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MIGRATION THE APPLICATIONS TO CLOUD COMPUTING

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ABSTRACT: Cloud computing is defined as a type of computing that depends on sharing computing resources rather than using local computer resources. What makes this technology different than traditional client-server architecture is that the resources are shared through virtualized machines. This technology is becoming popular as number advantages such as high scalability and reduced IT costs attract potential users. On the other hand, some challenges, such as legacy applications to be moved to cloud computing environment, are to be discussed. In this work, possible stages to manage and undertake such a migration are attempted to be explored and described. The stages are proposed not only to describe the necessary steps but also to itemize related constraints for each level of migration. Main limitations include plans for migration hence a comprehensive/complete work-flow targeting organization specific requirements such as financial, cultural and legislative parameters remains as a future research avenue. Nevertheless, main benefit of this work is to assist organizations who need to migrate legacy applications onto cloud environment is supported as the work-flow is argued be used as a base to determine the constraints/issues that may arise at the stages.

KEYWORDS: Cloud Computing, Migration to Cloud Environment, Virtual Machine, Work-flow.

1 INTRODUCTION

Cloud computing is an abstraction idea established on the thought of pooling physical resources and offer these resources as virtual resources [2]. It is a modern model for supplying resources, for platform-independent and applications platform for customers can access services [2]. There are many types of clouds and the services and applications that execute on clouds may or may not be delivered by a cloud provider [2].

2 CLOUD COMPUTING SERVICES MODELS

As cloud computing has advanced, various salesman offered clouds with various services related to them [2]. The set services presented adds else set of definitions known as the service model [2].

Three service types have been universally passable:

- **Infrastructure as a Service:** IaaS supply virtual machines, virtual storage machines, virtual infrastructure resources and else hardware holdings as resources that clients can provision [1-2-3].
- **Platform as a Service:** PaaS provides development frameworks, transactions, and control tools to manage applications that are hosted on the cloud [1-2-3].
- **Software as a Service:** SaaS is an environment that completes operating with applications services and the user interface [1-2-3].

The three different models taken with each other have come to be recognized as the SPI model of cloud computing. Many other models are also established, such as Storage as a Service (StaaS); Identity as a Service (IdaaS); and Compliance as a Service (CmaaS). However, the SPI services cover all else possibilities [2]. It is beneficial to view cloud models in terms of a hardware and software stack. One such representation, named the Cloud Reference Model, is shown in **Figure 1** [2]. The hardware and network are involved in the infrastructure at the lower stack [2]. When moved up on the stack, the remaining models will inherit the capabilities of the model under it. IaaS has the undermost model level on the stack and the SaaS has the upmost level on the stack models [2].

