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MicroServices-driven enterprise architecture model for infrastructure optimization

A. M. Abd-Elwahab[1], A. G. Mohamed[2*] and E. M. Shaaban[3]

Abstract

Enterprise architecture (EA) is a discipline that is becoming increasingly important for businesses that are undergoing digital transformation. EA encompasses the practice of designing and managing the entire architecture of an organization, including its business processes, information systems, and technology infrastructure. In this paper, we will explore the main objectives of EA in digital transformation and the ways in which EA can help businesses achieve their digital transformation goals. Enterprise architects can use MicroServices technology to enable digital transformation by designing the MicroServices architecture, establishing best practices and standards, supporting tools such as DevOps, aligning with the enterprise's cloud strategy, and enabling data integration. Decision makers can use enterprise architecture with MicroServices to make digital transformation by leveraging the benefits of MicroServices architecture to achieve their digital transformation goals.

Keywords MicroServices, Digital transformation, Enterprise architect

Introduction

The main objective of EA in digital transformation is to help businesses align their technology infrastructure and business processes with their overall strategic goals. This involves designing and managing a holistic architecture that enables the organization to respond effectively to the rapidly changing technological landscape [1]. One of the key objectives of EA in digital transformation is to ensure that the organization's technology infrastructure is flexible and adaptable. This is especially important in today's fast-paced business environment, where new technologies are constantly emerging, and businesses must be able to respond quickly to changing market conditions [2]. EA can help businesses achieve this objective by providing a framework for designing and managing technology infrastructure that is scalable, flexible, and resilient [7]. Another objective of EA in digital transformation is to ensure that the organization's technology infrastructure is aligned with its business processes. This involves designing and managing a technology infrastructure that supports the organization's business processes, rather than being a hindrance to them [7]. EA can help businesses achieve this objective by providing a framework for designing and managing technology infrastructure that is closely integrated with the organization's business processes [2, 7, 8].

MicroServices play a critical role in enabling digital transformation by providing businesses with the agility, scalability, and resilience needed to adapt to rapid technological change. By breaking down applications into smaller, independent services, businesses can more easily adopt new technologies and respond to changing customer needs [3]. MicroServices also enable businesses to more easily integrate with third-party services and APIs, which can help streamline operations and improve customer experiences. This can be particularly important in industries such as finance and healthcare, where data integration is critical [3]. EA in digital transformation

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aims to ensure that the organization's technology infrastructure is secure and compliant with relevant regulations and standards. This involves designing and managing a technology infrastructure that is secure, resilient, and compliant with relevant regulations and standards.

EA can help businesses achieve this objective by providing a framework for designing and managing technology infrastructure that is secure, resilient, and compliant with relevant regulations and standards [7].

This paper is organized as follows: in Section 1, the introduction, it explains digital transformation and digital infrastructure to drive enterprise architecture for infrastructure optimization. Section 2 examines the related work of enterprise architects, MicroServices, and digital transformation and the relationship between them, which is used to assist decision makers. In Section 3, we discuss the MicroServices-driven enterprise architecture model for infrastructure optimization. In Section 4, the experimental results display the performance. Finally, a conclusion and directions for future work are reported in Section 5.

Related work

In today's rapidly evolving technological landscape, organizations are constantly seeking ways to optimize their infrastructure to meet the increasing demands of scalability, flexibility, and efficiency. One approach that has gained significant attention is the MicroServices-Driven Enterprise Architecture Model [1, 20].

Ways in EA can help businesses achieve their digital transformation goals

EA provides the necessary framework and methodologies to guide businesses in their digital transformation journeys, enabling them to leverage technology effectively and achieve their desired business outcomes. EA can help businesses achieve their digital transformation goals in a number of way these include:

- *Providing a roadmap for digital transformation* EA can help businesses to develop a roadmap for digital transformation by providing a framework for designing and managing technology infrastructure that is aligned with the organization's strategic goals. This can help businesses to identify the technologies and processes that are most important for achieving their digital transformation goals.
- *Enabling agility and flexibility* EA can help businesses achieve agility and flexibility by designing and managing technology infrastructure that is scalable, flexible, and resilient. This can help businesses to respond quickly to changing market conditions and adopt new technologies and processes as needed.
- *Facilitating innovation* EA can help businesses to facilitate innovation by providing a framework for designing and managing technology infrastructure that supports experimentation and innovation. This can help businesses to develop new products and services more quickly and respond more effectively to customer needs.
- *Improving collaboration and communication* EA can help businesses to improve collaboration and communication by providing a framework for designing and managing technology infrastructure that supports collaboration and communication across different departments and business units. This can help businesses to break down silos and to improve cross-functional collaboration.
- *Ensuring security and compliance* EA can help businesses ensure security and compliance by designing and managing technology infrastructure that is secure, resilient, and compliant with relevant regulations and standards. This can help businesses protect sensitive data and avoid costly breaches and regulatory penalties [10].

Uses of Enterprise architect with MicroServices technology enable digital transformation

Enterprise architects can use MicroServices technology to enable digital transformation in several ways. Here are some examples:

- *Designing the MicroServices architecture* Enterprise architects can work with development teams to design a MicroServices architecture that aligns with the enterprise's digital transformation strategy. This includes identifying the services that need to be broken down into MicroServices, defining the API contracts between services, and establishing the governance and management processes that will ensure the MicroServices architecture is scalable and maintainable.
- *Establishing best practices and standards* Enterprise architects can establish best practices and standards for developing MicroServices, such as defining coding standards, security policies, and deployment processes. This ensures that the MicroServices are developed in a consistent and secure manner, and that they can be easily integrated into the enterprise's existing systems and processes.
- *Supporting DevOps* MicroServices architecture requires a DevOps approach to software develop-

ment, where development, testing, and deployment are integrated into a continuous delivery pipeline. Enterprise architects can support DevOps by designing and implementing the necessary infrastructure, tools, and processes to enable continuous delivery of MicroServices.

- *Aligning with cloud strategy* MicroServices architecture is well-suited to the cloud, as it allows services to be developed and deployed independently and at scale. Enterprise architects can align the MicroServices architecture with the enterprise's cloud strategy, identifying the cloud services and platforms that are best suited to host the MicroServices and ensuring that the MicroServices are designed to take advantage of the scalability and flexibility of the cloud.
- *Enabling data integration* MicroServices architecture can help enable data integration across the enterprise by breaking down data silos and allowing data to be shared across services. Enterprise architects can design the MicroServices architecture to enable data integration, defining the data models, APIs, and data governance policies that will ensure data are shared securely and efficiently across the enterprise.

Digital transformation with MicroServices

The digital transformation processes for the implementation and deployment of MicroServices in financial markets involve the following steps:

- *Identify the business objectives* The first step in Implementing and deploying MicroServices in digital transformation in financial markets is to identify the business objectives. This involves understanding the goals of the organization and how MicroServices can help achieve those goals.
- *Design the MicroServices architecture* The next step is to design the MicroServices architecture. This involves breaking down the monolithic application into smaller, independent services that can be developed and deployed independently.
- *Develop the MicroServices* Once the MicroServices architecture is designed, the next step is to develop the MicroServices. This involves developing each service using the appropriate technology stack and ensuring that each service is designed to be scalable, fault-tolerant, and secure.
- *Deploy the MicroServices* After the MicroServices are developed, the next step is to deploy them. This involves deploying each service to its own container or server ensure that they are isolated from each other and can be managed independently.
- *Implement service discovery and an API gateway* Once the MicroServices are deployed, the next step is to implement service discovery and an API gateway. This involves implementing tools and technologies that allow services to discover and communicate with each other and provide a unified interface for external clients to access the services.
- *Implement monitoring and logging* After the MicroServices are deployed and the service discovery and An API gateway are implemented, the next step is to implement monitoring and logging. This involves implementing tools and technologies that allow the system to be monitored for performance and availability and that provide logs for debugging and troubleshooting.
- *Test the MicroServices* Once the MicroServices are deployed and all the necessary tools and technologies are implemented, the next step is to test the MicroServices. This involves testing each service individually and in combination with other services ensure that they are functioning as expected.
- *Iterate and refine* Finally, the implementation and deployment of MicroServices in digital transformation in financial markets is an iterative process. It is important to continuously monitor and refine the system to ensure that it is meeting the business objectives and to make adjustments as needed.

