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OPTIMIZING CLOUD MIGRATION: DESIGNING ROBUST ARCHITECTURES FOR SEAMLESS TRANSITION FROM ON-PREMISES TO AZURE FOR SAP AND DATABASE SYSTEMS

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ABSTRACT
In the current complex world of IT specialization, organizations are moving towards cloud infrastructure to improve scalability, cost optimization, and flexibility. Microsoft Azure is one of the available platforms that provides a rich, flexible, and robust environment designed to face every migration, including SAP systems or other critical databases for the business. However, for migration to be smooth, it must be done systematically and effectively through a very well-secured, well-designed architecture for the cloud and a plan that will enable minimal disruption of the business in case of disasters. In this article, the author focuses on the most critical strategies and considerations that must be considered for a well-thought-out architecture that can support the migration of SAP workloads and other databases to the Azure Cloud. Organizations can now leverage Azure native tools, inclusive of Azure Migrate, SAP on Azure services, and database migration solutions, which shall enable organizations to experience a smooth journey to the Azure environment while adhering to compliance standards, achieving maximum performance efficiency and minimizing costs in the process.
Migration is a complex process containing certain phases involving the assessment, planning, process of performing, and optimization. Discovery is the first step in migration, where the organization looks at the current on-premise environment to see what is there, where the problems are, what the costs are, and how to prioritize. This was succeeded by implementing a high-availability design on Azure that would bring scalability, disaster recovery, and multi-region support to enterprise applications. This article discusses approaches to avoiding interruption of SAP systems and database workloads like SQL Server, Oracle, and PostgreSQL during migration. This is to maintain data integrity during replication, utilize cloud-native technology for always-on synchronization, and use a step-by-step migration approach to avoid risks relating to migration. Moreover, the article also focuses on the integral aspect of the requitable architecture regarding the ISO, GDPR policies, and other requirements for safe data processing and compliance with the legislation.
Optimization after migration is highly recommended to enhance the return on investment aspect of Azure Cloud applications. Azure Monitor, Azure Cost Management, and several other in-built tools for performance tuning help organizations better control their resources and applications. Moreover, it discusses using Azure pricing models like RI and Autoscale to control such costs. These are some of the ways that, if implemented, would help lock the business's infrastructure for the future and also help increase performance and stability. This article is a

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study specific to IT leaders and administrators. It provides guidelines with practical solutions for implementing RI and migrating SAP systems and databases from on-premise infrastructure to Azure cloud.

KEYWORDS:
Cloud Migration, Azure Architecture, SAP Migration, On-Premises Infrastructure, Database Migration, Hybrid Cloud, Scalability, High Availability, Data Security, Performance Optimization, Cloud Strategy, Cost Management, Network Configuration, Backup Solutions, Disaster Recovery, Compliance, Virtual Machines, Load Balancing, Resource Allocation, Containerization, Automation Tools, Integration Services, Monitoring Solutions, Data Transfer, Application Compatibility, DevOps Practices, User Training, Pilot Testing, Change Management, Continuous Improvement.

INTRODUCTION

With the digital transformation process gaining traction across organizations, getting Cloud Readiness through migration from an on-premises environment is becoming a major undertaking. The Microsoft-developed Azure Cloud is a complete package that hosts a variety of services that can help businesses harness the powers of cloud computing, including scalability, elasticity, and cost efficiencies. This migration is especially applicable to enterprises using the SAP system and other similar databases that show high performance and availability requirements.

1. Understanding Cloud Migration

Cloud migration is the movement of business applications and other organizational unit elements from local storage into cloud storage. Some reasons for this shift are chasing higher advantage, minimizing operating expenses, and better responding to disasters (Marston et al., 2011). A study also reveals that costs can be cut substantially by moving organizations to the cloud; Gartner claims that the amount can be slashed by up to 30% (Gartner, 2021). The new model is calculated to reduce organizational costs because businesses shift their main processes to the cloud, and infrastructure maintenance will be handled by cloud service providers.

2. The Importance of a Robust Architecture

More specifically, the paper outlines why a strong architectural foundation is crucial for organizations and those involved in software development.

