Efficient Migration of Application to Clouds: Analysis and Comparison

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Abstract— **Owing to the immense popularity in the last couple of years Cloud technology is being regarded as one of the most influential technology in new era. Given the long term benefits of adopting this new phenomenon, many organizations have decided to migrate to the cloud. However, due to rapidly evolving market and the security issues hovering over the cloud, most of the organizations are unsure about how to proceed with the migration into the cloud. After a brief introduction about the technology, this paper aims to provide an understanding of migration challenges. The paper analyses the migration of a web-based application, used for an academic organization, to the cloud. It also compares the application's performance when deployed to a traditional server versus its deployment to Windows Azure.**

Index Terms — **Application migration, Comparison, Migration Challenges, Windows Azure.**

I. INTRODUCTION

The growing popularity of the cloud computing [1, 2, 3, 4] trend has changed the way information technology (IT) Services are delivered, deployed, scaled and maintained. Over the last couple of years many companies such as Google, Microsoft and Amazon have used clouds to build highly scalable systems. However, cloud computing is not just for startups[5,6]; enterprises are attracted to cloud-based services as cloud providers market their services as being superior to in house data centers in terms of financial and technical dimensions e.g. more cost effective, equally or perhaps more reliable, and highly scalable [7, 8].

Measuring so many advantages of this disruptive technology, organizations are keen to migrate to the cloud. However, they are not clear about the migration process, outcomes and benefits.

The growing popularity of cloud migration and its management has not only accelerated the entire cloud environment but have also given rise to several cloud service providers to offer competitive and lucrative management solutions for organizations to run their daily operations competently.

While a cloud migration can present numerous challenges and raise security concerns, cloud computing can also enable a company to potentially reduce capital expenditures and operating costs while also benefiting from the dynamic scaling, high availability, multi-tenancy and effective resource allocation advantages cloud-based computing offers.

Even though implementing a Cloud migration intended at replacing an on premise major business application, may seem at times a simple straight forward process, it is fraught with loose ends which may undermine the true value of the investment and in fact put enterprises in worst situation than before.

II. MIGRATION CHALLENGES

A. Challenges

Migration Challenges	Description
Business Factors	• **Costs** • **Existing investments in IT** • **Data security** • **Regulations** • **Provisioning**
Technical Factors	• **Existing infrastructure** • **Security architecture** • **Complexity** • **Network and support** • **IT skills** • **Service Level Agreements (SLAs)**

Business Factors
The key business factors to consider when moving to the Cloud are as described below:

- **Existing investments in IT:** Small and Medium Enterprises (SMEs) are positively at an advantage over large organizations when we talk about Cloud migration. Due to a significantly restricted installed IT support SMEs may

be able to directly move into the Cloud. Most large corporations, however, have already made significant investments in their IT infrastructure. Huge investments and complexity of hardware, network, application support, administration, customization and integration would make it difficult for them to move away from their existing IT environment [9].

- **Costs:** The on hand cost model for IT is a blend of capital expenditure and operational expenditure. Organizations generally budget for peak loads incurring higher capital expenditure. However, these costs while being high are budgeted and predictable. Moving to an operational cost model through the adoption of the Cloud would mean paying for resources as per usage. This model implies unpredictable operational costs especially for those applications with varying demand for e.g. public facing websites. Therefore, it is important for organizations to estimate application usage and operational costs before moving to the Cloud. Further, migration costs need to be understood and factored in before making the decision to move into the Cloud. Failure to do this could negate the cost savings that are sought to be derived from the adoption of the Cloud [10].

- **Data security:** Security of data and other computing resources is a major concern while considering the move to the Cloud. Applications that have very sensitive and confidential information would be better off being behind the corporate firewall. Data with greater security tolerance however could be ported onto the Cloud. Technical mechanisms for data security in the Cloud are still evolving and security of data is still the top most inhibiter of Cloud adoption [11].

