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Mainframe Modernization: Cost Analysis and ROI for Migration

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Abstract: ***As businesses strive to enhance operational efficiency, reduce costs, and leverage the latest technological innovations, many are transitioning from legacy mainframe systems to distributed, open-source environments. Mainframes, once the cornerstone of enterprise IT infrastructure, have become costly and less flexible than modern computing paradigms. This paper explores the cost analysis of migrating from mainframe legacy systems to distributed systems utilizing open-source technologies. It examines the key factors influencing migration costs, identifies opportunities for cost savings, and builds a business case for migration, emphasizing the return on investment (ROI). By carefully analyzing the cost structure, the paper outlines strategies for effective migration, demonstrates the long-term benefits, and presents a compelling argument for organizations to modernize their IT infrastructures.***

I. INTRODUCTION

Mainframe systems have served as the backbone of many enterprise IT environments, particularly in sectors such as banking, insurance, government, and large-scale retail operations. These systems, which have been in place for decades, are recognized for their reliability, centralized control, and ability to process vast amounts of transactions. However, as businesses strive to remain competitive in an increasingly digital and fast-paced environment, the limitations of mainframe systems have become evident. These limitations include high operational costs, inflexibility, lack of scalability, and difficulty integrating with modern technologies.

The migration from mainframe systems to distributed, open-source systems is seen as a strategic move to overcome these limitations. Distributed systems, powered by open-source technologies, offer a more cost-effective, scalable, and flexible infrastructure. However, the transition is complex, involving multiple stages, and has significant cost implications. As a result, IT managers and executives must carefully evaluate the cost structure associated with such migrations, understand the potential for cost savings, and ensure that the migration leads to a positive return on investment (ROI).

This paper focuses on providing a detailed cost analysis of migrating from mainframe to distributed systems, outlining the key factors involved, the potential for cost savings, and how to create a business case that justifies the investment. It aims to assist decision-makers in understanding the full scope of costs and benefits associated with this transformation and to guide them through the process of modernizing their IT infrastructure.

II. PROBLEM STATEMENT

The decision to migrate from mainframe legacy systems to distributed, open-source systems presents several challenges, particularly when it comes to cost. Many organizations are aware that modernizing their infrastructure is essential to meet the demands of a competitive marketplace, but the financial implications of such a move can be a deterrent. The migration process involves significant initial investment, which can create hesitations in decision-making.

The primary challenges in this migration include:

1) *Upfront Costs:* The costs of hardware, software, and consulting services to support the migration can be substantial. Transitioning to distributed systems often requires purchasing new servers, storage solutions, and cloud infrastructure, as well as licenses for open-source platforms.
2) *Labor Costs:* Skilled resources are needed for both the migration process and the subsequent maintenance of the new systems. This includes hiring or training IT staff, bringing in consultants, and involving developers who can handle the transition.
3) *Downtime and Business Disruption:* Migrating to a new system can cause temporary disruptions in business operations. These downtimes, especially in critical applications, can lead to losses in productivity and revenue.
4) *Data Migration and Compatibility Issues:* Moving large volumes of data from mainframe systems to a new distributed environment is complex. Data integrity, transformation, and integration challenges may arise, leading to higher costs.
5) *Risk of Project Failure:* Mainframe modernization projects are notorious for their complexity and potential for failure, especially if not managed properly. The risk of project delays, cost overruns, and system failures must be carefully managed.

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6) *Long-term Operational Costs:* Despite the lower initial cost of distributed systems, businesses must consider long-term operational expenses related to maintenance, upgrades, and support.

To make a successful migration decision, businesses need to perform a detailed cost analysis, understand the hidden costs, and evaluate whether the long-term benefits will outweigh the initial investment.

III. SOLUTION

A comprehensive solution to mainframe migration requires a clear understanding of the migration process, the factors that influence cost, and the strategies that can help reduce costs. The migration process can be broken down into several phases, each with distinct cost considerations. Below, we will outline the key factors that impact the cost of migration, and the strategies organizations can use to reduce costs while maximizing the long-term benefits.

A. Key Factors Influencing the Cost of Migration

1) Infrastructure Costs

- Hardware and Software: Moving from mainframe to distributed systems typically requires purchasing new hardware and adopting new software platforms. While distributed systems often run on commodity hardware, the initial cost of purchasing servers, storage, and networking equipment can still be substantial. Additionally, open-source technologies can reduce software licensing costs but may still require enterprise-level support or commercial offerings for critical use cases.
- Cloud Services: Cloud-based systems present an alternative to on-premises hardware investments. Utilizing Infrastructure-as-a-Service (IaaS) offerings such as Amazon Web Services (AWS), Microsoft Azure, or Google Cloud can significantly reduce the cost of purchasing and maintaining hardware. Cloud computing allows organizations to only pay for what they use, providing greater scalability and flexibility.

