

# Migration results to a private cloud by using the M2CCF

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**Keywords:** Cloud computing, cloud computing adoption, ITIL.

**Abstract:** The cloud computing paradigm is transforming the way IT services are provided and consumed by changing IT products to services. The migration of in-house IT services to cloud computing must be performed carefully so as not to cause high losses in the institution. In this paper, we present the use of the framework developed by the same authors, to the migration of services, applications, data and infrastructures to cloud computing, M2CCF, compatible with Information Technology Infrastructure Library (ITIL). The work also discusses the results gathered from the real implementation of the framework in the migration of IT services to a private cloud.

## 1 INTRODUCTION

A growing number of organizations is expected to migrate their IT systems to cloud computing (CC) (Tušánová, 2012). Conversely, the migration to CC has a great growth potential with the current and predicted total budget to be spent on its services (Nkhoma and Dang, 2013). Indeed, there is few literature available on the process and methodological guidance on migrating existing software systems to cloud computing (Chauhan and Babar, 2011), namely because it is a new and evolving field (Conway and Curry, 2013).

The difficulties organizations are faced with when migrating their IT to CC, has started to gain the attention of the research community with works published on the topic such as (Ezzat, et al., 2011; Khajeh-Hosseini, et al., 2011; Kumar and Garg, 2012). However, none of these works has presented a systematic process, sufficiently detailed, in order to be useful as a guide for IT managers throughout the steps and decisions involved in a typical migration to CC. Moreover, this work was also triggered by the absolute need to improve research in CC as well as in IT Service Management (ITSM) identified by Robert Heininger (2012).

The migration to the CC paradigm by an organization requires a deep understanding of the institution IT as well as the dynamics of CC. By

other side, there is already an extensive set of recommendations for IT management and IT governance in general such as the Information Technology Infrastructure Library (ITIL). Accordingly, we developed the Migration to Cloud Computing Framework (M2CCF) to support the migration to CC which utilizes the information gathered and the knowledge acquired with the ITIL implementation.

This paper presents the results obtained after a real migration, with the M2CCF, of University Portucalense IT services to a private cloud.

The rest of the paper is organized as follows: Section 2 presents the overview of the cloud computing paradigm, its concerns and governance, the ITIL framework and an overview of various frameworks developed by other authors to support the migration to cloud computing. In Section 3 is presented the framework developed (M2CCF) and a case study of a real implementation of the M2CC. In Section 4 the results of the case study are discussed and analysed. Finally, the paper concludes in Section 5.

## 2 BACKGROUND

In this section is presented an overview of the CC paradigm as well as ITIL, since, as we argue, it is a companion of the M2CCF in the migration to cloud computing.

### 2.1 Cloud computing

The term “cloud computing” (CC) was coined in the fourth quarter of 2007, in the context of a joint project between IBM and Google (S. Zhang, Zhang, Chen, and Huo, 2010). One definition recognized by several authors, such as, (Foster, et al., 2008; Zhang, et al., 2010), considered as being holistic (Swamy, 2013) and adopting a broad scope is the one presented by The National Institute of Standards and Technology (NIST). According to that definition the CC is classified in four deployment models: public, private, hybrid and community. Each of the aforementioned deployment models is divided into three layers (also known as service models), according to the services it provides to the users (Mell and Grance, 2011; Vaquero, et al., 2009). These layers are, on the first level, Infrastructure as a Service (IaaS), where the user can afford, upon request, processor resources, storage and networking, among others. On a second level, the Platform as a Service (PaaS) layer allows users to implement their applications in the cloud, by using the programming languages and tools provided by the cloud service provider. The third layer corresponds to Software as a Service (SaaS), where the applications, provided by the cloud provider, are made available to the costumers.

The CC paradigm offers various advantages, such as the ability to dynamically adjust the resources according to the needs, a great scalability in resource utilization, a reduced initial investment, an easy access, but also has number of challenges that must be overcome. Note however, that some of these challenges are old but in a new scenario (Jansen, 2011). Among the challenges are issues such as the security (Armbrust et al., 2009), the service availability, the lack of knowledge on where is the information stored, the retrieval of the information (for instance at the end of contract or provider bankruptcy), the lack of legislation (it is mandatory to obtain appropriate legal advice) and the costs (the issues are somehow similar to rent or buy a car).

