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Comparative analysis of migration between cloud providers (AWS and Google Cloud) as a cost optimization strategy for high-load systems

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Abstract

The study focuses on conducting a comparative analysis of the migration process between two leading cloud service providers: Amazon Web Services and Google Cloud, considered as means of cost optimization for high-load systems. The aim of the work is to identify key economic and technical determinants defining the total cost of ownership (TCO) when changing cloud providers, as well as to build a substantiated decision-making model for carrying out such migration. As a methodological basis, analysis of scientific articles and industry reports for the period 2021–2025, comparison of pricing models and performance metrics of core cloud services (compute instances, data storage systems, network components) are used. The results of the study demonstrate that despite significant initial investments in migration, including costs for data egress and architectural refinements, the strategic transfer of workloads to the platform with a more favorable pricing structure (in particular, to Google Cloud with its Sustained Use Discounts program) is capable of ensuring a reduction in operational expenses in the long term. Based on the obtained data, a decision-making matrix is proposed, systematizing the criteria for selecting the target cloud platform depending on the specifics of the workload, expense profile and quality-of-service requirements. The presented conclusions and toolkit will be useful for technical directors, heads of IT departments and cloud solution architects in strategic planning and optimization of IT infrastructure.

Keywords: Cloud Migration; Cost Optimization; High-Load Systems; AWS; Google Cloud; Total Cost Of Ownership; Data Egress; Multi-Cloud Strategy; FinOps; Vendor Lock-In.

1. Introduction

In the context of the rapid expansion of the volumes of generated and processed information in the modern digital economy, requirements for the scalability, fault tolerance and throughput capacity of IT infrastructures are intensifying. Cloud computing has established itself as the primary mechanism for deploying high-load systems, providing dynamic scaling and pay-as-you-go pricing. According to estimates by International Data Corporation (IDC), global investments in public cloud services will reach USD 670 billion by the end of 2024 and exceed USD 1 trillion by 2027, with a compound annual growth rate (CAGR) of 19.9 % [7]. At the same time, Amazon Web Services (AWS) and Microsoft Azure continue to retain leading positions, while Google Cloud Platform (GCP) demonstrates active share growth, especially in the data analytics and machine learning segments [6].

The relevance of the study is determined by the increasing complexity of the vendor lock-in issue and the need for continuous improvement of operational expenditures (OpEx) in the face of intensifying competition. According to the Flexera State of the Cloud Report for 2024, cost optimization of existing cloud expenditures is a priority for 89 % of organizations [5]. A provider choice made several years ago may lose its economic justification over time due to the evolution of application architectures, changes in workload profiles or the introduction by competitors of more

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advantageous pricing models. In this context, inter-cloud migration transitions from a measure of last resort to a system of planned financial management.

The scientific gap consists in the insufficient codification and systematization of migration methodologies specifically for high-load solutions with a focus on the comparative analysis of AWS and Google Cloud. Existing studies are mainly limited either to a general overview of cloud services [2] or to procedures for migrating from on-premises infrastructure to the cloud [11], overlooking economic and technical barriers to inter-cloud transition, such as data egress fees, challenges in migrating managed databases and the need for personnel retraining.

The objective of the work is to identify the key economic and technical determinants that define the total cost of ownership (TCO) when changing a cloud provider, as well as to construct a justified decision-making model for performing such migration.

The scientific novelty of the work manifests in the systematization of criteria for selecting the target cloud platform and the proposal of a decision-making model for migrating high-load systems, in which the profitability analysis encompasses both direct and indirect costs.

The author's hypothesis is that a strategically calibrated inter-cloud migration, based on analysis of architectural dependencies and pricing mechanisms, can reduce long-term operational expenses despite significant initial investments in the migration process.

2. Materials and methods

In recent years reviews of cloud platforms have paid special attention to comparing the functionality performance and pricing models of AWS and Google Cloud as a key tool for cost optimization in high-load systems. Thus Gupta B., Mittal P., Mufti T. [1] conduct a service-oriented analysis: the authors systematize offerings of compute instances storage and networking services and then on the basis of price lists construct a basic cost comparison model. Kaushik P. et al. [2] profile CPU load operational I/O latencies and network metrics on equivalent AWS and GCP configurations demonstrating that under homogeneous workloads AWS delivers higher CPU performance whereas GCP offers advantageous cold data storage pricing.