It is necessary to underline the potential of cloud migration, which can become rather effective if a well-designed architecture is in place. Even with the notable benefits of technology in construction, a good structure helps to reduce risks of data loss, time loss, and security breaches. Analyzing the results of the Cloud Security Alliance in 2020, firms that focus on the fundamental architecture complain fewer about data breaches and downtime during the transition.

Table 1: Advantages of Having a Secure Architecture Based on the Cloud

Benefit	Description
Scalability	A degree of flexibility is needed when it comes to resource allocation.
High Availability	It ensures that systems are fully functioning and that users can access them with less downtime.
Enhanced Security	Preserves information security through the use of better security policies.
Performance Optimization	Optimizes resource usage on any particular application, enhancing its performance.

3. Key Components of Azure Architecture

This work centers on defining the five key components of Azure architecture, which are the following:

There should be some crucial blades to build a sound architecture for migration into the Azure environment. These include:

- **Compute Resources**: Azure offers different computing options, such as Virtual Machines or Azure Kubernetes Service (AKS). Applications can be run on flexible VMs, while AKS helps orchestrate the containers necessary to develop modern applications (Microsoft, 2021).

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- **Storage Solutions**: Businesses can choose Azure Blob Storage and Azure SQL Database for large data storage requirements because they are highly available and redundant. These storage choices benefit SAP applications, as these tools might need extensive databases (Microsoft, 2022).
- **Networking**: Desirable networking solutions are the basis for successful and safe data exchange between on-premises networks and Azure. Azure VNET and VPN Gateway offer a business secure connectivity solution for linking an on-premises environment with the cloud and, thus, a hybrid cloud environment (Microsoft, 2022).

Table 2: Major parts of Azure Migration framework

Component	Description
Compute Resources	Azure VMs and AKS for the efficient distribution of application workload
Storage Solutions	Blob Storage is used for file storage, and SQL Database is used for structured data storage.
Networking	We will discuss VNets and VPN Gateways for secure connection today.

4. Challenges in Migration

Unlike other processes, migration comes with challenges, assisted by different organizations that have realized the benefits of migrating to new platforms. One standard data problem organizations face is data compatibility, which means they must combine or migrate systems (Liu et al., 2021). Another important challenge is downtime considerations, for which organizations seek to maximize continuity of work interruptions during migration. Thirdly, the existing complex systems can impose challenges by hampering the process of migration (Smith & Jones, 2021).

5. Best Practices for Migration

To navigate these challenges successfully, organizations should adopt best practices throughout the migration process:

- **Assessment of Existing Infrastructure**: A system inventory in the current state must be performed to understand the likely compatibility problems and to identify resource requisites (Chen et al., 2020).
- **Development of a Comprehensive Migration Strategy**: Specific goals that should be captured in a well-defined migration strategy involve the following: the migration process and probable time frame, human and other resources required, and probably measures of risk control.
- **Implementation of Robust Monitoring and Backup Solutions:** Organizations should also monitor end-users during migration to track performance and any problems. Reliable solutions to maintaining data backup, data integrity, and accessibility throughout the process are also critical to its success (Cloud Security Alliance, 2020).

Altogether, the transformation from on-premises infrastructure to Azure Cloud means a new advanced level for the organizations, with more effective and expandable ways to manage the resources in their companies. However, to efficiently perform the transition, the existence of a stable and efficient architectural model that can support the integration process must be designed to work around the issues and recommended recommendations. Successful migration to the cloud requires a detailed understanding of the different components of Azure architecture, which, if well incorporated in a migration plan, will enable businesses to overcome the challenges of migration, thus enhancing the performance of their system while at the same time cutting expenses.

MATERIALS AND METHODS

The methodology for implementing the strong architecture that can help move SAP and other databases from on-premise to the Azure Cloud is stepwise. In this section, the strategy, tool, approach, models, and methodology adopted in the migration process are highlighted in detail.

1. Materials

1.1. Cloud Infrastructure

- The main subject of this migration is the Cloud Azure platform, which provides several services and tools for supporting enterprise applications. Key components include Azure Virtual Machines (VMs), which offer the computation resources needed to run SAP applications and databases.
- **Azure SQL Database**: This managed database service hosts relational databases with additional intelligence to ensure the best performance.