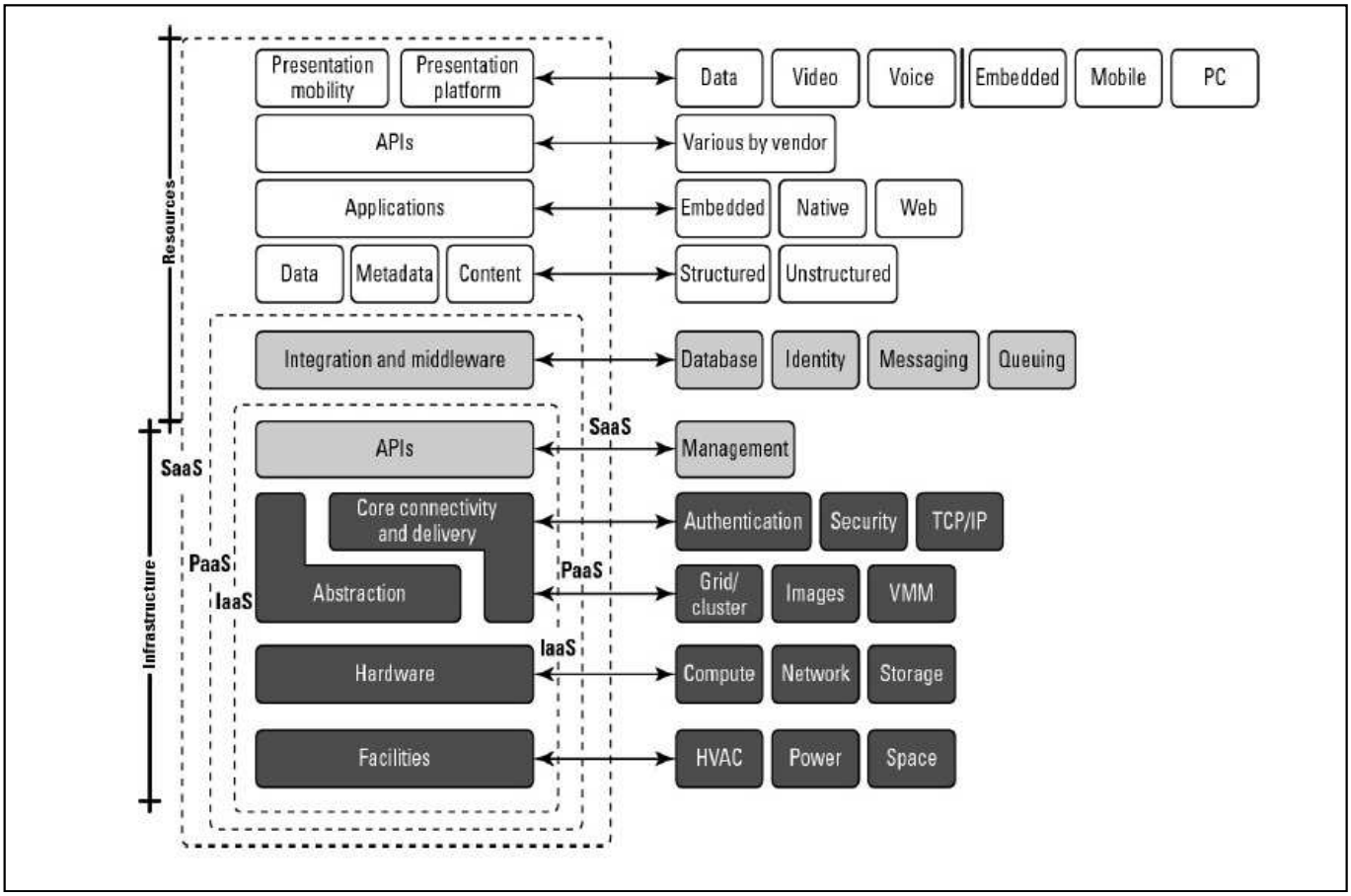

Figure 1. Cloud reference model [2]

3 BENEFITS OF CLOUD COMPUTING

1- **On-demand self-service:** Without the need for interaction with cloud provider personnel, a customer can obtain computer power resources according to customer needs [1-2-3-5].
2- **Broad network access:** The resources of the cloud are available over a network. These resources can be accessed over a network using the standard methods that provide an independent platform [2-3].
3- **Resource pooling:** Cloud computing creates one pool for resources that are pooled together in the system to support the multi-usage of resources [1-2-7].
4- **Rapid elasticity:** Computer power can be rapid and elastic provisioned. The customer can add or change computer power [1-2-7].
5- **Measured service:** Based on a metered system, the usage of cloud resources is reported to the user and measured [2].
6- **Lower costs:** Because cloud computing networks work with greater utilization and at higher efficiencies, important cost reductions often occur [1-2-3-7].
7- **Ease of utilization:** At times users do not need hardware or software licenses to implement services [1-2-7]. This is dependent upon the type of service being offered [2].
8- **Quality of Service:** QoS is something that can be obtained under contract with a cloud provider [1-2].

