Human and Intellectual Capital Management in the Cloud: Software Vendor Perspective

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Abstract: Cloud systems have shifted traditional on-premise software products towards new and service oriented solutions. In order to adapt to this new trend, traditional software vendors are facing a necessary evolution towards service oriented software products. This software evolution is quite complex and full of problems. This paper presents lessons learned and the issues that emerged in a project aimed to adapt Meta 4' PeopleNet solution to adopt a cloud computing approach. This project, designed as a two-step approach, presents a set of issues that are analyzed in this paper, namely: Software evolution, Software processes and Technology and Personnel issues. The resultant conclusions, that highlight the importance of people in this software evolution, are useful for companies facing a product evolution process towards cloud oriented environments.

Keywords: Information systems development, Cloud Computing, Software as a Service, Software Vendors
Categories: C.3, D.2.11, D.2.12, H.4.1, K.6.1, K.6.3

1 Introduction

Computing is being transformed into a model consisting of services that are commoditized and delivered in a manner similar to traditional utilities such as water, electricity, gas, and telephony [Buyya, 09]. As a result of this, cloud computing, the long-held dream of computing as a utility, has the potential to transform a large part of the IT industry, making software even more attractive as a service and shaping the way IT hardware is designed and purchased [Armbrust, 10]. Thus, the computing world is rapidly transforming towards the development of software for millions to consume as a service, rather than to run on their individual computers [Buyya, 09].

Cloud computing is obtaining increasing attention and is becoming one of most important current research topics (e.g. [Chang, 11], [Dong, 11]). As a result of this, “cloud computing” is becoming a buzz word in the computing industry [Motika, 12]. However, and in spite of its importance, according to [Grossman, 2009], no common standard or definition for cloud computing seems to exist. A good definition of the concept might be the one that Gartner proposes, defining cloud computing as “a style of computing where massively scalable IT-enabled capabilities are delivered ‘as a service’ to external customers using Internet technologies” [Heiser, 2009]. The word “cloud”, a metaphor for the Internet, was likely to have been inspired by internet illustrations which often depicted it as cloud images [Sultan, 2011].

The cloud offers several benefits like fast deployment, pay-for-use, lower costs, scalability, rapid provisioning, rapid elasticity, ubiquitous network access, greater resiliency, hypervisor protection against network attacks, low-cost disaster recovery and data storage solutions, on-demand security controls, real time detection of system tampering and rapid re-constitution of services [Subashini, 11]. There is no doubt about the paramount potential of cloud computing [Misra, 11], however there are also a set of challenges that cloud computing must face. On the technical side these include: accessibility vulnerabilities, virtualization vulnerabilities, web application vulnerabilities such as SQL injection and cross-site scripting, physical access issues, privacy and control issues arising from third parties having physical control of data, issues related to identity and credential management, issues related to data verification, tampering, integrity, confidentiality, data loss and theft, issues related to authentication of the respondent device or devices and IP spoofing [Subashini, 11]. From the business aspect, there is concern about cost-effectiveness [Misra, 11].

The services that can be offered by cloud computing can be listed in the following three main areas [Sultan, 10]:

- Infrastructure as a Service (IaaS). IaaS is also sometimes called Hardware as a Service (HaaS). It is the delivery of computer infrastructure as a service [Subashini, 11]. This model is advantageous to business users, since they do not need to invest in building and managing the IT systems hardware to take advantage of the latest technology; apart from greater flexibility, a key benefit of IaaS is the usage-based payment scheme (pay as they grow) [Rimal, 11]. According to [Klems, 09], IaaS commercial solutions include: Amazon’s Elastic Compute Cloud (EC2) and Simple Storage Service (S3), Joyent’s Accelerator and Rackspace’s Mosso
- Platform as a Service (PaaS). Services provided by the traditional computing model which involved teams of network, database, and system management experts to keep everything up and running (e.g., operating systems, databases, middleware, Web servers and other software) are now provided remotely by cloud providers under this layer [Sultan, 11]. PaaS provides the facilities required to support the complete lifecycle of building and delivering web applications and services [Subashini, 11]. Compared with conventional application development, PaaS can significantly reduce the development time, and also offers hundreds of readily available services [Rimal, 11]. App

Engine by Google and Force.com by Salesforce are examples of PaaS commercial applications.