Challenges that face to implement EA in digital transformation

While EA can be a powerful tool for supporting digital transformation, there are also a number of challenges that businesses may face when implementing EA in the context of digital transformation. Here are some of the main challenges:

- *Resistance to change* One of the biggest challenges of implementing EA in digital transformation is resistance to change. Digital transformation often involves significant changes to business processes, technology infrastructure, and organizational structures, and employees may be resistant to these changes. This can create a significant barrier to the successful implementation of EA in DT.
- *Lack of skills and expertise* Another challenge of implementing EA in digital transformation is the lack of skills and expertise required to design, implement, and manage complex technology infrastructure. This can be particularly challenging for businesses that do not have a strong IT department or that lack the resources to hire external experts.

- *Complex legacy systems* Many businesses have complex legacy systems that have evolved over time and are difficult to integrate with new technology infrastructure. This can create significant challenges when implementing EA in digital transformation, as businesses may need to find ways to integrate new systems with legacy systems in order to achieve their goals.
- *Unclear objectives* Another challenge of implementing EA in digital transformation is unclear objectives. Businesses may have a general idea of what they want to achieve through digital transformation, but they may not have a clear understanding of how to achieve these objectives or what specific outcomes they are looking for.
- *Budget constraints* Implementing EA in digital transformation can require significant investment in new technology infrastructure, software, and hardware. This can be challenging for businesses that have limited budgets or that are already facing financial pressures.
- *Data management and security* With the increasing use of data in digital transformation initiatives, businesses must address data management and security concerns. These can include issues such as data privacy, data quality, and data governance [11].

Implementing EA in the context of digital transformation can be challenging, and businesses must be prepared to overcome these challenges in order to achieve their digital transformation goals. These challenges include resistance to change, lack of skills and expertise, complex legacy systems, unclear objectives, budget constraints, and data management and security concerns [3].

Practices for enterprise architecture in digital transformation

To achieve the objectives of EA in digital transformation, businesses should follow a number of best practices [12, 13]. These include:

- *Developing a clear understanding of the organization's strategic goals* Before embarking on an EA initiative, businesses should develop a clear understanding of their strategic goals and how EA can help to achieve them
- *Establishing a governance framework* EA should be governed by a framework that includes clear roles and responsibilities, decision making processes, and communication.
- *Fostering collaboration and communication* EA should be designed and managed in a way that fosters collaboration and communication across different departments and business units. This can help break down silos and improve cross-functional collaboration.
- *Adopting a flexible and adaptable approach* EA should be designed and managed in a way that is flexible and adaptable in order to respond quickly to changing market conditions and emerging technologies.
- *Ensuring security and compliance* EA should be designed and managed in a way that ensures security and compliance with relevant regulations and standards.

Strategies for integrating new systems with legacy systems during digital transformation

Integrating new systems with legacy systems can be a significant challenge during digital transformation initiatives [14, 17]. Here are some strategies that businesses can use to address this challenge:

- *Develop a comprehensive integration strategy* A comprehensive integration strategy can help businesses to identify the most appropriate integration approach

Table 1 Case No. 1

Operating system OS	CPU type	Service type
AIX	RISC	Web service

This experiment shows the performance of the CPU which has **RISC** CPU with web service work load, and the graph below shows performance of CPU and Memory

Table 2 Case No. 2

Operating system OS	CPU type	Service type
AIX	RISC	MicroServices

This experiment shows the performance of the CPU which has **RISC** CPU with MicroServices work load and the graph below shows performance of the CPU and Memory and there is a difference between resources utilization MicroServices use and resources less than web service; the factor was change in service type which here used MicroServices; the graph below shows enhancement performance

Table 3 Case No. 3

Operating system OS	CPU type	Service type
Windows	CISC	MicroServices

This experiment used the various OS with various types of CPU and the factor was change in service type which here used MicroServices; the graph below shows enhancement performance which led to saving resource, and just using resources on demand, this impacts quicker performance and faster I/O making the system highly responsive

Table 4 Case No. 4

Operating system OS	CPU type	Service type
Windows	CISC	Web service

Experiment used the same OS with the same type of CPU "CISC" CPU and the factor was change in service type which here used web service; the graph below shows difference in performance and resources utilization between web service and MicroServices; this display in the experiment web service consumed resources more than MicroServices; and this led to use of high resources and this led to more cost; the impact is slower performance and slower I/O making the system slower to respond and making organization consume resources more than needs

Table 5 Result case numbers 1, 2, 3 and 4

	OS	CPU type	Service type	Used CPU	Used Memory
Case No. 1	AIX	RISC	Web Service	2 Core	33 GB
Case No. 2	AIX	RISC	MicroService	0.20 Core	6.7 GB
Case No. 3	Windows	CISC	MicroService	1.7 Core	20.3 GB
Case No. 4	Windows	CISC	Web Service	5.4 Core	48.6 GB

This table shows the difference of the performance results obtained in all experiments; we calculate the average CPU and Memory in 4 VM with the various aspects resources with different types of CPU and different types of Memory as observed in Table 5 between 4 VM with the various OS, and resources utilization in Case No. 2 is less than Case No. 1 and resources utilization in Case No. 3 is less than Case No. 4; this is because here MicroServices using this adaptive model assists to create infrastructure stable with recommended setup which needs each services and APP DB and WEB; this assists business to take right decision with fair cost without waste financial resources and infrastructure resources and gain the recommended performance that impacts market and client; and both of them gain the value from the highest quality of services and more profit with low cost for market

Table 6 Result case numbers 1 and 2

	OS	CPU type	Service type	Used CPU	Used Memory
Case No. 1	AIX	RISC	WEB Service	2 Core	33 GB
Case No. 2	AIX	RISC	MicroService	0.20 Core	6.7 GB

The comparison in Table 6 shows the result for case numbers 1 and 2 between web service and MicroServices in Case No. 1 and Case No. 2 with the same type of CPU and Memory; this experiment displays how MicroServices assist to save resources more than web service or traditional service with the same type of CPU and Memory; and this leads to a save cost for organizations; this assists to save resources and assists decision maker to make recommended decision finally assisting application architecture to develop applications that use resources on demand; this impacts quicker performance and faster I/O making the system highly respond

Table 7 Result case numbers 3 and 4

	OS	CPU type	Service type	Used CPU	Used Memory
Case No. 3	Windows	CISC	MicroService	1.7 Core	20.3 GB
Case No. 4	Windows	CISC	WEB Service	5.4 Core	48.6 GB

The comparison in Table 7 shows the result for case number 3 and 4 between web service and MicroServices in Case No. 3 and Case No. 4 with the same type of CPU and Memory; the various factor here is type of service; and this experiment displays how MicroServices assist in saving resource more than web service or traditional service with the same type of CPU and Memory which leads to saving cost for organizations. This helps to save resources and assists decision maker in making recommended decision; finally, its helps to assist application architecture in developing applications that use resources on demand; this impacts quicker performance and faster I/O making the system highly responsive

Table 8 Result case numbers 1 and 4

	OS	CPU type	Service type	Used CPU	Used Memory
Case No. 1	AIX	RISC	WEB Service	2 Core	33 GB
Case No. 4	Windows	CISC	WEB Service	5.4 Core	48.6 GB

