Migration of Software Services into Cloud for Reducing Cost and to Improve Efficiency

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Abstract—*Cloud computing is a set of IT services that are provided to a customer over a network on a leased basis and with the ability to scale up or down their service requirements. Cloud Computing holds the potential to eliminate the requirements for setting up of high-cost computing infrastructure for IT-based solutions and services that the industry uses. It promises to provide a flexible IT architecture, accessible through internet from lightweight portable devices. Many of the organizations want to migrate there services to cloud. The present cost of services by an individual company is a lot more compare to cloud. The cloud service providers (CSP) are interested to give there cloud access to provide the organizations services to the clients. Any organization, who want to migrate there services to cloud has to go through some algorithm like Xen Hypervisor algorithm. But while migrating, the services of individual are unavailable for some time. To avoid this problem, there should be an algorithm which can reduce the time of services unavailability while migrating into cloud.*

Keywords—Migration, cloud, cloud service provider, Hypervisor.

I. INTRODUCTION

Cloud Computing is a general term for anything that involves delivering hosted services over the Internet. Instead of a static system architecture, Cloud Computing supports the ability to dynamically scale up and quickly scale down, offering cloud consumers high reliability, quick response times, and the flexibility to handle traffic fluctuations and demand. Cloud computing also supports multi tenancy, providing systems configured in such a way that they can be pooled to be shared by many organizations or individuals. Virtualization technology allows cloud vendors to convert one server into many virtual machines, thereby eliminating client-server computing with single-purpose systems. This maximizes hardware capacity and allows customers to leverage economies of scale.

Most of the companies, educational institutes and other traders are showing their interest to migrate the part of servers, operations and other storages into cloud. But while migrating into the cloud, there is a services delay or unavailability. To avoid that there must be an algorithm which at least reduce the time of services unavailability.

II. LITERETURE REVIEW

Why Migrate?

There are economic and business reasons why an enterprise application can be migrated into the cloud, and there are also a number of technological reasons. Many of these efforts come up as initiatives in adoption of cloud technologies in the enterprise, resulting in integration of enterprise applications running off the captive data centers with the new ones that have been developed on the cloud. Adoption of or integration with cloud computing services is a use case of migration.

At the core, migration of an application into the cloud can happen in one of several ways: Either the application is clean and independent, so it runs as is; or perhaps some degree of code needs to be modified and adapted; or the design (and therefore the code) needs to be first migrated into the cloud computing service environment; or finally perhaps the migration results in the core architecture being migrated for a cloud computing service setting, this resulting in a new architecture being developed, along with the accompanying design and code implementation. Or perhaps while the application is migrated as is, it is the usage of the application that needs to be migrated and therefore adapted and modified. In brief, migration can happen at one of the five levels of application, code, design, architecture, and usage. With due simplification, the migration of an enterprise application is best captured by the following:

$$P \rightarrow P'_C + P'_l \rightarrow P'_{OFC} + P'_l$$

Where P is the application before migration running in captive data center, P'_C is the application part after migration either into a (hybrid) cloud, P'_l is the part of application being run in the captive local data center, and P'_{OFC} is the application part optimized for cloud. If an enterprise application cannot be migrated fully, it could result in some parts being run on the captive local data center while the rest are being migrated into the cloud—essentially a case of a hybrid cloud usage. However, when the entire application is migrated onto the cloud, then P_l is null. Indeed, the migration of the enterprise application P can happen at the five levels of application, code, design, architecture, and usage. It can be that the P_C migration happens at any of the five levels without any P_l component. Compound this with the kind of cloud computing service offering being applied—the IaaS model or PaaS or SaaS model—and we have a variety of migration use cases that need to be thought through thoroughly by the migration architects. To capture this situation succinctly, on enumeration, we have the following migration scenario use-case numbers: For migrating into an IaaS offering, there are 30 use-case scenarios. For migrating into a PaaS offering, there are 20 use-case scenarios. For migrating into a SaaS offering, it is purely a case of migration of usage, with no accompanying enterprise application migration—like the case of migrating from an existing local ERP system to SAP already being offered on a cloud. Of course, for each of these migration use-case scenarios, detailed approaches exist while for many commonly applicable scenarios, enterprises have consolidated their migration strategy best practices. In fact, the migration industry thrives on these custom and proprietary best practices. Many of these best practices are specialized at the level of the components of an enterprise application—like migrating application servers or the enterprise databases.