- Software as a Service (SaaS). SaaS (or application as a service) is a multi-tenant platform that uses common resources and a single instance of both the object code of an application as well as the underlying database to support multiple customers simultaneously [Rimal, 11]. In other words, SaaS is a software deployment model where applications are remotely hosted by the application or service provider and made available to customers on demand, over the Internet [Subashini, 11]. Commercial SaaS products include Google Apps, Salesforce CRM and Meta4 Global HR. SaaS seems attractive, cost-effective, easy to obtain and purchase, and well-known enough to be trustworthy [Wu, 11].

These models form the core of the cloud and they demonstrate certain characteristics such as on-demand self-service, multi-tenancy, ubiquitous network, measured service and rapid elasticity [Subashini, 11].

In any case, Cloud computing is a paradigm shift in computing with the potential of changing the whole perspective with which we look at computing today [Misra, 11]. Today, organizations are moving to a cloud computing model for their own needs [Wasserman, 11] and this trend leads the way for software vendors, taking traditional software packages through a software evolution process. This process is aimed at adapting them to cloud scenarios. Given that software evolution is not easy, the evolution of software packages is complex and full of problems [Colomo-Palacios, 11a]. The aim of this paper is to provide an overview of the lessons learned and the issues that emerged from a project aimed at adapting Meta 4' PeopleNet solution to adopt a cloud computing approach. Agreeing with [Runeson, 09], the case study methodology is well suited to many kinds of software engineering research, and this will be the approach adopted in this paper. In order to do this, the remainder of the paper is structured as follows. Section 2 provides a description of Meta4. Section 3 describes the main points regarding the project in its two phases. Section 4 depicts the lessons learned from this software evolution process. And finally, conclusions are drawn and future development work is presented in the final section.

2 Meta4: Company background

Meta4 is one of the world's leading providers of solutions for the management and development of human and intellectual capital (HICM). Founded in 1991 Meta4 is a company with 800 employees, offices in 12 countries and 1,300 clients worldwide. It has become one of the top three providers worldwide for Human Resources software.

Meta4 has been ranked within the top 500 software companies in the world for the first time, according to the 29th edition of the prestigious "The 2011 Software 500". This year the study only includes two Spanish companies. Meta4 appears at number 294 with an annual turnover of $63.5 million in 2010. The revenue of the company in 2010 was 47.3 million Euros with 13% growth compared to the year before. More than 50% of this revenue comes from international sources. Investment in R&D and innovation for 2010 was 20% of turnover.

It is important to highlight that for the third consecutive year and coinciding with its twentieth anniversary, Meta4 has obtained the "Best Place to Work" accolade, which sets it apart as one of the fifty best companies to work for in 2011.

Meta4 has branches in eleven countries, although the headquarters of the company is located in Madrid, Spain. Its HCM solution has a strong presence in Spanish and Portuguese-speaking countries as well as in France. However, the expansion of the company includes countries all over the world. According to [Holincheck, 11], approximately 75% of Meta4's customers implement the solution on-premises. However, Meta4 also offers options for hosting, and for a subscription license (approximately 15% of their customers have chosen a subscription license).

3 The project: Challenges and objectives

Meta 4 embraced SaaS and cloud computing in a two-step approach. The first step was the launch of SaaS Meta 4 back in 2007 and the second is Cloud-HICM, the company's newest project. In what follows, both initiatives are depicted.