9- **Reliability:** The reasons making the cloud highly reliable include the scale of cloud networks and their ability to provide balancing and failover [6-7].
10- **Outsourced IT management:** Cloud computing allows a user to manage system infrastructure resources [2]. Additionally, the customer manages and focuses on business [5] and achieves considerable reductions in IT staffing costs [2].
11- **Simplified maintenance and upgrade:** The system has centralized computing, so the user can simply do upgrades and patches [1-2-5-7]. This allows the user to access the latest software versions [2].

4 CHALLENGES OF CLOUD COMPUTING

1- Legacy applications system: Organizations have applications and computer power such as datacenters with servers where all devices will need to be eliminated and transitioned so as to reduce costs and increase flexibility with cloud providers [4-5-7].
2- Existing security, operations and processes within organizations which need to adjust to the new cloud computing model [5-7].

5 SAMPLE STUDY OF MIGRATION APPLICATION TO CLOUD

The study "Moving to the Cloud: Workload Migration Techniques and Approaches". Migrating workloads into cloud models is inherently an "application centric" activity where each image/instance in the cloud typically runs a single application workload so as to have those applications running correctly in the targeted cloud environment. First, the targeted applications need to be identified and separated from the other applications running on the same server. Then an image of that application, its underlying Operating System and infrastructure management agents need to be created and added to the cloud catalog. Finally, the image needs to be instantiated in the cloud environment and verified to run with acceptable Quality of Service (QoS) characteristics. The technical considerations for a migration can be summarized as [8]:

- Software compatibility;
- Reference architecture;
- Workload characteristics; and
- Platform dependencies.

Across all of the migration patterns, there are some common themes. These themes are described here in the context of the five phases/steps of moving the workload to the cloud and forming a high-level reference model. **Figure 2** illustrates the phases [8].

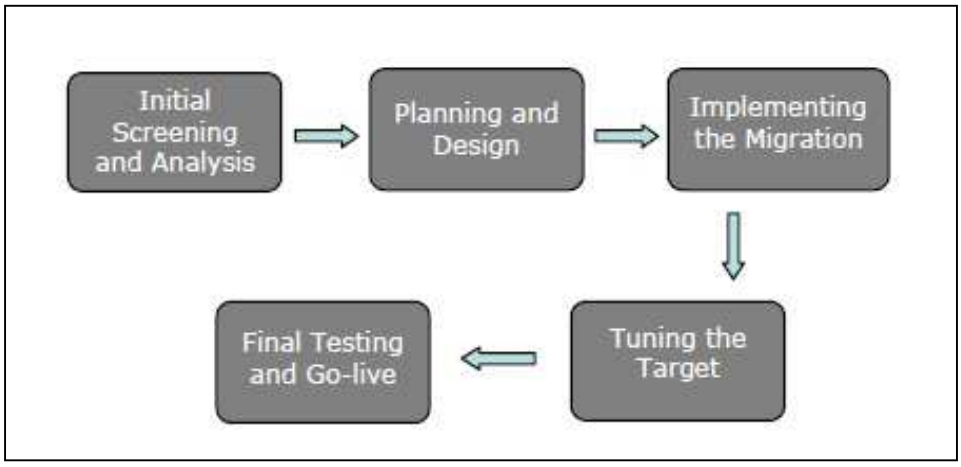

Figure 2. The five step methodology to cloud migration [8]

A) Initial Screening and Analysis

This involves collecting key data on existing workloads, applications and their dependencies, analyzing these data and determining possible migration candidates. The main activities for this phase are server inventory verification; server affinity analysis; and measuring server utilization [8]. The result of this phase is commonly the identification of workloads (e.g., Web

Serving, Web applications) that are suitable to be hosted in a given cloud environment and the costs involved. The same is usually provided in the form of the 'Application Report' [8].

B) Planning and Design

Once the inventory of the targeted applications has been identified and prioritized, the logical design of the applications in the cloud needs to be accomplished. This step involves detailed planning and design of the objective environment (memory, processor, disk storage etc.) as a given requirement. [8].

