

# Review of Cloud Migration Strategies: Exploring Advantages, Challenges and Cost Analysis

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**Abstract** —Cloud migration has emerged as a strategic imperative for organizations seeking to leverage the scalability, flexibility, and cost efficiencies offered by cloud computing. This paper presents a comprehensive survey of organizational cloud migration strategies, focusing on the advantages, challenges, and cost analysis associated with this transformative process. The study begins by elucidating the conceptual framework of cloud migration, delineating its fundamental principles and terminologies. Subsequently, it delves into the myriad advantages that compel organizations to migrate from on-premises infrastructures to cloud-based solutions. These advantages include enhanced scalability, improved resource utilization, and accelerated time-to-market for new initiatives. However, the migration journey is fraught with challenges, ranging from data security concerns to compatibility issues with legacy systems. This paper meticulously examines these challenges and elucidates strategies employed by organizations to overcome them, thereby ensuring a smooth transition to the cloud. Cost analysis constitutes a pivotal aspect of cloud migration decision-making. This study offers insights into the cost implications associated with various cloud deployment models, such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). By conducting a comparative analysis of capital expenditures (CapEx) and operational expenditures (OpEx) incurred in both on-premises and cloud environments, organizations can make informed decisions regarding cost optimization and resource allocation. Furthermore, the paper explores the critical considerations surrounding data security, regulatory compliance, and vendor selection in the context of cloud migration. Real-world case studies are presented to illustrate successful migration strategies adopted by leading organizations across diverse industries.

**Keywords** —Cloud migration, Cost analysis, Strategies, Re-hosting, Replatforming, Refactoring, Repurchasing, Retiring, Retaining

## I. INTRODUCTION

In today's rapidly evolving digital landscape, organizations are increasingly turning to cloud computing as a catalyst for innovation, agility, and competitive advantage. Cloud migration, the process of transitioning data, applications, and IT infrastructure from on-premises environments to cloud-based platforms, has emerged as a strategic imperative for and management. Unlike traditional on-premises setups, where organizations are responsible for procuring, maintaining, and upgrading hardware and software resources, cloud computing offers a pay-as-you-go model, enabling businesses to provision computing resources on-demand and scale dynamically in response to fluctuating workloads. This paradigm shift has

not only democratized access to cutting-edge technologies but has also empowered organizations to focus their efforts on innovation and core competencies rather than infrastructure maintenance. The motivation behind cloud migration stems from a myriad of factors, chief among them being the need for scalability and agility. In today's hyper-connected world, businesses are confronted with unprecedented fluctuations in demand and evolving customer expectations. Cloud computing provides a scalable and elastic infrastructure that can seamlessly accommodate spikes in traffic and support dynamic business requirements, thereby enabling organizations to stay nimble and responsive in the face of change. Furthermore, cloud migration promises significant cost savings and operational efficiencies compared to traditional on-premises deployments. By shifting from a capital expenditure (CapEx) model to an operational expenditure (OpEx) model, organizations can eliminate upfront infrastructure investments and reduce the total cost of ownership (TCO) associated with IT infrastructure provisioning and maintenance. Additionally, cloud computing offers economies of scale, allowing businesses to leverage shared infrastructure and benefit from lower operational costs.

However, despite the compelling advantages of cloud migration, organizations must navigate a myriad of challenges and considerations throughout the migration journey. From data security and compliance concerns to interoperability issues and vendor lock-in risks, the migration process entails a complex array of technical, operational, and strategic considerations that require careful planning and execution. Against this backdrop, this paper seeks to provide a comprehensive survey of organizational cloud migration strategies, with a focus on elucidating the advantages, challenges, and cost implications associated with this transformative process. By examining real-world case studies, conducting a comparative cost analysis, and exploring emerging trends in cloud migration, this study aims to equip organizations with the requisite knowledge and insights to navigate the complexities of cloud adoption and harness its transformative potential. In the subsequent sections of this paper, we delve into the conceptual framework of cloud migration, analyze the advantages and challenges inherent in the migration process, conduct a comprehensive cost analysis, and explore critical considerations surrounding data security, regulatory compliance, and vendor selection. Real-world case studies are presented to illustrate successful migration strate-

gies adopted by leading organizations across diverse industries. Finally, the paper concludes with a discussion of future trends and implications for organizations embarking on the cloud migration journey.