3.1 PeopleNet SaaS

Meta4's PeopleNet solution presents two models: an on-premises model and the newer SaaS deployment model. PeopleNet offers a multi-tenant architecture which supports SaaS delivery, as well as customer choice to subscribe to the software via remote delivery or deploy the HR software on-site. This service has been part of the company portfolio since 2007 in Spain, 2008 in France and 2009 in Latin America. In 2009, Meta4 launched its global HR SaaS solution for Global customers. Software hosting takes place from Meta4's primary data center in Madrid, Spain; however, the company also has backup data center locations in France, Amsterdam and London, as well as one more in Latin America. These data centers are ISO 27001 and SSAE 16 certified. The basic infrastructure of these datacenters is depicted in Figure 1.

This infrastructure comprises firewalls to filter connections to the datacenter and a set of server layers including application and web servers along with a set of persistence scalable servers (NAS array). Hosting specifications include, citing the most relevant ones:

- Functional and technical evolutions: all upgrades are automatic and transparent to the customer.
- Corrective maintenance: incidences and enhancements are included as part of the Meta4 platform and software maintenance.
- Data and application backup: configuration and client data are backed up regularly.
- Security framework: includes internet firewalls/IPS, anti-virus, dedicated FTP server for content uploading and downloading using the SSH protocol, secured data transactions, 24x7 physical security surveillance at data centers, company data protection and confidentiality, authentication, and secure identity management.
- Service level agreements (SLAs).

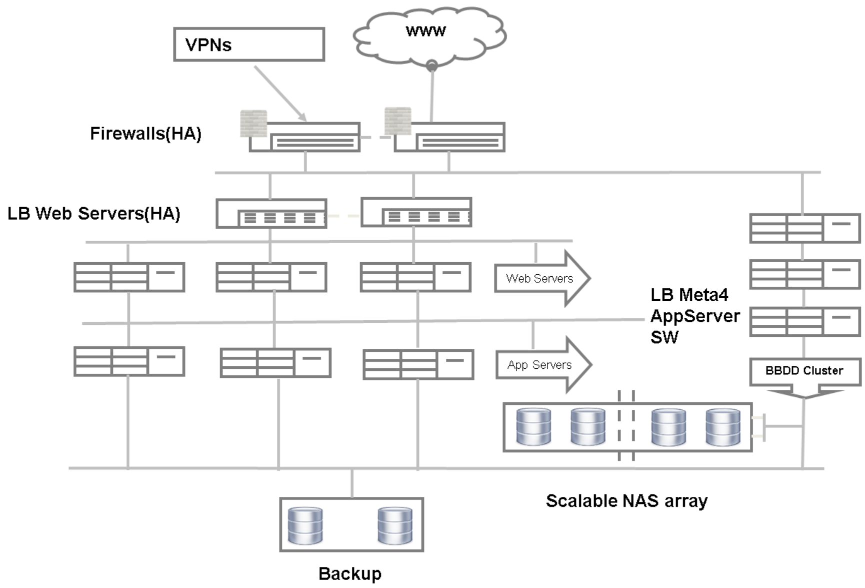

Figure 1: SaaS Platform Infrastructure

3.2 The next step: Cloud-HICM

Meta4 is now faced with a new project to enable SaaS based on PaaS and IaaS structures. This project should solve the technical problems posed by this change in strategy for the company in relation to their development, whose presence in the market has been expanding for over twenty years. Beyond the novelty of business structural change, from a strictly technological standpoint, the project has considerable appeal. There are challenges that are considered unresolved, technical literature or existing business solutions that must be addressed and solved. In what follows, the main challenges are reviewed and explained in terms of their novelty and solution.

Adaptation of PeopleNet to SaaS multitenancy environments based on PaaS and IaaS

This software evolution is not trivial. There are several tasks that are included in this challenge; however, two of them are significant in terms of their novelty. The first is the transformation of the core of the application to support the capabilities of configuration and multitenancy. This objective is linked to various technological aspects an explanation of which is undertaken in the following lines. The second task arises from the intrinsic richness of user interfaces that HICM tools must implement; so, a novel deployment mechanism based on soft computing was designed. This allows intelligent and improved deployment using replication and intelligent configuration management.

