-model planning structure that means to build the proficiency of a heterogeneous foundation from the vitality utilization point of view. The approach depends on a cursor that empowers the contribution of clients and suppliers to make booking strategies. The objective is to convey an administration that is corresponding to the successful request and take out vitality squander regularly because of asset over-measuring.

The paper by Llopis et al in 2016 exhibits how a cost-benefit analysis of different plots acknowledges puts light on trade-offs between cost, performance, and energy for precise scientific computational work- loads.

Palumbo et al in 2016 suggested the possibility of adopting coarse-grained hardware configuration to make dynamic energy management possible.

In 2016, Cassagne et al presented a new dynamic and universally acceptable execution of a Successive Cancellation (SC) decoder (multi-precision support and intra-/inter- frame strategy support). This universally acceptable SC decoder is used to perform comparisons of the different arrangements in terms of throughput, latency and energy intake.

III. ENERGY EFFICIENCY AND QOS IN CLOUDS

Many studies observe that the Cloud phenomenon may increase the problem of carbon emissions and global warming. The reason behind this is that the collective demand for computing resources is going to increase dramatically in the next few years. Even the most efficiently built datacenter with the highest utilization rates will only mitigate, rather than eliminate, harmful CO2 emissions. The reason given is that Cloud providers are more interested in electricity cost reduction rather than carbon emission.

The energy efficiency is important because it is profitable in long run. It is sustainable and important for growth. Multiple application's' usage in various forms affects the energy efficiency. While sending the images over the internet if the user reduces the resolution then energy can be saved. By running multiple applications in shared server also energy can be saved. While developing software, it is useful to let the application log the steps it is taking and their intermediate results, to diagnose bugs or other problems.

Most multiplatform softwares and hardwares are platform independent i.e. they can run in the same manner on any platform on operating system without requiring changes to be made. Being platform independent has its own advantages and disadvantages. The platform independent softwares generally need a slightly different layer of abstraction than the normal programs. They are difficult to generate and require more resources. If developed poorly they may cause security breaches on the platform they are being run on. But even after all of these, they still remain very popular as they make the our work of data sharing and resuse of data possible and much more easier.

We use multiplatform softwares in our day to day life. The only difference is that we may or may not be aware of it. A very common multiplatform software is Cloud Computing. We all have atleast one cloud account which we use to store and share data. It can be accessed from any device and hence is gaining popularity. A newfangled technology that has hectored almost every other technology in the recent times is the cloud computing technology. Amid the colossal buzz, it is difficult to believe the immensity of this technology. Nonetheless, there are concrete reasons why prospectors are delving deeper into the ins and outs of cloud computing.

The key benefits include productivity maintenance, ensures security, saving money, accessibility support and reliability.

Cloud computing is also gaining popularity among mid-size and small business, enabling many businesses to access to application software over high-speed internet connection without the need for investing in computer software and hardware. Cloud technology is a new buzz in the market, when it arrived it was was not clear how its implication will affect the business world. Most prevalent is its popularity in the customer service space. CRM's have become wildly popular as they have been very effective in improving customer service or thousands of businesses.

Following the upcoming trend in cloud computing, there is a possibility that use of cloud computing will increase weven further. If IT, in future tends to indulge in too much of projects in order to acquire resources, this could lead the business side to be switching to green computing. Although, huge companies might not find cloud a replaceable solution, but the cloud services will probably start being used for managing the company website or the email.

These days, a lot of international companies have reduced IT jobs and have started considering cloud to be a large pool full of jobs, thereby increasing the jobs related to the cloud. Cloud is undoubtedly serving as a major contributor to the companies in increasing their profits. The companies in huge countries like the U.S. these days are hiring lesser amount of IT recruits, and are instead hiring people from countries like India to handle all their work via cloud using cloud services.

This is definitely going to lead to the downfall of the IT sector and rise of cloud in the near future.

Energy, Performance and QoS play a very important role in energy efficiency of a device. These tradeoffs have been improvised by sample simulations by various science workers all around the globe and this is still an area of interest of the researchers.

Best performance with maximum power efficiency is what the world is aiming for today. The companies are switching to technologies which will give them high output and low energy consumption simultaneously. Some of the trade-offs possible between performance and energy are:

Use of technologies like LTE which will help increasing the performance, as well as improve energy efficiency by reducing the battery drainage.