- **Regulations:** Geopolitical issues especially for Governments and financial institutions should be carefully evaluated before making the transition to the Cloud. In the Indian context this is especially relevant as most Cloud data centers are not located within the country. It is also important to ensure that local regulations relevant to each organization should be adhered to before deciding to move to the Cloud [12].

- **Provisioning:** One of the key features of the Cloud is the quick provisioning of resources. Applications that need to be quickly available and scaled up rapidly based on demand are ideal candidates for the Cloud. Most organizations have business requirements that need to be supported by quick provisioning of IT data, e.g. an organization running a limited period online marketing campaign. Several applications are seasonal in nature as well for example HR and Payroll applications, which need resources to be processed only during certain periods. These sorts of applications can make use of the ability of the Cloud to quickly provision resources [13].

2) Technical Factors

Some of the key technical aspects to be considered are:

- **Existing infrastructure:** The traditional IT architecture is optimized to cater to the current demand in the sector. Moving to the Cloud would necessitate a change in the IT architecture. With applications moving into the Cloud, the way IT is delivered to end users would undergo a radical change. Some end user support would be dependent on the Cloud service provider response. Hence, organizations would have to concentrate on building vendor management competencies [14].

- **Security architecture:** Application security and controls would need to change to adapt to the Cloud ecosystem. New types of mechanisms would be required to secure data in transit and at rest. Identity and access management mechanisms would need to be adapted to Cloud deployments. Further, data encryption mechanisms and key management for the Cloud are yet to mature [15].

- **Complexity:** Simple applications can be easily migrated to the Cloud and the amount of effort required in moving such applications may not be too significant. These applications can be directly migrated to Software as a Service [13] (SaaS) applications already available from various vendors. E.g. e-Mail applications can be directly ported onto Cloud offerings like Office365, Google Apps or Lotus Live. Similarly, moving a simple web server to an Infrastructure as Service (IaaS) platform may not require as much effort. Migration of complex applications however, needs elaborate planning and testing prior to implementation. Legacy applications and existing enterprise applications could require code changes to work on the Cloud.

- **Network and support:** With applications moving to the Cloud, there is a real risk of the network becoming the single point of failure. Further, due to a large number of connections to the external Cloud, the bandwidth may need to be upgraded. Hence, organizations would need to plan for better and reliable network connections to the Cloud. This could mean that organizations may incur higher costs for additional and higher capacity network connections. Further, a higher level of support would be required of telecom providers to ensure that any downtime is minimized [16].

- **IT skills:** Although the Cloud is based on existing technologies, it would require updated skills within the IT team, especially on architecture, implementation, develop and operation. For organizations not yet exposed to newer IT technologies like virtualization, Web 2.0 etc. the learning curve would be sharper. Further, migration of applications to the Cloud is perceived by IT teams as a loss of control. These types of cultural challenges would need to be addressed prior to deciding the migration to the Cloud.

- **Service Level Agreements (SLAs):** Another key aspect to consider before migrating to the Cloud is whether Cloud service providers are able to provide SLAs that the business needs. This is quite essential considering the limited control organizations have over applications on the Cloud. SLAs need to address the concerns of availability, confidentiality and integrity of the application. Further, it should clearly outline service provider responsibilities and penalties for failure to meet agreed service levels [17].

B. Related Work

Cloud computing is not only about technology; it also represents the fundamental change in how IT is provisioned and used. Before adopting the cloud computing; enterprises have to consider its benefits, risks and effects on their organization. Lot of research work is being carried out by individuals as well as the organizations on whether to embrace this disruptive technology or not. Some of them have proposed models on how to migrate the existing application onto the cloud. This section highlights some of them. The work by Khajeh-Hosseini *et al.* [18] illustrates the potential benefits and risks associated with the migration of an IT system in the oil & gas industry from an in-house data centre to Amazon EC2 from a broad variety of stakeholder perspectives across the enterprise, thus transcending the typical, yet narrow, financial and technical analysis. This work clearly states the need for a proper migration process.