2) Labor Costs

- Consultants and Migration Experts: A successful migration often requires expertise in both legacy systems and modern distributed technologies. This expertise typically comes at a premium, especially if the migration project is large or complex. Consultants help ensure that the migration is executed smoothly, reducing the risk of downtime or system failure.
- Internal Staff Training: The existing IT workforce will likely need training in new technologies such as containerization, cloud computing, DevOps practices, and other distributed system paradigms. While this requires an investment in training programs and certifications, it can reduce future reliance on external consultants and improve internal expertise.

3) Downtime and Business Disruption

- Business Continuity Planning: A key factor in managing migration costs is minimizing downtime and ensuring business continuity. A poorly executed migration can lead to lengthy outages, impacting productivity, customer service, and revenue. Companies must invest in a detailed migration plan, which includes testing, data validation, and phased rollouts to reduce the risk of disruption.

4) Data Migration and Integration

- Data Complexity: Migrating large volumes of data from mainframe systems to distributed systems can be complex. Data may need to be transformed or cleaned to fit into the new environment. Ensuring compatibility between old and new systems can require custom development or middleware, which adds to the cost.
- Automation Tools: Leveraging automation tools for data migration can help streamline the process, reduce human errors, and speed up the migration timeline. Automation tools for testing, validation, and integration can also lower costs by reducing the need for manual intervention.

B. Opportunities to Save Costs

1) Leveraging Open-Source Technologies

- One of the most significant opportunities to save costs is through the adoption of open-source software. Solutions such as Linux for operating systems, PostgreSQL for databases, and Kubernetes for container orchestration can significantly reduce the need for costly proprietary licenses. Open-source tools are not only cost-effective but also provide flexibility and scalability for modern application architectures.

2) Cloud Adoption and Virtualization

- Moving to the cloud offers both cost savings and scalability. Cloud service providers offer pay-as-you-go models, meaning that organizations can scale their infrastructure as needed, without incurring unnecessary capital expenditures. Additionally, many cloud providers offer managed services that reduce the need for in-house IT staff, further lowering operational costs.

3) Automation of Migration Processes

- Automating portions of the migration process can help reduce labor costs and accelerate the project. Automated tools for database migration, code refactoring, and testing can significantly shorten the migration timeline, resulting in faster realization of benefits. Additionally, these tools help mitigate the risk of human error, which can be costly in complex migrations.

4) Phased and Hybrid Migration Approach

- A phased migration approach allows organizations to move workloads incrementally, minimizing business disruption and spreading out the costs over time. This method can be less risky and easier to manage, as critical systems are moved first, allowing for testing and troubleshooting before tackling more complex workloads.
- A hybrid migration approach, where the legacy mainframe and new distributed systems run in parallel during the transition period, can also reduce risk and allow for smoother integration.

C. Building the Business Case and ROI Analysis

Creating a robust business case for migration requires a careful balance between costs and benefits. The ROI calculation involves both financial and non-financial factors.

1) Financial Benefits

- Lower Operational Costs: Distributed systems typically incur lower operating costs, particularly in terms of hardware maintenance, software licensing, and energy consumption. Open-source solutions help eliminate licensing fees, and cloud solutions provide economies of scale.
- Scalability and Flexibility: Distributed systems can scale more easily to meet growing business needs, which helps avoid the costs associated with overprovisioning on mainframe systems.
- Faster Time to Market: With distributed systems, organizations can quickly deploy new applications and features, accelerating time to market and increasing business agility.

2) Non-Financial Benefits

- Improved Agility: Distributed systems enable greater flexibility, allowing businesses to quickly adapt to changes in the market, customer needs, and technological advancements.
- Security Enhancements: Modern distributed systems offer improved security features, such as automatic patching and enhanced data protection, which can reduce the risk of data breaches.
- Employee Productivity: A modernized IT environment with open-source tools fosters innovation and attracts top talent, enhancing employee satisfaction and productivity.