In order to reduce energy consumption in routers and switches, the designers are making use of photonic technologies which results in low power us-age during the interconnection of routers' subsystems.

One of the possible trade-off is achieved by the communication protocol, PRTP (Partial Reliability Transport Protocol), which unlike TCP, limits the loss of packets, thus leading to more energy efficiency as well as lesser de-lays in sending data, thus improving the performance.

One such initiative has been taken to create something called the GreenWeb. GreenWeb more efficiently guides the web browser engine to save processor energy without sacrificing user experience. The language extensions, implemented as CSS style rules, allow developers to express hints to the browser, which in turn conserves power when excessive computational horsepower is not necessary.

IV. FUTURE PROSPECTS

As mentioned earlier, Cloud computing, one of the most used multi platform software will experience increase in its area of use and existence. A time when everything becomes online is not very far. The multiplatform mobile apps which provide comfort of use to all mobile phone operating system users is getting increasing attention. The multiplatform market can be termed as niche market as of now, and thus has a lot of prospect and profit in terms of marketing future.

Energy Efficiency for the same is still being worked on and hence, it also provides great opportunities for researchers and developers to come up with better ideas and algorithms to lead the world into a greener and more sustainable world.

V. RESEARCH QUESTIONS

A. We investigated following research questions during for multi-platform and hardware software's

1) Is energy efficiency really an issue in multi-platform software's?
2) How often and how ubiquitously multiplatform or multi-hardware applications are used?
3) How popular is cloud computing?
4) What are the tradeoffs possible between performance and energy?
5) Is GreenWeb helping energy efficiency?
6) What are the ways to make multiplatform and multi-hardware applications more energy efficient
7) What are the retrospective and prospective remarks on platform independency?
8) What are the future prospects of the applications which can run on multiple platforms and hardware resources?

VI. SURVEY AND RESULTS

A. Questions

1) Name
2) E-mail\
3) Do you use cloud computing?
a) Yes
b) No

B. What service provider do you use for cloud computing?

1) Dropbox
2) Emc^2
3) Google
4) AWS
5) Other

C. Are you a clouder?

1) Yes
2) No

D. How often do you access your cloud account?

1) Once a day
2) Multiple times a day
3) Weekly
4) Monthly
5) Once in a year
6) I don't use cloud computing

E. Are you satisfied with the cloud computing services?

1) Yes
2) No
3) Maybe

F. Do you use any other multiplatform software?

1) Yes
2) No
    a) If yes, please specify.
    b) Survey Results

The survey was conducted on 40 students. The survey was in an online Google form and two entries that we received were not genuine bringing the final count to 38. Living in the 21st century, as expected most of the participants of the survey used cloud, 94.7% to be more precise. Also a large number of them called themselves clouders.

We also concluded that most popular cloud computing platforms are Dropbox and Google Drive. Almost 81.5% of the sample used Dropbox and Google drive.

22.22% of the cloud computing users use their accounts more than once a day while 8.3% use it daily.

Considering the satisfaction of the service providers they use, 77.78% people were satisfied, 5.56% were not satisfied and 16.67% were indecisive about their stand.

Out of all participants, 84.21% didn't use any other multi-platform software while only15.79% did. Out of 15.79%, only 40% gave the names of other softwares that they use.

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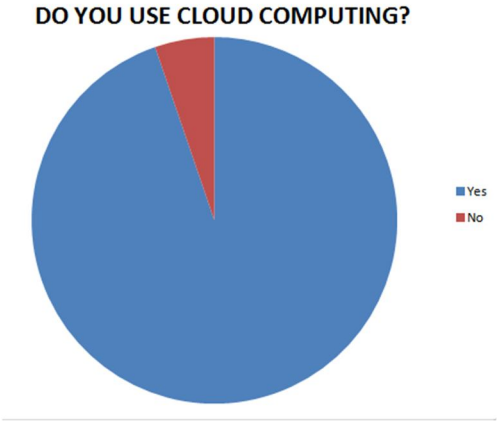