C) Implementing the Migration

This step is where the workloads are moved to the cloud platform using the most appropriate technique. It involves the following multi-step process [8]:

1) Prepare the target – At this stage, it is important that an organization has a clear vision of the target cloud environment. Depending on whether the type of cloud is a public cloud, private cloud or a hybrid cloud, the target infrastructure preparation is tailored accordingly. The level of preparation also depends on the actual migration scenario. However, the common requirement is usually building a virtual machine instance from one of the available images in the target cloud catalog [8].

2) Migrate – Migrating/creating images from existing workloads, or reinstalling the software stack of the existing workload on the target cloud platform [8].

3) Data Migration – Data migration from the current environment to the target cloud environment [8].

4) Standardization – Standardizing or adjusting the created image so that it is compliant with the infrastructure management services of the cloud environment [8].

5) Integration – Complete integration wherever required to insure connectivity from the moved workload to dependent application services and data in the cloud environment [8].

D) Tuning the Target Environment

Once the customer's existing instances have been moved to the aim cloud platform, these instances are to go through modification step to configure them to the aim cloud environment's architecture standards. These include [8]:

- Removal of any non-standard tools and agents;
- Applying any operating system level security patches;
- Conforming to the target environment security policy or regulatory requirements; and
- Installation of the target cloud environment's management tools

E) Final testing and go-live

This is the last phase where it is assured that the moved workload is performing as expected and the cloud platform now becomes the production environment for the moved workload [8].

6 DESIGN WORKFLOW FOR MIGRATION

In this paper, we endeavor to describe the workflow for migration steps to cloud computing. The workflow shows the possible stages to migrate legacy applications to public cloud computing. It is important to decide which type of cloud computing is to be the target of migration. It is better to determine the cloud model in order to deliver clear steps and consider probabilities for migration. The developer writes a report that explains the suggestion stages to help the organization in migration.

6.1 SUPPORT DECISION MAKING STAGE

The organization defines the applications target that migrates to the cloud and selects a suitable cloud after collection and analyses of the cloud provider. After this stage, the costs for migration and deployment of the applications in the cloud are described. It shows all possible constraints for each step and attempts to solve them.

- **Technical analyses**

'Technical analyses' means preparing a description profile for each application. This profile contents are the characteristics for each application. Those characteristics may influence its migration to the cloud. Additionally, the

developer must identify the characteristics related to use and operation. The developer should also capture the characteristics that are related to how to run this application-like environment, type of OS, API and Platform. Furthermore, the developer needs to know how many users have access to the application. In this step, the developer determines which applications will migrate to the cloud and which ones will not migrate. Finally, it is axiomatic that modern applications are easier to migrate to the cloud and old applications are difficult to migrate.

This step captures all the constraints related to applications and environments. For example, network connections and devices are difficult to migrate. In addition, the systems for monitoring are used to monitor the performance of applications. It is not necessary to move these are to the cloud. (See Figure 3).

- **Organization analyses**

In this step, the developer captures information related to organization characteristic such as the policy of organization and the routine of running applications. Moreover, in this step, captured information is related to the responsibility that determines the operational viability for the applications. The developer can describe the constraints that are related to this step, such as the laws or any else rule by which the organization must be stay, and which somehow might impact its adoption of cloud-based solutions, similarly to the policy of an organization preventing to store database servers outside the organization building. (See **Figure 3**, Support Decision Stage).

- **Selecting a suitable cloud provider cloud analyses**

This step captures the necessary information for the cloud provider. The characteristics of the cloud are very important because in this step, the type of cloud and cloud model is determined. Generally, more applications are migrated to the public cloud or use the hybrid cloud technique. The private cloud uses other computing techniques to gain the benefits of cloud computing. Furthermore, the cloud model is important for the next step of cost analysis and a suitable application with the cloud provider. There are two important migrations for legacy applications to the cloud which depend on the cloud provider model. (See **Figure 3**, Support decision stage).