The comparison in Table 8 shows the result for case numbers 1 and 4 between web service and web service; the various factor here is CPU type in Case No. 1 and Case No. 4 with different types of CPU and Memory in Case No. 1 showing resources utilization less than Case No. 4 and this result shows how the type of CPU is considered an important factor in application architecture and infrastructure architecture which helps to save resources and this leads to save cost for organizations and assists decision maker in making recommended decision

Table 9 Result case numbers 2 and 3

	OS	CPU type	Service type	Used CPU	Used Memory
Case No. 2	AIX	RISC	MicroService	0.20 Core	6.7 GB
Case No. 3	Windows	CISC	MicroService	1.7 Core	20.3 GB

The comparison in Table 9 shows the result for case numbers 2 and 3 between MicroServices and MicroServices; the various factor here is CPU type in Case No. 2 and Case No. 3 with different types of CPU and Memory in Case No. 2 showing less resources utilization than Case No. 3 and this result shows how the type of CPU and service type are considered an important factor in application architecture and infrastructure architecture which helps to save resources and this leads to save cost for organizations and assists decision maker in making recommended decision

for each legacy system. This strategy should consider factors such as the age of the system, the complexity of the system, and the level of customization.

- *Implement middleware* Middleware can help connect new systems with legacy systems, enabling data to flow seamlessly between the two. Middleware can also help to standardize data formats and protocols, which can simplify the integration process.
- *Use APIs* Application programming interfaces (APIs) can be used to facilitate communication between new and legacy systems. APIs can enable different systems to exchange data and commands, which can

Providing a roadmap for digital transformation
Enabling agility and flexibility
Facilitating innovation
Improving collaboration and communication
Ensuring security and compliance

Fig. 1 Ways of using EA with digital transformation goals

Designing the Microservices Architecture
Establishing Best Practices and Standards
Supporting DevOps:
Aligning with Cloud Strategy
Enabling Data Integration

Fig. 2 Uses of EA with MicroServices technologies

help streamline business processes and reduce manual work.

- *Adopt a phased approach* Adopting a phased approach to integration can help minimize disruption to existing business processes. Businesses can start by integrating systems that are the least complex or that have the highest business value, and then gradually move on to more complex systems.
- *Leverage MicroServices architecture* A MicroServices architecture can help businesses to break down legacy systems into smaller, modular components that can be updated and integrated more easily. This approach can help to reduce the complexity of integration and enable businesses to adopt new technologies more quickly.
- *Implement a data integration platform* A data integration platform can help to integrate data from different systems, enabling businesses to gain a single view of their data. This can help improve decision making and enable businesses to identify new opportunities for growth.
- *Use data mapping and transformation tools* Data mapping and transformation tools can help to simplify the process of integrating data from different systems. These tools can enable businesses to map data fields from different systems and transform data into a format that can be easily integrated.

Best practices for implementing digital transformation strategies

To successfully implement digital transformation strategies, businesses should follow a number of best practices [15, 16]. These include:

- *Develop a clear vision and strategy* Before embarking on a digital transformation initiative, businesses should develop a clear vision and strategy for how they will use technology to achieve their goals. This should involve setting clear objectives, identify-

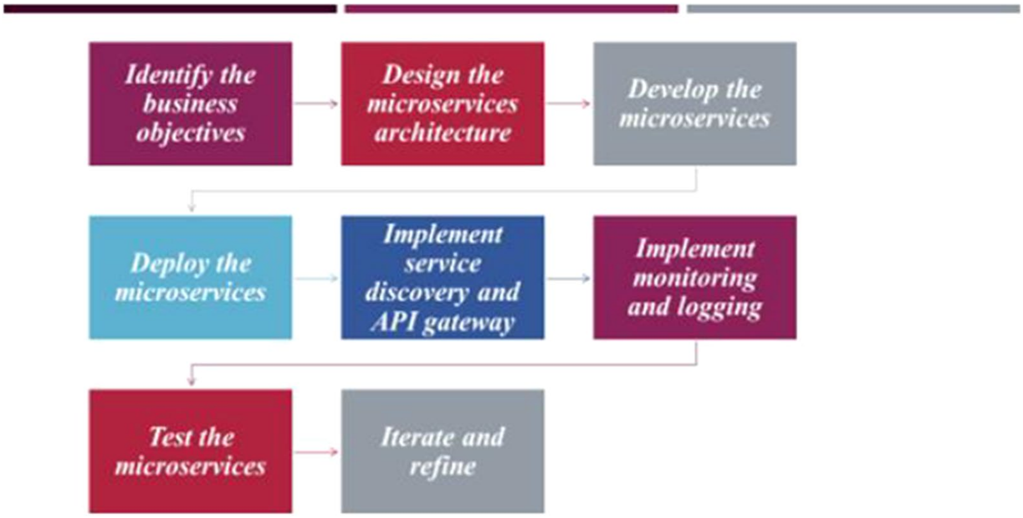
Identify the business objectives
Design the microservices architecture
Develop the microservices
Deploy the microservices
Implement service discovery and API gateway
Implement monitoring and logging
Test the microservices
Iterate and refine

Fig. 3 The steps of implementation MicroServices in digital transformation

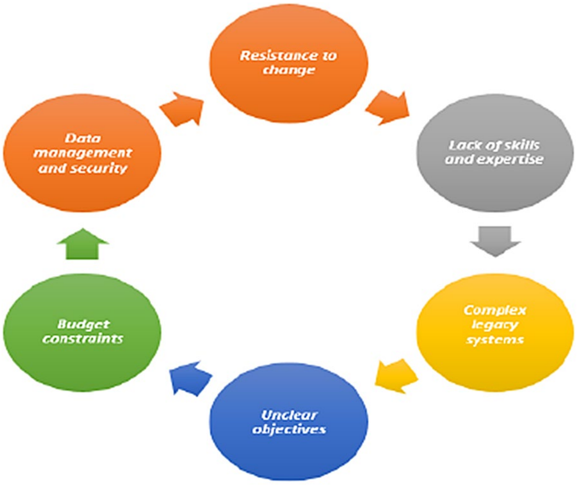

Fig. 4 The challenges of implementing EA in digital transformation

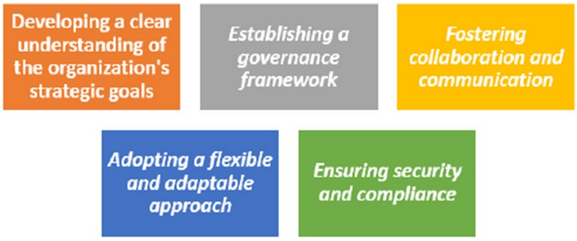
Developing a clear understanding of the organization's strategic goals
Establishing a governance framework
Fostering collaboration and communication
Adopting a flexible and adaptable approach
Ensuring security and compliance

Fig. 5 EA practices for enterprise architecture in digital transformation

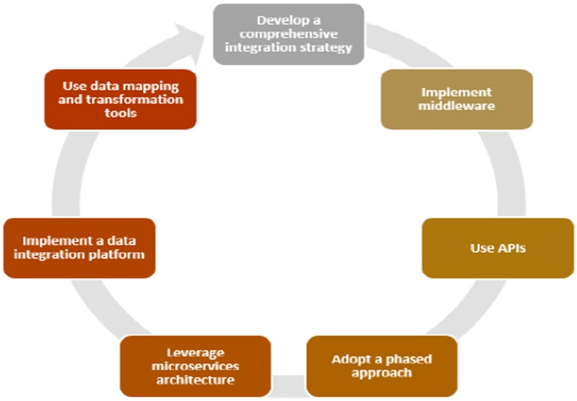
Develop a comprehensive integration strategy
Implement middleware
Use APIs
Adopt a phased approach
Leverage microservices architecture
Implement a data integration platform
Use data mapping and transformation tools

Fig. 6 Integrating strategies new systems with legacy systems

ing key stakeholders, and developing a roadmap for implementation.

