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AOD Model: A Case Study Based, Comprehensive Guide to a Novel Cloud Migration Strategy

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Abstract:

Cloud computing has seen tremendous growth and adoption from companies around the world due to its ability to cut down organizational costs and provide rapid elasticity. There are several benefits of adopting a cloud from an organization perspective but often organizations are not aware of why, and how they should adopt to this new technologies. Cloud adoption frameworks help organizations in systematically adopting this new technology while extracting the most out of its benefits. This study proposes a new cloud adoption frame called the Adapt-Optimize-Deliver (AOD) framework, specifically helping those organizations which are seeking cloud migrating services from an external service provider, also called the Cloud Beaker. We prove that the AOD framework allows organizations to seamlessly shift to the cloud of their cloud service provider (CSP) by analyzing a real-life case study where an organizations legacy systems were moved to the cloud using this framework. Moreover, the AOD framework can seamlessly integrate with the CAF of the CSP. We analyzed three well researched CAFs from the literature as well as the CAFs offered by the Big Three CSPs namely, Google, Microsoft and Amazon.

Keywords: Adapt-Optimize-Deliver (AOD), Cloud service provider (CSP), Cloud adoptions frameworks (CAF), Information Systems (IS), Technology-Organization-Environment (TOE).

Introduction

Cloud Computing has emerged as a novel solution for companies and businesses seeking rapid scalability, agility and efficiency in their business model. Organizations motivated by the promise of cost savings and highly controllable flexibility have migrated their legacy systems to various clouds over the previous decade. Despite the various promises of cloud technology in easing the day-to-day data-related processes of businesses easier, the real challenge faced by most businesses is adopting and migrating to the right cloud solution for their company. In other words, the path to a successful cloud migration is riddled with complexities, and various security and privacy risks. These hurdles demand for a comprehensive and practical cloud adoption plan or a well-structured framework that can employed during the cloud migration process. Following a well-structured framework ensures correctness in the adoption phase and makes continuous development on the newly migrated systems possible.

This study proposes a novel technique called the "Adapt, Optimize, and Deliver (AOD) Model" which facilitates seamless cloud adoption for companies. We also present a case study where this model was employed in successfully deploying the legacy systems of FCE Benefits, a company that provides health and welfare benefits solutions to government contractors, to the cloud. Using this case study as a yardstick, we establish that the AOD Model presents a comprehensive approach to guide organizations through their cloud adoption journey.

The main questions answered by this study include:

1. What are the current cloud adoption frameworks (CAFs), both theoretical and practical?
2. Which practical CAFs are widely used in the current era of cloud migration?
3. How the AOD is model different from the currently employed frameworks, and why should it be used?
4. What are the benefits of using the AOD model?

Considering the research questions laid down by this study, we give a brief overview of the AOD model to provide a setting for further explanation for the practicality of the proposed framework.

The AOD model

The AOD model is a combination of "Adaptation, Optimization and Delivery" aspects of the cloud migration process. Each of these three steps contain a number of sub-steps which help clarify the migration process for both the cloud adopters (CA) and migration implementers (MIs).

A phase-wise and more detailed explanation of each of the steps is provided later in the study. Furthermore we also discuss the various controls under each aspect of the AOD model and present a real-life case study where this model was successfully implemented to ensure seamless cloud adoption of a company, FCE Benefits.

Four sections constitute this paper. These are: a detailed literature review of the current cloud migration frameworks and strategies, an explanation of the methodology employed for this paper and an overview of the case study, discussion of the results obtained by employing the methodology, and finally the conclusion

derived from the results obtained. In the following section, we present a literature review of currently employed migration technologies.

Literature review

Discussing about cloud adoption requires a definition of the term "cloud computing". The National Institute of Standards and Technology (NIST) defines cloud computing as " a model for ubiquitous, convenient, on-demand access to a shared pool of configurable computing resources (ser1vers, storage, applications) which can be rapidly allocated and released with minimal effort or service provider interaction" (NIST, 2012). Furthermore, the report by NIST (2012) also goes on to define the various service models of cloud computing (SaaS, PaaS, and IaaS), its benefits (measured service, on-demand availability, rapid elasticity, broad network access, and resource pooling), and its different deployment models (public, private, hybrid and community clouds).