Single-Sign-On connectors designed for cloud environments

The expansion of the cloud computing model has been hampered by security problems presented by Single-Sign-On connectors for access to resources through a single authentication process. Therefore, the implementation of a multiplatform Single-Sign-On connector poses a technological challenge that technologies such as Security Assertion Markup Language (SAML) 2.0 do not solve for cloud environments: that is; the ability for different Single-Sign-On clients to interact with a cloud platform that simultaneously apply different authentication identity providers. According to [Hwang, 10], security issues have prevented businesses from fully accepting cloud platforms. In addition, interoperability of applications in the cloud is limited [Jiménez-Domingo, 2011]. These two joint aspects are key issues for internet researchers around the globe.

Thus, elaborating on the subject, one of the elements that has not yet been resolved in the literature is the Single-Sign-On service across different vendors and applications in the cloud. There are security flaws, as the one reported by [Mansfield-Devine, 08] with regard to the OASIS Security Assertion Markup Language along with a long list of commercial security providers (e.g. Shibboleth). This scenario poses an unmet need that is the development of a Single-Sign-On connector that interacts with tenants, along with a set of diverse security servers in a transparent and unified manner.

Design, implementation and testing of an inheritance mechanism for cloud applications

Inheritance, among other aspects, has been identified as one of the most salient features of object-oriented programming from its very beginning (e.g. [Stefik, 85]). This feature allows a large number of applications in the software domain. Meta4 has been using this feature in their solutions since its first release. However, in cloud computing environments data resides at the IaaS layer and this data is exploited by other layers regardless of location or organization.

Adaptation of current configuration applications to PaaS philosophy

According to [Galinec, 10], HICM SaaS continues to grow at two to three times the pace of on-premises solutions. However, most of these are far from being considered true cloud computing solutions, being rather light or merely a nominal development of the old service Application Service Provider (ASP). One of the elements characterizing the cloud applications is the presence of the PaaS layer. This layer presents different characteristics, among which are included services for developing, testing and maintaining applications in an integrated manner [Lawton, 08].

HICM Meta4 solutions allow users a high degree of configuration. Using these applications, users can arrange the set of elements and behaviors that make up the solution in response to customer needs without building new versions of the product. These sets of tools are key for customer communities and consequently must be implemented in the cloud version.

Automatic and semi-automatic control and monitoring mechanisms

In spite of the criticism about availability of cloud services (e.g. [Marston, 11]), availability should be a feature of every cloud application. According to [Paquette, 10] a key selling point to cloud computing has been the potential for 100%, non-interrupted availability to the customer.

Internal components of the system need some type of functionality able to warrantee an availability of nearly 100%, resulting in only a few hours a month of unexpected system shutdown. In this case scenario, such components must present one of the following characteristics:

- Replication
- Recovery

Replication is the feature that has a component to support multiple instances simultaneously and, in the case of a failure, responsibility is delegated to one of its copies. On the other hand, recovery is the creation and replacement of an instance of a component by a new one. No matter what option a given environment chooses to implement, what really matters is the detection and recovery of a failure as soon as possible in order to comply with service level agreements. Taking this into account, it is essential to establish a set of specific rules for each of the service components. These rules will be used to determine the health status of the service and, if necessary, generate alerts to internal and external systems in various ways.

4 Lessons learned

The lessons learned during the different phases of the project can be classified into the following four categories:

4.1 Software evolution in SaaS environments

Packaged software (also known as shrink-wrapped, commercial-off-the-shelf (COTS) and commercial software) means all software sold as a tradable product (purchased from a vendor, distributor or store) [Sawyer, 00]. The first product software came about as a result of an agreement reached between IBM and the United States Department of Justice in the later 1960s to unbundle the software from hardware [Carmel, 97]. In just half a century, product software has become a major worldwide industry [Xu, 07]. The software business is a special industry where making one copy or one million copies of a software product costs about the same [Cusumano, 04].

ASP and SaaS present a business model that provides computer-based services to customers over networks in which, from the vendors' perspective, huge costs in distributing the software to end-users can be avoided [Xu, 07]. Delivering software applications over a network is an old idea (the concept goes back to time-sharing in the 1960s and 1970s, as well as application hosting in the 1980s and 1990s), but in the past has not reached the level of an industry platform [Cusumano, 10].