- *Engage employees* Digital transformation requires the support and buy-in of employees at all levels of the organization. To achieve this, businesses should engage employees in the process and provide opportunities for training and development.

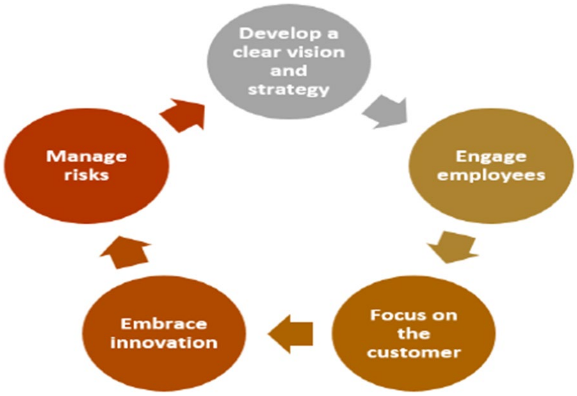

Fig. 7 Implementing digital transformation strategies

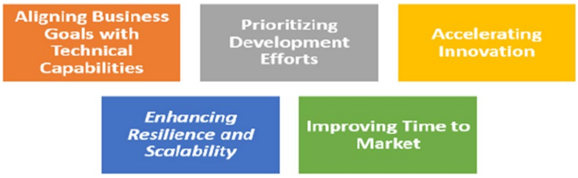
Aligning Business Goals with Technical Capabilities
Prioritizing Development Efforts
Accelerating Innovation
Enhancing Resilience and Scalability
Improving Time to Market

Fig. 8 Decision makers steps to achieve digital transformation

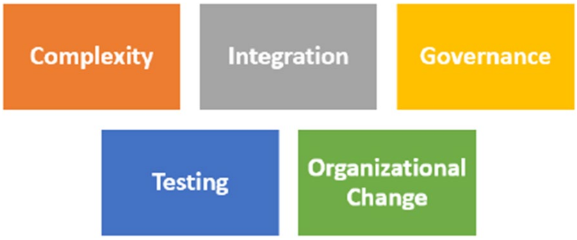

Fig. 9 Challenges that face decision makers during the implementing MicroServices architecture

- *Focus on the customer* Digital transformation should be driven by a focus on the customer. Businesses should seek to understand customer needs and preferences and use this information to inform their technology adoption and implementation strategies.
- *Embrace innovation* Digital transformation requires a willingness to embrace innovation and try new things. Businesses should encourage experimentation and risk-taking, and be willing to pivot if a particular strategy is not working.
- *Manage risks* Digital transformation involves risks, and businesses must take steps to manage and mitigate these risks. This includes ensuring the security of sensitive data, complying with regulatory requirements, and managing the risks associated with new technologies.

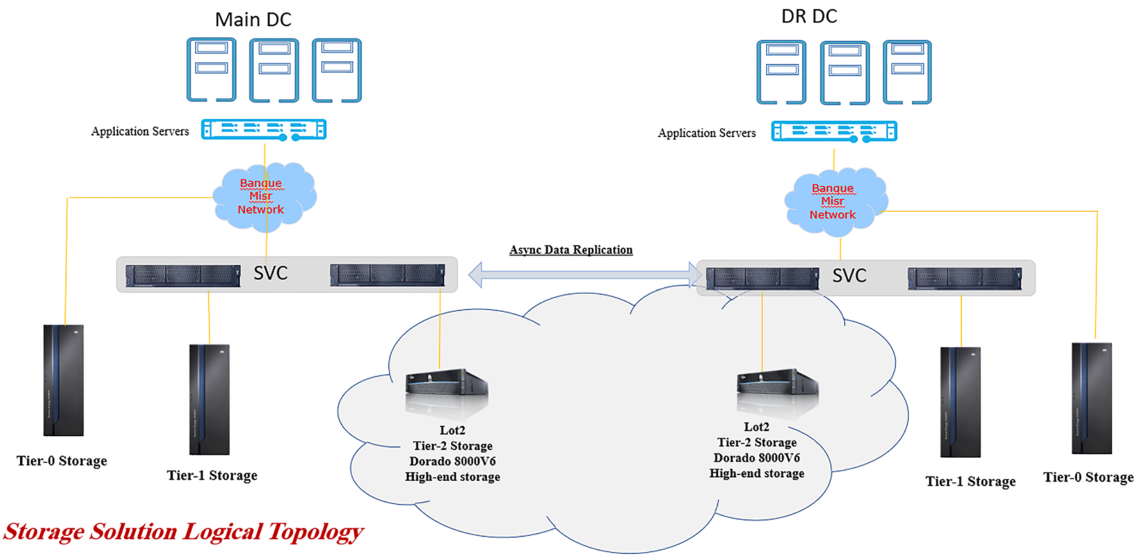

Fig. 10 Storage solution logical topology [21]

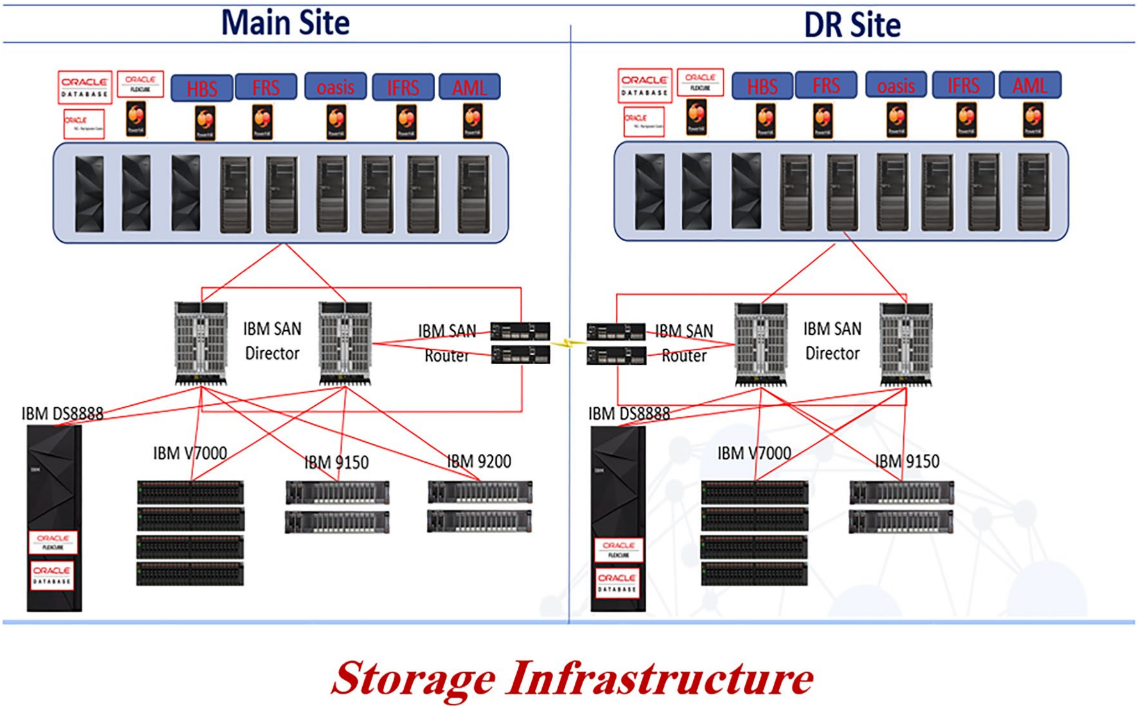

Fig. 11 Storage Infrastructure

Decision makers use enterprise architect with MicroServices to make digital transformation

Decision makers can use enterprise architecture with MicroServices to drive digital transformation by leveraging the benefits of MicroServices architecture to achieve their digital transformation goals [12, 16].