### 2.2 ITIL

Enterprise activities increasingly rely on the fundamental support of IT to sustain the growth of the business. Amongst the IT governance frameworks, ITIL gains prominence on the migration to CC because, as stated by (Sahibudin, et al., 2008), implementers should use ITIL to define strategies, plans and processes, which are the key actions to migrate to CC. Furthermore, ITIL is chosen by its acceptance. Indeed ITIL is the most widely adopted approach for IT (Mourad and Johari, 2014), with an acceptance of 28% followed by COBIT with 12,9% (ISACA, 2011).

The ITIL is a de facto standard and the reference model for IT management processes. This model was developed by the English government for use in IT companies, and was quickly adopted across Europe as the standard for best practice in service delivery IT.

Published by the Central Communications and Telecommunications Agency (CCTA) and, more recently, the Office of Government Commerce (OGC), ITIL provides a practical, no-nonsense framework for identifying, planning, delivering and supporting IT services to the business. Consisting of a set of good practices, described over five volumes known as Service Strategy, Service Design, Service Transition, Service Operation and Continual Service Improvement, ITIL is currently in version 3 (known as ITILv3 and ITIL 2011 edition). Its last update was in 2011, ITILv3 it has been rapidly adopted throughout Europe as the de facto standard for best practices in IT service delivery.

### 2.3 Migration to cloud computing, frameworks

Several authors investigated the migration to CC. Accordingly, in this section, we expose a summary of these works. More details and a comparative study of these works can be found in (Cardoso, Moreira, and Simões, 2014).

Among the works developed for migration to CC is the work of Vivek Kundra (2011) that proposes a decision framework for CC migration. Adela Tušanová (2012) suggest a six step framework. Ali Khajeh-Hosseini et al., in (Khajeh-Hosseini, et al., 2010b), describe the challenges that a decision maker faces when assessing the feasibility of the CC migration in their organizations, and presents the Cloud Adoption Toolkit, which has been developed to support this process.

Ezzat et al. in (2011) proposes a framework focused to support decision makers, in their migration to CC, depending on their own business

cases and predefined issues. They view the migration to CC under three perspectives, the business, the technical and the economic ones. In (Chauhan and Babar, 2011) the authors summarize their practical experience by reporting the information gathered when they migrated the Hackstat open-source software's framework, to the CC. Patricia V. Beserra et al., in (Beserra, et al., 2012) present Cloudstep, a step-by-step decision process aimed at supporting legacy application migration to the CC. The process was exemplified with the migration of a medical commercial application to the CC. The approach followed by Frey et al. (2012), CloudMIG for migration to CC, aims at supporting SaaS providers in the comparison and planning phases to migrate enterprise software systems to IaaS or PaaS based clouds. Banerjee in (2012) addresses the migration to CC of enterprise level workloads without redesigning or re-engineering the existing applications. The Innovation Value Institute (IVI) from the National University of Ireland Maynooth ("Innovation Value Institute (IVI)," n.d.) consortium to address the issues involved in the CC migration developed and tested a life cycle for systematically managing cloud migration projects, the IVI Cloud Computing Life Cycle (Conway and Curry, 2013).

According to the analysed documents, the majority of the studied frameworks do not include an initial step to define a strategy for the migration of services to CC. Besides that, they do not address risk management nor legal issues either, nor analyses the impact of migrating services to CC. Additionally, the contracts management, the vendor lock-in, the testing of the achieved solution, the use of good practices and the continual improvement of the solution are other issues that are not covered by the analysed solutions.

Notwithstanding each of the studied frameworks offer a solution to migrate IT to CC, none of them points a way to enforce that the actions developed to complete each process (that make up the framework) are managed, done appropriately and in an organized way. To solve this, an IT governance framework, such as ITIL or COBIT, could be used as a reference to define each of the framework processes to achieve the best solution for the organization.