Cloud computing framework can be understood as a systemic methodology which allows companies to implement cloud computing under the umbrella of best practices both on the technical front and the organizational front (Chang et al., 2015). These frameworks are pivotal in shaping the strategic decisions and operational processes necessary for successful and practical cloud migration (Zbořil & Svatá, 2022). As organizations increasingly recognize the advantages of cloud-based infrastructure and services, understanding the significance of CAFs becomes paramount. Resultantly, researchers over the years have suggested a number of frameworks and models for easing oraganizational shift to the cloud.

Information systems (IS) and technology adoption frameworks like the Technology-Organization-Environment (TOE) framework, often in combination with a number of other frameworks like Diffusion-Of-Innovation (DOI) and the Technology-Acceptance-Model (TAM) has been discussed or used by a number of researchers as a basis for their CAFss (Wan Mohd Isa et al., 2019; Gangwar et al., 2015). The TOE framework, initially proposed by Tornatzsky and Fleischer (1990) (Oliveira & Martins, 2011) has empirical support by various researchers (Al-Hujran et al., 2018) as it is often used as a yardstick in explaining adoption of new IS where cloud computing is no exception. In essence, the TOE enables researchers to analyze the adoption of a new technology in an organization working under any certain environment. Technology factors encompass the characteristics of the technology, including its perceived advantages, complexity, compatibility, and observability. Organizational factors involve the organization's internal elements like its structure, culture, leadership, and resources. Environmental factors encompass external elements such as competition, regulations, industry standards, and market conditions. Together, these factors shape the adoption and success of new technologies within organizations (Oliveira & Martins, 2011). Resultantly the various frameworks analyzed in this paper derive their models either solely from TOE, or using a combination of TOE with another IS adoption theory to present their model.

CAFs in the literature

A total of three CAFs were analyzed for this study. Furthermore, we also analyzed the cloud adoption models being offered by the 'big three' cloud service providers (CSP) at the time of writing, Google, Microsoft and Amazon. The analysis of a number of a number of adoption framework allows for a holistic view and extraction of common points across all the analyzed framework.

Zbořil and Svatá (2022) present a comprehensive cloud adoption framework with 122 controls divided into 8 phases. Their cloud adoption framework has phases including: 'strategy, plan, ready, adoption-migrate, adoption-innovate, govern, and manage'. Zbořil and Svatá draw their framework from established complex frameworks such as Cloud Computing Compliance Controls Catalog (C5), Clouds Controls Matrix, Microsoft's, and Amazon's. Its maturity model is derived from the Cloud Capability Maturity Model (CCMM).

TOE-DOI based cloud adoption framework by Alqarni and Barnawi (2019) measures the effectiveness of the models in Technological, Organizational, and Business and Environmental readiness while mentioning certain set of controls under each step. Another highlight of this framework is its ability to categorize the technological complexity of cloud deployment into three main categories of infrastructure, data and security.

A unified cloud adoption framework is presented by Paredes-Gualtor et al. (2017) which lays down a more step-by-step approach to organization cloud adoption. The six step procedure given by the CAF of Paredes-Gualtor et al. includes 1) current situation definition 2) requirements definition 3) Providers analysis 4) Providers Assessment 5) decision and finally 6) migration.

Google (2018) presents a systematic approach to cloud adoption in their whitepaper. They claim that their framework can simplify the adoption process for businesses irrespective of the CSP chosen. An emphasis is put on personal evaluation of the company in analyzing its position on the cloud adoption journey. With a combination of 4 themes and three phases, companies employing Google CAF can systematically analyze where they stand on the adoption journey.

Microsoft (2023) provides a 'full lifecycle framework' for their Azure cloud platform which lays down four major steps to cloud migration. These steps are defining adoption strategy, planning the adoption at an organizational level, preparing the cloud environment for the migration, and finally migrate to the configured cloud. Three measures of security, management and governance work in the hindsight of all the four steps.

Amazon Web Service's Cloud Adoption Framework (AWS-CAF) (Amazon, 2023) provides a comprehensive guide to assist organizations in planning and executing their cloud transformation initiatives. It encompasses six key perspectives: Business, People, Governance, Platform, Security, and Operations, each addressing foundational capabilities crucial for cloud readiness and success. Furthermore, the AWS CAF offers a four-phase approach to cloud transformation, including Envision, Align, Launch, and Scale. It aids organizations in identifying transformation opportunities, enhancing cloud readiness, and refining their transformation roadmap iteratively.

