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Original Article

A Comparative Analysis of Cloud Migration Frameworks for Mainframe Modernization: AWS vs Azure vs GCP

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Abstract: *Mainframe systems have been the backbone of many large enterprises for decades, but the rapidly evolving IT landscape, coupled with the need for greater scalability, flexibility, and cost-efficiency, is driving organizations to modernize their legacy systems. Cloud migration is a key strategy for transforming mainframe applications to align with contemporary business demands. This research provides a comprehensive comparative analysis of the cloud migration frameworks offered by the three leading cloud providers—Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP)—focusing on their applicability for mainframe modernization. The paper evaluates each provider's tools, services, scalability, security features, cost structures, and migration strategies to help organizations make informed decisions about their cloud migration approach. By examining real-world case studies and drawing insights from industry practices, this paper provides a detailed overview of the strengths and weaknesses of each platform, ultimately offering recommendations based on specific use cases and organizational needs.*

Keywords: *Mainframe Modernization, Cloud Migration, AWS, Microsoft Azure, Google Cloud Platform (GCP), Legacy Systems, Rehosting, Replatforming, Refactoring, Cost Efficiency, Scalability, Security and Compliance, Cloud Migration Frameworks, Digital Transformation.*

I. INTRODUCTION

Mainframe systems have been central to many organizations' IT infrastructure for decades, particularly for industries like banking, insurance, and government. These legacy systems were designed to handle high volumes of transactions, provide stability, and support critical business operations. However, as technology has progressed, organizations face increasing challenges in maintaining these aging systems. The growing demand for digital transformation, scalability, and cost efficiency has made it essential for many businesses to modernize or migrate their mainframe applications to more flexible, cloud-based environments. Cloud migration is increasingly seen as a viable strategy for transforming legacy systems into agile, scalable, and cost-effective solutions.

Cloud platforms like Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP) have emerged as key players in the migration process, offering specialized tools and frameworks for mainframe modernization. The selection of a suitable cloud provider and migration framework is critical to ensuring a smooth and successful transition from a mainframe environment. This research aims to provide a comprehensive comparative analysis of the cloud migration frameworks available from AWS, Azure, and GCP, examining their key features, tools, and capabilities for mainframe modernization. The study also highlights the strengths and weaknesses of each platform in order to guide organizations in choosing the best fit for their modernization needs.

II. MAINFRAME MODERNIZATION OVERVIEW

Mainframe modernization refers to the process of migrating legacy mainframe systems and applications to more contemporary platforms such as cloud infrastructure or distributed computing environments. It encompasses a range of approaches, from simple rehosting (lifting and shifting) of applications to more complex replatforming, refactoring, or even rebuilding of systems to take full advantage of modern cloud capabilities. This transformation is often necessary due to the growing operational costs associated with maintaining legacy systems, the difficulty of integrating with modern technologies, and the limited scalability of mainframe environments.

Mainframe modernization strategies generally fall into five categories known as the "Five Rs": Rehost, Replatform, Refactor, Rebuild, and Replace. Rehosting involves moving the mainframe workload to a cloud environment without major changes to the underlying codebase. Replatforming may require adapting the application to fit cloud environments but with minimal code changes. Refactoring or reengineering involves revising applications to fully leverage cloud-native features like microservices and containers. Rebuilding may involve starting from scratch and recreating the mainframe functionality with modern technologies. Finally, replacing refers to completely replacing legacy systems with off-the-shelf cloud-based solutions or software-as-a-service (SaaS) alternatives.

Key considerations for organizations embarking on this journey include data migration strategies, application compatibility, ensuring business continuity during the transition, and the integration of legacy systems with cloud environments. Despite the potential benefits, challenges such as skill shortages, legacy system dependencies, and the complexity of managing hybrid environments can complicate the modernization process.

III. CLOUD MIGRATION FRAMEWORKS OVERVIEW

This section will explore the cloud migration frameworks provided by the three major cloud providers—AWS, Microsoft Azure, and Google Cloud Platform—and highlight their respective tools and capabilities for facilitating mainframe modernization. These frameworks are designed to streamline the migration process by offering automated tools, pre-configured services, and resources to guide organizations through each stage of their cloud journey.

A. AWS Cloud Migration Framework:

AWS provides a comprehensive suite of tools specifically designed for migrating legacy mainframe applications to the cloud. The AWS Mainframe Modernization service helps organizations rehost, replatform, or refactor mainframe workloads. Additionally, the AWS Migration Hub allows users to track the migration process across different services and provides migration plans, cost estimates, and resource recommendations. AWS also offers a range of compute, storage, and networking services, as well as security features, which are essential for ensuring that modernized mainframe applications operate efficiently in the cloud.

B. Azure Cloud Migration Framework:

Microsoft Azure has a range of services aimed at simplifying the migration of legacy systems to the cloud. Azure's Migration Center offers an integrated set of tools for discovering, planning, and executing mainframe migrations. Azure's Virtual Machines, along with its Azure VMware Solution, enable businesses to move mainframe workloads to cloud-hosted VMs with minimal changes. Azure also supports refactoring and rearchitecting mainframe applications using tools like Azure Kubernetes Service (AKS) and Azure DevOps, facilitating the development of cloud-native applications.