### 3 MIGRATION TO CLOUD COMPUTING

In this section we shortly present our M2CC framework (Cardoso, et al. 2015), and discuss its application on a real migration of IT services to CC scenario.

#### 3.1 Framework

In the outsourcing processes there is always an interaction between IT's service provider and the customer. Accordingly, we have grouped the activities of the M2CCF, into two major groups, the on premise and the off premise, both aggregating the activities that an organization has to perform when migrating services towards the CC. These groups match the key's stakeholders of this process, that is, the customers and the CSPs.

The on premise group embraces the activities that the organization must solve on their own to migrate services to the CC. Accordingly it consists in four steps, "Define a strategy", "Identify and understand", "Define, select analyse and map" and "Migrate and govern". On its side, the off premise group encompasses processes to provide "Information about cloud services" and the cloud services. Before starting the process of migrating to the CC, the organization must at first identify and understand the business and technical issues, which lead to a migration of services and applications to the CC. Among these issues, there are cost savings, agility and scalability offered by the CC. At the "Define a strategy" process, the organization comprehends the CC concept, identifies the reasons why to migrate services to the CC and develop a strategy plan. In the "Identify and understand" process, the customer performs a full assessment of the infrastructure, services, applications and data, to perceive in full detail its IT, to identify what to migrate and to later compare in-house versus CC solutions. After comprehending his IT, the customer is ready to define a migration's plan in the "Select analyse and map" process. Based on the information of the earlier processes, on the migration plan and in the information gathered from the CSPs, he chooses the most appropriate suppliers for the migration.

A sub-process analyses and ponders the whole information to produce the input to the "Map" sub-process mapping out services to their cloud counterparts or creating new ones. Lastly, in the "Migrate and govern" process, the organization migrates the selected services and applications to the CSPs according to the defined migration's plan. The

migration is performed with the joint participation of the IT department, business, CSPs and with the service integrator (where appropriated). This migration may be phased, and there must be a validation by the end of each phase, according to the customer needs. Finally, the customer collects information regarding the performance of the CSPs and checks if they are in accordance as specified in the contracts and the SLA.

### **3.2 Case study**

Taking into account, on the one side, the benefits that the methodology of the case study expose in investigating real life phenomena (Yin, 2003) and for the other hand the prescription the same author does of it, we consider the case study to be the adequate choice of a methodological approach to comprehend and validate the problem under the research. In the subsequent paragraphs, a case study of migrating services and applications to the CC (developed at the University Portucalense Infante D. Henrique - herein referred to as UPT, a typical higher education institution) is presented. The aim of this case study is to understand, explore and describe the migration's process to the CC under the framework developed in (Cardoso et al., 2015) as well as its relationship with ITIL.

The working methodology towards this case study entailed a close monitoring of all stages leading to the migration of services to the CC, the participation in the decision-making process and the intervention in the whole process of installing a private cloud and on the migration of services to the implemented environment.

All of the work in this case study took place in accordance with the guidelines of the framework developed. Thus, the UPT IT's area starts the whole process by defining the initial strategy with broad outlines and guidelines for the whole process. This phase is followed by the stage of identification and understanding of all services, applications and data in use by the UPT area of IT. This stage is vital to establish a strong foundation of information for pursuing the subsequent phases of the framework.

The next process, "Define, select, analyse and map" begins by defining a migration's plan, which delineates all the details of the migration process itself. Concomitantly, it runs the "Select providers" sub-process where the proposals are analysed and the suppliers that best fit the needs identified are selected. Following these processes and according to the information added so far, the team responsible by the migration's process analyses the aspects of

the solution and conducts, in collaboration with the supplier, a test to the solution. The "Map" sub-process follows near the end of this process. It is a sub-process where the services' applications and data, defined to be migrated to the CC, and the corresponding CC services are matched. The migration's process ends with the physical migration of the selected services to the CC's environment. This process also includes a pilot test of the entire solution as well as the training of actors and the beginning of a continuous process of monitoring and improvement of the solution as a whole.