In essence, current CAFs are more centered towards directly interacting with the customer and often overlook the various intermediary bodies and businesses which offer cloud migration services to the end customer, namely the Cloud Beakers (Barker et al., 2015). Statistical data suggests that a Cloud Beaker, providing services or consultation, is a significant entity (Markets and Markets, 2020). This

often creates a deadlock where a brokers and a customer have to fit into the same lens of 'one-organization' for the CAFs discussed above.

Limitations and issues of CAFs

Literature suggests that there are a number of issues and factors that hinder seamless integration of CAFs in the adoption processes. El-Gazzar (2014) thoroughly analyzed the 51 articles and concluded that there are 8 common factors that affect cloud adoption for businesses which are internal, external, organizational evaluation, proof of concept, adoption decision, implementation, and integration, IT governance, and confirmation. Alqarni and Barnawi (2019) adopt a more technical stance on analyzing the factors creating issues in organization cloud adoption. These factors range from data availability, virtualization management to skill and knowledge levels of the employees in the organization adopting the cloud.

A number of common themes can be found in the literature which include security, compatibility, data privacy and cost related issues (Al-Hujran et al., 2018; El-Gazzar, 2014; Wulf et al., 2021; Feuerlicht et al., 2011; Chang et al., 2015). The main gap found by this study is that despite the fact that current CAFs have the ability to systematically assess various issues in cloud adoption process, they often overlook the complexities brought forth when a Cloud Beaker is introduced in the adoption process.

This gap demands a simple, and practical CAF that enables organizations to seamlessly integrate cloud technology while dealing the complexities of involving a third-party service provider (the brokers) in the adoption process. We believe that the AOD model can provide the necessary flexibility and enable organizations to adopt cloud technologies irrespective of the CSP being employed. In the following section we delve deeper into the AOD model's intricacies.

AOD Model, A detailed overview

As the name suggests, the AOD model is divided into three aspects of the cloud adoption process namely *adoption, optimization* and *delivery*. Each of these aspects further have a number of control variables which guide the cloud adoption process for brokers and organizations. We explain the model in detail in the following section and also provide a simple figure giving an overview of how this model iteratively works to ensure correct and efficient cloud adoption.

When analyzed from a migration-perspective the AOD model consists of three essential layers. The Foundation Layer, which establishes a solid foundation for teams to adapt, learn, and build on cloud technologies; the Migration Layer, which helps businesses plan and execute successful cloud migrations in an optimized method; and the Modernization Layer, which provides tools and strategies for upgrading applications in the cloud in a sustainable and cost effective way (Couso, 2023). In essence these three layers also point back to adaption, optimization and delivery aspect of the AOD, which we explain below in detail.

Adaptation: Preliminary adjustments to avoid change resistance

Compatibility issues between the on-premises computing systems of companies and the target cloud for migration is a common issue (Gangwar et al., 2015). Adaptation phase in the AOD model lays down practical steps to avoid change resistance in companies when migrating the company systems to the cloud. Controlling variables in this phase include:

1. *Communication and Coordination*: this control variable ensures standardized information sharing across the CSP, Cloud Beaker and the cloud adopting organization.
2. *Training and Skill enhancing*: the adopting organizations employee are systematically trained on the cloud-deployed systems.
3. *Technical compatibility*: the cloud adopting organization's various computer applications that are to be deployed from legacy systems to the virtualized environment are made technically compatible to the target cloud by employing migration plan of CSP selected.

Optimization: Enhancing performance, cost efficiency and scalability

In this phase of the AOD model, the cloud is configured to the specific needs of the client to ensure higher performance of the company's legacy systems migrated while providing a fair and sustainable cost-benefit ratio. Following are the four control variables in this step:

1. *Performance Optimization*: Steps are taken to ensure peak performance to identify bottlenecks, fine-tune configurations, and ensure optimal resource allocation.
2. *Optimizing Expenditure*: Implementing cost management strategies such as right-sizing, resource scheduling, and leveraging reserved instances to minimize cloud spending are the focus of this control variable. Cloud expenditure is notorious due to the various nuanced pricing mechanisms under the umbrella of the pay-as-you-go model (Plummer, 2012).
3. *Network and Security Optimization*: Optimizing network configurations, such as reducing latency and improving load balancing, and ensuring proper security checks from the organizations side is the purpose of this control variable.
4. *Scalable Architecture*: This control variable ensures that the Cloud Beakers providing migrations services design cloud infrastructure that can easily scale up or down based on changing business needs, ensuring flexibility and agility.

