Methodology for Developing and Application Outsourcing in the Cloud Using SOA

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Keywords: Cloud Computing, SOA and Cloud Computing, Business Model, Business Model and Cloud and SOA.

Abstract: New technologies such as, the new Information and Communication Technology ICT, break new paths and redefines the way we understand business, the Cloud Computing is one of them. The on demand resource gathering and the per usage payment scheme are now commonplace, and allows companies to save on their ICT investments. Despite the importance of this issue, we still lack methodologies that help companies, to develop applications oriented for its exploitation in the Cloud. In this study we aim to fill this gap and propose a methodology for the development of ICT applications, which are directed towards a business model, and further outsourcing in the Cloud. In the former the *Development of SOA applications*, we take, as a baseline scenario, a business model from which to obtain a business process model. To this end, we use software engineering tools; and in the latter *The Outsourcing* we propose a guide that would facilitate uploading business models into the Cloud; to this end we describe a SOA governance model, which controls the SOA. Additionally we propose a Cloud government that integrates Service Level Agreements SLAs, plus SOA governance, and Cloud architecture. Finally we apply our methodology in an example illustrating our proposal. We believe that our proposal can be used as a guide/pattern for the development of business applications.

1 INTRODUCTION

New technologies such as, the new Information and Communication Technology ICT, break new paths and redefine the way we understand business. In a few years time, Cloud Computing has become the spotlight of myriad companies that see this technology as a place from which to develop, manage and launch their businesses. This is due to several causes such as: *the possibility of market expansion*, Cloud companies can now reach every corner of the globe; *savings resulting from ICT technologies*, everything in the Cloud is consumed as a service and payments owed are determined by usage; *the ability to expand or contract resources by needed*, in addition it is possible to use any technology or tool without having to invest any money in them, thereby avoiding obsolescence. But business migration to the Cloud, including its data, services and processes, should be made based on well-defined strategies, for example using the Service Oriented Architect SOA philosophy

We think that SOA and Cloud technologies complement each other. *SOA* is directed towards the development of service-oriented applications, as it is a framework that allows the development of business-oriented computer systems, using services. These services can be reused by other companies and are independent from each other, which makes them easily modifiable. *Cloud Computing* is a technology that provides: Platform as a Service PaaS, Software as a Service SaaS, Infrastructure as a Service IaaS, and Data as a Service DaaS. Generally the use of any resource "as a service" can be referred to as XaaS. Applications based on SOA can be included within SaaS. In the Cloud, these resources (as services) are being used by users that do not know where they (resources) are physically stored. In (Wilkes, 2011) some valid principles for SOA and Cloud are defined as: *Resource Decoupling*, services allow suppliers to become independent from; the only dependence remains within the provided service and not through the implementation process. *Service implementation encapsulation:* behind the published interface the user only should know how

the service is used. *Use based on Service Level Agreements SLA*, which define obligations between supplier and consumer. *Share and Reuse*, Cloud services should be designed to share and to reuse by many consumers. *Autonomy*, services should be independent. *Discovery*, Cloud services must be easily discoverable. *Modularity and Composition*, Cloud services can be composed of other services.

Several authors believe that Cloud and SOA are suitable for business outsourcing in the cloud. We agree with (Wilkes, 2011) where the authors discuss the modernization of business and ICT in the Cloud, noting that both have common.

In this paper, we propose aligning the Cloud strategy with business strategy according to the SOA paradigm. We propose a methodology directed towards the *development* and *outsourcing/externalization* of business applications using SOA. *In the development process*, we take a *business Model* as a base from which to develop a *business process Model*, we then use software engineering tools to obtain a *business services Model*, suitable for implementation. *In the outsourcing process,* we propose a guide to exploit SOA applications in the Cloud following the Business Process Modeling BPM and SOA government models. In the best of our knowledge we have not found applications development methodologies focused to its exploitation in the Cloud.

This paper is structured as follows: In Section 2 we will see some studies related to the Cloud and SOA. Section 3 presents our proposal. Section 4 we shows a study case where we apply our methodology. And Section 5 exposes some conclusions and future research.

