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Scalability Challenges In Enterprise Applications : Design and Solutions

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ABSTRACT

The problem of migrating particular applications and their layers and components to the cloud, as well as to define possible solutions. This separates absolute migrations and components migration, and classifies them according to the effects on the application performance and scalability respectively. The study also addresses other pertinent issues like security, scalability, and compliance issues in the process of migration. In this context, analysing the migration process in detail, the paper contributes the key lessons that would be valuable for the SW architects and developers, and outlines the migration roadmap that can be followed in the future such migrations. For the improvement of migration strategies, some important research topics are also presented.

Keywords : Cloud Migration, Application Layers, Scalability, Security, Hybrid Cloud

Introduction

Scalability is a key issue that affects the AINut, as it aims at identifying enterprise applications as they grow and as the number of users rises. This is the capability of the application to accommodate increased workload, data and users with high performance so as to enable efficient running of a program and user satisfaction. Nevertheless, the ability to scale up enterprise applications comes with the following challenges. The architectural constraints of the system, constrained database performance and congested networks. Also, the process should be done without increasing the system's complexity and also maintain its security, this should entail having automation, load balancing and horizontal/vertical scaling. Activities like cloud native, microservices, containerization and resource management are the remedies to these above said challenges. When solving the scalar issues, several pitfalls have to be taken into account, and if the application cannot grow together with the enterprise, or the programming mistakes decrease an application's availability, users will be affected. This paper explains generally faced scale issues and looks at the design patterns and approaches for creating the scalable application for an enterprise.

LITERATURE REVIEW

Data Stores for Application Performance Monitoring

According to the authors Rabl et al. 2012, with the increasing complexity of the enterprise systems the requirement for the better monitoring tools has become apparent. While previous monitoring systems just aimed at the usage of resources, current systems monitor specifics such as specific methods invoked or exact transactions in distributed architectures. Such a level of granularity results in accurate evaluation and prediction of the performances as well as enormous amounts of data.

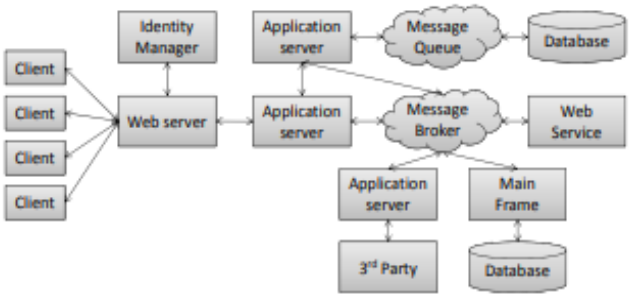

Figure 1: Example of an enterprise system architecture

(Source: Rabl *et al.* 2012)

The problem which arises due to this big data is that it becomes very difficult to manage it especially for APM systems. As usual, efficient storage and archive of this high volume of data presents another challenge where the system must be capable of processing the data rate as well as providing real time information about the health status of basal structures. In recent years, technologies for huge and fast data storage became extremely popular, known as key-value stores and NoSQL databases (Rabl *et al.* 2012). These systems are developed to address the requirement of APM horizontality, high throughput, and low-latency access by using for real time control. There is a diversified list of open source data stores that have been developed and boast of different features and settings for the purpose of monitoring. The key issues include the understanding of the performance, how these stores are set up and some specific settings that are required to be understood by organizations interested in functioning APM solutions in large dynamic environments.

Architectural Features of Cloud Computing

According to the authors Rimal *et al.* 2011, cloud computing hence refers to a new model of utilizing information technology services where resources are available over the Internet through a pool of remotely provided resources that can be rapidly provisioned and dynamically configured. This convenience quota based service delivery system is also advantageous as organizations do not have to invest heavily in structures to support these services (Rimal *et al.* 2011). However, there is a major problem in this regard, and that is the lack of a general well-defined global architecture or a blueprint that can sufficiently serve the needs of the enterprise, the customer and the CSP.