Deliver: Continuous delivery for sustainable cloud adoption

The final phase in the AOD model is to 'Deliver' the cloud solution. AOD model ensures that systematic and sustainable changes are made to the deployed systems to ensure that they are compatible with the ever changing technologies and techniques in famous cloud infrastructures. The control variables in this phase are:

1. *DevOps-based Continual monitoring and development*: Best practice software management and development techniques are employed to ensure that faster and more reliable deployments of changes.

2. *Feedback Mechanisms*: Organization specific end-users feedback loops are managed under this control variable that helps to identify areas for improvement and ensure solutions meet evolving business needs.
3. *Research and Development* (R&D) adaptability: this control variable allows companies to stay informed of emerging cloud technologies and industry trends.

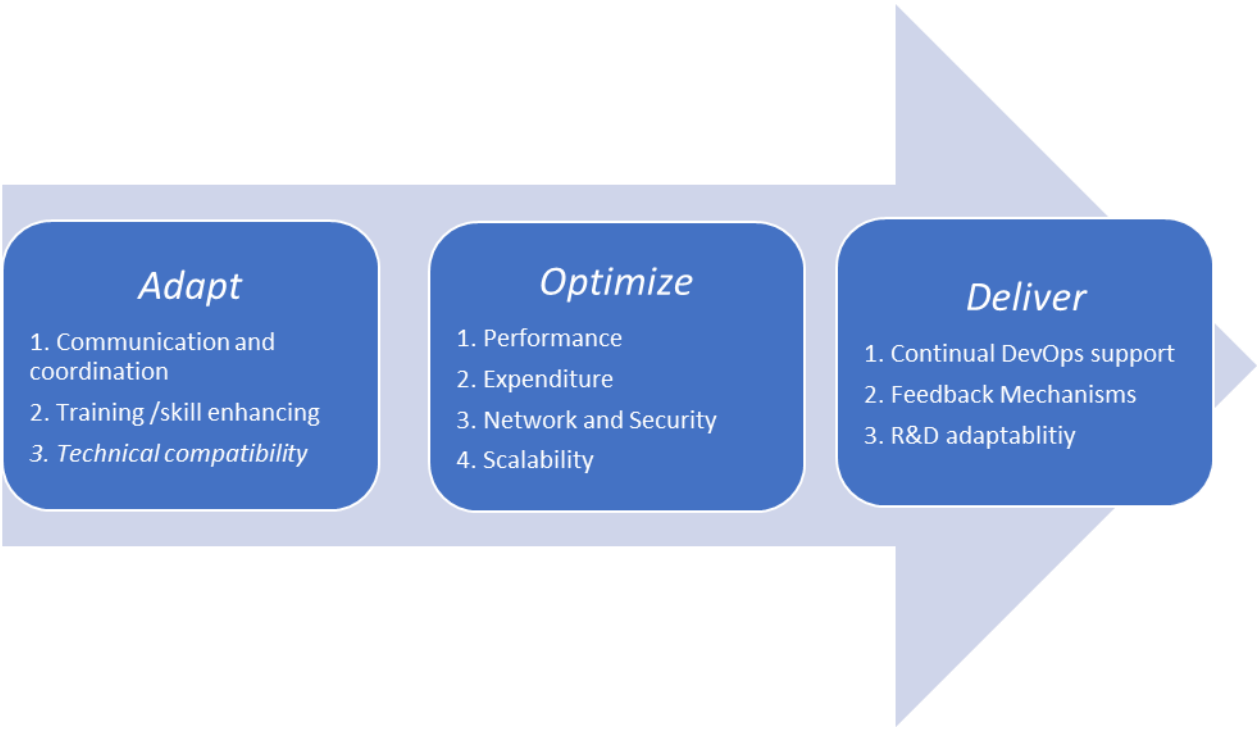

Figure-1: Graphical representation of the AOD model

Method

The methodology employed in this research combines a comprehensive literature review of existing cloud adoption frameworks and models with an in-depth analysis of a real-life case study involving FCE Benefits Administrators, Inc. The objective of this approach is to provide a holistic understanding of the AOD Model and its application in a practical context.