3) ROI Calculation

The ROI of mainframe modernization can be calculated using the following formula:

$$ROI = \frac{\text{Net Benefits}}{\text{Total Costs}} \times 100$$

Where:

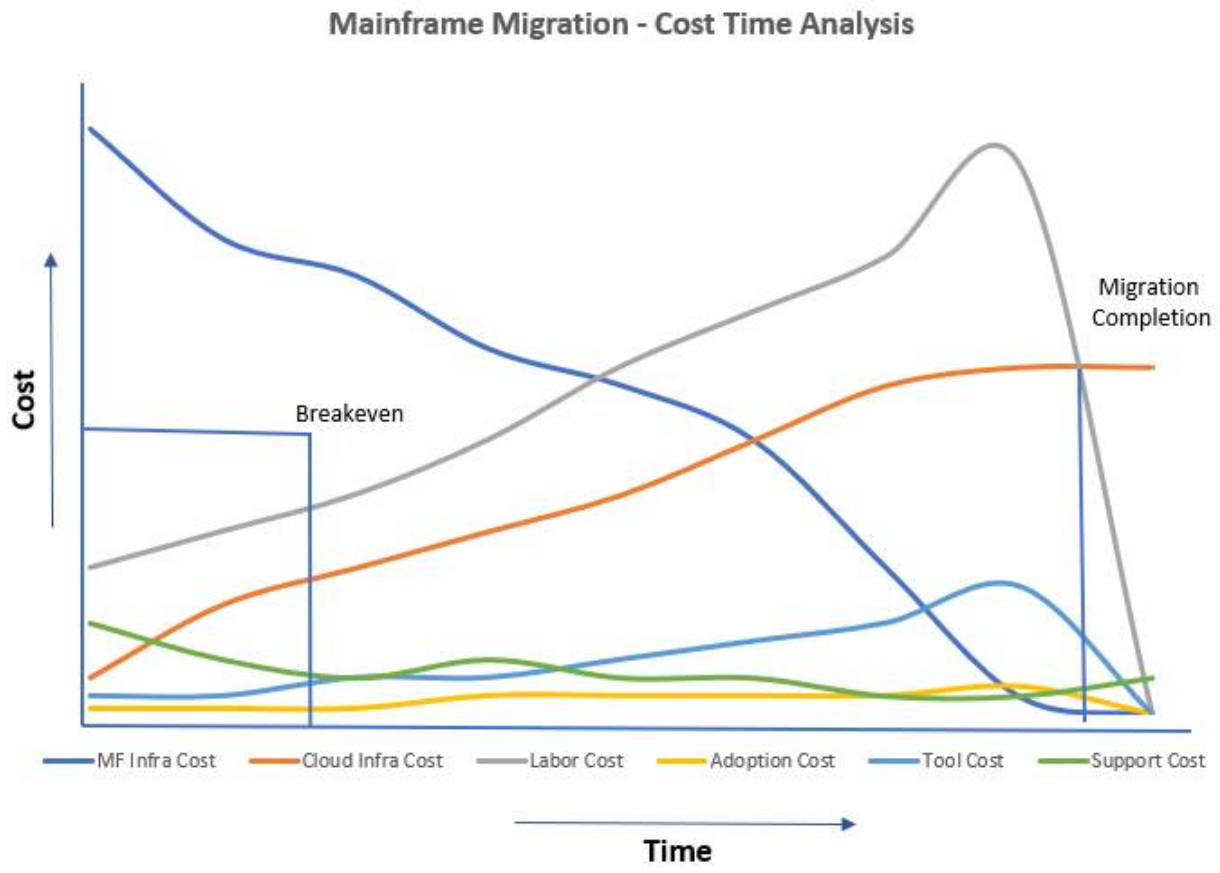
- Net Benefits = Savings from reduced operational costs, improved performance, and increased revenue generation.
- Total Costs = Costs associated with migration, including infrastructure, labor, training, and business disruption.

A positive ROI indicates that the long-term benefits of the migration outweigh the initial costs, making it a financially sound decision.

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IV. MATERIALS AND METHODS

As we considered the various parameters for the data sets we made the following observations for ROI calculation, we had the following inputs to consider



A. Mainframe Infrastructure Cost (↓)

Mainframe infrastructure costs are generally calculated based on the resources consumed by the mainframe environment, and one of the primary metrics used to measure this is the Million Instructions Per Second (MIPS). MIPS measures the processor performance, representing how many millions of instructions the mainframe CPU can process per second. During the migration process, the infrastructure moves from legacy to cloud/on-prem thereby reducing the current infrastructure costs YoY.