Legacy application to public cloud IaaS: In this migration, the user is granted full privileges on the virtual machines. The user has the ability to select an OS and any necessary software to run an application. Moreover, the developer must know about all the information that assists the selection of the machine. For example, some cloud providers offer elastic services such that the consumer can change the instance machine specifications (CPU, RAM and HD) similarly to Elastic Cloud Computing (EC2) for Amazon Web Services (AWS) cloud provider. Amazon EC2 provides the selection of selecting between 10 different instance types which are distributed across many instance families, as shown below.

- *General-Purpose family*: This family includes the M1 and M3 instance types which have a balance of CPU, memory, and network resources.
- *Compute-Optimized family*: These instances include C1 and CC2 types. Examples of such applications include front end fleets for high-traffic web sites.
- *Memory-Optimized family*: These instances are designed for memory-intensive applications. Instances in this family have the lowest cost per GB of RAM.
- *Storage-Optimized*: These instances are designed for large-scale data warehouses.

Legacy Application to Public Cloud PaaS: In this migration, the user just creates and manages applications. The developer in this case of migration should be aware of more information that relates to the cloud provider, including:

- PaaS supporting the programming language used to implement the application. For example, Google Apps Engine (GAE) simply supports two programming languages: Python and Java, while Microsoft Azure supports a set of .NET programming languages;
- which databases are supported by the PaaS;
- Checking restrictions and limitations of the selected PaaS, such as whether the application requires a long processing time.

- **Cost analyses**

In this step, the developer should describe the financial state for migration. After marking which application is suitable to migrate and after selecting the suitable cloud provider, the developer explains the cost for each application running in the cloud environment. Additionally, this step describes the costs of running applications in traditional computing to make financial comparisons with costs of running applications in the cloud in order to gain maximum benefits from using external cloud services. The resolution of this step is to give information related to the cost of running all applications that will move to the cloud to help in the support decision making as seen on **Figure 3**.

- **Defining constraints**

There are many constraints that appear in this stage. Each constraint relates to each step. The constraints relate to technical matters, such as security usage for applications and communication among applications. The constraints relating to the organization include resistance from organization members to the change of computing for applications or legal issues regarding physical location; for example, governmental data that must be stored regionally. The constraints related to cloud providers such as the available services inside the cloud and the model of cloud.