Most software product companies today offer Web-based hosted versions of their applications [Cusumano, 10]. This trend has changed the way software is produced and consumed [Wasserman, 11]. For software firms, the transition to an SaaS business model means much more than just delivering standard software products through the Internet [Ojala, 11]. Several concerns emerge, such as financial issues, security, SLAs, integration and limited customization, to cite those most relevant and reported. Focusing on the latter, the work of [Colomo-Palacios, 11a] provides a case study on the evolution of Meta4 to a rich internet application environment. In the case of the evolution of PeopleNet to cloud environments, following the path of other SaaS vendors and as reported in the literature (e.g. [Concha, 10], [Papazoglou, 11], [Riedl, 10]), tenant configuration is available, but the degree of configuration is limited compared to on-premise tools. This decision is rooted in the need to ensure good maintainability and evolution without unreasonable effort.

4.2 Software process

Software product development has some specific difficulties, mainly in its unpredictability [Xu, 07]. As a result of this randomness, there is need for an established method to guide the process [Colomo-Palacios, 11a] as well as tools to help managers in this management [García-Peñalvo, 11]. Back in the eighties, [Humphrey, 89] stated that the quality of a software system is governed by the quality of the process used to develop it. As a result of this fact, the need for a specific packaged software process model has been pointed out in the literature since the early nineties (e.g. [Carmel, 95]). In packaged software or market-driven product development, software process presents an iterative nature where new versions of the product are delivered via established release cycles (e.g. [Gorschek, 06]). [García-Crespo, 09] introduce methodology for the project management of market-driven software development adopting an approach that focuses on the continuous improvement of the process. Again, as reported in [Colomo-Palacios, 11a], the adaptation of this method in this particular context was successful and requires a customization to fit the particular case of each projects. Moreover, taking into account that organizations need technological infrastructures to manage software processes [García, 11], software artifacts and procedures were accessible from a common source.

However, in this particular case, two main conclusions can be drawn regarding software processes. Firstly, the difference between market pull and technology push requirements and their importance in the whole requirements process, and as a consequence of this to release planning. As reported by [Gorschek, 11], the use of product strategies (roadmaps) helped in the balancing of these two aspects in requirement prioritization. Road-mapping is one approach that companies have used to bridge the gap between business planning and product development [Lehtola, 09]. This technique has been identified as key for software product managers (e.g. [Ebert, 07]) and organizations alike (e.g. [Svahnberg, 10]).

The second conclusion is the need to achieve a good time-to-market. The literature (e.g. [Karlsson, 07]) states that time-to-market is a survival attribute for packaged software vendors. In this case, a feature of PeopleNet helped to cut time-to-market times. PeopleNet, from its very beginning, permits multitenant use and, although some new functionalities were added to further adapt the platform to a commercial SaaS environment, time-to-market records were more than acceptable.

4.3 Personnel issues

Software work is highly intensive in human capital (e.g. [Casado-Lumbreras, 11], [Colomo-Palacios, 10], [Colomo-Palacios, 11b]). In software development projects, the management of people is particularly critical [Liu, 11]. In packaged software development projects, this is even more critical. Packaged software development teams are quite different from traditional information systems development (e.g. [Carmel, 97], [Carmel, 98], [Dubé, 98], [Sawyer, 98], [Sawyer, 01], [Swanson, 05]).

According to [Sawyer, 98] the major differentiating factors may be at the individual level; moreover, this investigation points out three characteristics of the packaged software developers: level of formal education, years of professional experience, and team stability (as measured by time in the same job and time as a member of the same team). Focusing on the last aspect, [Akgün, 05] reported that team stability, team member familiarity and interpersonal trust had a positive impact on knowledge management and also had a positive influence on team learning, speed-to-market and new product success. Not in vain, Barry Boehm included personnel continuity as one of the cost drivers and team cohesion as one of the scaling drivers in his famous Constructive Cost Model (COCOMO) model [Boehm, 81], [Boehm, 00]. This importance is key in the case of Meta4, in which the average practitioner in software development teams has around fifteen years of experience in the company. In addition to a strong individualistic culture, software development professionals present a high nominal productivity and, as a result of this combination of factors, software development efforts, like the one reported in this paper, are normally kept within constraints of time, effort and budget.