### **3.3 Results obtained**

In technical terms the implemented solution improved the operating conditions of the services migrated to the private cloud. This improvement was reflected at the level of management, which became centralized and was carried out in a much more automated way and the services provided require now considerably less time in order to produce results.

Based on the research developed and on the UPT IT needs identified it was confirmed that the private cloud is the best suitable solution. The tasks of the M2CC framework were performed according to ITIL. For every process of the M2CC's framework, we found out that ITIL has support, except in what relates to the management of the IT's staff.

## **4 DISCUSSION**

To support the validation of the framework developed, amongst other actions that are not within the scope of this paper, a case study was accomplished.

### **4.1 Migration results**

The findings of the case study indicate a close relationship between the process identified in the M2CC's framework to migrate IT to the CC and ITIL, although some aspects, like the management of IT's human resources and the project management, are not covered by ITIL. All other are sufficient to cover the demands of the M2CC's framework.

The first ITIL book, "Service Strategy", provides guidance on clarification and prioritization of service provider investments in services. As such, the major usage occurs is in the first two processes of the M2CC's framework – the first defining a

strategy and the second gathering information concerning the current state of the in-house IT's infrastructure. The second book, "Service Design", aims to design appropriate and innovative services to meet the business requirements. Hence, its major usage is on the gathering information from the current IT's infrastructure and definition of the services in the cloud. Hereinafter is the "Service Transition" book, and as the name suggests, it takes care of the transition of services, that is, builds and deploys IT services. Its major usage, is in the "Migrate and Govern" M2CC framework's process, which is the process that is responsible for the real migration of services, applications and data to the CC. This last process of the M2CC's framework, is also responsible for the services in the cloud environment functioning and its improvement. As such, the last of the ITIL books, "Service Operation" and "Continual Service improvement" provides major support to this process.

Despite the M2CC framework widely benefits from ITIL, it is not required that the organization previously implements ITIL so that it is able to perform the migration to the CC. The team responsible for the migration to the cloud may only implement the necessary ITIL processes to gather the required information or to manage some processes. However, it should be pointed out that if the organization already follows the ITIL framework, the usage of the M2CC framework is simplified.

The case study allowed us to validate the framework developed and solve minor issues. For example, the task "Test the solution in a controlled environment" was added because of a practical necessity by the time of the cloud's implementation. According to our study, the use of good practices to implement the migration of services to the CC benefits the organizations, mainly because they can reuse the majority of the work performed by them

when deploying the good practices' framework and their results in the migration to the CC. Additionally, when both the customer and the CSP have implemented the same good practices, they have a common language facilitating therefore their communication.

To further, validate the results achieved, three interviews were conducted with the UPT staff that has a direct contact with the services migrated to the private cloud.

## 4.2 Interviews

The first interview, done to 16 employees, is intended to validate the tests performed in a controlled environment to validate the details of the achieved solution. The interviews questions and the results are depicted on Figure 1.

According to the results, the tests provide the expected outcomes - the migration to the CC of the selected services and applications was successful and the technical difficulties were overcome.

Interview II was accomplished to evaluate the perception of the staff directly affected by the migration to the CC (a total of 16 interviews). Taking into account the answers to questions, one, two and three, of the conducted survey, see Figure 2, we can conclude that 100% of the users consider that the functionalities of the applications remains unchanged and not suffer any access breaks during the migration's period.

In terms of access, the users also recognize that there had been no change in accessing the applications they already had. The previous and detailed analysis of the applications used and the users' habits led to selecting a period for the migration of applications that would have less impact to the users.