Authors Gohil R., Patel H. [3] emphasize the convenience of cost-calculation tools and integration with CI/CD infrastructure: they show how automated price calculators enable rapid modeling of migration scenarios yet point out significant variability in final figures depending on regional tariffs. Borra P. [4] proposes an adaptive provider-selection strategy: based on analysis of a large set of pricing plans the author demonstrates that an optimal mixed approach may involve placing hot workloads in AWS and long-term archives in GCP.

Industry reports supplement academic studies with global statistics and viewpoints of leading analytical agencies. Flexera 2024 State of the Cloud Report [5] records the growing popularity of resource reservation strategies and the use of spot instances for substantial cost reduction with 68 % of organizations planning to increase spending on FinOps tools. According to Gartner® [6] AWS firmly maintains leadership in platform breadth and ecosystem maturity whereas GCP earns praise for innovations in big data and machine learning. IDC [7] confirms that the total public cloud services market reached $669.2 billion in 2023 with GCP's share showing the highest growth rate of approximately 30 % year-over-year.

In the segment of hybrid and multi-cloud strategies Anh N. H. [8] proposes a classification of migration approaches (lift and shift replatform refactor) comparing them by criteria of flexibility security and economic efficiency. According to their decision-making model for high-load systems the replatform stage achieves an optimal balance between architecture refactoring costs and performance gains. Merseedi K. J., Zeebaree S. R. M. [9] describe mechanisms for orchestrating data and load between AWS and GCP to minimize network expenses and risks of vendor lock-in.

Case studies and economic analyses help to reveal the real effects of migration. In Health Care Cloud Migration Case Study Deloitte US [11] the migration of an EMR system to GCP is described where through automatic scaling and redistribution of idle resources it was possible to reduce total costs by 30 %. Thallam N. S. T. [10] in turn perform a comprehensive TCO analysis of transitioning HPC workloads from on-premise to the cloud showing reduction in costs while warning of hidden expenses for data transfer and management services.

Thus despite relative consistency in comparison methodologies (service catalogs plus synthetic benchmarks) results often contradict each other: some authors prioritize AWS on the basis of raw performance metrics [2] others favor GCP for its accommodating storage and analytics service pricing [4]. Industry reports do not always take into account the specifics of high-load systems and inherent migration overheads focusing instead on general trends [5, 6, 7]. Literature on hybrid strategies clearly describes technical and organizational models but does not provide quantitative assessments of the cost versus resilience trade-off under real workloads [8, 9]. Meanwhile case studies and financial analyses focus on immediate TCO overlooking long-term effects such as deterioration of application portability or cultural barriers within organizations [10, 11]. Therefore further in-depth research into end-to-end ownership cost metrics for high-load systems that considers full migration life cycles and mixed architectures is required.

3. Results and Discussion

Based on the conducted analysis of existing research, a methodology for comparative analysis of high-load system migration processes between AWS and Google Cloud platforms is proposed, including the evaluation of architectural solutions, financial performance modeling and the development of criteria for a justified choice.

A typical high-load infrastructure comprises a load balancer for incoming traffic, a cluster of automatically scalable web and/or application servers, a managed relational or NoSQL DBMS, a caching layer and object storage for static content.

Migrating such an environment requires not only a lift-and-shift transfer of virtual instances but also the adaptation of the architecture to the native services of the target cloud platform in order to enhance efficiency and optimize costs (approaches refactoring or re-architecting) [1, 2, 4].

Figure 1 presents the schema of a high-load web application adopted as the baseline model for further analysis.

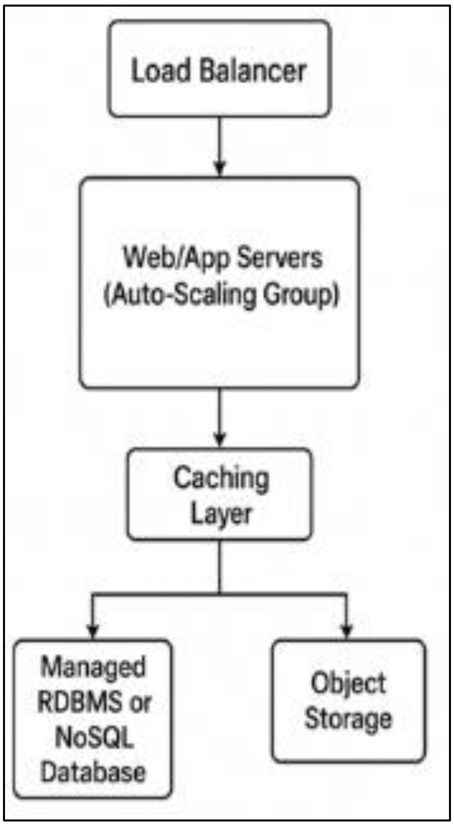

Figure 1 Typical architecture of a high-load web application (compiled by the author based on [1, 2, 4]).