## II. LITERATURE REVIEW

The paper [1] by Rabie Khabouz is grounded in sociotechnical systems theory and explores strategies employed by IT architects in legacy systems modernization projects. In the context of healthcare and financial services industries in San Antonio-New Braunfels, Texas, interviews with eight IT architects and review of organizational documents reveal key themes. Collaboration, system documentation, and technical training emerge as prominent strategies. The study underscores the importance of integrating collaboration, documentation, and training into modernization projects. This literature review highlights the significance of legacy systems modernization in enterprise IT, emphasizing the role of sociotechnical approaches in achieving successful outcomes.

The research [2] by Sivakumar Ponnusamy et al., Navigating the Modernization of Legacy Applications and Data: Effective Strategies and Best Practices synthesizes existing literature to explore motivations, challenges, strategies, and best practices in modernizing legacy systems. The study identifies business necessities and technological advancements as primary drivers for modernization while highlighting challenges such as data migration complexities, legacy system intricacies, and user acceptance issues. Strategies and best practices, including astute planning and strategic decision-making, are proposed to navigate these challenges successfully. The review emphasizes the importance of selecting the right modernization approach to transform dated systems into valuable assets aligned with current business demands and technological advancements. Through a comprehensive literature review, this study provides insights and recommendations to guide organizations in navigating the modernization journey effectively.

The paper [3] by Carlos Blanco et al. states that Data Warehouses (DW) play a critical role in managing enterprise information for decision-making processes, necessitating robust security measures to protect against unauthorized access. However, security considerations are often relegated to later stages in DW development, posing challenges for integrating security constraints effectively. Legacy systems further complicate matters, requiring reverse engineering for re-documentation and identification of new security requirements. To address these issues, a Model-Driven Architecture (MDA) approach is proposed, aiming to incorporate security considerations from the early stages of development. It introduces an Architecture-Driven Modernization (ADM) process focused on deriving conceptual security models from legacy OLAP systems within the proposed MDA framework. Through a review of existing literature, this study explores the challenges of integrating security into DW development and proposes an ADM process to address these challenges, emphasizing the importance of early consideration of security in DW modernization efforts.

The paper [4] by Virpi Hotti talks about how organizational changes often necessitate the modernization of information systems, yet decision-making in this regard is hindered by divergent perspectives among suppliers and clients. It presents a review of modernization statements from existing literature, aiming to elucidate the various definitions and domains of modernization. A total of 42 statements from 36 papers are analyzed, revealing a lack of consensus on the concept of modernization. To achieve alignment in understanding, transparency regarding the scope of changes is emphasized. Additionally, the analysis examines relationships within enterprise architecture entities to inform modernization decisions. Case-based lessons from the semantic assets of Finnish social welfare systems underscore the importance of understanding suppliers' knowledge gaps. Furthermore, the paper discusses prohibited data groups and logical data stores within the TO-GAF content metamodel, providing insights for modernization efforts. Through this review, the study contributes to enhancing clarity and coherence in information system modernization endeavors.

Dr. A. Shaji George's paper [5] investigates the unintended consequences of enterprise cloud migration on institutional IT knowledge and expertise. The paper highlights the erosion of internal expertise related to on-premises systems due to cloud migration. The paper identifies a limitation in that there is limited discussion on potential solutions or strategies to mitigate the identified challenges. Falguni Mehrotra's paper, [6] explores cloud migration strategies and their suitability based on cloud service models. Mehrotra acknowledges a limitation in that there is limited discussion on specific tools or frameworks used for cloud migration strategies. The paper also discusses the complexities of legacy system migration tasks in a cloud environment. The paper [7] by Injuwe et al. proposes a conceptual framework for user control during cloud data migration in a SaaS environment. The authors acknowledge that their framework is conceptual and requires further validation through empirical testing to assess its effectiveness in real-world scenarios. The paper [8] by S. Sisodia et al. explores the complexities and considerations involved in choosing cloud computing models and service providers tailored to specific business requirements. The authors acknowledge that their findings and recommendations may not account for rapidly evolving cloud computing technologies and market dynamics. Additionally, the paper's limited focus on specific case studies and scenarios may restrict the generalizability of their findings to diverse business contexts.