Here are some ways decision makers can use enterprise architecture with MicroServices to make digital transformation:

- *Aligning business goals with technical capabilities* Decision makers can work with enterprise archi-

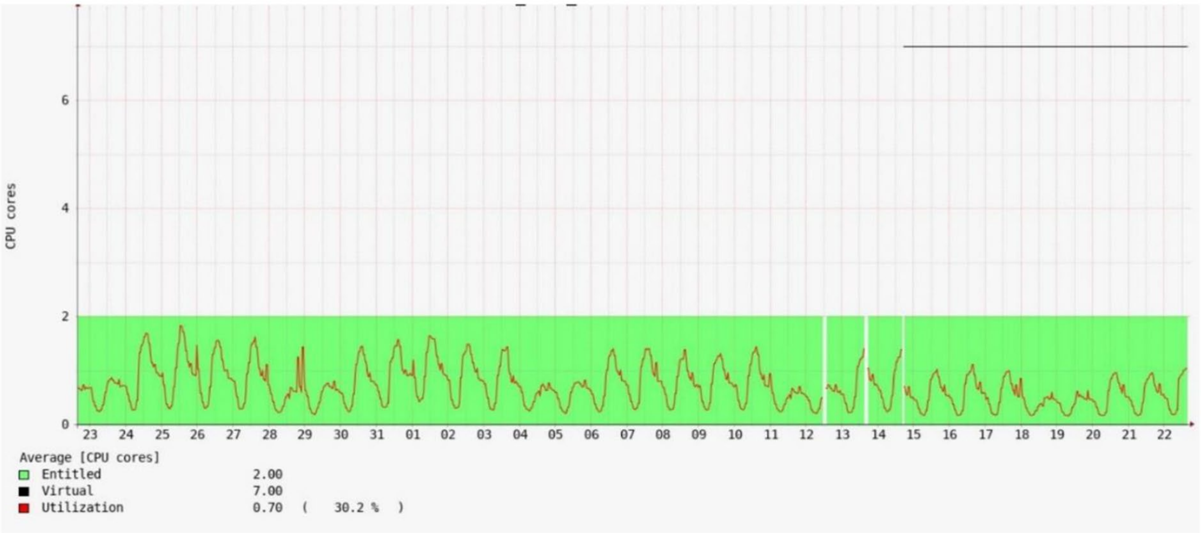

Fig. 12 Case No. 1 CPU utilization

tects to ensure that the MicroServices architecture aligns with the enterprise's digital transformation goals. This includes understanding the business goals, identifying the key capabilities required to achieve those goals, and designing the MicroServices architecture to support those capabilities.

- *Prioritizing* development efforts**:** Decision makers can use enterprise architecture with MicroServices to prioritize development efforts based on business value. By breaking down monolithic applications into smaller, modular pieces, decision makers can focus development efforts on the most critical services, enabling them to deliver value to customers more quickly.
- *Accelerating innovation* Decision makers can use enterprise architecture with MicroServices to accelerate innovation by adopting an agile development approach. MicroServices architecture enables teams to develop and deploy services independently, allowing them to innovate quickly and respond to changing customer needs.
- *Enhancing resilience and scalability* Decision makers can use enterprise architecture with MicroServices to enhance the resilience and scalability of