Figure1: Cloud Computing Usage

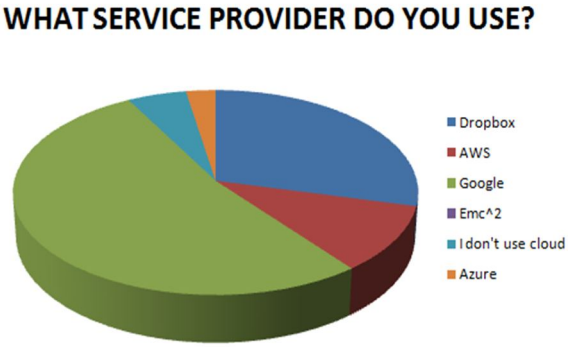

Figure 2: Service Provider Used

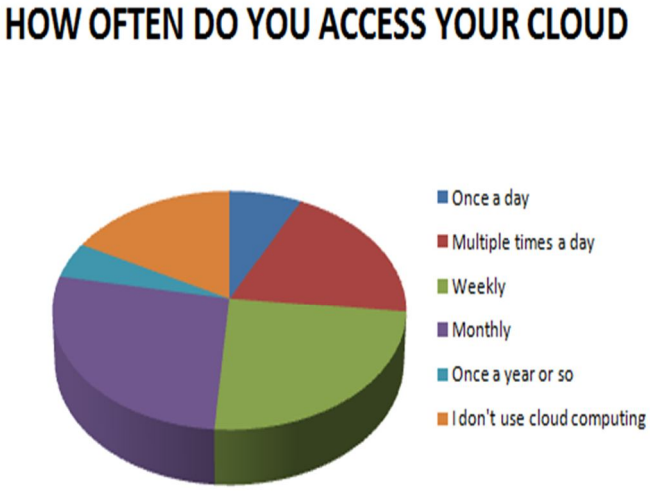

Figure 3: Frequency of Cloud Usage

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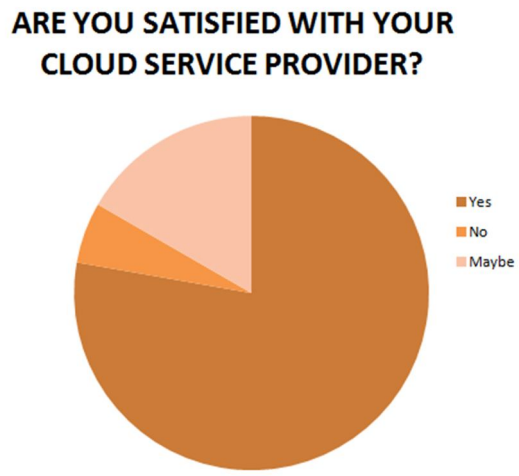