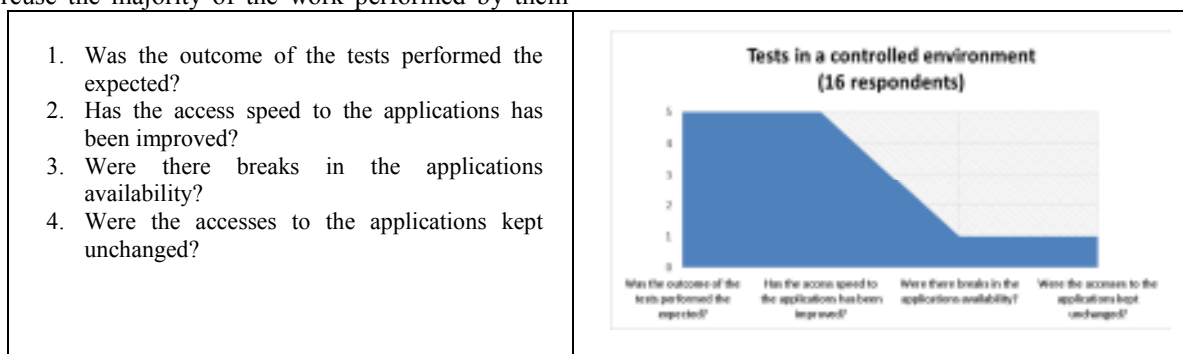


Figure 1 - Interview I

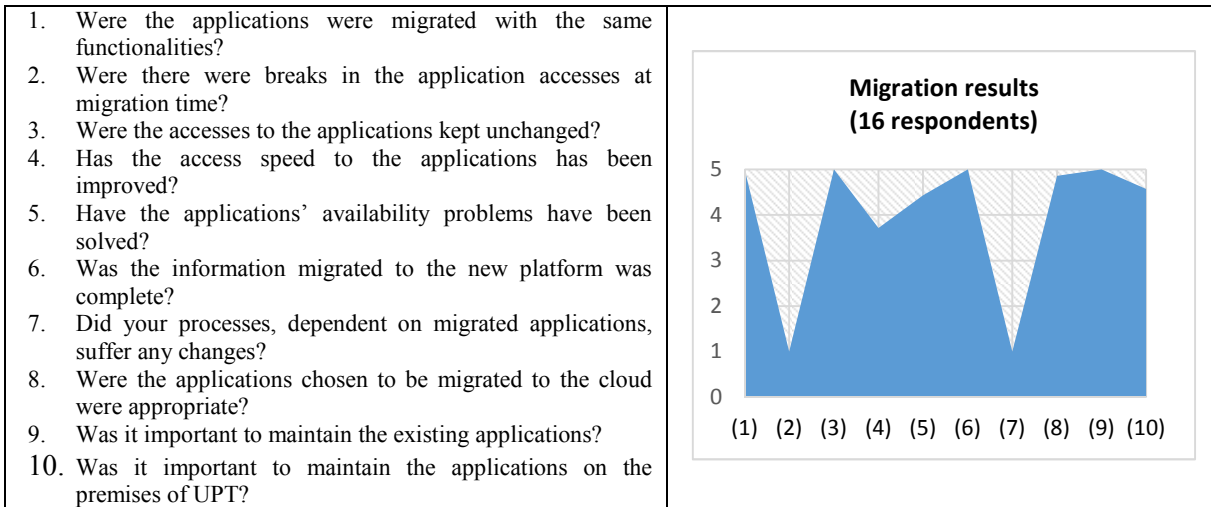


Figure 2 - Interview II

This analysis was performed in the process of “Identify and Understand” and reinforced in the “Define, select, analyse and Map” particularly in “Define a Migration Plan” for example in the access definition.

Questions four and five refer to the troubleshooting, equated in the initial phase of implementation of the framework, in the process “Define a strategy” when defining “Why move to cloud”. It is widely spread view that the speed of access to services has been improved and the availability problems were solved. Some of these, still felt by some users, are due to intermediate servers that have not yet migrated to the new solution, such as proxy servers.

Question six aims to assess the initial study of the information that each application uses. According to the feedback from the users, all the information used by applications has been preserved in the new environment. This information was collected in connection with the “Identify and Understand”.

According to the answers obtained to questions seven, eight and nine, we found out that the migration did not cause any disruptions during normal day-to-day of the users. These issues resulted from the validation of processes “Identify and Understand”, “Analyse and test” and “Migrate and

govern”, for example in gathering information about services in the process “Identify and Understand”, in analysing the impact on the sub-process “Analyse and test” and in selecting applications to migrate from sub-process “Define a migration plan”, namely “What to move”.