## III. CLOUD MIGRATION CONCEPTS AND DEFINITIONS

Cloud migration is the process of transferring digital assets, such as applications, data, and IT infrastructure, from on-premises environments to cloud-based platforms. This transformative journey involves a series of steps and considerations aimed at leveraging the scalability, flexibility, and cost efficiencies offered by cloud computing. In this section, we delve into the key concepts and definitions that underpin cloud migration initiatives, providing a comprehensive overview of

the foundational principles and terminologies associated with this paradigm shift.

#### A. Cloud Computing Fundamentals

Cloud computing is a paradigm that enables ubiquitous access to shared pools of configurable computing resources (e.g., networks, servers, storage, applications) delivered over the internet. The National Institute of Standards and Technology (NIST) defines cloud computing as a model that encompasses five essential characteristics, namely on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service. These characteristics form the foundational principles of cloud computing and underpin its transformative potential in delivering scalable, on-demand IT services to organizations of all sizes.

#### B. Types of Cloud Services

Cloud computing offers a spectrum of services that cater to diverse organizational needs and use cases. The three primary service models in cloud computing are Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).

1) *Infrastructure as a Service (IaaS)*: IaaS provides virtualized computing resources over the internet, including virtual machines, storage, and networking infrastructure. With IaaS, organizations can deploy and manage their applications and workloads on a flexible, pay-as-you-go basis, without the need to invest in physical hardware or infrastructure.

2) *Platform as a Service (PaaS)*: PaaS offers a platform for developers to build, deploy, and manage applications without the complexity of underlying infrastructure management. PaaS providers offer a comprehensive set of development tools, middleware, and runtime environments, enabling organizations to focus on application development and innovation while abstracting away the underlying infrastructure complexity.

3) *Software as a Service (SaaS)*: SaaS delivers software applications over the internet on a subscription basis, eliminating the need for organizations to install, maintain, and update software locally. Common examples of SaaS applications include email, customer relationship management (CRM), and productivity tools, such as Microsoft Office 365 and Google Workspace.

#### C. Cloud Deployment Models

Cloud computing offers several deployment models, each catering to specific organizational requirements and preferences. The primary deployment models include public cloud, private cloud, hybrid cloud, and multi-cloud.

1) *Public Cloud*: : Public cloud providers offer computing resources and services to multiple tenants over the internet. Organizations leverage public cloud infrastructure for its scalability, flexibility, and cost-effectiveness, paying only for the resources they consume on a pay-as-you-go basis.

2) *Private Cloud*: : Private cloud infrastructure is dedicated to a single organization and may be hosted on-premises or by a third-party service provider. Private clouds offer greater control, security, and customization options compared to public clouds, making them suitable for organizations with stringent security and compliance requirements.

3) *Hybrid Cloud*: : Hybrid cloud combines elements of public and private cloud infrastructure, enabling organizations to leverage the scalability and flexibility of public clouds while retaining control over sensitive data and critical workloads in private cloud environments. Hybrid cloud architectures facilitate seamless workload portability and data orchestration across diverse cloud environments.

4) *Multi-Cloud*: : Multi-cloud refers to the use of multiple cloud providers to host different workloads and applications. Organizations adopt a multi-cloud strategy to mitigate vendor lock-in, enhance redundancy and fault tolerance, and optimize costs by leveraging the strengths of different cloud providers for specific use cases.

#### D. Cloud Migration Strategies

Cloud migration encompasses a spectrum of strategies and approaches tailored to the unique requirements and constraints of each organization. Common cloud migration strategies include:

1) *Rehosting (Lift and Shift)*: : Rehosting involves migrating applications and workloads to the cloud without making significant changes to their architecture or codebase. This approach offers a rapid migration path but may not fully leverage the benefits of cloud-native services.

2) *Replatforming (Lift, Tinker, and Shift)*: : Replatforming entails optimizing applications for the cloud by making minor modifications to their architecture or codebase to take advantage of cloud-native features and services. This approach offers a balance between speed and optimization, enabling organizations to modernize their applications while minimizing disruption.

3) *Refactoring (Re-architecting)*: : Refactoring involves redesigning applications from the ground up to leverage cloud-native architectures, microservices, and serverless computing paradigms. While refactoring offers maximum flexibility and optimization, it requires significant time, resources, and expertise to execute effectively.

