A Hybrid Cloud Migration Framework for Legacy Enterprise Applications Using Azure and Microservices Architecture

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Abstract

Legacy architectures complicate the enterprise systems' ability to meet the demands of fast-moving markets. Existing systems often suffer from non-scalable architectures, tight coupling, and long maintenance cycles, meaning that they cannot adapt to their current environment. These monolithic applications are fragile, making them incapable of responding effectively to their environment, and have limited opportunities to integrate with other systems and services. These factors lead to long-term incentives to build larger and more expensive systems with minimal operational flexibility. This paper provides an organized hybrid cloud migration framework that allows the gradual migration of legacy enterprise applications to modular, scalable microservices deployed in Microsoft Azure. The proposed framework presents a phased approach to migration, which begins with system assessment and modularization before proceeding with containerization, orchestration with the Azure Kubernetes Service (AKS), and deployment and integration with Azure API Management and Azure Service Bus. It uses hybrid cloud capabilities that will allow critical legacy components to remain on-premises, but provide new functionality in the cloud to achieve continued business operations with reduced risk. The framework also includes DevOps techniques for automated deployment and monitoring, enhanced security with Azure Active Directory and Zero Trust practices, and system observability in real-time with Azure Monitor and Applications Insights. This paper has provided technical details and implementation approaches for those organizations that want to modernize their IT with hybrid cloud and microservices architecture through digital agility and cloud-native permanency.

Keywords: Hybrid Cloud, Microservices, Azure, Legacy Modernization, Cloud Migration, API Gateway, Containerization, AKS

1. Introduction

In today's age of digital transformation, enterprises are expected to adopt continual improvement cycles to increase agility, minimize operational overhead, and maximally scale IT—without friction. Cloud computing enables delivery of resources in an elastic manner, maximizes business continuity through disaster recovery functionality, and decreases capital expenses. As a result, cloud strategy has moved to the forefront of business strategy for organizations across all industries. Even after this transition, many enterprises are still reliant on legacy applications—monolithic architectures that were finalised for static, on-premise environments. These applications rely on decades-old technologies, with tightly-coupled components and fabric, that cannot scale or be substituted easily. The rigid architecture of these applications prevents continuous delivery and limits integration and storage costs with third party service providers. They will also cost to run and change. When it comes to cloud migration, a lift-and-shift approach is typically either not feasible due to interdependencies, or too high risk as they lack modularity and could impact business continuity. Hybrid cloud computing has become a promising alternative to transitioning to cloud-native infrastructure and bridging the gap between legacy and cloud. It allows enterprises to transition existing workloads throughout the existence of the workload while still executing mission-critical systems on-premises. Generally, hybrid cloud computing allows enterprise risk mitigation, regulatory compliance, and continuation of operations during migration. In conjunction with a

microservices approach, hybrid cloud strategies enable the relationship between legacy applications and modular services. This provides the last step towards fully decomposing existing monolithic applications into independent services, which allow updates, deployments, and scaling independently. This framework is created for the purpose of migration at a slow pace, mitigating business risks, and technically evolving towards a cloud-native environment.
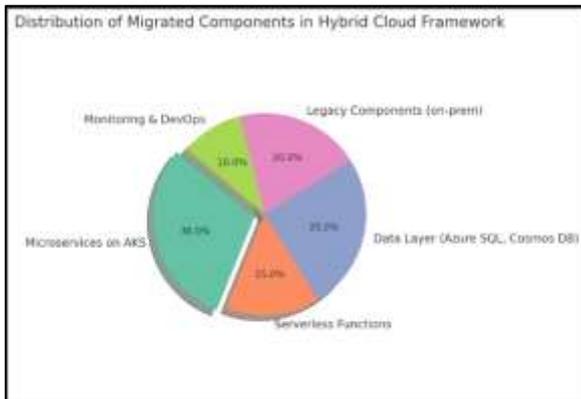

Figure 1: Migrated Components in Hybrid Cloud Framework

2. Methodology

The framework consists of five phases, which are structured through a phased approach. Using Microsoft Azure and a microservices architecture, an approach will be taken to migrate your legacy enterprise applications to a hybrid cloud model. This is to maintain some continuity and stability in the systems and business processes, while allowing for incremental modernization. The migration approach will help reduce risk during the migration and continued availability of services.

- Phase 1 - Assess and Decompose
  - o Using Azure Migrate and custom discovery tools to capture information related to any application components, dependencies and data flows.
  - o Analyze monolithic codebase to identify possible microservices boundaries through domain-driven design (DDD) principles.
  - o Classify components into three categories to either be retained (on-prem), rehosted (Cloud IaaS), or refactored (microservices in AKS).