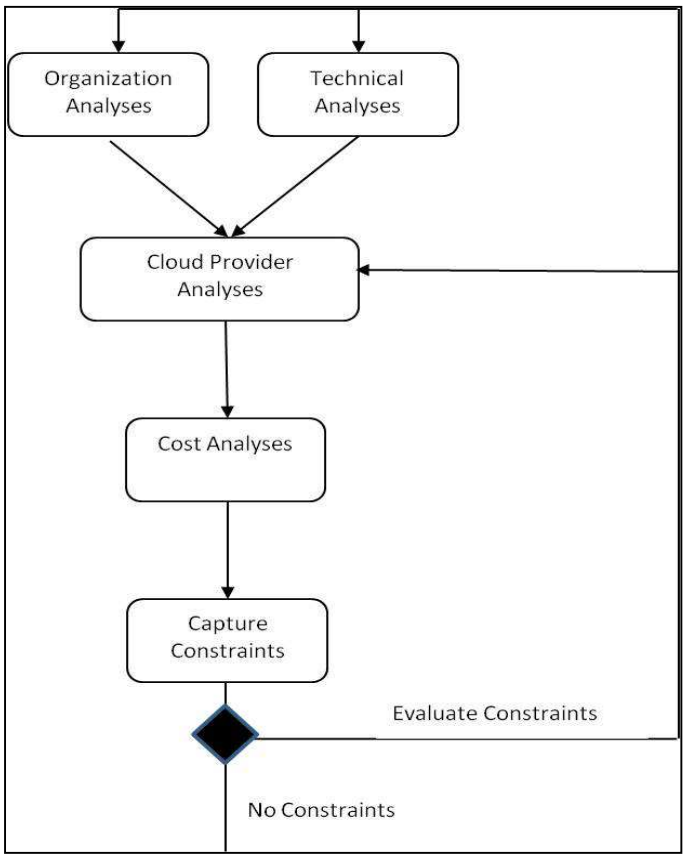

Figure 3 Support decision stage

The figure above explains the important steps in the decision-making stage. In the first step, the developer should analyze the application with the organization because these two analyses can determine the target application which will migrate to the cloud. After these steps the developer analyzes the candidate cloud provider so as to select the suitable cloud for migration. Then the developer carries out a cost analysis for each application to explain the various costs of running applications inside or outside the organization. Finally, all possible constraints will appear.

6.2 DEFINING THE MIGRATION PLANNING STAGE

This stage has two important steps: Migration Applications Planning inside the Cloud and outside the Cloud.

- **Migration applications planning inside the cloud**

In this step, the instances are selected from the cloud provider in order to deploy the target application inside cloud computing. Moreover, the developer must describe the logic design for the target application inside the cloud as the target application must define the power resources (CPU, memory, HD, etc.) that will be selected in the cloud environment. After that the interconnections among the application instants are defined.

- **Migration applications planning outside cloud**

The developer needs to define the order for moving the applications; for example, when an organization has two servers (web server and database server) and the web server has a dynamic site that connects to the database server. In this case, the first server migrates the database server because when the web server migrates after the database server, the test for the dynamic site is possible. Other considerations to be made by the developer include the utilization of target applications. Moreover, the developer needs to consider Application to Application Interfaces.

- **Obtaining and solving constraints**

After achieving the above two steps, the developer can obtain the constraints related to this stage and attempt to solve them; for example, the need to change application power resources inside the cloud instance in order to appropriate target applications or changes in applications design for fitting into the cloud environment. Finally, the developer should identify the sequence in which applications are to be moved to the target cloud. (See **Figure 4**, Planning Migration Stage)

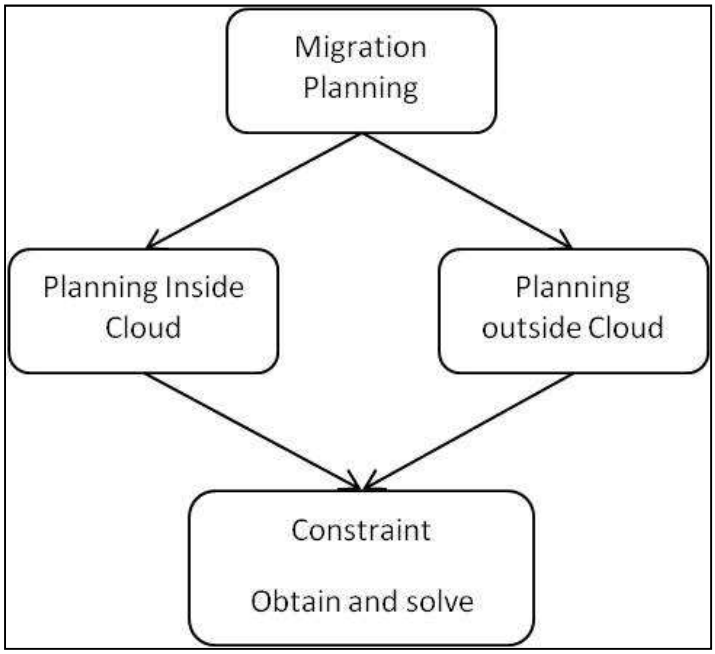

Figure 4 Planning the migration stage

6.3 IMPLEMENT MIGRATION STAGE

In this stage, the developer should be considering the outcome of the planning stage. The reality of the migration to cloud computing starts in this stage. The difficulty of implementing migration depends on the model of cloud computing and target applications. For example, in order to migrate a server to an IaaS cloud provider, the developer needs to prepare the instance (a virtual machine) after configuring this instance to deploy the server on it. To migrate applications to a PaaS cloud provider after checking the platform environment, the developer can deploy applications directly. (See Figure 5)

There are three main steps in this stage.