2 STATE OF THE ART

Opportunities offered by the Internet to modern society are immense and growing on a daily basis; constantly technological advances break new ground towards providing society with better and faster communications aside from new ways to interact, do business, teach, learn and much more.

The new Cloud technologies are considered by many authors a derivative of other technologies, as in (Buyya, 2009) where a study on computer vision in the XXI century is performed, covering briefly the progress of modern society, they consider Grid computing, Peer to Peer, and SOA technologies like precursors of the Cloud Computing. In addition, they establish an approach what they call "Cloud market-

oriented resource management", these are based on the deployment of Service Level Agreements SLAs, between providers and users, and risk management associated with the violation of SLAs. In (Youseff, 2010) a proposal of the Cloud ontology is shown, which aims to unify concepts as to improve their understanding; the authors also consider the Cloud as a technology derived from other such as SOA, Virtualization, Distributed architectures, Grid and Cluster computing from which the Cloud inherits its advantages and limitations. They present their ontology in 5 different layers: 1) Hardware; 2) Kernel; 3) IaaS: DaaS and computational resources as a service CaaS; 4) PasS and 5) SaaS. Cloud technologies are a matter of research as shown in projects (Khan, 2012), (MacKenzie, 2006), (Wang, 2008), (Buyya, 2009), (Alvarez, 2012), (Mircea (a), 2010). We believe that SOA is a mature architecture suitable for the Cloud, in (MacKenzie, 2006) the OASIS Reference Model for SOA, is shown; where *the reference model* is defined as a model that seeks to provide common semantics, that can be used without ambiguity between different implementations. It defines the SOA essence, and emerges with a common vocabulary and understanding, independent from the technology that influences the SOA deployment. According to (MacKenzie, 2006), SOA is a paradigm for organizing and utilizing distributed capabilities, which may be under the control of different owners. Entities, individuals and organizations create capabilities to solve or support solutions to problems they face in their businesses. Thus, *the needs of some people are met with capabilities offered by others*. A capability can be used without knowing its details. The service is SOAs' core, and it is defined in the dictionary as "*The performance do work (a function) by one for another*". Regarding SOA, services are the mechanism by which needs and capabilities are produced together.

There are many studies that recommend using SOA in the Cloud, all from different points of view, as in (Wang, 2008) where the authors define the workspace as the abstraction of an execution environment, which can be dynamically available to authorized clients using standard well defined protocols. The authors think that orchestration and service organization can be managed by SOA. In (Buyya, 2009) new ways of locating resources, depending on the level of service contracted between consumers and suppliers, are presented. The authors of (Soltani, 2012) propose using BPM and Model-Driven Development to develop SOA architecture. They show a method that defines how to transform a

business process in an executable process to identify services SOA automatically. The main objective of this paper is to automate the development process of enterprise information systems, under the service-oriented paradigm, although its proposal does not contemplates the outsourcing process as we do in this paper. In (Mircea (a), 2010) the authors present a relationship between BPM, SOA and Cloud at the organizational level. They propose a design pattern created specifically for an environment such as the university, and they highlight the use of Cloud Computing and the construction of reusable components, benefiting customers and suppliers. In our proposal, we give a methodology *to develop* applications which can be use for any business model. Worth noting (Wilkes, 2011), which speaks of service-based businesses in the Cloud while saying that "*all roads still lead to SOA*"; it presents SOA as an essential way to modernize organizations, and bring business to the Cloud. They think that in the near future SaaS vendors will provide business service sets, in the concept of Business as a service BaaS. They speak of the rebirth of SOA, and they say "*It is no longer a question of "should I use SOA or not?", as SOA is the way the cloud operates*". Its proposal considers two additional layers to the Cloud infrastructure layer: 1) *business as a service* layer, and 2) *platform as a service* layer. Other studies are focused on the usefulness of Cloud within specific areas, as in (Alvarez, 2012) where the authors focus their proposal on how to run a university management model. Also (Piórkowski, 2012) provides a dissertation on the use of SOA within the construction of services that would allow for new ways of teaching. In (Gonzalo, 2013) a new model of higher education hosted in the Cloud is shown, under the philosophy of use on demand and pay per use.