1) Determine the MIPS Utilized by the System

MIPS is used to measure the processing power of the mainframe. The total MIPS used can depend on several factors, including:

- The number of Logical Partitions (LPARs): Each LPAR is essentially an isolated virtual machine running on the mainframe, and it is allocated a certain amount of processing power.
- Processor Capacity: Different models of mainframes (e.g., IBM Z15, Z16) have different performance capabilities, and the MIPS rating will vary depending on the model and configuration of the processor.
- Workload: The type of workloads running on the mainframe (e.g., batch jobs, online transaction processing) can affect MIPS usage.

To determine the MIPS of a system, you need to either:

- Use a Software Measurement Tool: Tools like IBM's z/OS Resource Measurement Facility (RMF), IBM OMEGAMON, or IBM Capacity Provisioning provide metrics on CPU utilization in MIPS.
- Use IBM's Capacity Planner: This can help in calculating the CPU demand based on current and projected workloads.

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2) Understand IBM's Pricing Models for Mainframe Costs

a) Rolling 4-Hour Average (4-Hour Rolling Window) Model

One of the most common pricing models used by IBM is based on the 4-hour rolling average of the CPU utilization in MIPS. Under this model, IBM charges customers based on the average CPU usage during any 4-hour window throughout the month.

b) Sub-capacity Pricing Model

The sub-capacity pricing model is another way IBM charges for mainframe usage, where customers pay for the CPU capacity they actually use, rather than the full capacity of their system.

c) Full-Capacity Pricing Model

The full-capacity pricing model charges customers based on the total available processing capacity of the mainframe, regardless of how much of that capacity is actually used.

d) Software Subcapacity Pricing (for IBM Software)

Another important component of IBM's mainframe pricing is software subcapacity pricing. IBM charges customers based on the amount of processing power their mainframe is using for specific software applications, like DB2, CICS, or IMS.

e) Performance-Based Pricing

In performance-based pricing, the cost is tied directly to the performance of the system and the workloads running on it. This can involve pricing based on the overall throughput or transaction processing.

f) Subscription-based Pricing

Some IBM mainframe customers opt for subscription-based pricing, which allows them to pay a fixed monthly or yearly fee for access to mainframe capacity. This model is typically used for customers who want a predictable, low-cost structure without surprises based on variable workloads.

B. Cloud Infrastructure Cost (↑)

As more and more infrastructure moves to cloud from legacy, the cloud infrastructure costs increase. The cost of a mainframe in MIPS (Millions of Instructions Per Second) compared to the cost of a cloud-based platform can vary significantly:

A large mainframe with over 11,000 MIPS can cost around $1,600 per MIPS annually. A 100 MIPS mainframe can cost up to $100,000 per year.

A similar infrastructure to a large mainframe on AWS can cost around $350,000 per year or $29,000 per month. On Azure, a 5,000-MIPS infrastructure can cost about one-tenth the cost of an MIPS infrastructure.

There's no universal formula for determining the number of virtual central processing units (vCPUs) needed to run mainframe workloads. However, you can use benchmark studies to estimate the number and type of vCPUs you'll need.

Migrating to a cloud-based platform can result in significant savings in annual operating expenses. Some customers achieve nearly 90% in savings, while others may achieve closer to 50-60%.

C. Labor Cost **(↑)**

Mainframe migration cost involves labor cost including subject matter experts and consultants having experience in dealing with big and complex migrations through organization dynamics as such programs tend to be multi-year engagements. Optimizing the right delivery team for any product and application migration in an organization is they key, usually LoC and complexity are factors determining the size and structure of the team required to carry out the migration.

1) Lines of Code (LOC)

- Definition: The number of lines of code in the legacy mainframe application is a direct measure of its size and, to some extent, its complexity. The more LOC, the more effort will be required to migrate it.
- Consideration: A higher number of lines of code usually implies a larger team is needed, especially if the code is scattered across multiple modules, programs, or systems.

2) Complexity of the Legacy System

- Code Complexity: Systems that have complex business logic, intertwined modules, and many dependencies will require more time and expertise to migrate. Mainframe code often involves legacy languages like COBOL, PL/I, or Assembler, which require specialized knowledge.
- Integration Complexity: If the legacy system interacts with multiple systems, databases, or applications, the migration will be more challenging due to the need for data integration, API development, and testing.
- Data and Database Complexity: Complex databases (e.g., IMS, DB2) require careful migration planning, including data mapping, data validation, and ensuring consistency between the legacy and new system.
- Batch Processing vs. Online Systems: Batch systems (e.g., overnight jobs, large-volume processing) might require different handling compared to online systems (e.g., real-time transaction processing).
- Customizations: Legacy systems often have highly customized features that require specialized knowledge to modernize or replicate in the new environment.