Figure 4: Satisfaction of Cloud Services

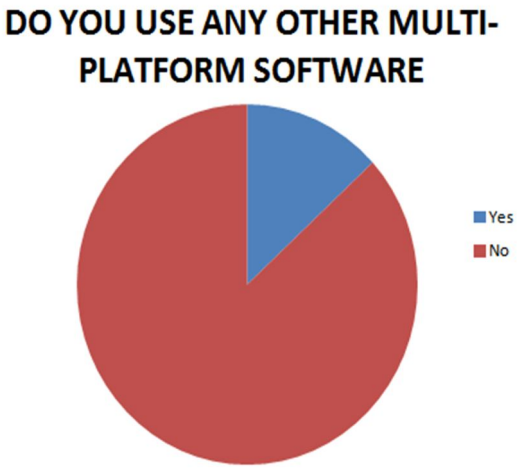

Figure 5: Other Multi-platform Softwares used

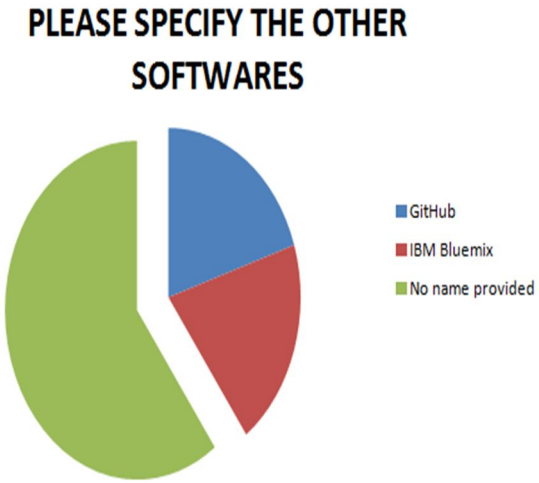

Figure 6: Other Software's in common use

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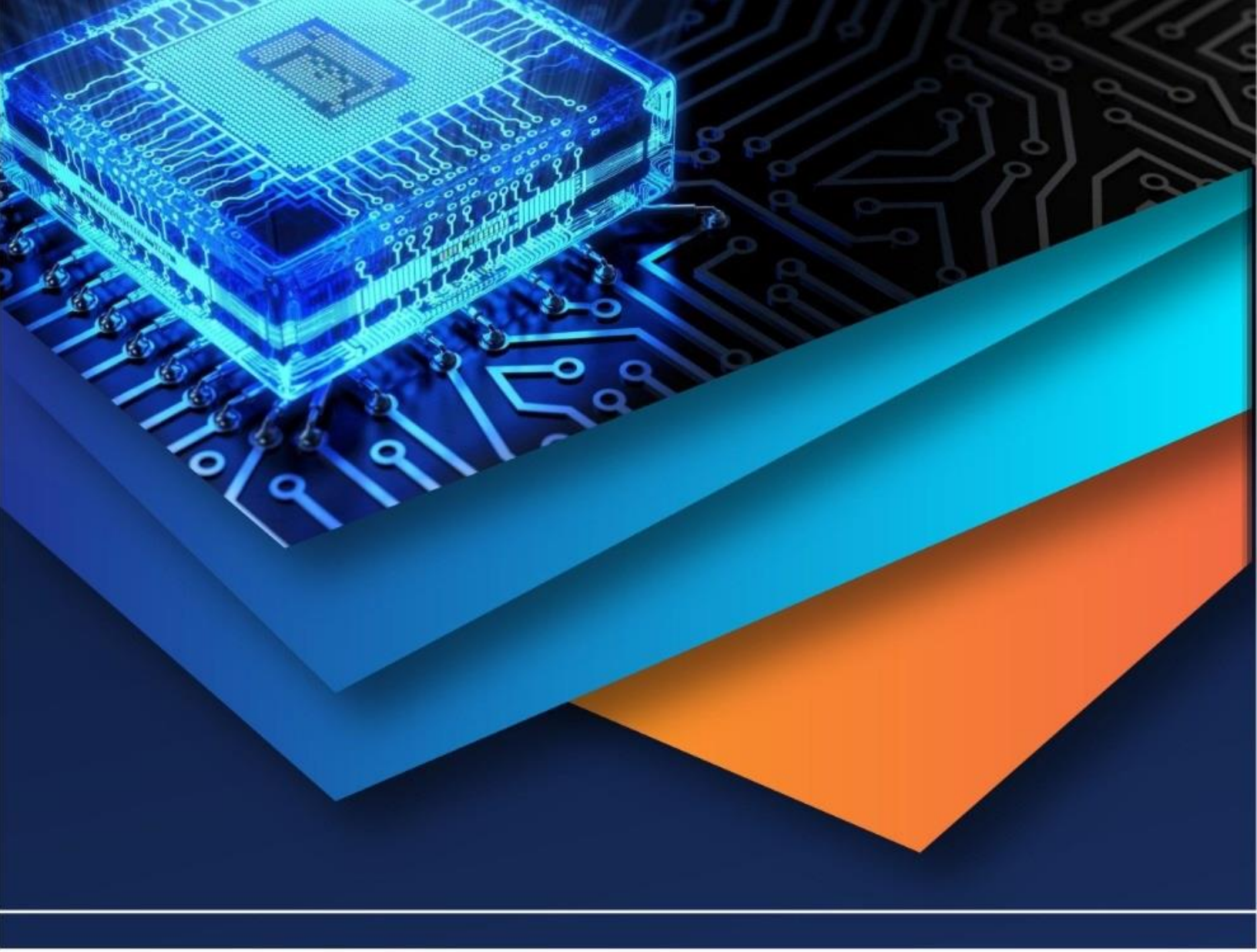

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