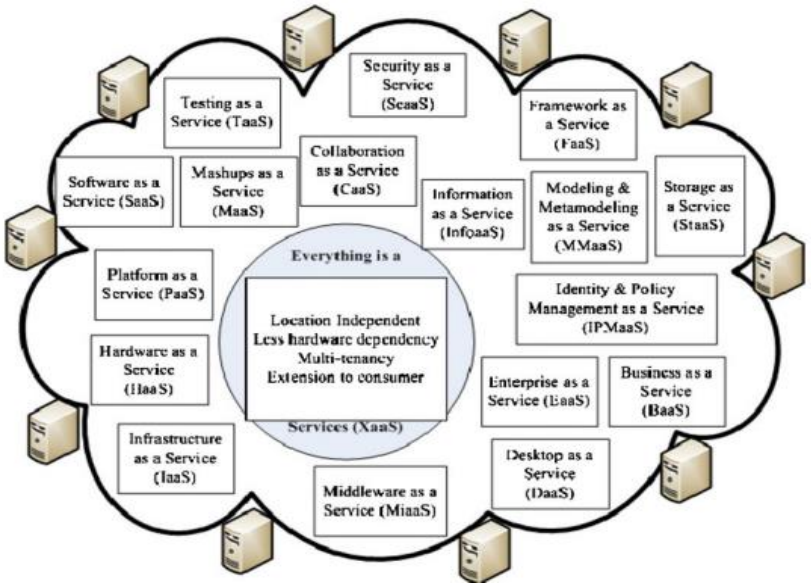

Figure 2: Cloud computing: everything is a service model

(Source: Rimal *et al.* 2011)

In this context, there are several requirements that the architecture of cloud systems has to meet, namely flexibility and scalability, security, high availability and resource utilization. Core characteristics such as multi-tenancy, virtualization, flexibility, service on demand are the key principles that define whether Cloud Computing will be successful or not. Some of these are used in the organization and management of cloud resources and others on how enterprises use cloud to their advantage. Organizations are experiencing the shift from traditional client-server to the cloud working environment; therefore, it is critical for software architects and application developers to comprehend the support of cloud services architectural approaches for building a scalable, secure, and efficient application in cloud environments. These changing architectural properties give an outline which architects and developers need to establish future cloud systems to withstand all types of requirements of industries.

Challenges in Application Migration to the Cloud

According to the author Andrikopoulos *et al.* 2013, scales, the main challenges of migrating legacy applications to Cloud are relative with the new computing models that need one to understand the changes in application architecture and resource utilization. Prior work is mostly related to full stack migration where information is typically migrated using virtualization techniques to run the applications over the Cloud (Andrikopoulos *et al.* 2013). However, as the flexibility and granularity of Cloud services increase it is now possible to migrate only application layers or components. This approach to migration brings certain specificities for each layer of the application and can affect its resources and performance, for example, data layer, business layer, and presentation layer.

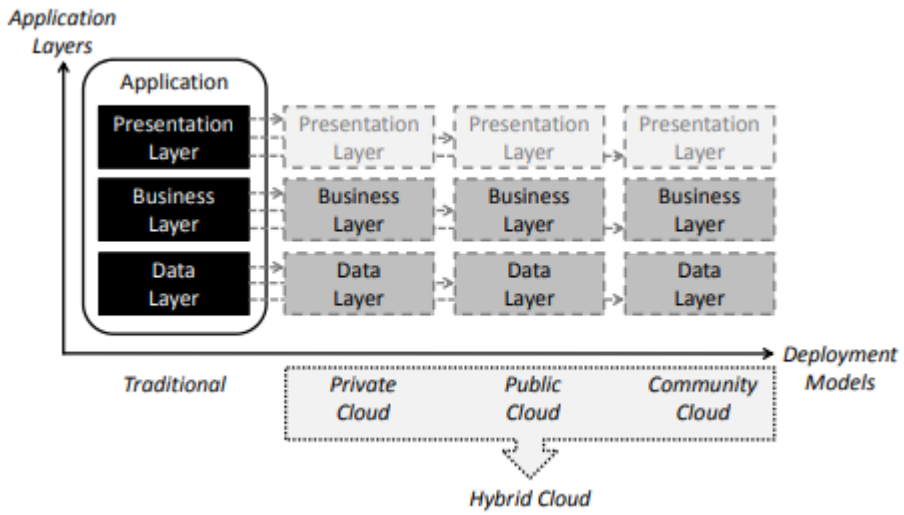

Figure 3: Overview of Cloud Deployment Models, Application Layers and Possible Migrations