- **Preparing the target application and cloud**

After the developer gains the clear vision of the cloud model and the target application, the developer tries to adopt the planning to migrate applications to the target cloud. For example, images are created for servers to prepare them for deployment in the cloud. Moreover, it is very important in this step to follow the sequences found in the previous stage. Finally, the cloud side is prepared for the migrated the target applications; for example, create virtual images (instances).

- **Migrating application and images server**

There are many possible methods for performance in this step. The first one is to direct the migrated server images to instances (virtual machines); in other words, from physical machine to virtual machine. The other method is to migrate applications to the platform cloud without any change or reconfiguration. Some server migrations need to change in the server operating system to obtain more cost benefits for cloud computing. The former method depends on the model of cloud and type of application. Additionally it is possible to use solution tools to carry out the migration without the need to re-install a virtual machine in the cloud side or re-deployment of applications such as the 'Zapp Migration Tool' from AppZero, which extracts only the in-scope application from the source machine and enables it to run on the target cloud computer.

- **Migration configuration files and data**

In this step, the developer needs to transfer the configuration file that relates to the migrated applications after changing it to work inside the cloud environment. An example is the configuration file for the web server 'Apache web server.' Additionally, the web pages file relates to the web site that is hosted on the web server. Finally, the developer needs to move any necessary data to the virtual machine to make this machine more reliable and make it a utility; for example, migrating the data to the database server by using a dump file or backup file that is extracted inside the virtual machine server.

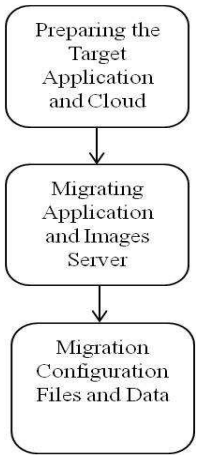

Figure 5 Implementing migration

6.4 TEST MIGRATION STAGE

This is the final stage which ensures the developer that the migrated applications or server work well. The testing tool depends on applications and services. Moreover, it is possible to use monitoring software that is used at the source side 'local datacenter.' It can also use traditional methods to check the Windows operating system such as the Task Manager to test the CPU and memory usage. The important job for this stage is discovering any problems and constraints for the migration and specifies each problem or constraint to its previous stage. Finally, this stage is necessary to confirm the migration, the migrated applications and the performance of the servers. (See Figure 6).

6.5 CREATING A DOCUMENTATION REPORT FOR REFERENCING

The developer writes the report to manage the migration consistent with the above stages. The form of this report depends on developer style. It is important to follow the order of stages of the workflow migration, which contains stages for starting the migration of the legacy applications to cloud computing. (See Figure 6).