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- **Azure Blob Storage** is used for storing huge volumes of unorganized data, such as backups and logs.
- **Azure Virtual Network (VNet):** Customers use this service to create a secure and isolated environment for Azure resources.

1.2. Migration Tools

Several tools were employed to facilitate the migration process, including:

- **Azure Migrate**: An all-encompassing solution for evaluating and moving an organization's on-premises applications to the cloud. Its features include dependency mapping, performance analysis, and cost estimation.
- **Azure Site Recovery**: This tool reproduces workloads to help with disaster avoidance, recovery, and business continuity.
- **Database Migration Service (DMS):** This service helps move databases to Azure SQL Database with no or little disruption of services.

1.3. Assessment and Planning Tools

Before migration, a thorough assessment was conducted using various tools:

- **Cloud Adoption Framework (CAF):** While Microsoft has outlined the above as a plan for execution, it also has a framework with industry benchmarks, documentation, and tool-span to accompany the cloud adoption assessment.
- **Azure Advisor:** This service provides best practices and recommendations for Azure resources tailored to the organization's specific needs.

2. Methods

2.1. Assessment Phase

The migration process started with the preliminary evaluation of the on-premises environment. This involved:

- **Inventory Analysis**: Azure Migrate, along with other tools, was used to prepare a detailed list of all the applications, databases, and their interdependencies. This helped us determine which applications were suitable for migration and their compatibility challenges.
- **Performance Baseline:** Data from the existing infrastructure were gathered to set the benchmark for achieving performance parameters. This data was vital to evaluate initial and subsequent measures before and after migration.

2.2. Migration Strategy Development

As part of the migration initiative, the following actions have been proposed in the development of the migration strategy:

Based on the assessment findings, a migration strategy was developed that included:

- **Lift-and-Shift Method**: The applications that needed LAMP layer updates underwent a lift-and-shift policy, and the migration could be done quickly without extensive modifications.
- **Re-architecting**: Based on the findings above, applications that required additional optimization for the cloud environment were chosen for re-architecture. This involved refactoring applications to use other native cloud application features, including microservices and serverless paradigms.

2.3. Migration Execution

The execution phase of the migration involved several key steps:

- **Preparation:** Migration tasks before the migration process involved creating the Azure resources provision, configuring Vnets, and determining security measures to be employed. This secured the environment in advance before the migration had started.
- **Data Migration:** Available databases are also migrated using the Database Migration Service with little or no downtime. This involved:
  a. **Schema Migration:** Migration of the schemas of the databases to Azure SQL Database.
  b. **Data Transfer:** Using the migration strategies over the web to transfer data while concurrently ensuring the availability of the applications.
- **Application Migration:** See 5.4 Portability scenario. Applications were migrated in phases according to the developed strategy. This included:
  a. **Testing:** Every application was rigorously tested in the Azure environment for functionality and performance.

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b. **User Acceptance Testing (UAT):** End-users test to ensure that the applications developed meet business purposes.

2.4. Post-Migration Optimization

After migration, several activities were conducted to optimize the cloud environment:

- **Performance Monitoring:** Azure was used to monitor the performance and utilization of the required resources in this application and to discover any constraints.
- **Cost Management:** Various Cost Management tools within Azure assisted in scrutinizing the spending pattern and defined settings to efficiently use resources to curtail expenses.
- **Feedback Collection:** This was aimed at getting feedback from the users to determine what needs to be changed to make them accept the new cloud environment.

2.5. Documentation and Training

Extensive documentation of the migration process was developed to record all the necessary knowledge for further management. Sensitivity training sessions were also conducted to ensure that all the IT staff and end-users were aware of the new Azure environment.

The materials and methods presented in this section give practical guidelines on performing a non-disruptive transition from on-premises physical infrastructure to the Azure Cloud for SAP and other databases. More specifically, through a competent evaluation process, organization development, implementation plans, and a strict implementation process, one can perform a smooth and efficient move that leads to improved operational efficiency, scalability, and security. By integrating Microsoft Azure services with handling best practices from CAFACT, Azure sets organizations on the right course to fully optimize cloud technology.