(Source: Andrikopoulos *et al.* 2013)

However, it is also critical to consider the concerns that cross its layers of operations such as security issues, scalability issues and communication issues between layers as it migrates from one level to another. Knowledge of these never kinds of migrations, their effects across the application layers, and the correlations in use for adaptation is helpful in Cloud transitions. Peculiarities related to research in application migration towards Cloud environments: Using this context, the following open issues should be mentioned:automation tools for adaptation of applications and optimization techniques.

Methods

Migration Type Categorization

The understand migrations more constructively, there are several classifications of different types of application migrations depending on the scope of work and, therefore, the degree of adaptation. Two main forms of migration are “direct deploy”, which translates into copying the application with the aim of hosting in a plain based on its capabilities, and “re-hosting”, which involves remodeling components of the application like databases or business logic for full utilization of the cloud environment (Agrawal *et al.* 2011). It is also discussed whether only some unified communications components should be migrated to the cloud while others remain in the company’s environment. It remains useful in establishing the level of resource necessary as well as the intrusion to current application architecture hence provides a practical way of evaluating the appropriate migration strategy in accordance with the organizations requirement, cost and time factors.

Layer-Specific Migration Challenges

Various layers of an application bring different sets of challenges during the migration exercise to the cloud. When it comes to the data layer, it is important to optimize storage for the use of cloud-native databases, that would be more scalable and secure. Business application logic should be redesigned to enable the use of services from the cloud zone like managed functions and microservices and can imply the modification of essential business processes (Vaquero *et al.* 2011). Lastly, there may be changes necessary to communicate with cloud services, as well as, modifications to the user interfaces to optimize their function across different devices.

These layer considerations need to take precautions to prevent poor performance and compatibility issues in the cloud layers and enablers, which in turnывает the application functionality.

Cross-Cutting Concerns

They are issues that are relevant to various levels of the application and that are present throughout the whole migration. These are; security, in which encryption of data and access control must be achieved in addition to meeting set regulations. The solution has to be scalable and this is achieved through the flexibility of the different components of the application with reference to cloud elasticity (Banerjee *et al.* 2017). Some activities such as monitoring and logging are essential during migration for the purpose of tracking the performances, noting the problems that are experienced, and enhancing migration. Solving all these issues systematically guarantees that the migrated application may perform securely, effectively, and, more to the point, without an adverse impact in the cloud environment.

Result

Migration Performance Analysis

There was a difference in the efficiency of various migration strategies based on the type of migration strategy. It was observed that full-stack "lift and shift" migrations could be quickly deployed but the consequent adjustment of the components had poor resource utilization on public cloud since some of the components are not fully utilizing auto-scalable native capabilities. When it comes to migration on the other hand, the re-architecture migration plan such as refactoring business logic and data layers, and other parts of the system to be run in the cloud architectures performed better after migration (Karakus and Durresi, 2017). These applications could grow better and had better fault tolerance and although migration was more extensive and required longer time and resources. The findings shed light on the differences between point migrations and optimization of cloud operations.

Layer-Specific Adaptation Outcomes

The evaluation experience of changing individual application layers to cloud environments was mixed. The ultimate layer demonstrated the highest level of improvement in terms of performance especially when migrating from the use of application and storage server environments to managed cloud databases which are more scalable and more redundant to on-premise storage. When it came to the business logic refactoring, there were more issues that needed more effort and often during the transition to the microservices or serverless style, there were observed some degradation of performance on initial phases (Manchana, 2017). Some of the improvements were made on the presentation layer; CDNs for delivering cloud-based contents were responsive while the redesign of interfaces to multiparadigm increased development complexity. Nevertheless, individual layer adaptation provided better alignment with the cloud capabilities.