In summary, we have not found studies where the development of business models oriented towards its externalization/outsourcing in the Cloud are defined, using the SOA design paradigm and the BPM process management model, as we propose in this paper.

3 PROPOSED METHODOLOGY

SOA is a paradigm or philosophy, in other words, a different perspective from the traditional approach to the design and construction of flexible and highly scalable software systems, which reflect business organization. Traditional software development

models follow *process-oriented* or *object-oriented* paradigms; but these are, currently, insufficient towards capturing new business challenges that businesses require, and towards expanding them through the Internet. Therefore, there is a need for methodologies based on *service-oriented* paradigm which can be integrated for their development in the Cloud. They must allow carrying out business projects quickly and easily, adapting by changing the needs of business processes and with the benefits that the reusability offers. The SOA architecture is a good candidate because it enables users to design, to build, to develop and to integrate business services.

We agree with (Wilkes, 2011) and consider necessary to add a new layer on the traditional infrastructure of Cloud, the BaaS layer. We define a methodology for the development of business models focused for their externalization in the Cloud, which will be implemented on BaaS layer, we can see this in the Figure 1.
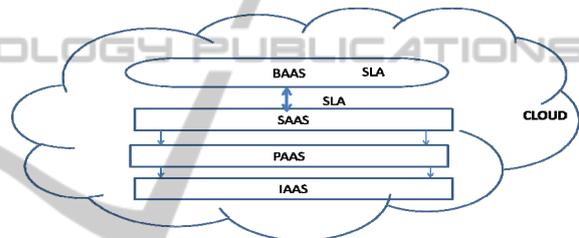

Figure 1: Cloud Infrastructure adding the business layer BaaS.

The Figure 2 shows two parts of our methodology: The *SOA Architecture* and the *Exploitation*. In the following we describe these in detail using diagrams and UML specifications.

3.1 SOA Architecture

To build an application using SOA that collects the *business Model* of any company, we propose two phases: *Business Modelling* and *Design*.
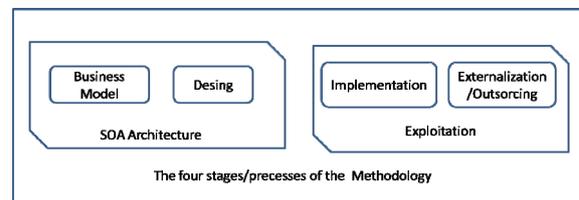

Figure 2: Integration of the SOA and the Cloud.

3.1.1 Business Modelling Phase

In this phase we take the *business Model* of any

organization as a starting point and carry out three activities: *Analysis of the organization, Identify business processes,* and *Action description.* With all these we form a *Business Process Modelling.*

Analysis of the Organization
This activity aims to study the Organization for which the project is being carried out to extract relevant information from the business. To this end, we make an analysis of the current status of the organization in terms of their current processes, tools, clients, skills, areas for improvement, etc.

Identify the Business Processes
After analyzing the main elements that support the business, we identify and describe the processes that are performed and the users involved; and we represent them through a use cases UC diagram. In Figure 3 we observe *n* business processes represented as *n* Business UC and using single user.
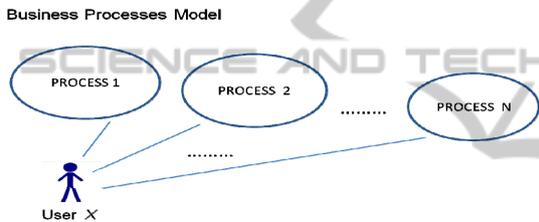
Business Processes Model

Figure 3: Identification of business processes.