Deciding on the Cloud Migration

In fact, several proof of concepts and prototypes of the enterprise application are experimented on the cloud to take help in making a sound decision on migrating into the cloud. Post migration, the ROI on the migration should be positive for a broad range of pricing variability. Arriving at a decision for undertaking migration demands that either the compelling factors be clearly understood or the pragmatic approach of consulting a group of experts be constituted. In the latter case, much like software estimation, one applies Wide- Band Delphi Techniques to make decisions. We use the following technique: A questionnaire with several classes of key questions that impact the IT due to the migration of the enterprise application is posed to a select audience chosen for their technology and business expertise. Assume that there are M such classes. Each class of questions is assigned a certain relative weightage Bi in the context of the entire questionnaire. Assume that in the M classes of questions, there was a class with a maximum of N questions. We can then model the weightage-based decision making as MxN weightage matrix as follows:

$$C_l \leq \sum_{i=1}^{M} B_i \left(\sum_{j=1}^{N} A_{ij} X_{ij} \right) \leq C_h$$

where C_l is the lower weightage threshold and C_h is the higher weightage threshold while A_{ij} is the specific constant assigned for a question and X_{ij} is the fraction between 0 and 1 that represents the degree to which that answer to the question is relevant and applicable. Since all except one class of questions do not have all N questions, the corresponding has a null value. The lower and higher thresholds are defined to rule out trivial cases of migration. A simplified variant of this method can be presented as a balanced scorecard- oriented decision making. An example of that approach to the adoption of cloud is found in Dargha.

III. THE SEVEN-STEP MODEL OF MIGRATION INTO A CLOUD

Typically migration initiatives into the cloud are implemented in phases or in stages. A structured and process-oriented approach to migration into a cloud has several advantages of capturing within itself the best practices of many migration projects. While migration has been a difficult and vague subject—of not much interest to the academics and left to the industry practitioners—not many efforts across the industry have been put in to consolidate what has been found to be both a top revenue earner and a long standing customer pain. After due study and practice, we share the Seven-Step Model of Migration into the Cloud as part of our efforts in understanding and leveraging the cloud computing service offerings in the enterprise context. In a succinct way, captures the essence of the steps in the model of migration into the cloud, while captures the iterative process of the seven-step migration into the cloud. Cloud migration assessments comprise assessments to understand the issues involved in the specific case of migration at the application level or the code, the design, the architecture, or usage levels. In addition, migration assessments are done for the tools being used, the test cases as well as configurations, functionalities, and NFRs of the enterprise application. This results in a meaningful formulation of a comprehensive migration

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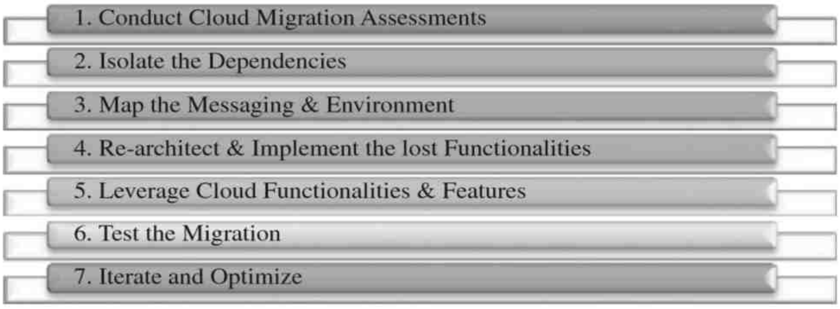
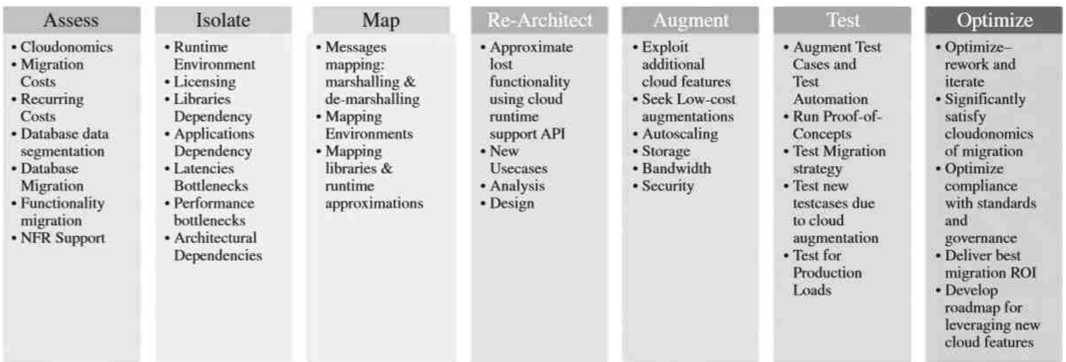
strategy. The first step of the iterative process of the seven-step model of migration is basically at the assessment level. Proof of concepts or prototypes for various approaches to the migration along with the leveraging of pricing parameters enables one to make appropriate assessments. These assessments are about the cost of migration as well as about the ROI that can be achieved in the case of production version. The next process step is in isolating all systemic and environmental dependencies of the enterprise application components within the captive data center.