Literature review methodology

In the literature review phase, we aimed to identify and analyze relevant academic papers and cloud adoption frameworks. The following steps were taken to conduct the literature review:

1. Keyword Selection: We initiated the literature review by identifying pertinent keywords, including "cloud adoption framework," "cloud computing," and "adoption." These keywords were supplemented with additional terms such as "cloud strategy," "cloud adoption model," and "cloud service providers" to ensure comprehensive coverage.
2. Search Strategy: We conducted searches across reputable academic databases, including IEEE Xplore, Researchgate, and Elsevier. A total

of 17 papers were included in the review, which presented a wide range of cloud adoption frameworks and models.

3. Selection of Frameworks: Within the literature, we identified six notable cloud adoption frameworks. These frameworks were selected for analysis based on their relevance and comprehensiveness. Notably, three of these frameworks were proposed by researchers in the literature: the Unified Cloud Computing Adoption Framework by Paredes-Gualtor et al. (2017), A Cloud Adoption Framework by Zbořil & Svatá (2022), and the TOE-DOI-based cloud adoption framework by Alqarni and Barnawi (2019). The remaining three frameworks were sourced from the main cloud providers: Microsoft, Amazon, and Google.

Methodology of the case study: FCE benefits administrators, Inc

Selection of FCE Benefits Administrators, Inc. as the case study organization was based on its significant role as a full-service Third Party Administrator (TPA) and employee benefits firm specializing in government contractors' fringe benefit plans. The choice of FCE Benefits allowed us to explore the practical application of the AOD Model within a relevant business context. Moreover the organization was planning to adopt the cloud infrastructure to reduce its operational costs which amounted to $x annually/monthly. FCE Benefits employed the services of Cloud Beaker LLC, a cloud migration service provider which, in the context of our research, acts as the Cloud Beaker.

1. Data Collection Methods and Tools: To gather information for the case study, a combination of methods was employed. It included in-depth interviews with key personnel at FCE Benefits, document analysis of their cloud adoption strategies and practices. The initial examining their legacy systems for ensuring feasibility and compatibility on cloud adoption.
2. Ethical Considerations: Throughout the case study, ethical considerations were prioritized. Informed consent was obtained from all participants in the interviews. Anonymity and confidentiality were maintained to protect sensitive information. The research adhered to ethical guidelines and policies, ensuring the integrity and trustworthiness of the data collected.

All in all, the combination of the literature review and the FCE Benefits case study provides a robust foundation for the analysis of the AOD Model's applicability and effectiveness in real-world cloud adoption scenarios. This methodology allows for a comprehensive examination of the research objectives and offers insights into the novel cloud adoption strategy presented in this study.

Results and discussion

This section is dedicated to analyzing the results from the case study. After that we synthesized the literature review and the AOD model to present the findings of this paper.

Case study overview

We begin this overview with an introduction to the cloud adoption company itself. FCE Benefits Administrators, Inc. is a full-service Third Party Administrator (TPA) and employee benefits firm specializing in the design, implementation, and administration of compliant cost-effective fringe benefit plans for government contractors (FCE Benefits Inc., n.d.). The organization's business context is significant, given its commitment to offering customized solutions to government contractors, which often require complex and secure IT infrastructure. This complexity presents unique challenges and opportunities for cloud adoption.

Why FCE Benefits?

FCE Benefits was chosen as the focus of this case study due to three main compelling reasons:

i. Relevance: FCE Benefits' specialization in government contractors' fringe benefit plans entails dealing with sensitive data, compliance requirements, and cost-effectiveness, making their cloud adoption journey highly relevant to the study of cloud frameworks and strategies.
ii. Complexity: The nature of FCE Benefits' operations, with a need for robust and secure IT infrastructure, made it an ideal candidate to investigate the adaptation, optimization, and delivery phases of the AOD Model in a real-world setting.
iii. Cloud Beaker Involvement: The presence of Cloud Beaker LLC as the migration service provider adds an additional layer of complexity and interest to the case study, as it is essential to understand how such services fit into the overall cloud adoption process.