Actions Description
For every business UC defined in the previous activity, we define the future actions using an activity diagram. Figure 4 shows an example of the actions that should perform a process *x.*
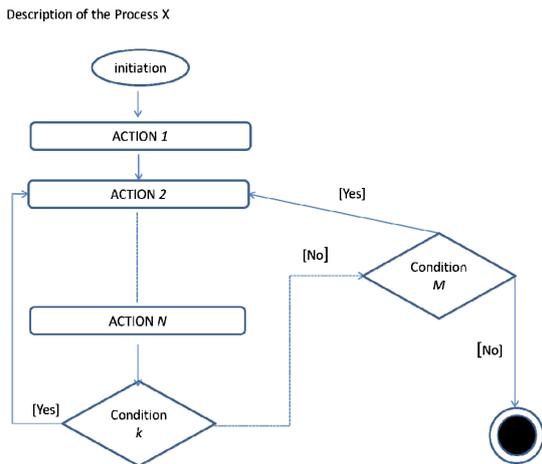

Figure 4: Activity diagram of a generic use case that provides support to a process *X.*

3.1.2 Design Phase

In this phase, each the processes represented by a UC in the previous phase, is described. For this purpose we perform four activities: 1) *Identify* and categorize services. 2) *Discover* existing services. 3) *Specify* services. 4) *Define* the Orchestration of services.

Identify and Categorize Services
This activity aims to identify the *business services* needed to perform each business process, which are categorized according to a type of service. These can be: focusing on *processes/tasks* (those that describe the business logic, them being composed of a set of services); of *entity* (describe the business logic (but only the simple or unitary parts); *basic or useful* (describing access to external utilities of the application, for example databases). We can observe this in Figure 5.
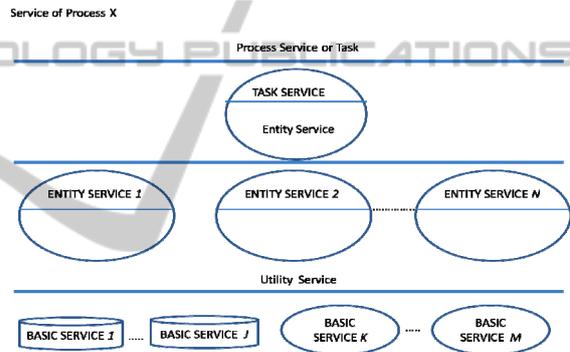

Figure 5: Identification and categorization of services of a process *X.*

Discover Existing Services
This activity aims to find the business services that may be already implemented, and they can be reused. Observe this in Figure 6.
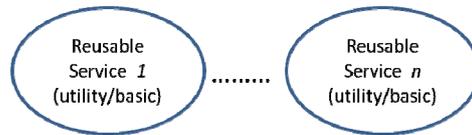

Figure 6: Discovery of existing services for its reuse

Specify Services
This activity aims to specify the business services that were previously identified, defining service contracts for each along with their interfaces. In turn, interfaces contain operations and their parameters, which are related with actions described in the activity diagram in the above phase. We can see this in Figure 7.
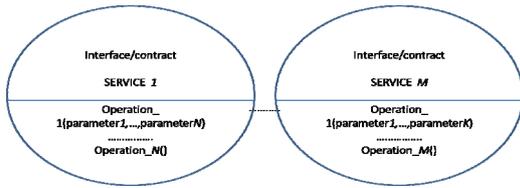
Figure 7: Specification of business services of a process *X*.

Services Orchestration

In this point the orchestration defines the sequence of operations that allow for interaction between business services, which is necessary for each and every business process. We can see this represented in Figure 8.
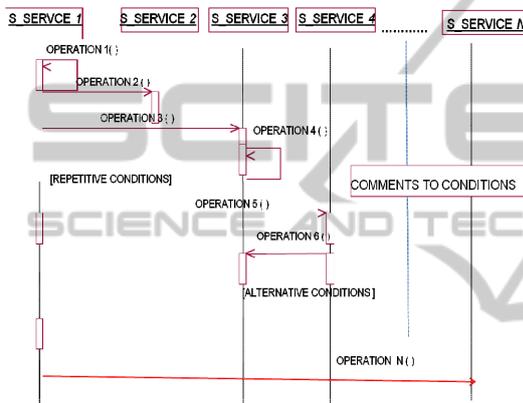

Figure 8: Representation by a sequence diagram of the orchestration of business services in a process *X*.