4) *Repurchasing (Drop and Shop)*: : Repurchasing involves replacing on-premises software with cloud-based equivalents, such as migrating from a legacy on-premises CRM system to a cloud-based CRM SaaS solution. This approach offers rapid deployment and reduced maintenance overheads but may entail data migration and integration challenges.

5) *Retiring*: : Retiring involves decommissioning legacy applications and workloads that are no longer viable or necessary, thereby reducing complexity and streamlining the migration process.

6) *Retaining*: : Retaining involves maintaining certain applications or workloads on-premises due to regulatory, compliance, or performance considerations, while selectively migrating others to the cloud.



### E. Cloud Migration Lifecycle

The cloud migration lifecycle encompasses a series of phases, from assessment and planning to execution, monitoring, and optimization. Common stages in the cloud migration lifecycle include:

1) *Assessment and Discovery*: : Assessing the existing IT landscape, identifying workloads and applications suitable for migration, and conducting a comprehensive analysis of dependencies, performance requirements, and compliance considerations.

2) *Planning and Preparation*: : Developing a detailed migration plan, defining migration strategies and priorities, estimating costs and resource requirements, and establishing governance and security frameworks to ensure a smooth migration process.

3) *Migration Execution*: : Executing the migration plan, including provisioning cloud resources, migrating data and applications, configuring networking and security policies, and validating functionality and performance in the cloud environment.

4) *Post-Migration Testing and Validation*: : Conducting thorough testing and validation to ensure that migrated workloads and applications meet performance, security, and compliance requirements in the cloud environment.

5) *Optimization and Continuous Improvement*: : Continuously monitoring and optimizing cloud resources, refining governance and security policies, and leveraging cloud-native services and automation tools to drive efficiency and innovation.

## IV. ADVANTAGES OF CLOUD MIGRATION

Migration Strategy	Advantage 1: Cost Savings	Advantage 2: Scalability	Advantage 3: Performance Optimization	Advantage 4: Enhanced Security
Rehosting (Lift and Shift)	Present	Present	Absent	Absent
Replatforming (Lift, Tinker, and Shift)	Present	Present	Present	Absent
Refactoring (Re-architecting)	Absent	Present	Present	Present
Repurchasing	Present	Absent	Present	Present
Retiring	Present	Absent	Absent	Absent
Retaining	Absent	Absent	Absent	Present

Fig. 1. Table of advantages of cloud migration

### A. Rehosting (Lift and Shift)

Rehosting involves moving applications to the cloud with minimal or no modifications. This strategy offers significant cost savings by transitioning from capital expenditures to a pay-as-you-go model, which can reduce upfront costs. It allows for leveraging the cloud's scalability without making significant changes to the application, enabling quick migration. However, while it does not typically optimize performance for the cloud, it can still offer some efficiency gains. Security remains unchanged in this strategy, meaning the existing security posture is maintained without leveraging advanced cloud security features.

### B. Replatforming (Lift, Tinker, and Shift)

Replatforming involves making some optimizations to the application during the migration to the cloud. This strategy can lead to cost savings while optimizing parts of the application for cloud efficiency. It improves scalability by utilizing some cloud-native features, allowing for better resource management and flexibility. The application undergoes partial performance optimization, which can enhance its operation in the cloud environment. Additionally, some security enhancements can be achieved by incorporating cloud services, offering better protection than the original setup.

### C. Refactoring (Re-architecting)

Refactoring, or re-architecting, involves extensively re-designing the application to fully utilize cloud capabilities. Although this approach has higher initial costs, it offers potential long-term savings through improved efficiency and reduced operational costs. It fully leverages cloud scalability features, ensuring that the application can efficiently handle varying workloads. Performance is thoroughly optimized for the cloud, providing significant improvements in speed and responsiveness. Refactoring also allows for comprehensive use of advanced cloud security capabilities, enhancing the overall security posture of the application.

### D. Repurchasing

Repurchasing entails moving to a completely new cloud-native application, such as SaaS (Software as a Service). This strategy reduces operational costs by eliminating the need to maintain and update the existing application. The new solution often comes with built-in optimizations for performance, ensuring a smooth and efficient user experience. While scalability may depend on the chosen solution, many cloud-native applications offer robust scalability options. Additionally, these solutions typically include advanced security features, providing enhanced protection out-of-the-box.

