Government Cloud as a Shared Service: A Reference Architecture for the Public Administration

Summary of dissertation for the degree of Master in Information Systems and Computer Engineering

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ABSTRACT

Public service agencies, including government, education and health care, are increasingly looking for more flexible and cheaper ways of improving the efficiency, flexibility, operational agility and integrity of their information systems. Cloud computing has come to be recognized as a more acceptable business model and implementation, therefore ensuring that public sector organizations achieve their aspirations.

With the emerging of these technologies/cloud solutions and with some references from countries that already have Cloud implementations in their governments, the need arose in building an archimate design capable of facilitating its implementation, being created with the help of reference enterprise architectures. This is this thesis goal, develop a reference application architecture for the governmental cloud in the public administration.

The present thesis follows the design science methodology, a methodology that presents in its evolution five phases, which describes successive steps to combine theory to practice, we identify the various solutions and dimensions of cloud service providers for the public administration, combining the perspectives of these suppliers and their consumers.

Keywords: Cloud Computing, Reference Architecture, Enterprise Architecture, Public Administration, Cloud Solutions

1. INTRODUCTION

In recent years, new trends in cloud computing (CC) infrastructures have gained importance as a major accelerator and enhancer in the process of rationalizing the use of ICTs from a material or financial point of view, thus bringing about a change in the economy and providing greater sustainability, enabling the provision of services to all public sector.

Some managers perceive that the CC market may be a strategic opportunity for their business (Armbrust.M et al., 2009).

According to the Government Cloud Strategy (2011), "government cloud is not a single entity owned by the government, but a continuous and iterative process of work that will in some way
allow the use of a range of cloud services, and changes the way we acquire and operate ICT in every public sector”.

In the public administration area, the application of a model for a government cloud brings a greater dynamism in the use and implementation of ICTs within the public sector, stimulating the rationalization and reduction of general costs with IT departments, thus providing greater integration and standardization of services between different government departments.

It is important to question how the adoption of decentralization policies requires the precision and definition of the procedures normally adopted. In this way, the need arose to build a design that will help to implement and integrate a government cloud model for public administration. To that end, enterprise architecture is the key to build our reference "architecture" because it represents a set of principles, methods and models that are used to define and design the organizational structure of an organization.

According to Vergara (2009), objectives are the results to be achieved in response to the proposed problem, so the main objective of this dissertation is to build a government cloud reference architecture for public administrations. To achieve this, some key questions have been raised that we will need to answer from collecting data, analysing them, and collecting data from cloud service providers already in the market.

1.1 Research Question

To achieve our objectives previously presented, some starting points were formulated:

Q1. What attributes (requirements) for selecting cloud services are most relevant to implementing a Government Cloud?

Q2. What functionalities (modules) does a governmental cloud for public administration must possess?

In possession of the answers to the above research questions, we can, then, correctly address the problem identified for this work and develop a method that allows us to create a reference architecture for the public administration easy to maintain.
2. RELATED WORK

In this chapter, the most relevant concepts of the work related to the topic under consideration that can contribute to the resolution of the previously identified problem are analyzed.

2.1 Enterprise Architecture

Enterprise Architecture (EA) is a set of principles, methods and models that are used in the design and implementation of the organizational structure of a company, its business processes, IS and infrastructure (Lankhorst, 2005). An enterprise architecture consists of several layers (Godinez, 2010). As far as the development of this work is concerned, we will focus on the application layer of an enterprise architecture, since this layer is responsible for creating and managing IA.

2.1.1 ArchiMate Framework

In this section, we make a description of the archimate framework to do a contextualization about what is Enterprise Architecture (EA).

The architecture is seen by (IEEE, 2000) as “The fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution.”

EA is the specification of the components of the organization (departments, divisions, etc.), the relationships between them and the relationship between organization and the environment. EA provides a lot of views of the organization depending what is the target public or a group of stakeholders (Group, 2012).

ArchiMate Framework is divided in three main layers: Business Layer, Application Layer and Technology Layer. Each layer uses the components of below layer. Business uses components of application and application uses components of technology. In business layer is defined the business process, in application layer is defined the applications which support the business of the organization and in technology layer is defined the hardware where applications run, network and servers needed to the applications of organization.
The core elements of archiMate framework that each layer has are: the active structure elements, passive structure elements and behavior elements. The active elements are the elements which perform actions; the passive elements are the elements where active elements perform actions and behavior elements are the actions that active elements perform. In this work archiMate framework is the basis of application architecture and every model use this framework.

2.2 Cloud Computing

Since Cloud Computing is a recent area of study and research by the scientific community, there still is no clear definition of the concept. Many definitions have been proposed by several authors on many publications. The definition that will be considered for this document is the NIST definition, which says: “Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.”