C. GCP Cloud Migration Framework:

Google Cloud's approach to mainframe modernization revolves around its Migrate for Compute Engine service, which helps organizations move workloads to Google Cloud with minimal disruption. GCP also supports the use of containers and microservices through its Kubernetes Engine (GKE) and Anthos, which are ideal for organizations looking to refactor and modernize their applications. GCP's strength lies in its powerful data analytics and machine learning capabilities, which can be leveraged to enhance the functionality of mainframe applications once they are migrated.

IV. COMPARATIVE ANALYSIS OF AWS, AZURE, AND GCP FOR MAINFRAME MODERNIZATION

In this section, a detailed comparative analysis of AWS, Azure, and GCP will be presented, focusing on key criteria such as migration strategy alignment, tools and services, cost models, security, and performance.

A. Cloud Strategy Alignment:

The three providers offer different approaches to mainframe migration. AWS tends to focus on a more traditional approach with a variety of options for rehosting and replatforming. Azure offers a hybrid approach with strong integration with on-premise systems, which is especially attractive for enterprises that are already using Microsoft products. GCP, on the other hand, emphasizes modern application architectures like containers and microservices, making it ideal for organizations looking to refactor or rebuild their mainframe workloads.

B. Migration Tools and Services:

AWS provides specialized services like AWS Mainframe Modernization and the Migration Hub to simplify the migration process. Azure's Migration Center and tools such as Azure Site Recovery and Azure VMware Solution help organizations migrate workloads with minimal disruption. GCP's Migrate for Compute Engine and its strong containerization support (via Kubernetes) provide robust solutions for organizations aiming for cloud-native transformations.

C. Cost and Scalability:

Each cloud provider offers different pricing models that can impact the overall cost of migration and operation. AWS generally operates on a pay-as-you-go basis, which can be cost-effective for smaller migrations but may incur higher costs for larger-scale migrations. Azure's pricing structure is competitive, especially for organizations already using Microsoft's licensing models. GCP tends to offer attractive pricing for compute resources, particularly with sustained use discounts. Scalability is a key advantage of all three platforms, but each has unique features in terms of vertical and horizontal scaling.

D. Security and Compliance:

Security is a top concern during the migration of critical business applications. AWS offers a wide range of security features, including encryption, IAM (Identity and Access Management), and compliance with industry standards like HIPAA and GDPR. Azure's hybrid capabilities ensure that on-premise and cloud-based systems are securely integrated. GCP's security offerings are known for their robustness, with strong identity and access management tools, encryption, and compliance with global standards.

E. Performance and Reliability:

Each provider offers high availability and reliability features, but AWS is known for its global reach and redundancy, making it a strong contender for large enterprises. Azure's global data center network provides excellent redundancy, and GCP is often praised for its high-performance computing capabilities, especially in data-intensive workloads.

V. CASE STUDIES AND REAL-WORLD IMPLEMENTATIONS

This section will present a series of case studies illustrating how various organizations have used AWS, Azure, and GCP to migrate their mainframe workloads to the cloud. These case studies will highlight the specific challenges faced by each organization, the tools and migration strategies employed, and the outcomes of the migration process.

A. AWS Case Study:

A large financial institution migrates its mission-critical banking applications from mainframe to AWS. The case study will explore the tools used (such as AWS Migration Hub and Mainframe Modernization), the challenges encountered in migrating legacy COBOL applications, and the benefits realized post-migration, such as improved scalability and reduced operational costs.

B. Azure Case Study:

A multinational healthcare provider moves its legacy hospital management system to Azure. The study will focus on the use of Azure's hybrid capabilities, integration with existing on-premise systems, and the adoption of Azure Virtual Machines and DevOps tools for refactoring applications.

C. GCP Case Study:

A retail giant modernizes its supply chain management system by migrating its mainframe-based applications to Google Cloud. The case study will explore the use of GCP's containerization tools, Kubernetes, and machine learning capabilities to enhance the supply chain's performance post-migration.

VI. KEY FINDINGS AND INSIGHTS

After analyzing the cloud migration frameworks of AWS, Azure, and GCP, several key findings and insights can be drawn:

- AWS tends to be the most flexible for organizations looking to rehost and replatform their mainframe systems with minimal changes.
- Azure excels in hybrid cloud solutions and is well-suited for businesses already relying on Microsoft technologies.
- GCP offers superior tools for organizations interested in refactoring applications or adopting cloud-native architectures like containers and microservices.
- Each platform has distinct strengths, so the choice of cloud provider should be based on an organization's existing technology stack, migration goals, and specific needs (e.g., security, compliance, and scalability).

VII. CONCLUSION

In conclusion, this research provides a comprehensive analysis of the cloud migration frameworks offered by AWS, Azure, and GCP for mainframe modernization. Each platform has its unique strengths, and the decision to choose one over the others should be based on specific organizational needs and use cases. For organizations looking to maintain as much legacy functionality as possible, AWS and Azure provide robust tools for rehosting and replatforming, while GCP offers compelling options for those seeking to fully modernize their mainframe systems through containers and cloud-native applications. Ultimately, a successful migration strategy will involve a detailed assessment of business goals, technical requirements, and budget constraints.

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