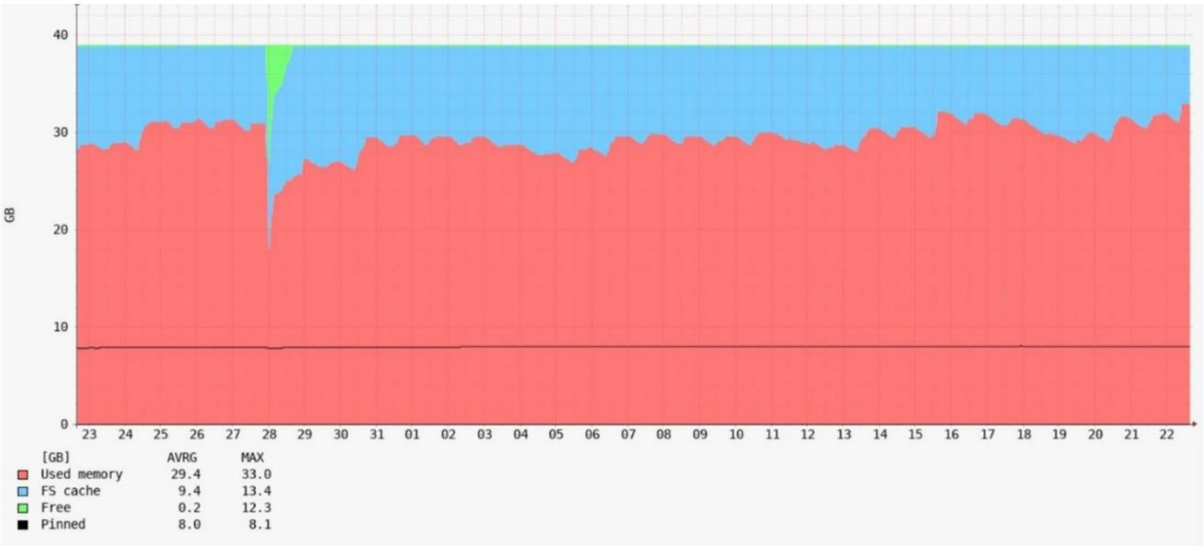

Fig. 13 Case No. 1 Memory utilization

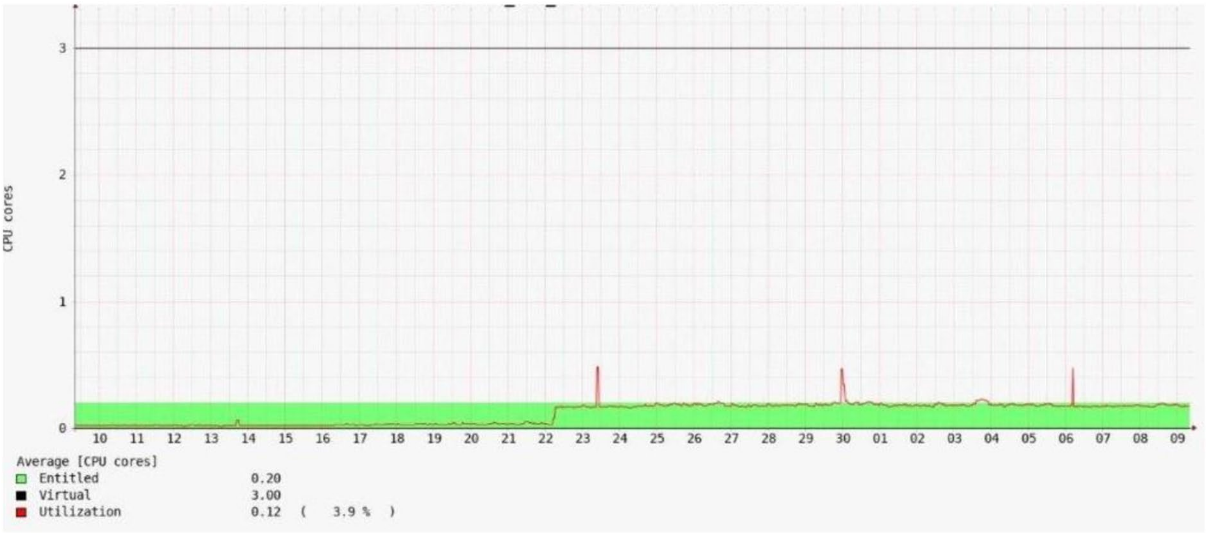

Fig. 14 Case No. 2 CPU utilization

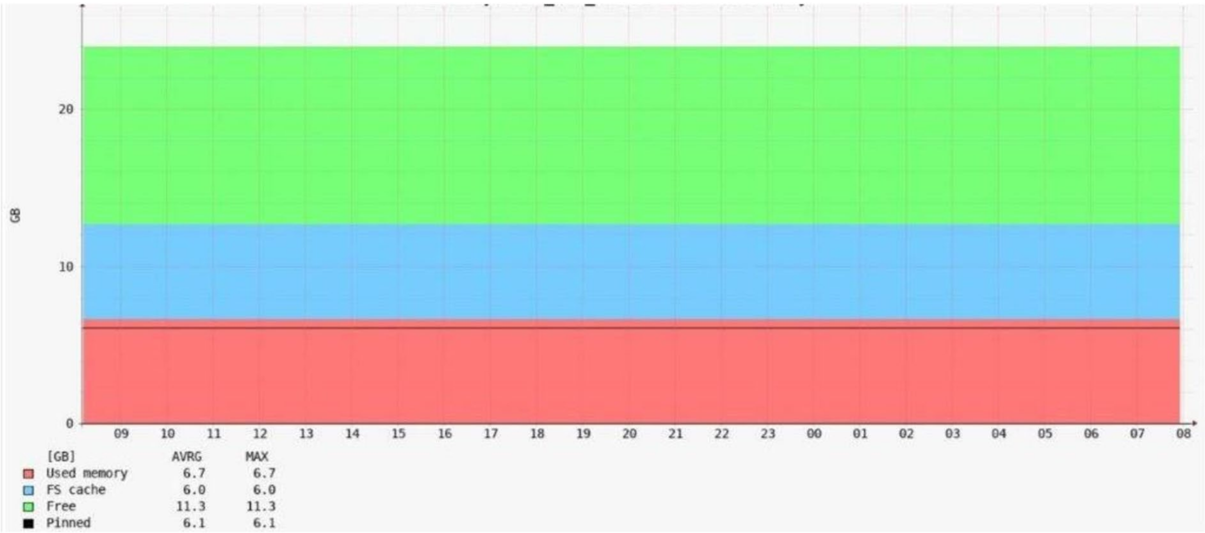

Fig. 15 Case No. 2 Memory utilization

their systems. By breaking down applications into smaller, self-contained components, MicroServices architecture enables decision makers to scale their systems more easily and to ensure that failures in one service do not impact the entire system.

- *Improving time to market* Decision makers can use enterprise architecture with MicroServices to improve their time to market for new products and services. MicroServices architecture enables faster development and deployment of new services, allowing decision makers to respond more quickly to changing market demands.

Decision makers can use enterprise architecture with MicroServices to make digital transformation by aligning business goals with technical capabilities, prioritizing development efforts, accelerating innovation, enhancing resilience and scalability, and improving time to market [12, 13, 15, 16].

Challenges that decision makers face when implementing MicroServices architecture

Implementing MicroServices architecture can bring numerous benefits, but decision makers may face several challenges during the implementation process [17, 20].

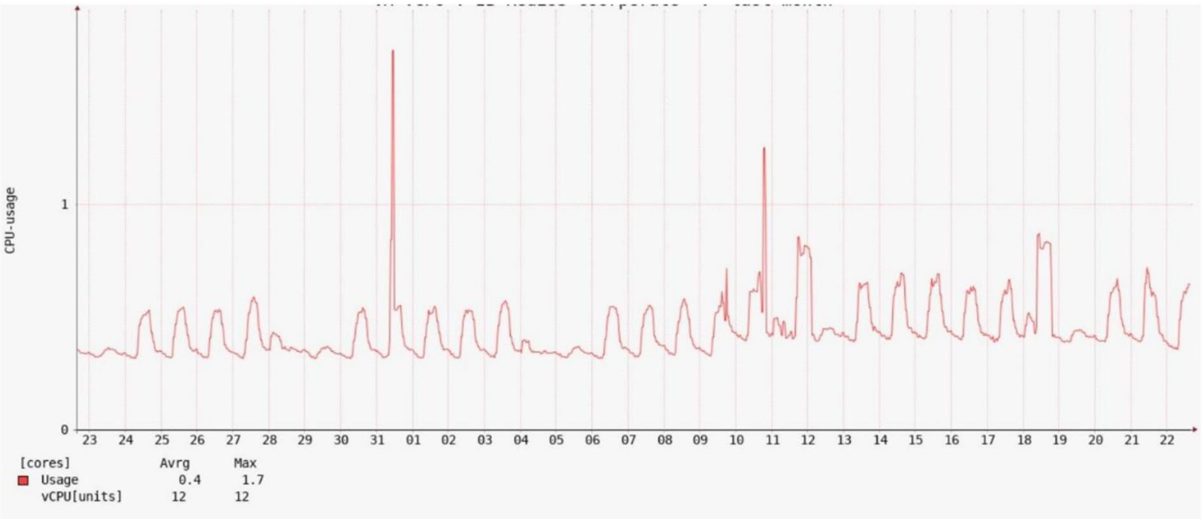

Fig. 16 Case No. 3 CPU utilization

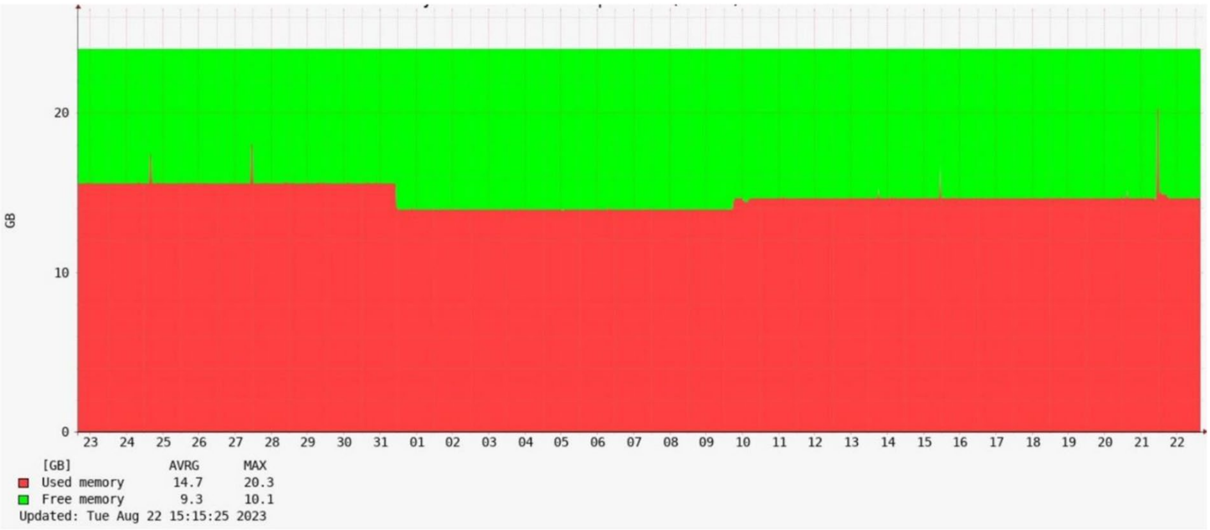

Fig. 17 Case No. 3 Memory utilization

Here are some challenges that decision makers may face when implementing MicroServices architecture:

- *Complexity* MicroServices architecture can introduce added complexity to an enterprise's IT environment, as it requires a more distributed architecture with multiple services communicating with each other. This can make it more challenging to manage and monitor the system, and can require additional resources to maintain.
- *Integration* MicroServices architecture can make integration more complex, as it requires multiple services to communicate with each other effectively. Integration challenges can arise when services are developed using different technologies or programming languages, or when services have different data models or APIs.
- *Governance* MicroServices architecture can make governance more challenging, as it requires clear policies and procedures ensure that the MicroServices are developed and managed in a consistent and secure manner. This can require additional resources, such as governance teams and tools, to ensure that the MicroServices architecture is managed effectively.