DESCRIBING AZURE MIGRATION ARCHITECTURE

The shift from local infrastructure to Azure Cloud needs a detailed architecture plan. Below are several practical architectural approaches:

1. Hybrid Cloud Architecture

Companies can keep their important on-site data centers running smoothly by adding Azure features that increase performance and adaptability. Key components include:

- Organizations can access Azure through ExpressRoute to create direct private connections.
- Azure Site Recovery helps us maintain our operations when disasters strike.
- Our most important changes include the addition of Azure Active Directory to simplify users' digital connections.

This cloud delivery model works best when an organization moves slowly to cloud services.

2. Lift-and-Shift Architecture

The lift and shift migration copies existing applications to Azure with only fundamental changes. This typically utilizes:

- Azure Virtual Machines handles the application hosting.
- Azure Blob Storage helps companies store data across multiple servers.
- Azure Networking helps organizations create dependable, secure network links.

This method suits businesses that want fast cloud gains yet require minor service interruptions.

3. Refactored Architecture

A refactored architecture needs applications to work better in Azure through product updates. Essential components include:

- The design uses Azure Kubernetes Service (AKS) to handle container operations.
- Azure Functions helps companies do serverless computing work.
- Our Azure environment includes an Azure SQL database for database management.

Organizations using this model want to build systems that will work better across more users without impacting performance.

4. Cloud-Native Architecture

Cloud-native applications are built to work smoothly inside cloud settings. Important components include:

- Azure App Services lets you host web applications.
- Azure Cosmos DB provides a distributed database system for multiple data models operating globally.
- Projects benefit from workflow automation solutions that Azure Logic Apps provides.

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Organizations use this approach most often to create modern cloud applications from scratch.

5. Current Changes in Cloud-Entering Technologies

As organizations migrate to Azure, several key trends are shaping the landscape:

- **Increased Adoption of AI and Machine Learning**: Organizations use Azure's powerful AI and ML technology to improve how applications work and how systems make decisions.
- **Growth of Serverless Computing:** Companies select serverless architectures to cut operating costs while adding flexibility without needing to manage infrastructure.
- **Focus on Security and Compliance:** The need to implement robust security solutions has grown alongside growing regulatory demands for reliability during application migrations.
- **Integration of DevOps Practices:** Companies use Agile and DevOps techniques to link development stages better and make their teams work faster.

Organizations achieve better cloud benefits through Azure migration by following current design standards and cloud computing concepts.

Figure 1: The graphic shows how these updates developed step by step throughout time.

We study present trends when companies move operations to the cloud.

Trends in Cloud Migration

Cloud service use has continued to grow since 2010 because companies prefer combining public and private clouds. Businesses pay more for security and compliance because they understand their legal requirements.

LITERATURE REVIEW

The shift in focus from traditional 'on-premise' systems to cloud environments, and more specifically to Microsoft's Azure, has become an area of interest for strategic organizations seeking to improve organizational

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operational effectiveness and flexibility. This paper consolidates the important and emerging findings from current literature and presents them under such aspects as trends, methods of studying cloud migration, challenges, and successes, especially in migrating the SAP or other database systems.

1. Cloud Migration Strategies

Numerous migration approaches have been postulated in the literature. Marston et al. (2011) also note that organizations can use the lift-and-shift approach, which transfers applications without making significant adjustments. This method is preferred mainly because it takes longer than any other method. As identified in prior work, such as Kuo (2021), the 're-architecting' method offers better long-term advantages by configuring applications specifically to take full advantage of cloud-native characteristics. This applies to refactoring applications and optimizing these for the cloud with strategies like serverless and microservices.

2. The Significance of a Sound Design

It is also important that the structures have to be properly designed to make the migration process more manageable. In their article, Zhan et al. identified that such architecture could allay the downtime during the changeover, improve security, and maintain the integrity of records. The authors are deeply concerned about the lack of an explicit architectural vision and mission, which should accommodate such components as load balancing, redundancy, and disaster recovery options.

3. Subcomponents of Azure Architecture

Various reviews indicate that various important requisites must be considered important in migration to Azure. Platforms are, in essence, basic building blocks of the application and can be physical or virtual; compute resources are Azure Virtual Machines and Azure Kubernetes Service (Microsoft, 2022). Microsoft Azure file storage, such as the Azure Blob Storage and Azure SQL Database, are the requisite data storage platforms (Patel & Raval, 2020).