The Seven-Step Model of Migration into the Cloud. (*Source:* Infosys Research.)

This, in turn, yields a picture of the level of complexity of the migration. After isolation is complete, one then goes about generating the mapping constructs between what shall possibly remain in the local captive data center and what goes onto the cloud. Perhaps a substantial part of the enterprise application needs to be re- architected, redesigned, and re-implemented on the cloud. This gets in just about the functionality of the original enterprise application. Due to this migration, it is possible perhaps that some functionality is lost. In the next process step we leverage the intrinsic features of the cloud computing service to augment our enterprise application in its own small ways. Having done the augmentation, we validate and test the new form of the enterprise application with an extensive test suite that comprises testing the components of the enterprise application on the cloud as well. These test results could be positive or mixed. In the latter case, we iterate and optimize as appropriate. After several such optimizing iterations, the migration is deemed successful.



Some details of the iterative Seven-Step Model of Migration into the Cloud.

Our best practices indicate that it is best to iterate through this Seven-Step Model process for optimizing and ensuring that the migration into the cloud is both robust and comprehensive. captures the typical components of the best practices accumulated in the practice of the Seven-Step Model of Migration into the Cloud. Though not comprehensive in enumeration, it is representative. Compared with the typical approach8 to migration into the

Amazon AWS, our Seven-step model is more generic, versatile, and comprehensive. The typical migration into the Amazon AWS is a phased over several steps. It is about six steps as discussed in several white papers in the Amazon website and is as follows: The first phase is the cloud migration assessment phase wherein dependencies are isolated and strategies worked out to handle these dependen- cies. The next phase is in trying out proof of concepts to build a reference migration architecture. The third phase is the data migration phase wherein database data segmentation and cleansing is completed. This phase also tries to leverage the various cloud storage options as best suited. The fourth phase comprises the application migration wherein either a "forklift strategy" of migrating the key enterprise application along with its dependencies (other applications) into the cloud is pursued. Or perhaps using the "hybrid migration strategy," the critical parts of the enterprise application are retained in the local captive data center while noncritical parts are moved into the cloud. The fifth phase comprises leveraging the various Amazon AWS features like elasticity, autoscaling, cloud storage, and so on. Finally in the sixth phase, the migration is optimized for the cloud. These phases are representative of how typical IT staff would like to migrate an enterprise application without touching its innards but only perhaps at the level of configurations—this perfectly matches with the typical IaaS cloud computing offerings. However, this is just a subset of our Seven-step Migration Model and is very specific and proprietary to Amazon cloud offering.

Live Migration and High Availability: Live migration (which is also called hot or real-time migration) can be defined as the movement of a virtual machine from one physical host to another while being powered on. When it is properly carried out, this process takes place without any noticeable effect from the end user's point of view (a matter of milliseconds). One of the most significant advantages of live migration is the fact that it facilitates proactive maintenance in case of failure, because the potential problem can be resolved before the disruption of service occurs. Live migration can also be used for load balancing in which work is shared among computers in order to optimize the utilization of available CPU resources.

IV. LIVE MIGRATION ANATOMY, XEN HYPERVISOR ALGORITHM

In this section we will explain live migration's mechanism and how memory and virtual machine states are being transferred, through the network, from one host A to another host B [21]; the Xen hypervisor is an example for this mechanism. The logical steps that are executed when migrating an OS are summarized in. In this research, the migration process has been viewed as a transactional interaction between the two hosts involved:

Stage 0: Pre-Migration. An active virtual machine exists on the physical host A.