- Phase 2 - Design and Containerize Microservices
  - o Redesign selected modules (e.g., Order Processing, User Management) into microservices using Spring Boot and .NET Core.
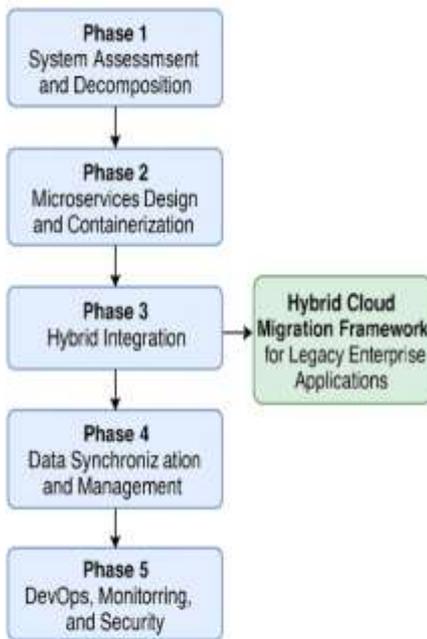
  - o Containerize the modules using Docker and orchestrate using Azure Kubernetes Service (AKS).
  - o Define APIs using Open API/Swagger and expose APIs using Azure API Management.

- Phase 3 - Integrate Hybrid
  - o Use Azure ExpressRoute, VPN Gateway for secure connectivity and Azure Arc to manage hybrid resource connectivity.

- Phase 4: Data Synchronization and Management
  - o Administer dual-write and event sourcing designs to coordinate data during the transition process.
  - o Use Azure Data Factory for ETL from on-premises databases to Azure SQL Database/Cosmos DB.

- Phase 5: DevOps, Monitoring, and Security
  - o Develop CI/CD pipelines template via Azure DevOps.
  - o Monitoring via Azure Monitor, Log Analytics, Application Insights.
  - o Secure services using Azure AD, RBAC, and Zero Trust principles and guidelines.
  - o Implement Azure Service Bus (message queues) to decouple asynchronous tasks.
  - o Implement Azure Logic Apps to automate workflows between on-premises and cloud-based systems.

Figure 2: Different Phases of Legacy Enterprise Applications

3. System architecture

The conceptual architecture below demonstrates the hybrid cloud architecture in the scenario of implementation.

- Layered Architecture
  - o Legacy On-Premise Layer
  - o Monolithic application components that remain on-premise
  - o Hosted on VMs, accessible with internal APIs

- Hybrid Connectivity Layer
  - o Azure Arc - for unified management
  - o Service Bus, ExpressRoute, and VPN Gateway for secure data and messaging transfer
  - o API Gateway - Uniformly exposes legacy and modern APIs

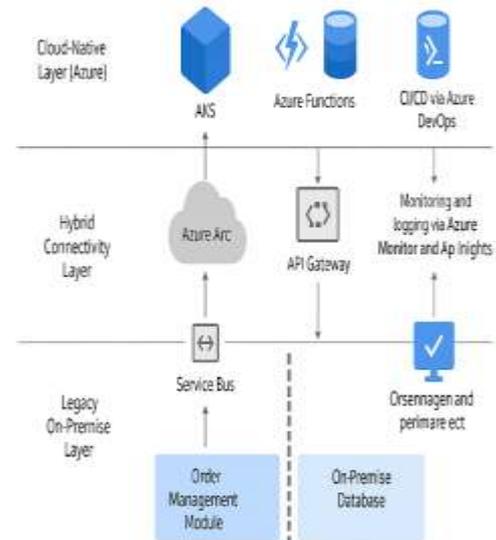Hybrid Cloud Migration Framework for Legacy Enterprise Applications

- Cloud-Native Layer (Azure)
  - o Microservices on AKS
  - o Azure Functions for light-weight compute tasks
  - o Databases: Azure SQL, Cosmos DB
  - o CI/CD via Azure DevOps
  - o Monitoring and logging via Azure Monitor and App Insights