Klems *et al.* [19] presented as a framework that could be used to compare the costs of using cloud computing with more conventional approaches, such as using in house IT infrastructure. Their framework was very briefly evaluated using two case studies. However, no results were provided because the framework was at an early developmental stage and more conceptual than concrete.

Another methodology and tools for model-driven migration of legacy applications to a service-oriented architecture with deployment in the cloud; i.e. the Service Cloud paradigm was presented by P. Mohagheghi et al. [20]. The migration approach used here is the Architecture Driven Modernization (ADM) [21] by OMG. In this concept, modernization starts with the extraction of the architecture of the legacy application (the "Recover" activity). Having the architectural model helps to analyze the legacy system, identify the best ways for modernization and benefit from Model-Driven Engineering (MDE) technologies for generation of the new system. This information will be then translated into models covering different aspects of the architecture: Business Process, Business Rules, Components, Implementation, and Test specifications. Though this process of migration is still a work in progress, it nowhere talks about the migration challenges and ways to handle them.

Another approach by a group [22] at IBM talks about many automated tools for cloud migration, the challenges and the experiences. In their work they have clearly stated the need for a smooth migration of workload from the previous environment to the new cloud enabled environment in a cost effective way, with minimal disruption and risk. They have introduced extensions to an integrated automation capability that enables workload migration and discussed the impact that automated migration has on the cost and risks.

All these work clearly states the need for a well defined process for cloud migration and the benefits that can be achieved after migration. Though a lot has been talked about cloud computing; there is significantly very less contribution on the process of migration. The work presented here for cloud migration is based on the software engineering approach and attempt to evaluate the cloud migration in terms of response time.

C. Contribution Summary

In this we have highlighted some of the challenges in cloud migration process and various works done in the area of cloud migration. Section III describes about the system being implemented on the premises and its subsequent migration to Windows Azure, followed by section IV which discusses about the analysis and conclusion.

III. MIGRATION TO WINDOWS AZURE

This section describes the migration process of a web application to the Azure platform. In order to fully leverage the benefits of cloud services, this application needed to be migrated to cloud.

The application being migrated is developed using PHP and the My SQL Server. The main goal of the application is to maintain a database of the research scholars of an academic institution along with providing research related information to the scholars. Besides this it also offers a common platform in the form of a forum to the scholars to discuss about their research activities, upcoming conferences, new findings, research paper publication etc.

The application migration to the azure platform involved the following steps:

- Migration of the database from My SQL to SQL Azure
- Modification of the application's database connection string, so that it works on the new cloud database
- Conversion of the source web application project into a Windows Azure Web Role project, and testing it to assure that it run in the local development fabric
- Creation of an application deployment package for Windows Azure, and load it to a newly created hosted service in the Windows Azure subscribed platform.
- Testing of the application deployed to the Windows Azure.

The migration process was carried out without any major issues. When the application is scaled up horizontally it creates an instance which enables the application to cope with many

simultaneous accesses. As Microsoft accepts SLAs with at least two instances, the web role for the migrated application must have at least two instances. The existence of more than one instance causes the application to stop working because of the use of the session state by the application.