Cloud adoption process at FCE benefits

The cloud adoption process at FCE Benefits was guided by the AOD Model, thus consisting of three key phases of adaptation, optimization, and delivery. Below we analyze these three phases in the context of the case study.

- Adapt Phase: During the adapt phase, FCE Benefits assessed their existing IT infrastructure, which mainly comprised legacy on-premise systems. Their Cloud Beaker, Cloud Beaker LLC, played a pivotal role in understanding their existing systems, identifying the potential for migration, and formulating a strategic plan for the transition to the cloud. This phase involved identifying the most suitable cloud service provider from Google, Microsoft, and AWS Amazon.
- Optimize Phase: The optimization phase involved the actual migration of FCE Benefits' legacy systems to the chosen cloud service provider. The Cloud Beaker worked closely with FCE Benefits to ensure a seamless transition, minimizing downtime, and optimizing

performance. This phase also included fine-tuning cloud resources to meet the organization's specific needs, cost-effectively.

- Deliver Phase: In the deliver phase, FCE Benefits leveraged the cloud environment to enhance their operations. This phase focused on implementing cloud-native solutions, improving data accessibility and security, and ensuring compliance with government regulations. It also marked the beginning of ongoing monitoring, maintenance, and further optimization efforts.

Relevant statistics and insights

Throughout the case study, several relevant statistics and insights emerged:

- Cost Savings: FCE Benefits experienced a noticeable reduction in IT infrastructure and maintenance costs after migrating to the cloud, which is critical for government contractors striving for cost-effective solutions.
- Enhanced Security: The cloud adoption process allowed FCE Benefits to enhance the security of sensitive data, particularly critical for compliance in their industry.
- Scalability: The cloud environment enabled FCE Benefits to scale their IT infrastructure as needed, supporting their flexibility and adaptability in serving government contractors' evolving needs.
- Efficiency: The optimized cloud environment resulted in increased operational efficiency and improved customer service.

Lessons Learnt

The case study of FCE Benefits Administrators, Inc. provides a valuable real-world illustration of the AOD Model's application in a complex business environment, shedding light on the adaptability, optimization, and delivery phases within a cloud adoption strategy, especially in the context of government contractor benefits administration. It also provides an insider's look into how governmental organizations are run with the on-premise configuration and what factors are crucial that make the stakeholder chose the move towards clouds.

Conclusion

This research presented a new CAF that helps cloud adopting organization in a setting where they are seeking services from a Cloud Beaker in implementing their services on the cloud. We conclude this study by listing down the findings, implications and limitations and future research directions.

Findings

The triangulation of the literature, research and a practical case study points to the following key findings in analyzing the practicality of the AOD model.

- The AOD model can be successfully applied to help organizations with complex systems, where the cloud adopting organization is aided by a Cloud Beaker or an intermediary service provider.

- AOD model is flexible enough that it can be employed on top of a CSPs CAF and further enhance the productivity of the three stakeholders (adopting organization, Cloud Beaker, and CSP).
- The AOD model can be considered a derivative of the TOE framework where it also puts an emphasis on the adaptation of technology for a specific organization working under a given environment.

Implications of this research

This research on the AOD model adds a new perspective to the literature of CAFs which doesn't discuss the involvement of additional stakeholders in the cloud adoption process. Furthermore, it opens up the way towards a new research path for future research where multi-stakeholder CAFs can be discussed where the adopting organization is seeking various cloud services from a number of different stakeholders in a more complex setting than the case study in this research discusses.

Limitation of AOD and Future Research Directions

There are a number of limitations of the AOD model this research found. The AOD model may present the same set of steps as provided the CAF of the CSP. Thus it may force the organizations to choose between the more practical approaches, which in turn may result in an entirely different outcome primarily in the migration phase. Thus, the AOD model demands additional time and effort from the Cloud Beakers and cloud adopters to analyze which strategy (the one from the AOD model or the one provided by the CSP) is more beneficial for their specific use case. Another limitation for this study is its validation process. The AOD model's adoption has been thoroughly analyzed only once as it is a novel model. The continued practicality of this model demands that it must employed and tested in a set of different organization and environments.

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