The comparison of key AWS and GCP services relevant to this architecture is presented in Table 1.

Table 1 Comparison of key AWS and Google Cloud services for high-load systems (compiled by the author based on [2, 3, 4, 10]).

Service category	Amazon Web Services (AWS)	Google Cloud (GCP)	Key differences in the context of migration and costs
Compute resources (VM)	Amazon EC2 (Elastic Compute Cloud)	Google Compute Engine (GCE)	GCP offers automatic sustained use discounts (SUDs) which are more beneficial for stable workloads without the need for upfront payment. AWS requires upfront payment (Savings Plans/RIs) to obtain maximum discounts.
Object storage	Amazon S3 (Simple Storage Service)	Google Cloud Storage	Pricing is comparable but the cost of operations GET PUT and egress may differ. GCP often offers lower prices for cold storage classes.
Managed relational databases	Amazon RDS (Relational Database Service)	Google Cloud SQL	Database migration is the most complex stage. GCP Cloud SQL offers simple integration with other Google services. Cost depends on performance vCPU RAM IOPS.
Load balancing	Elastic Load Balancing (ALB/NLB)	Cloud Load Balancing	Both providers offer global load balancers. GCP pricing may be more predictable as it includes data processing and an hourly rate per forwarding rule.
Network and egress traffic	AWS Global Accelerator / VPC	Google Cloud VPC / CDN Interconnect	A critical cost factor. Egress costs at AWS are traditionally higher. GCP offers a more generous free tier and lower per GB prices at high volumes.

The process of inter-cloud migration can be divided into four main stages, as shown in Figure 2.

Conducted analysis confirms the initial hypothesis: migrating high-load systems from AWS to Google Cloud can ensure a stable reduction of costs. At the same time the decision to migrate should not rely exclusively on comparing regular payments. The following important factors come to the forefront:

Expenses for outgoing traffic (Data Egress). This is a one-time but significant cost item that must be meticulously modelled and calculated already at the preliminary assessment stage.

Complexity of database transfer. The relocation of voluminous and resource-intensive repositories is associated with a high risk of downtime and potential data loss, and therefore requires development of a detailed migration plan and fallback strategies.

Human factor. The presence of competencies in GCP within the team is a cornerstone condition for a successful transition and stable operation of the new infrastructure [2, 4].

In the further course of the research recommendations will be developed in detail and substantiated regarding the migration of high-load systems between the AWS and Google Cloud platforms with the aim of cost optimization.

To begin with it is recommended to conduct a comprehensive audit of the current infrastructure and workloads, collecting metrics on CPU usage, memory, disk space and network traffic. Such an assessment will allow for identification of bottlenecks and determination of potential areas of savings when transferring resources between cloud providers. Simultaneously the total cost of ownership (TCO), including licensing, software support and license fees, should be assessed to correctly compare current expenses with the forecasted costs on AWS and Google Cloud.