Stage 1: Reservation. A request is issued to migrate an OS from host A to host B (a precondition is that the necessary resources exist on B and on a VM container of that size).

Stage 2: Iterative Pre-Copy. During the first iteration, all pages are transferred from A to B. Subsequent iterations copy only those pages dirtied during the previous transfer phase.

Stage 3: Stop-and-Copy. Running OS instance at A is suspended, and its network traffic is redirected to B. As described in reference 21, CPU state and any remaining inconsistent memory pages are then transferred. At the end of this stage, there is a consistent suspended copy of the VM at both A and B. The copy at A is considered primary and is resumed in case of failure.

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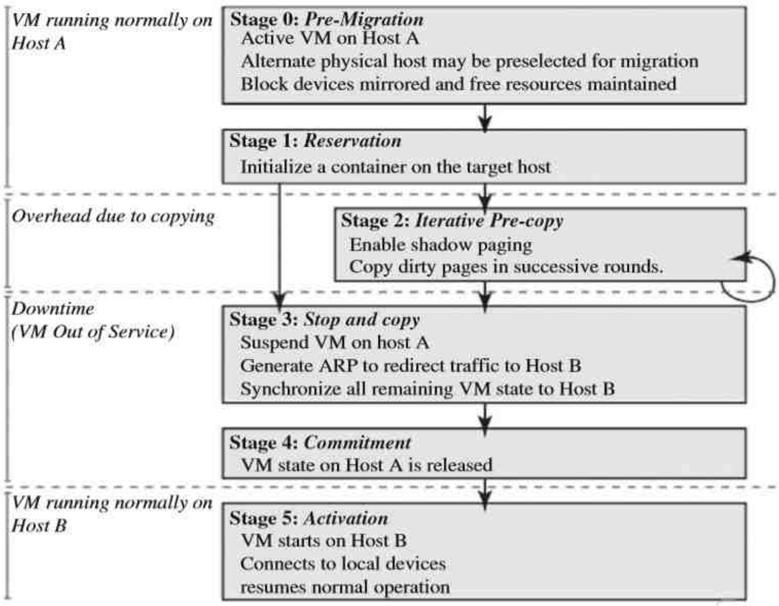

Live migration timeline

Stage 4: Commitment. Host B indicates to A that it has successfully received a consistent OS image. Host A acknowledges this message as a commitment of the migration transaction. Host A may now discard the original VM, and host B becomes the primary host.

Stage 5: Activation. The migrated VM on B is now activated. Post-migration code runs to reattach the device's drivers to the new machine and advertise moved IP addresses.

V. MIGRATION RISKS AND MITIGATION

The biggest challenge to any cloud migration project is how effectively the migration risks are identified and mitigated. In the Seven-Step Model of Migration into the Cloud, the process step of testing and validating includes efforts to identify the key migration risks. In the optimization step, we address various approaches to mitigate the identified migration risks. Migration risks for migrating into the cloud fall under two broad categories: the general migration risks and the security-related migration risks. In the former we address several issues including performance monitoring and tuning essentially identifying all possible production level deviants; the business continuity and disaster recovery in the world of cloud computing service; the compliance with standards and governance issues; the IP and licensing issues; the quality of service (QoS) parameters as well as the corresponding SLAs committed to; the ownership, transfer, and storage of data in the application; the portability and interoperability issues which could help mitigate potential vendor lock-ins; the issues that result in trivializing and non-comprehending the complexities of migration that results in migration failure and loss of senior management's business confidence in these efforts.

On the security front, the cloud migration risks are plenty as addressed in the guideline document published by the Cloud Security Alliance. Issues include security at various levels of the enterprise application as applicable on the cloud in addition to issues of trust and issues of privacy. There are several legal compliances that a migration strategy and implementation has to fulfill, including obtaining the right execution logs as well as retaining the rights to all audit trails at a detailed level which currently may not be fully available. On matters of governance, there are several shortcomings in the current cloud computing service vendors. Matters of multi-tenancy and the impact of IT data leakage in the cloud computing environments is acknowledged; however, the robustness of the solutions to prevent it is not fully validated. Key aspects of vulnerability management and incident responses quality are yet to be supported in a substantial way by the cloud service vendors. Finally there are issues of consistent identity management as well. These and several of the issues are discussed in future. Issues and challenges listed in table continue to be the persistent research and engineering challenges in coming up with appropriate cloud computing implementations.

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