IV. ANALYSIS AND COMPARISON

Following the migration of the application on cloud, we call for performance comparison of results in order to evaluate the advantages in terms of performance between deployment in the cloud and deployment on-premises. For that, we deployed the application both to an on premises server and to Windows Azure. To compare the performance of the above two deployments, the LoadStorm's solution (www.loadstorm.com) for load tests has been used. LoadStorm allows the creation of test scenarios, simulating a sequence of user tasks on a web application, and then run those test scenarios on the application. A few seconds after the test starts, with one simulated user, LoadStorm starts to create concurrent users and each user executes the test scenario. The performance tests' results are depicted in the graphics in figures 1 and 2. Each graphic shows, in the x axis, the number of simultaneous virtual users sending requests to a server, and in the y axis, the response time average, for all simultaneous users, and the response time peak, for the user that waited longer. The performance comparison involved, then, the creation of sets of equal test scenarios invoking several pages of each one of the deployments. Given the access profile for the application deployed, no more than 25 simultaneous accesses to the application are expected, and that was reflected in the test scenarios. These test scenarios were run on the systems being compared, and figures 1 and 2 show the results obtained when running one of those test scenarios on the Windows Azure and the on-premises application, respectively.
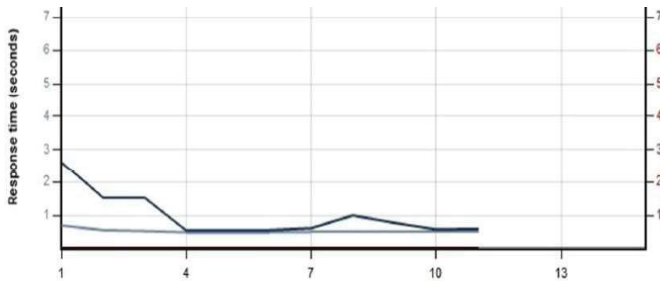

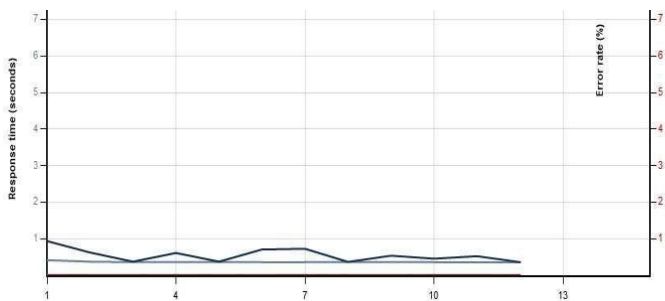Figure 1: Performance test results for application deployed in Windows Azure platform

Figure 2: Performance test results for application deployed on premises

The test results of the Azure's and on-premises' solutions show that the response time peaks were low, and similar, between less than 1 second and 2,5 seconds, and didn't suffer with the increase in the number of users. Through a small case study, we have shown that application performance doesn't deteriorate when migrating applications to the cloud. This is mainly because cloud based applications benefit from elastic resources that grow and shrink according to the user needs. So, at least the same performance for applications and other IT services, or even a performance increase in cases where more simultaneous users exist, is expected when migrating to the cloud. Other major benefits for adopting the cloud for deploying new and existing systems are savings on the purchase of equipment and software, and reducing maintenance and administration costs of IT, the reduction of energy consumption, because the computing center and information storage are not on-premises, better protection against disasters, because cloud services providers typically implement fault tolerance mechanisms, such as data replication, redundant connections or multiple data centers, and access to the information and applications from anywhere and through various devices. There are, however, some issues that companies must consider before acquiring cloud services. These are usually related to security and privacy issues, because although wanting to benefit from the advantages of the cloud, users want to keep control of their data .Other aspects that must be considered before acquiring cloud services have to do with legal and regulatory concerns, like the physical location of customers' data, and the lack of standards compliance by cloud services providers.

V. CONCLUSION

While the Cloud promises several benefits, migration to the Cloud needs to be meticulously planned. Depending on business and technical considerations, organizations need to select the appropriate applications and infrastructure for migration, as all applications and infrastructure are not suited for the Cloud. A phased approach to Cloud migration is required to move applications to the Cloud while navigating through various minefields. This would enable organizations to ensure that the costs of migration to the Cloud do not exceed its benefits. Further, different types of organizations for e.g. SMEs, large corporations and Governments need to consider factors relevant to themselves before embarking on this journey. To summarize, the Cloud holds promise for all types of organizations. However, different approaches are required by each organization to leverage the Cloud effectively. Through this study we have concluded that an application's performance doesn't deteriorate when migrating applications to the cloud and thus organizations after careful considerations can leverage the benefits of this revolutionary technology.

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