As noted by Soni et al. (2021), two features that matter most are Azure VNets and VPN Gateways, which are responsible for communication between premises and cloud space. This definitely indicates that for migration to be easy and efficient, the network's architecture needs to be correct.

4. Challenges in Migration

With the documented advantages of cloud migration, several factors can act as barriers to the process. As highlighted by Ali et al. (2020), organizations experience data compatibility challenges, making the migration process even more complex. Systems existing before the transformation to the cloud may not be migrated directly and smoothly. Also, worries about unavailable periods may include specific dangers to maintaining the organization, as discussed by Zhang et al. (2021). These risks can only be avoided if organizations take caution in developing migration schedules and equally come up with a strict testing regime.

5. Best Practices for Migration

Before performing the migration, many best practices have been recognized according to the literature on the subject. A swift review of infrastructure should occur; moreover, any gaps in infrastructure need to be assessed critically. Cummings, Cummings, Conant, and Schira (2022) in their study urge managers to take an inventory to accurately determine the problems and issues that arise from the applications and data. This assessment helps choose an effective migration strategy in the corresponding organization.

Moreover, a specific code migration plan needs to be defined. In their work, Garrison et al. (2021) recommend performing a phased migration, where workloads that require initial priority are migrated first. This way, organizations can avoid significant interference and fine-tune scenarios based on initial mass transfer experiences.

6. Security Considerations

Security is always an issue to consider when migrating to the cloud. Many papers focus on the need for overlaying security protocols in migrating systems. As Zhang et al. (2020) concluded, organizations should recommend a defense-in-depth strategy using layers of security controls to guard the information. This comprises implementing proper means of securing data, such as encryption and control of access to cloud systems and constant examination of the cloud system environment.

Adherence to regulation is also essential to ensure that the business conforms to the best-set standard. According to Kaur et al. (2021), for an organization to go for cloud migration, it is Stella's responsibility to consider doing it under permissible rules and regulations such as GDPR and HIPAA. This means that there must be a good understanding of the law that applies to storing and processing data in the cloud environment.

7. Post-Migration Optimization

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Optimization after migration is rarely considered, but it should be considered the final and critical hurdle in the path to the full exploitation of cloud computing. Ram et al. (2021) state that organizations have to track cloud performance and cost daily to know where optimization is necessary. This may entail rightsizing resources, implementing auto-scaling, and utilizing serverless compute choices.

Moreover, feedback should be captured after migration to ensure that proper information from users and other stakeholders is captured. The described iterative approach may more effectively support the optimization of cloud resources and assist any emerging challenges.

The literature shows that the architecture of migrating from on-premise infrastructure to the Azure Cloud entails planning, executing, and improving the general design framework. As for the strategies and best practices, it should be noted that the organizations encountered several problems and faced various situations, which is why an individual approach should be applied. Based on these dynamics and the data from recent research, organizations can better manage the challenges of cloud transition.

DISCUSSION

The transition from an on-premise environment to Azure Cloud for SAP and other databases has its share of prospects and challenges. In recapitulating the literature review, this section focuses on significant propositions highlighting the role of strategic planning, technical architecture, and post-change optimization in guaranteeing a successful migration process.

Strategic planning and assessment or MAP 97.

One of the key objectives when forming strategies for moving applications to the cloud is to plan systematically. As pointed out by Cummings et al. (2022), there is a need to undertake a comprehensive analysis of the IT environment before undertaking the conversion. This assessment helps organizations determine the relationship between applications and data, which is important when mapping migration strategy. It is crucial to identify the core applications and the needs regarding their maintenance to avoid focusing on the unessential and disruption of the procedure.

Furthermore, as recommended by Garrison et al., phasing the migration strategy leads to an improved migration experience in the migration process. Such a plan enables organizations to perfect the migration process and solve any issues that may arise when migrating less important applications while migrating other important applications, but it is not so critical to go through the entire migration process because their migration is likely to be time-consuming and face several challenges. On the same note, the way this iteration helps to minimize the challenge of potential downtime is also cumulative; it helps to increase the capacity of organizations to handle cloud environments.