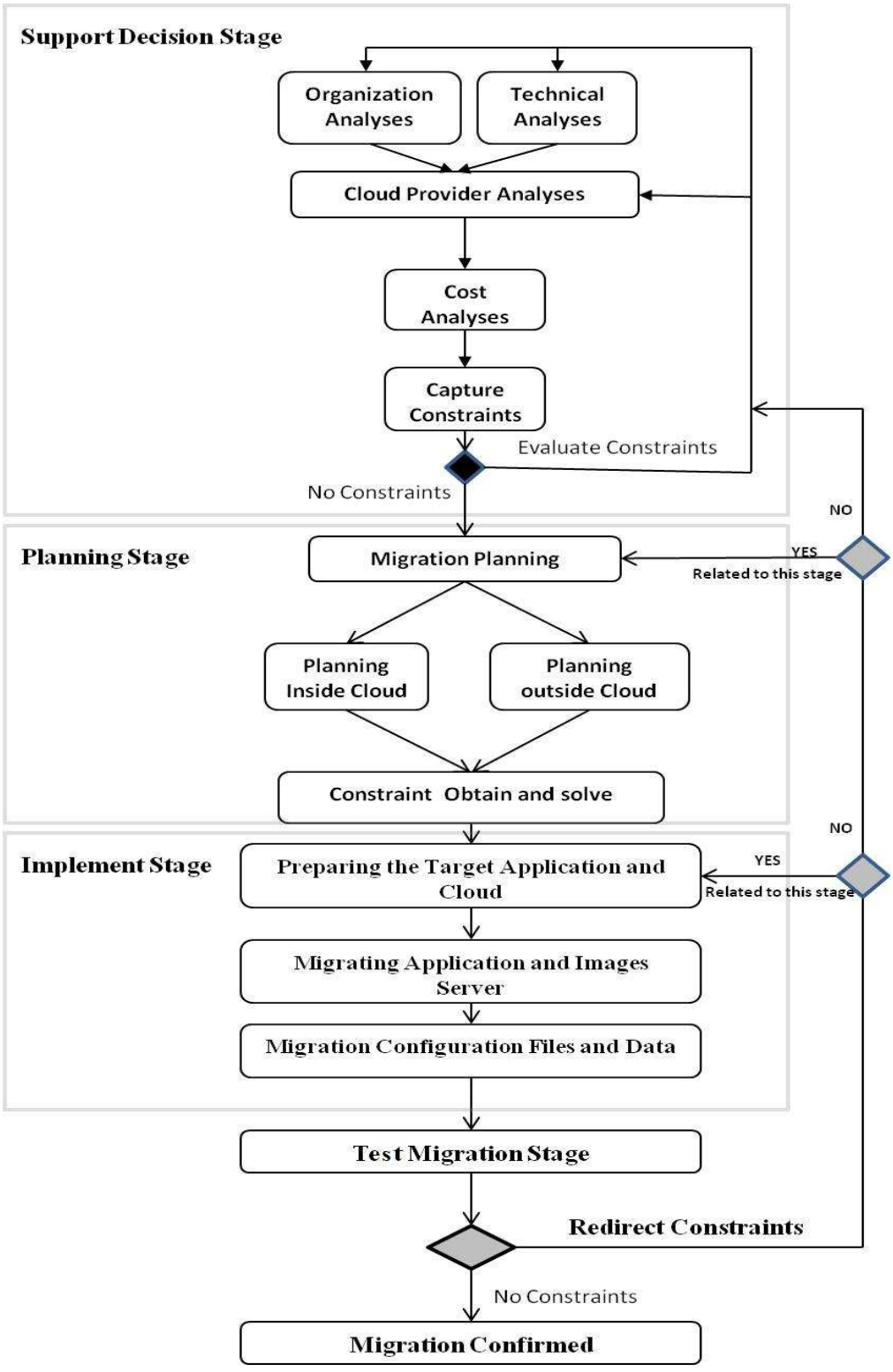

Figure 6 Workflow migration

7 CONCLUSION

This thesis presents migration workflow with possible stages for the migration of applications to cloud computing. These stages help organizations to make decisions for the migration of applications from traditional computing to cloud computing by supporting a decision and then defining many plans for migration, after which the following actions are taken: selecting a

suitable plan and implementing the selected plan and finally testing the applications in the cloud environments to confirm this migration. The research question has been addressed with the following findings and related limitations.

8 FUTURE WORK

In future work, it is possible to define migration workflow for applications which are deployed in the cloud computing IaaS model to move to the cloud computing PaaS model and to try to explain the changes that are implemented on applications to become more suitable to work in the new cloud PaaS environment.

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