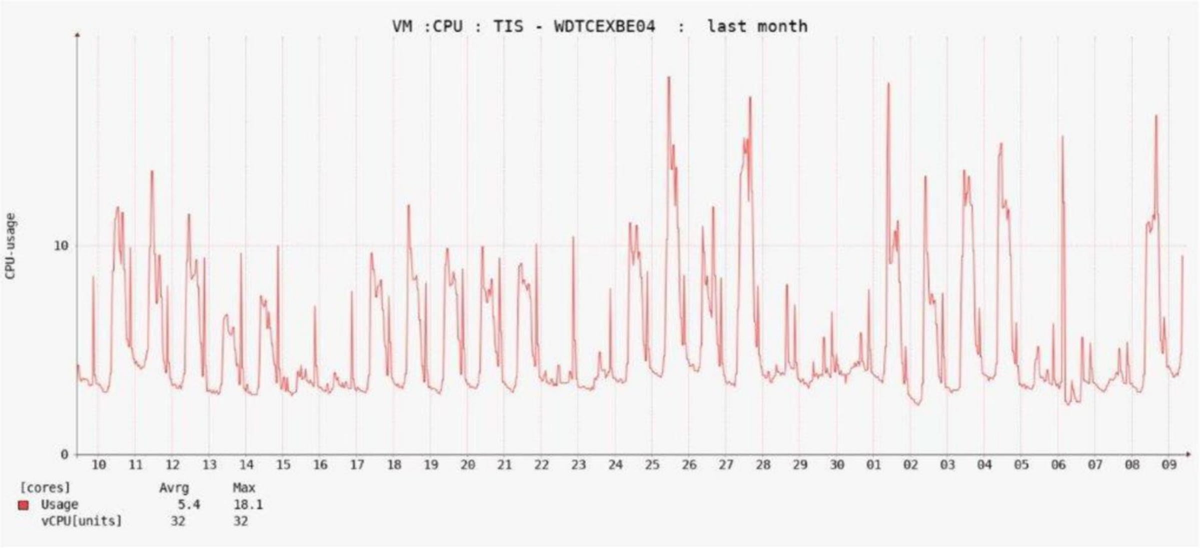

Fig. 18 Case No. 4 CPU utilization

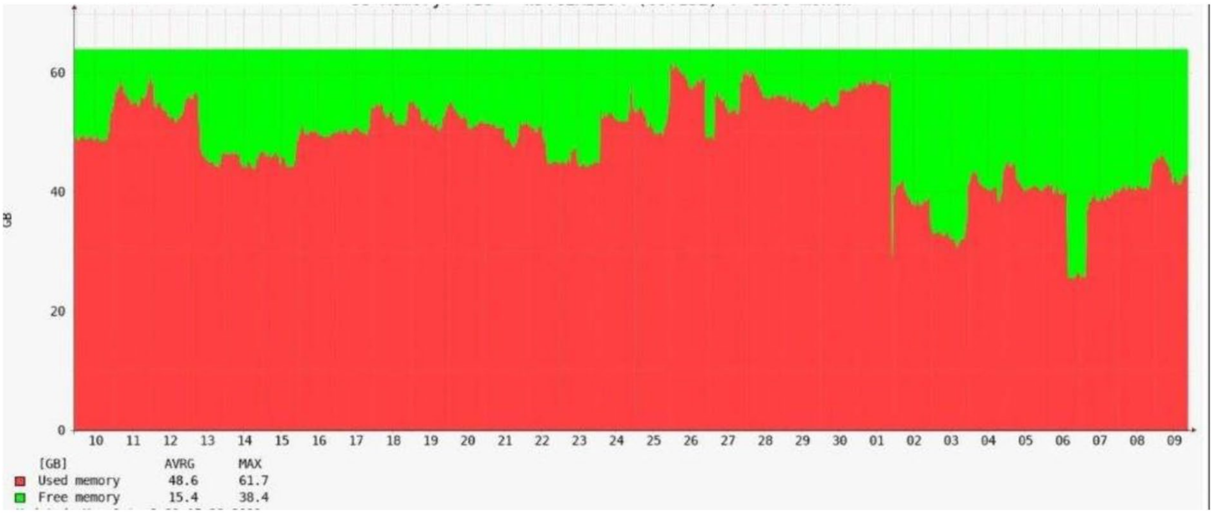

Fig. 19 Case No. 4 Memory utilization

- *Testing* Testing can be more challenging with MicroServices architecture, as it requires testing the individual services as well as the system as a whole. Testing each service in isolation can be more complex, as it requires simulating the interactions between services.
- *Organizational change* Implementing MicroServices architecture can require significant organizational change, as it requires different teams to work together more closely and to adopt new development practices. This can require additional training and resources ensure that teams are prepared to work in a more collaborative and agile manner.

Decision makers may face challenges when implementing a MicroServices architecture, including complexity, integration, governance, testing, and organizational change. These challenges can be addressed and overcome, enabling an enterprise to reap the benefits of MicroServices architecture [17–20].

Methods

In this research, we focused on comparing the performance of servers utilizing different CPU architectures:

Complex Instruction Set Computing (CISC) and Reduced Instruction Set Computing (RISC). We selected two servers for our experiments, one equipped with a CISC-based CPU and the other with a RISC-based CPU we propose a MicroServices-Driven Enterprise Architecture Model for Infrastructure Optimization. The model is designed to leverage the benefits of MicroServices architecture to enhance scalability, flexibility, and efficiency in enterprise systems. It promotes the decomposition of monolithic applications into independently deployable MicroServices, each with its own bounded context, allowing for easier development, deployment, and maintenance.

Data sources

Since our focus was on evaluating CPU architecture, our experiments did not rely on external data sources. Instead, we used synthetic workloads and benchmarking tasks that were specifically designed to stress the CPU's capabilities.

Storage solution logical topology model

Model of the data center server and the transition energy consumption model of the virtual machine analyzed the factors that affect server performance and energy consumption, combined with experimental data, and established a data center server energy consumption model.

Next, by analyzing the transition process of the virtual machine in detail, we analyzed the performance of the virtual machine during the transition process, the transition performance and the energy consumption cost of the transition, and the transitional energy consumption model of the virtual machine is established. Due to the transfer of virtual machines, the number of servers used to meet the task requirements is reduced, and ultimately, the goal of reducing the total energy consumption of the data center can be achieved [21].

Experimental result for virtual machine performance

These experimental studies describe performance on two servers which have two operating systems with different types of CPU and Memory. These lead to selecting the best performance that is going to be suitable with the work goal.

Results and discussion

We conducted a series of experiments to compare the performance and optimization potential of the MicroServices-Driven Enterprise Architecture Model on servers with CISC and RISC CPUs. The experiments were designed to evaluate key performance metrics and assess the impact of CPU architecture on the model's effectiveness.

We developed a representative application based on the MicroServices architecture, incorporating multiple services responsible for different functionalities. The application simulated a real-world enterprise system, emphasizing scalability, fault tolerance, and efficient resource utilization.