### E. Retiring

Retiring involves decommissioning applications that are no longer useful or relevant. This strategy offers cost savings by eliminating expenses associated with maintaining, updating, and securing unused applications. By removing outdated applications, organizations can also reduce security risks, ensuring that only necessary and actively managed applications are in operation. This simplification of the IT environment can lead to a more streamlined and secure infrastructure.

### F. Retaining

Retaining means keeping applications in their current environment without migrating to the cloud. This strategy avoids the immediate costs and complexities associated with migration, offering cost stability. While it does not benefit from cloud scalability, it allows organizations to maintain their existing setup without disruption. Performance remains unchanged, as does the security posture, which continues to be managed on-premises or within the current environment. This approach

is suitable for applications that are not yet ready or suitable for cloud migration.

## V. CHALLENGES OF CLOUD MIGRATION

Migration Strategy	Challenge 1: Complexity	Challenge 2: Cost	Challenge 3: Time	Challenge 4: Compatibility
Rehosting (Lift and Shift)	Absent	Absent	Present	Absent
Replatforming (Lift, Tinker, and Shift)	Present	Absent	Present	Present
Refactoring (Re-architecting)	Present	Present	Present	Present
Repurchasing	Present	Present	Absent	Present
Retiring	Absent	Absent	Present	Absent
Retaining	Absent	Absent	Absent	Present

Fig. 2. Table of challenges of cloud migration

### A. Rehosting (Lift and Shift)

Rehosting involves moving applications to the cloud with minimal or no modifications. This strategy, while generally straightforward due to the minimal changes required, does present certain challenges. The initial costs are typically low, but operational costs may increase over time as the application may not be optimized for the cloud environment. Although it can be implemented quickly by lifting the existing infrastructure to the cloud, there is a potential for higher long-term expenses. Compatibility is usually high since no major modifications are needed, but the application may not take full advantage of cloud-specific optimizations.

### B. Replatforming (Lift, Tinker, and Shift)

Replatforming involves making some optimizations to the application during the migration to the cloud. This approach has moderate complexity because it requires minor modifications and optimizations, which can introduce challenges. While the initial costs are moderate with potential future savings, the process takes longer than rehosting due to the necessary tweaks. Compatibility issues may arise as platform-specific optimizations are made, potentially complicating the migration and requiring more thorough testing and adjustments to ensure smooth operation.

### C. Refactoring (Re-architecting)

Refactoring, or re-architecting, involves extensively re-designing the application to fully utilize cloud capabilities. This strategy is highly complex, involving a complete overhaul of the application architecture. The high initial costs are due to the extensive development and testing required, making it a resource-intensive process. It is also time-consuming because of the comprehensive changes needed, which can delay deployment. Compatibility can be a significant challenge, as adopting new technologies and paradigms may require substantial adjustments and learning, complicating the transition.

### D. Repurchasing

Repurchasing entails moving to a completely new cloud-native application, such as SaaS (Software as a Service). This strategy involves moderate complexity due to the learning curve and the integration of a new system. The initial cost is high, as purchasing and transitioning to a new system can be expensive. However, it can be implemented relatively quickly compared to refactoring. Compatibility issues might arise due to differences between the old and new systems, necessitating thorough planning and potential adjustments to ensure the new system meets all business requirements and integrates smoothly.

### E. Retiring

Retiring involves decommissioning applications that are no longer useful or relevant. Although this strategy has low complexity, as it simply involves phasing out applications, it presents certain challenges. The cost savings are minimal initially, though it can reduce ongoing operational costs. It can be time-consuming to ensure all dependencies are addressed and that there is no disruption to business processes. Compatibility is not a concern since the application is being retired, but careful planning is needed to ensure a smooth transition and that all dependent systems are properly adjusted or replaced.

### F. Retaining

Retaining means keeping applications in their current environment without migrating to the cloud. This strategy avoids additional complexity since the system remains unchanged. However, it presents challenges such as no immediate cost savings and potential for higher long-term maintenance costs. While no migration time is required, this approach may impact future scalability and performance, limiting the ability to leverage cloud benefits. Compatibility remains unchanged, but as the technology landscape evolves, the retained systems may face issues with future integrations, potentially requiring more significant updates later on.