The Cloud follows a model called the SPI Model (SaaS, PaaS, and IaaS). This model goes from the less complexity of implementation (SaaS) and more optimized service to a more complex to implement service (IaaS), but more flexible on its uses. PaaS is the middle term, providing more flexibility than the first, but being less complex than the second. As defined in (Mell et al., 2011):

- Infrastructure as a Service (IaaS) – The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer can deploy and run arbitrary software, which can include operating systems and applications.
- **Platform as a Service (PaaS)** – The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider.
- **Software as a Service (SaaS)** – The capability provided to the consumer is to use the provider’s applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface.

It’s also important to mention the different types of Clouds that exist (Mell et al., 2011):

- **Public Cloud** – The cloud infrastructure is provisioned for open use by the public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider.
- **Private Cloud** – The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises.
- **Hybrid Cloud** – The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

### 2.3 Government Cloud Strategies

In this section, we present some governments solutions and their implementation for the cloud governments public administration.

Cloud computing implementation initiatives in some countries around the world are already a prominent and accepted reality for the most part. Countries such as the UK, Italy, Spain, Australia, etc. already have a cloud computing implementation strategy to serve their various local administrations.

### 3. PROPOSAL

Below, we present the final architecture solution adopted in this research. This architecture schematic shows the various components at work inside the prototype and the providers chosen, as well as some other information, to further clarify how all these components will play together.
3.1 - Development

In this phase, we follow principles of enterprise architecture to build our solution, so the first principle says that reference architecture is the elaboration of an organization's mission, vision and strategy, it facilitates a shared understanding between various products, organizations and disciplines about the current architecture and vision about the future organization. The second principle refers that a reference architecture is based on concepts proven in practice. Most often preceding architectures are mined for these proven concepts. For architecture renovation and innovation validation and proof can be based on reference implementations and prototyping.

These principles are represented in two main steps to achieve the desired reference application architecture, we firstly defined the mission, vision and strategy for our architecture, and in the second step we will gather proven information/concepts in practice with some cloud services providers in the market. Figure 10 simplifies the steps to follow for what we want to achieve.

![Figure 1 - Construction of the Reference Architecture](image)

To fulfill the first principle, we also define the mission, vision and strategy for our reference architecture represented in a motivational diagram in archimate for better understanding, see figure 2.

![Figure 2 – reference architecture motivational diagram](image)
After having identified the mission, vision and strategy for our reference architecture, we have defined the features and functionalities of a cloud architecture derived from cloud solutions from some cloud service providers already in the market.

So, based on these features and functionalities, we have developed a representative table of three cloud service providers as shown in the table below:

- IBM;
- Oracle;
- VMware;
- Government Cloud UK

<table>
<thead>
<tr>
<th></th>
<th>IBM</th>
<th>Oracle</th>
<th>VMware</th>
<th>Government Cloud UK</th>
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<tbody>
<tr>
<td>client/citizen access</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Service Catalog</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Service levels</td>
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<tr>
<td>Service monitoring and reporting</td>
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<tr>
<td>security and audit</td>
<td>X</td>
<td>X</td>
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<td>X</td>
</tr>
<tr>
<td>Service management</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Workload/resource management</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>User interface</td>
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<td>X</td>
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<td>X</td>
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<tr>
<td>Contact center</td>
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The table above represent common modules between selected cloud service providers, the answers to the RFIs were provided by ESPAP (Entidade de Serviços Partilhados da Administração Pública). It is important to mention that for the final reference architecture it will be consider the module’s functionalities.
The modules were defined from a set of cloud service providers, which have already implemented several solutions in the market and with them it was possible to define a standard framework that serves the public administration.

3.2 – Architecture

Thus, based on the RFI's provided by the Cloud service providers to ESPAP, it will be possible to extract some key functionalities/components (see figure 3) for our final reference architecture.

Figure 3 - Reference Architecture functionalities

Figure 4 – Cloud functionalities Oracle
The above architectures represent the main functionalities of some cloud services providers known in the market. Below we present the final solution architecture adopted in this research. This architecture scheme shows the various components that work within the broker prototype and the defined providers, as well as some other information.
4. CONCLUSION

For Marston et al. (2011), cloud computing represents a transformation in the way IT services are invented, developed, made available, maintained and paid for.

The economic contraction situation in which we live today means that government must cut costs, the computer park of organizations has always been and will be a great investment, so cloud computing solves the problem with maintenance costs, since all services are available from the cloud.

With this solution, it was possible to highlight very relevant points for the implementation of a governmental cloud, necessarily by knowing the technological solutions of cloud providers, its application and technological infrastructures in ways to support all public sector. This solution brings support implementation in the way government need reduce and manage IT Infrastructures in the public administration.

REFERENCES