Necessary features of solid architecture

The literature focuses on the fact that having a strong cloud architecture is crucial to managing risks associated with migration. A good architecture enables scalability, high availability, and security, crucial measures toward organizational goals. According to Zhan et al. (2019), using elements like load balancing and disaster recovery within the architecture can complement system robustness.

Furthermore, decisions made during and about Azure components, including Azure Virtual Machines and Azure SQL Database, are critical to the successful migration. These components can significantly improve quality and data handling or usage (Patel & Raval, 2020). Any organization must also be wary of the architectural design and continually evaluate its compatibility with the organization's desires.

Addressing Challenges

There are undoubtedly many benefits associated with cloud migration, but organizations also face several challenges. As pointed out by Ali et al. (2020), data compatibility has the potential to become a problem during migration processes, especially where a legacy system is being used. To handle these issues, an organization should focus on training employees and client growth so that they can better handle the task within the field of cloud infrastructure.

Security and compliance are also equally important during the migration process. The following are some of the significant migration challenges. According to Zhang et al. (2020), enhanced defense-in-depth protection, which involves using different layers of security measures, is mandatory for guarding such information. There is also a need to navigate rules like GDPR and HIPAA across the migration process, making it important for organizations to accommodate the understanding of legal concerns in a cloud environment (Kaur et al., 2021).

Continuous Optimization

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Optimization should be done after migration to ensure the company gets the most from cloud adoption. Following the works of Ram et al. (2021), it is critical to observe cloud performance and costs to determine unique niches for optimization. It also enables the ongoing evaluation to meet new requirements, utilize resources well, and improve operational efficiency.

Moreover, feedback loops to capture information from cloud consumers would be helpful for other refinements in cloud frameworks. This cyclical method not only encourages creativity but also ensures that the cloud environment always accommodates users' and organizations' demands.

Planning, architecture, change management, and optimization are Some preconditions for migrating from a local basis to Azure Cloud for SAP and other databases. If organizations match the drawbacks and incorporate the ideas from the modern literature, they can avoid errors and maximize the usage of opportunities given by cloud computing.

CONCLUSION

Switching from on-premises to Azure Cloud for SAP and other databases is a massive shift that needs to be discussed and analyzed. This shift provides organizations with an opportunity to unlock superior levels of scalability, better performance, and cost optimization. However, many issues arise, making it require a plan to address technical as well as organizational issues of cloud migration.

Strategic Planning: As a Framework

Early in the literature, planning remains an important element central to cloud migration efforts. Even if a needs analysis has not been made to determine which applications should go to the cloud first, a detailed analysis of current infrastructures will help an organization determine what applications it cannot do without as it seeks to start its migration process. This approach to going about the venture will reduce the many interferences and help organizations improve their operations as the new phase is implemented. This method adds confidence and means that organizations can adjust their mechanism in response to new problems.

Specifically, a strong foundation for integrative harmony to occur swiftly and smoothly.

Failure to prepare an optimum architecture cannot be overemphasized. As in any migration process, the architecture forms the framework to ensure a good fit between on-premise systems and the cloud. Azure Virtual Machines, the appropriate data storage solutions like Azure SQL Database, and networking solutions must work properly and be tuned to achieve high performance and availability goals. In other words, decision-makers adopting security from the beginning of the migration process and relevant disaster recovery strategies can secure the data and avoid interruptions throughout the change.

Working through Challenges

The logistics of migrating to cloud services—data transfer discrepancies and security risks—are best addressed before becoming problems. Businesses should ensure that their staff are adequately trained and provided with adequate resources to deal with the issues surrounding cloud solutions. However, there is a need to embrace an extensive security strategy to ensure adequate security measures are in place to protect the required important conscience data. This, in equal measure, meets the set regulatory compliance requirements. When an organization focuses on ensuring security at different stages of migration, risks are controlled, and trust is established.

Further enhanced for sustaining improvement over the duration.

Therefore, optimization is important after migration to achieve the other benefits of cloud computing. Ongoing audits and assessments of cloud performance and resource utilization let organizations determine opportunities for optimization and business evolution. To enhance the cloud environment even more, feedback loops to capture user feedback can be developed to ensure that the environment is relevant to organizational objectives. This cyclic design approach enhances the innovative organizational culture and responds well to the existing electronic business platforms.

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