The second significant finding has to do with the importance of the role of the project/product manager. The success of any product depends on the skills and competences of its product manager [Ebert, 07]. However, and taking into account the technology push nature of the project, this could seduce product managers into starting more projects than their development resources can handle [Ebert, 08]. In this scenario, requirements prioritization is seen as one of the cornerstones of successful product management for market-driven product development (e.g. [Käkölä, 11], [Karlsson, 07], [Lehtola, 09], [Mottonen, 09]); moreover, the intrinsic nature of requirements engineering as human-centred activity [Niu, 11] forces the adoption of a defined strategy. Thus, in this case, a consecutive project approach was adopted and in between projects, several releases of the product were issued, making the project affordable in terms of its management and attractive from a customer perspective. The experience of the product manager was crucial in achieving this success. PeopleNet product manager is very important for the evolution of the SaaS platform: all important decisions regarding the product and its evolution need to be checked by this person, either as a single decision-maker or together with other colleagues.

4.4 Technology

Several lessons learned can be grouped under the technology umbrella. The first is related to the integration of SaaS systems with on-premise software packages. [Sahoo, 09] states that the integration of SaaS and cloud applications with on-premise software packages is difficult to accomplish and expensive to execute. Although the adoption of web services and Service Oriented Architectures (SOA) by both sides has significantly simplified the integration process, this integration can still face serious challenges [Liu, 10]: network address translation (NAT), firewalls and trust issues. Focusing on this last issue, Meta4 opted to open its PeopleNet for interconnection using asynchronous methods. Taking into account that PeopleNet deals with human capital data, most customers expressed their requirement to keep such data out of information exchange among providers and, as a result of this, integration is now available asynchronously.

The second concern is about configuration in SaaS environments. As reported in the software evolution section, this is one of the main issues of cloud computing adoption. The intention of the company is to provide PeopleNet in a SaaS environment with a set of configuration mechanisms, but bearing in mind maintainability of the solution form an operational viewpoint. This is achieved by adapting traditional customization capabilities to PaaS philosophy, enabling tools such as business logic inheritance mechanisms for cloud based applications.

Finally, security is the cornerstone of cloud adoption (e.g. [Jaeger, 10], [Subashini, 11], [Takabi, 10]) and so it is in this case. However, the project included a feature that was able to help in closing this gap: the design of Single-Sign-On connectors for cloud environments. This mechanism enables enhanced integration and greater trust among applications at the execution level by means of integrated and unique authentication. In this scenario, evolved authentication and identity management mechanisms (e.g. [García-Crespo, 11]) could be a way to provide resource access based on knowledge-oriented descriptions enabled by semantic technologies.

5 Concluding remarks

Cloud applications, like other disruptive technologies, present superior advantages and many practical problems that must be solved. These issues must be addressed by software vendors in order to attract an increasing customer base to this business model. The literature shows that significant improvements are being made by the software industry worldwide. However, newer and more mature solutions are still needed to attain quicker and softer adoption.

This case study highlights some of the realities involved when packaged software vendors confront software evolution to cloud environments. The authors hope that the findings presented in this paper will help practitioners and researchers in guiding them to a more mature and evolved generation of cloud based applications.

The implications of the software evolution for on-premise software vendors towards cloud solutions provide a wide number of lines for future research. Firstly, authors suggest investigating the differences between cloud and on-premise software adoptions for organizations. In second term, authors aim to investigate corporate culture and its influence on cloud-computing adoption in organizational contexts. Finally, and taking into account the nature of the software process, authors propose to study and to compare the management of software development teams in cloud and on-premise environments.

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