Impact of Cross-Cutting Concerns

Failure on how to address cross-cutting concerns while migrating the application had a great influence towards the general outcome of the application in the cloud. The strict approach to security during migration was to become compliant to the industry standards while handling data in one, two, and three environments and, thus, it made it complex. Scalability alone was closely pinned as a critical bar in sustaining performance especially

during peak times and particularly when embracing elastic clouds (Breivold and Sandström, 2015). Further, the monitoring and logging approach accustomed to provided the means for constant evaluation of the performance after the migration to YouTube and identified possible performance problem areas. Incorporating the above challenges early also enabled the formation of the more stable cloud solutions, which improved the overall long term reliability when transitioning to this new structure.

Discussion

The issues described above from the analysis of different migration strategies and layers show that migration to Cloud is both an opportunity and a challenge. Initially, it is easy to apply the lift and shift strategy where an organization simply moves workloads directly, without optimizing them for the public cloud. On the other hand, a myriad of benefits can be achieved in the process, if one migrates/transforms each individual application layer in a step-by-step manner or if one re-architects components for cloud environments in an ongoing process. Nevertheless, it comes with the cost of extensive refactoring and modulation among different layers and complexities of business logic and data. Of all the migration techniques, the data layer migration was the most effective as well as the cloud native databases provided optimal performance and availability benefits. Business logic, however, had issues mainly during migration decisions, specifically as the movement towards the microservices or serverless architectures means that a new development paradigm is needed and testing is more complex (Villamizar *et al.* 2015). The presentation layer showed the advantages of using cloud such as CDNs, but also discussed the necessity of the constant updating of interfaces for the purpose of creating unified look-and-feel for end-users across various gadgets. Moreover, there were some issues that transcended the boundaries of the migration approach and became factors affecting the success of the project: security, scalability, compliance, and the rest. The area where implementing secure practices with fortifying the security of the sensitive data in the cloud was more complicated but very much vital for retaining the trust of enterprises. Some drawbacks of the cloud platform included scalability and cost effectiveness; while the cloud environment allows for auto-scaling, incorrect setting or migrating strategies may result in the environment consuming too many or too few resources (Jammal *et al.* 2014). Therefore, it is a strategic, cost effective, efficient and effective cloud migration strategy that considers the various components of improving speed, resource usage and attaining overall alignment with cloud platforms.

Future Directions

There are certain factors about the cloud migration process that need to be addressed to enhance the process. One of the most effective areas is the interaction between migration and adaptation to improve the effective usage of cloud options or to adapt certain parts of the application, such as components, for the requirements of cloud architecture. Special tools for the copying of business rules, databases, and other critical layers will help to lessen the time and labor costs as well as reduce the impact of human mistakes (Ahmed *et al.* 2017). Moreover, mechanisms that apply artificial intelligence to migration and can determine optimal migration solutions depending on the requirements provided by the applications such as performance, costs, or the ability to scale can better the decision-making process. Moreover, more research is needed specifically on hybrid and multi-cloud since it is a trend organizations may use to minimize their dependence on a single vendor and ensure they have redundant systems. It is also conceivable that adaptability and recomputation of functions as a prerequisite for workload pattern optimization are about to be explored within AI and machine learning. Last but not least, concerning more and more security issues like multi-cloud and hybrid cloud security the latter

aspect will be crucial as regards to the rise in data protection regulations. Security mechanisms for migrating applications to cloud-native applications will also ensure that the resulting cloud environment is safer than current platforms.

Conclusion

As the applications continue to migrate to cloud, this has very economical benefits and risks as illustrated below. As mentioned earlier full-stack migration techniques are very fast but they do not always make best use of the cloud services. Layer-specific migrations, though more complex, offer greater performance and scalability in the long run. There are benefits from adopting the cloud relating to the lack of good information management, business logic refactoring, and security. Cloud migration is going to be the basis for intelligent, self-service environments that ease out complexity in the complete migration process and make it possible to shift to better forms of new-age process-oriented clouds.

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