For each server, we deployed the MicroServices-based application and collected performance metrics such as response time, throughput, and resource utilization. We performed the experiments under varying workload conditions to assess the model's performance across different scenarios.

Our experiments yielded significant findings regarding the MicroServices-Driven Enterprise Architecture Model and the influence of CPU architecture on its performance:

- *Scalability* Both servers demonstrated the model's ability to scale horizontally by adding or removing instances of MicroServices based on demand. However, the RISC-based server showed better scalability due to its optimized instruction set and streamlined execution.
- *Efficiency* The RISC-based server exhibited improved resource utilization and efficiency in executing MicroServices compared to the CISC-based server. The simplified instruction set and optimized control flow in the RISC architecture resulted in faster execution and reduced overhead.

Conclusion

In this study, we proposed a MicroServices-Driven Enterprise Architecture Model for Infrastructure Optimization and conducted experiments to evaluate its performance and optimization potential on servers with different CPU architectures. The results of our experiments provide valuable insights into the effectiveness of the model and the impact of CPU architecture on its performance. One of the key findings from our experiments is the scalability of the MicroServices-Driven Enterprise Architecture Model. Both the CISC-based and RISC-based servers demonstrated the model's ability to scale horizontally by adding or removing instances of MicroServices based on demand. However, the RISC-based server exhibited better scalability due to its optimized instruction set and streamlined execution. Furthermore, our experiments revealed that the RISC-based server showcased improved resource utilization and efficiency in executing MicroServices compared to the CISC-based server. The simplified instruction set and optimized control flow in the RISC architecture led to faster execution and reduced overhead, resulting in enhanced overall performance for the MicroServices-based application. It is important to note that while the CISC-based server performed better in certain compute-intensive tasks, the RISC-based server excelled in memory access and control flow operations.

These findings emphasize the performance tradeoffs associated with different CPU architectures when implementing MicroServices-based enterprise systems. To improve the clarity and relevance of our conclusion, we have focused on summarizing the key findings and directly linking them to the research objectives. We have avoided introducing unrelated topics, ensuring a more concise and focused conclusion. In conclusion, our study demonstrates the effectiveness of the MicroServices-Driven Enterprise Architecture Model for Infrastructure Optimization. The experiments reveal the influence of CPU architecture on the model's performance, highlighting the importance of considering architectural choices for optimizing MicroServices-based systems. These findings provide valuable insights for system architects and practitioners in making informed decisions regarding CPU architectures and optimizing enterprise systems (Tables 1, 2, 3, 4, 5, 6, 7, 8, 9).

For future research it would be beneficial to investigate other CPU architectures, such as hybrid architectures or emerging technologies, to further explore their impact on the performance of MicroServices-based systems. Additionally, exploring advanced techniques for workload balancing and resource allocation within the MicroServices architecture could contribute to further optimization and scalability improvements (Figs. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19).

Abbreviations

RISC	Reduced instruction set computer
CISC	Complex instruction set computer
DT	Digital transformation
EA	Enterprise architect
VM	Virtual machines

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Note applicable

Author contributions

A.G.M., "a Master of business information system", extracted this paper from his Master thesis. All authors read and approved the final manuscript. All authors contributed equally to this work.

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Availability of data and materials

Dataset used during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

It is appropriate to thank colleagues, inform about shared use centers, indicate the contributions of authors to the research reported in the manuscript and provide any information that may affect the understanding and assessment of the content.

Consent for publication

Not applicable.

Informed consent

For this type of study, informed consent is not required.

Competing Interests

The authors declare that they have no competing interests.

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References

1. Zhang D (2023) Storage optimization algorithm design of cloud computing edge node based on artificial intelligence technology. J Ambient Intell Humaniz Comput 14(3):1461–1471
2. van de Wetering R (2019) Dynamic enterprise architecture capabilities: conceptualization and validation. In: Business information systems: 22nd international conference, BIS 2019, Seville, Spain, June 26–28, 2019, proceedings, Part II 22. Springer International Publishing, pp 221–232
3. Haugeland SG, Nguyen PH, Song H, Chauvel F (2021) Migrating monoliths to microservices-based customizable multi-tenant cloud-native apps. In: 2021 47th Euromicro conference on software engineering and advanced applications (SEAA). IEEE, pp 170–177
4. Filippone G, Autili M, Rossi F, Tivoli M (2021) Migration of monoliths through the synthesis of microservices using combinatorial optimization. In: 2021 IEEE International symposium on software reliability engineering workshops (ISSREW). IEEE, pp 144–147
5. Prasandy T, Murad DF, Darwis T (2020) Migrating application from monolith to microservices. In: 2020 International conference on information management and technology (ICIMTech). IEEE, pp 726–731
6. Taibi D, Lenarduzzi V, Pahl C (2017) Processes, motivations, and issues for migrating to microservices architectures: an empirical investigation. IEEE Cloud Comput 4(5):22–32
7. Aliee FS, Kashfi H, Farahani B (2019) The evolving enterprise architecture: a digital transformation perspective. In: Proceedings of the international conference on omni-layer intelligent systems, pp 179–183
8. Zhang M, Chen H, Luo A (2018) A systematic review of business-IT alignment research with enterprise architecture. IEEE Access 6:18933–18944
9. Long Y, Qiao H (2021) Technology roadmap for transforming enterprises into cloud native. In: 2021 International conference of social computing and digital economy (ICSCDE). IEEE, pp 324–327
10. Zaoui F, Souissi N (2020) Roadmap for digital transformation: a literature review. Procedia Comput Sci 175:621–628
11. Jamshidi P, Pahl C, Mendonça NC, Lewis J, Tilkov S (2018) Microservices: the journey so far and challenges ahead. IEEE Softw 35(3):24–35
12. Van den Berg M, Slot R, van Steenbergen M, Faasse P, van Vliet H (2019) How enterprise architecture improves the quality of IT investment decisions. J Syst Softw 152:134–150
13. Hannemann I, Rodrigues S, Loures E, Deschamps F, Cestari J (2022) Applying a decision model based on multiple criteria decision making methods to evaluate the influence of digital transformation technologies on enterprise architecture principles. IET Collab Intell Manuf 4(2):101–111

14. Kazanavičius J, Mažeika D (2019) Migrating legacy software to microservices architecture. In: 2019 Open conference of electrical, electronic and information sciences (eStream). IEEE, pp 1–5
15. Bao J, Lu Z, Wu J, Zhang S, Zhong Y (2014) Implementing a novel load-aware auto scale scheme for private cloud resource management platform. In: 2014 IEEE network operations and management symposium (NOMS). IEEE, pp 1–4
16. Ray P, Pal P (2020) Extending the semat kernel for the practice of designing and implementing microservice-based applications using domain driven design. In: 2020 IEEE 32nd Conference on software engineering education and training (CSEE&T). IEEE, pp 1–4
17. Hämäläinen M (2020). A framework for a smart city design: digital transformation in the Helsinki smart city. Entrepreneurship and the community: a multidisciplinary perspective on creativity, social challenges, and business, pp 63–86
18. Velepucha V, Flores P (2021) Monoliths to microservices-migration problems and challenges: a sms. In: 2021 Second international conference on information systems and software technologies (ICI2ST). IEEE, pp 135–142
19. Pham XQ, Nguyen TD, Huynh-The T, Huh EN, Kim DS (2022) Distributed cloud computing: architecture, enabling technologies, and open challenges. IEEE Consumer Electron Mag. https://doi.org/10.1109/MCE.2022.3192132
20. Huang SY, Chen CY, Chen JY, Chao HC (2023) A survey on resource management for cloud native mobile computing: opportunities and challenges. Symmetry 15(2):538
21. Mohamed AG, Shaaban EM, Abd-Elwaha A (2023) An adaptive model to reach optimum resources utilization in financial market

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