You can estimate the total effort required for the migration project using a simplified approach based on the Lines of Code (LOC) and the complexity of the system.

The basic formula for effort estimation is:

$$\text{Effort} = \frac{\text{LOC} \times \text{Complexity Factor}}{\text{Productivity Factor}}$$

To determine the optimal team structure for a mainframe migration, you must consider several factors, including lines of code (LOC), system complexity, and the required skill sets. By calculating the total effort required (in person-days), breaking down the migration into phases, and assigning specialized resources to each phase, you can determine the appropriate team size and composition.

D. Adoption Cost **(↑)**

It's essential to consider the adoption and training costs for your existing resources who are currently working with the legacy system. These costs are critical for ensuring that your team can effectively transition from legacy systems (e.g., COBOL, CICS) to modern platforms (e.g., Java, cloud technologies, microservices) without impacting productivity or performance.

The key factors influencing the adoption and training costs include the complexity of the migration, the experience level of existing staff, the types of skills required, and the training duration. Additionally, you need to assess the organizational change management and knowledge transfer processes.

Total Training Cost= (Number of Employees × Training Duration × Cost per Employee per Hour) + Cost of External Trainers + Cost of Training Tools and Resources + Post-Training Support

The adoption and training costs for your team working on legacy systems depend on several factors, including skill gaps, training delivery methods, and the complexity of the new technologies being adopted. Estimating training costs using a structured formula helps allocate the necessary resources.

Additionally, a well-planned training strategy—combined with effective knowledge transfer and post-training support—ensures a smooth transition for your existing team from legacy systems to modern platforms.

E. Tools Cost **(↑)**

1) Cost of Tools for Automation and Code Conversion

Costs vary significantly based on:

- Licensing Model: Perpetual license vs. subscription-based.
- Features: Tools offering extensive automation and AI capabilities might cost more.
- Scale of Use: Larger migrations with greater codebases will need scalable tools, impacting cost.
- Customization Needs: Tools requiring heavy customization for specific environments might incur extra charges.
- Support and Maintenance: Higher service levels may increase costs.
- Cloud Integration: If migrating to cloud-native architectures, tools with built-in support for cloud ecosystems might cost more.

2) Factors for Selection of Code Conversion Tools

When selecting tools, consider the following:

- Compatibility: Support for existing mainframe languages (COBOL, PL/I, etc.) and target language/platform.
- Automation Level: How much manual intervention is minimized in code conversion and testing.
- Scalability: Can the tool handle large codebases or incremental migrations?
- Quality Assurance: Built-in testing frameworks and code quality assessment.
- Customization: Extent to which the tool can adapt to your specific use case.
- Vendor Support: Availability of training, customer service, and documentation.
- Cost: Aligning budget with expected ROI.
- Community and Adoption: Larger user bases often mean better peer support and reliability.

F. Support Cost **(↑)**

Once the migration is complete, support costs transition to managing the new system and ensuring stability.

1) Managed Services
- Employing vendors for ongoing monitoring, updates, and performance tuning.

2) System Maintenance
- Support for migrated applications and code, ensuring compatibility with evolving environments.

3) Cloud or Modernized System Support
- If the target is a cloud platform, costs may include platform support and scaling, separate from migration tools.

4) Optimization and Enhancements
- Post-migration, regular updates or optimizations are common, especially for performance or compliance needs.

5) Skill Retention:
- Retaining or upskilling staff to maintain the new system effectively.

6) SLAs and Downtime Prevention
- Investment in high-availability infrastructure and premium SLAs with vendors to minimize downtime costs.

Once the migration is complete, the costs are reduced drastically for the below factors

A. Mainframe Infrastructure Costs **(↓)**
B. Labor Costs **(↓)**
C. Adoption Costs **(↓)**
D. Tools **(↓)**

Consistent costs over a period

E. Cloud Infrastructure Costs **(→)**
F. Support Costs **(→)**

V. SUMMARY

Migrating from mainframe legacy systems to distributed systems utilizing open-source technologies offers significant opportunities for cost savings, improved scalability, and business agility. However, the process is complex and costly, requiring careful planning and execution to ensure a positive return on investment.