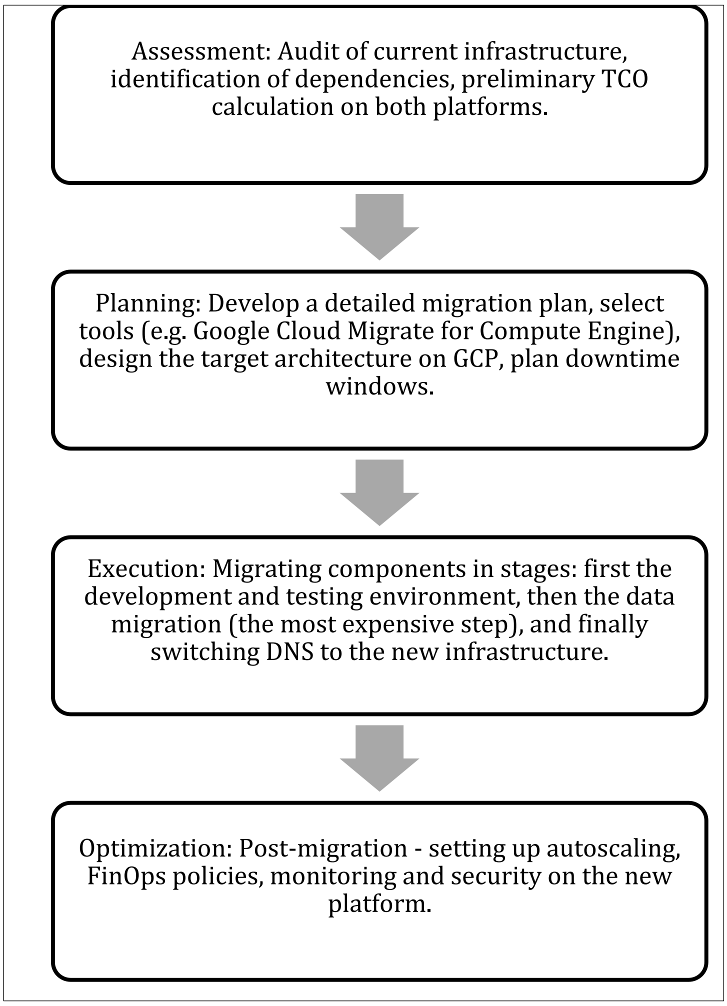

Figure 2 Stages of the intercloud migration process (compiled by the author based on [8, 9, 10]).

When analyzing the pricing models of cloud services it is advisable to distinguish the key cost drivers: computing resources, data storage, outbound traffic and specialized services (for example databases or event processing systems). It is recommended to align the specifications of AWS virtual machines (EC2, Fargate) with the analogous capabilities of Google Cloud (Compute Engine, Cloud Run), taking into account differences in billing for I/O and network transfer. This approach makes it possible to forecast costs in advance and to determine the optimal instance types for each task.

The choice of migration strategy should be based on the maturity of the applications and the required level of architectural modification. To minimize initial investments a lift-and-shift approach is often employed with subsequent proper refactoring for cloud services. At the same time it is advisable to consider containerization via Kubernetes (EKS vs GKE) or a serverless approach (AWS Lambda vs Google Cloud Functions), which in the long term will ensure greater scalability and reduced costs for idle resources.

As part of migration preparation it is recommended to test the tools offered by both providers: AWS Migration Hub and Database Migration Service, as well as Google Migrate for Compute Engine and Database Migration Service. Conducting a pilot proof-of-concept on critically important subsystems will allow validation of data transfer scenarios, configuration of network policies and security roles, thereby minimizing the risks of downtime and unforeseen expenses.

When designing the target architecture special attention should be paid to automatic scaling and infrastructure as code (Infrastructure as Code). The use of Terraform or Cloud Deployment Manager will enable centralized resource management in AWS and Google Cloud, unifying deployment processes and simplifying configuration reviews. It is also important to configure auto-scaling policies that account for seasonal and peak loads, and to apply a cluster warm-up strategy to ensure readiness for traffic growth.

To maintain financial discipline it is recommended to implement FinOps practices: establish budgets and cost alerts, implement a resource tagging system to detail expenses by project and team, and integrate cloud APIs for automatic data export to a BI system. This approach ensures transparency of expenditures and enables rapid identification of anomalies related to cost increases.

After migration completion billing parameters should be optimized: acquire Reserved Instances or Savings Plans in AWS and Committed Use Discounts in Google Cloud for long-term, predictable workloads. It is also advisable to use spot instances (AWS Spot Instances, Google Preemptible VMs) for unregulated or background tasks, which will provide significant cost reduction compared to on-demand resources.

Finally, it is recommended to establish a process of continual improvement: regularly review the cloud usage strategy, analyze the effectiveness of implemented optimizations, and train teams on new provider features. Such a culture of continuous enhancement will ensure architectural adaptability and maximize the return on investment in cloud infrastructure.

4. Conclusion

In this study an analysis was conducted of the migration of resource-intensive information systems between the AWS and Google Cloud platforms as a mechanism for cost optimization. It was found that although AWS retains a leading market position, Google Cloud can offer comparable and in some cases more advantageous operating conditions under stable and predictable workloads, primarily owing to its long-term discount policy and lower egress network traffic rates.

The principal conclusion of this work is the confirmation that multi-cloud migration constitutes an effective yet inherently complex tool for strategic management of IT expenditures. The proposed methodology comprises a phased migration plan, a detailed cost calculation model and a decision-making matrix, enabling formalization of the evaluation process and minimization of risks associated with the transition. The results obtained challenge the perception of migration as an exclusively technical task, positioning it instead as an integral element of corporate financial strategy in the field of cloud technologies (FinOps).

Prospects for further research may involve adapting the model to specific types of workloads, for example serverless architectures or high-performance computing (HPC), as well as developing methods to reduce indirect costs arising from temporary performance degradation and the need for personnel adaptation.

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