## VI. COST ANALYSIS

### A. Rehosting (Lift and Shift)

Rehosting entails low initial costs as it involves minimal changes to the existing infrastructure. However, operational costs can range from medium to high due to potential inefficiencies in the cloud environment. The cost savings potential is generally low to medium, depending on the efficiency of the existing system. Additional cost factors include increased operational costs because the application may not benefit from cloud-specific optimizations, which can lead to suboptimal performance and higher expenses over time.

### B. Replatforming (Lift, Tinker, and Shift)

Replatforming comes with medium initial costs due to the necessary tweaks and modifications required for migration. Operational costs are also medium, as the application benefits from some cloud efficiency optimizations. The cost savings potential is medium, balancing the initial expenditure with

Migration Strategy	Initial Cost	Operational Cost	Cost Savings Potential	Additional Cost Factors
Rehosting (Lift and Shift)	Low	Medium to High	Low to Medium	Increased operational costs due to lack of optimization
Replatforming (Lift, Tinker, and Shift)	Medium	Medium	Medium	Costs associated with minor modifications and optimizations
Refactoring (Re-architecting)	High	Low to Medium	High	High development and testing costs, but potential long-term savings
Repurchasing	Medium to High	Medium to High	Medium	Costs for purchasing new software and potential retraining
Retiring	Low	None	High	Costs for decommissioning and ensuring all dependencies are handled
Retaining	None	High	None	Ongoing maintenance and potential technical debt costs

Fig. 3. Table of cost analysis of cloud migration

future operational savings. Additional cost factors include the expenses associated with modifying and optimizing specific components for the cloud, which can improve performance but require upfront investment.

#### C. Refactoring (Re-architecting)

Refactoring involves high initial costs due to the extensive development and redesign efforts needed to optimize the application for the cloud. However, operational costs can be low to medium, with the potential for significant efficiency improvements. The cost savings potential is high, offering long-term savings through enhanced cloud performance and scalability. Additional cost factors include high development and testing costs initially, but these are offset by the potential for reduced operational costs over time as the application becomes more efficient and scalable.

#### D. Repurchasing

Repurchasing has medium to high initial costs, depending on the expense of new software and licensing. Operational costs can vary from medium to high, influenced by the efficiency of the new system. The cost savings potential is medium, with the opportunity for savings through the use of more efficient software solutions. Additional cost factors include expenses for acquiring new software, possible retraining of staff, and efforts required for integrating the new system into existing workflows, which can add to the overall cost.

#### E. Retiring

Retiring an application involves low initial costs, primarily focused on the decommissioning efforts required to phase out the application. There are no ongoing operational costs, as the application is no longer in use. The cost savings potential is high, due to the elimination of maintenance and operational expenses associated with the retired application. Additional cost factors include ensuring all dependencies are addressed and that the application is properly decommissioned, which may involve some upfront planning and execution costs.

#### F. Retaining

Retaining an application incurs no initial costs since no migration is undertaken. However, operational costs can be high due to the ongoing maintenance required and potential inefficiencies of running the application in its current environment. The cost savings potential is negligible, with the likelihood of increased costs over time due to the accumulation of technical debt. Additional cost factors include continuous maintenance expenses and the risk of escalating technical debt if the application is not eventually migrated or modernized, potentially leading to higher costs in the future.

### VII. CONCLUSION

Cloud migration presents a transformative opportunity for organizations to enhance scalability, optimize resource utilization, accelerate time-to-market, and drive innovation. However, the migration journey is fraught with challenges, including data security concerns, interoperability issues, vendor lock-in risks, and the complexity of migration processes. Conducting a comprehensive cost analysis and addressing critical considerations such as data security, regulatory compliance, and vendor selection are essential for ensuring a successful transition to the cloud.

By leveraging the insights and strategies presented in this paper, organizations can navigate the complexities of cloud migration, maximize the value of their investments, and harness the transformative potential of cloud computing. Emerging trends in cloud migration further illustrate the successful strategies adopted by leading organizations across diverse industries, providing valuable lessons and best practices for those embarking on their cloud migration journey.

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