This paper has outlined the key factors influencing migration costs, including infrastructure, labor, downtime, and data migration. It also highlighted opportunities for cost savings through open-source adoption, cloud infrastructure, automation, and phased migration approaches. By building a strong business case and performing a comprehensive ROI analysis, organizations can make informed decisions about modernizing their IT infrastructure.

Ultimately, mainframe modernization offers significant long-term benefits that can transform an organization's ability to innovate, scale, and compete in today's digital world. With the right approach, the migration can be a valuable investment in the future of the business.

Digital transformation also includes managing the organization's change. While it's of utmost importance to choose the right strategy for migration with a clear business case, it's equally important to manage stakeholders, their interests, and power to still navigate through the core outcomes of transformation.

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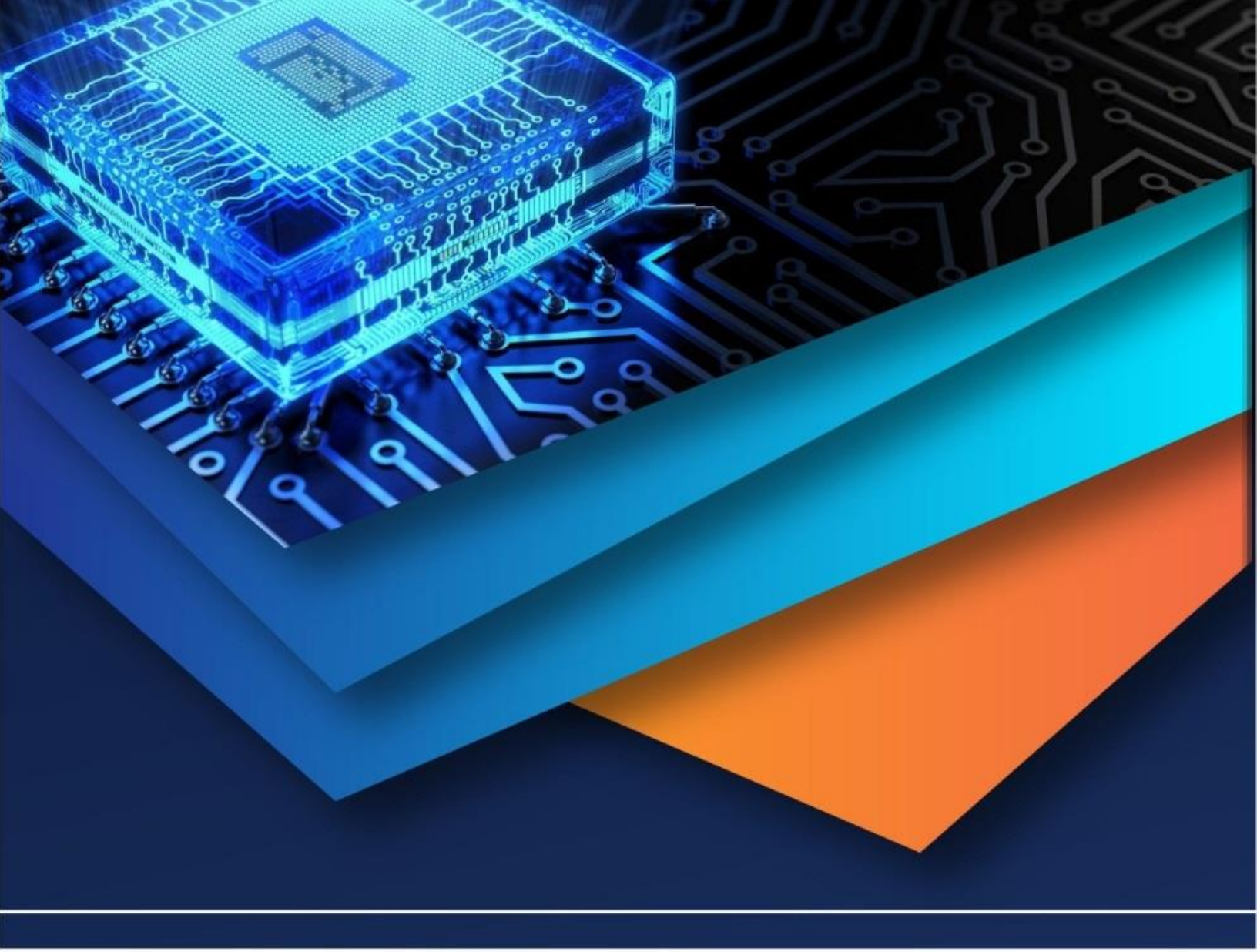
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