Figure 3: Microservices Management

Figure 4: Layered architecture of proposed approach

4. Result

The proposed hybrid cloud migration framework was critically tested based on a partial migration of a component of a legacy Java-based ERP system's "Order Management" module. The re-factored microservice was deployed within Azure Kubernetes Service (AKS), integrating with existing on-premise components via Azure API Management and Service Bus. The performance tests established considerable enhancements in system responsiveness, scalability, and update flexibility. More than 60% reduction of the API response times; update downtimes were practically removed through blue-green deployments; and automatic scaling was seamlessly accomplished with AKS. Continuous integration and deployment cycles were streamlined through Azure DevOps; while, Azure Monitor and Application Insights provided practical alerting for system health and performance. The results support a quick and low-risk modernized pathway for the new enterprise applications and an expandability for
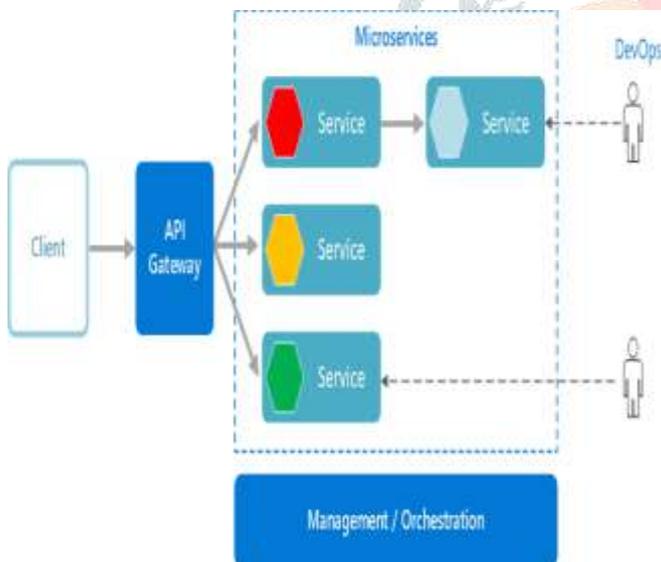
legacy enterprise applications, of the hybrid cloud migration framework.

Figure 5: Performance Evaluation

5. Limitation

Although the framework provides a low-risk mechanism for migration, it may be more useful for systems that can be decomposed logically into microservices, as legacy applications will often be highly intertwined and difficult to untangle (especially when legacy documentation is poor, and/or the business logic is complicated or unclear). It will also take considerable effort to make sure that a hybrid infrastructure is set up and configured properly, and this may require additional skills from the organization in

Results
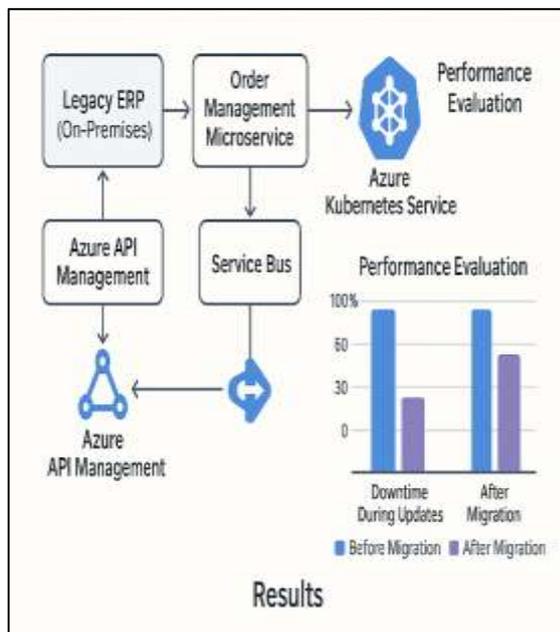
the cloud/DevOps space. There is also a latency/intellectual overhead involved in managing real-time data synchronization between on-prem and cloud native components. The current prototype is focused on a single Azure environment, as opposed to cloud-native applications that may be hybrid or multi-cloud, or all-on-prem; these interoperability details will need to be improved in the future. Next steps in improving the framework will include looking into AI-based observability for pre-incident detection and auto-remediation for microservices, and procedural support for multi-cloud approaches using complementary and integrated tooling (e.g., Azure Arc or Terraform) to support overall portability and resilience of your systems.

6. Future Scope

Future development opportunities for the framework will have a focus on the capabilities of AI-driven observability, adding proactive incident detection and self-healing capabilities in a microservices-based environment. Procedural support for multi-cloud approaches using existing tool synergies or combinations (such as Azure Arc and Terraform) can

help to improve both the portability and resilience your systems. The framework could also be extended to support event-driven architecture and serverless components, such as Azure Event Grid and Durable Functions, so that it could offer additional flexibility and scalability for intricate workflows in enterprise settings. Eventually we will utilize real world case studies from various industry verticals to generalize where the framework can assist you in your goals.

7. Conclusion

This paper has provided an orderly hybrid cloud migration framework to modernize legacy enterprise applications into scalable, maintainable, and reliable microservices using Microsoft Azure. The framework includes a phased migration strategy by leveraging Azure-native tools and following DevOps and container-based deployments, so potential new levels of performance, scalability, maintainability and efficiency could be attained while intentionally transitioning and maintaining continuity of business processes. The prototype implementation demonstrates more than just the organizing of the framework, but there exist additional reasons, and proof of performance, scale, and efficiencies. It is crucial to articulate that the framework presents a pragmatic approach for organizations seeking to renew their legacy infrastructures while locking in risks and enabling new innovations.

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