Question 10 relates to the cloud type chosen in the sub-process “Defines the migration plan”. However, it also comprehends the security required by the institution validated in the sub-process “Define a migration plan”, with the risks discussed in the sub-process “Analyse and test” and the sub-process “Select the providers”.

Interview III, see Figure 3, aims to validate the fact that the solution achieved encompasses the CC’s technical advantages. This interview has showed that the solution achieved includes various CC advantages such as, the capacity to dynamically change the resources of the machines, facilitate the task of creating new machines, activate and deactivate machines according to the needs and the possibility of having templates to create new machines based on a common configuration. Moreover, the solution also solves some problems found, such as improving the backup processes, increase the service’s availability and the speed to access these services.

The implemented solution allowed:	
1. To improve the backup process?	7. To reduce the number of physical machines?
2. To dynamically change the resources allocated to machines?	8. To reduce the consumption of electrical energy?
3. To increase the service's availability?	9. To turn on and off machines according to the needs?
4. To improve the access speed to the applications?	10. To create machines for testing and delete them when they are no longer needed?
5. To help you create new machines?	11. To generated new machines from a template?
6. Decreasing the amount of time needed to create a new machine and providing new services?	

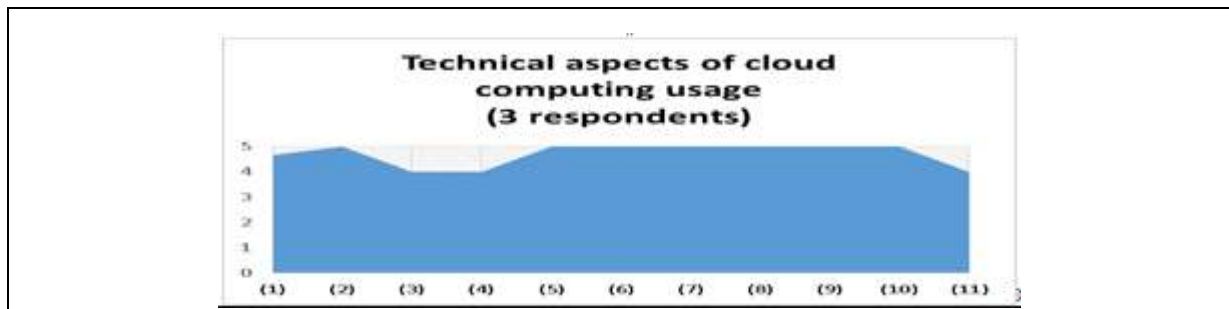


Figure 3 - Interview III

## 5 CONCLUSIONS

IT managers are increasingly concerned in minimizing investments; capitalize on investments already made and the way the services are performed to achieve greater productivity with lesser costs. The CC is a paradigm that allows customers to start new services or expand already existent ones without requiring large upfront investments, enabling customers to acquire and release resources dynamically according to their needs in a pay-as-you-go form. One of the main challenges facing the migration to this new paradigm is the need to review and to adapt the services and IT processes to operate in the new paradigm. Another issue arises from the difficulty of bringing services back to the environment they had before, after they have migrated to the cloud. One other issue occurs from the costs involved in the migration. Therefore, the migration to CC must be carefully planned and performed. So, it is important to investigate how the organizations can efficiently and effectively migrate IT from the conventional model to CC.

Taking into account, the need to better meet the user requirements with lower costs, the advantages of the CC, the advantages of ITIL in managing IT services (with its major acceptance and adoption's index compared with other service management frameworks) and the possibility to use the information gathered by ITIL, the work developed examined the adequacy of ITIL in the migration of

traditional IT environments to CC. By creating a framework to migrate services to CC and mapping the processes of the framework to the ITIL processes, we validate the applicability of ITIL to the migration to CC.

Bearing in mind that there are some interdependencies among the ITIL processes and that implementing the whole ITIL is not an easy task, we purpose, as a future work, to develop a "mini-ITIL" to support the Small and Medium Enterprises (SMEs) that have not implemented ITIL, in the migration to the CC.

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