3.2 Exploitation

In this part, we proceed to the implementation of all business services that were identified in the design phase. Afterward, processes and business services will be externalized/outsourced in the Cloud. To fulfil this purpose we carry out two phases: *Implementation* and *Externalization in the Cloud*.

3.2.1 Implementation Phase

This phase aims to implement business services following the structure defined in 3.1.2.3 section. For this we can use Web services technology.

3.2.2 Externalization in the Cloud Phase

This activity aims to conduct a study of the resources that are needed to carry out the implementation of SOA and exploitation of the business in the Cloud, and then hiring these resources, if necessary. The externalization in the Cloud is done in three activities: *Process Orchestration*, *SOA Governance Model*, and *Cloud Government Model*.

Process Orchestration

In this activity we describe the orchestration of business processes and services, and their rules; to this end we use a BPM, which provide a set of rules for business process management. We observe in Figure 9 an orchestration where business processes and services are interspersed.
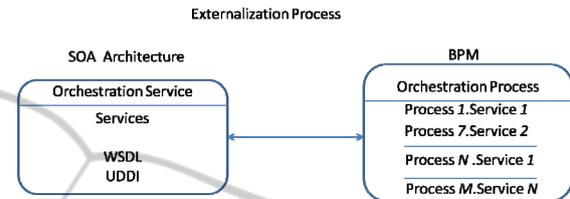

Figure 9: Orchestration of business processes and services, using BPM.

SOA Governance Model

This activity prepares the exploitation of SOA, which represent the business model in the Cloud. It is necessary to guide and direct the mentioned SOA architecture, defining what to do, how to do it, who has authority to do each action, and how to measure the results. This is done by defining a SOA governance model. Figure 10 shows SOA governance and its interaction with the other components of the Cloud. The SOA governance is subject to the Cloud Government.
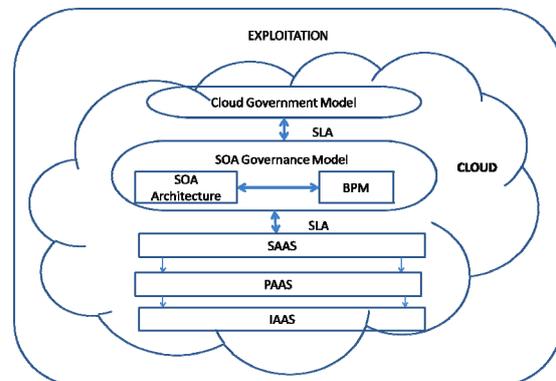

Figure 10: Structure of the outsourcing/externalization of a business model in the cloud using SOA.

Cloud Government Model

In this activity the cloud provider agreements are specified; which will be reflected in the SLAs, for this reason we ask the following questions: Who owns the services? Who provides the services? Who consumes the services? Where is a particular service? Who is responsible for it? And so on. Cloud government comprehends SLAs and SOA

governance and Cloud architecture, which is defined specifically for each business model, this is represented in Figure 10.

4 STUDY CASE

We have chose as a practical example for validate our proposal those shown in (Gonzalo, 2013). They propose a new educational model (business model) named "*Use on demand, pay per use*". They aim to achieve *"Higher education from anywhere, with access from any mobile device, at any time, without requiring large investments for students, and with reuse and optimization of resources by universities. Cost by consumption and consumption by service"*. The student will only pay for what they use, and may pursue such studies as they deem appropriate. With this philosophy the educational provision at the University is extended, breaking down the barrier of space, time and also the economics. We wish to develop a business model that outsources to the Cloud, while supporting these requirements, following our methodology step by step.

4.1 SOA Architecture

4.1.1 Business Modelling Phase

We have developed a management application named "*Use on demand pay per use*" which will provide students with the following functionalities:

- To study higher education courses such as bachelor's degrees, masters or doctorates.
- The students can choose among enrolling:
  - A full course, which is composed of a set of subjects.
  - A module, which corresponds to a set of interrelated subjects.
  - One or more independent subjects.
- To create a profile that allows access to the chosen educational provision.
- Paying a minimum fee for registration can be required, even though in some cases could be null.
- From this time the student will have their own virtual environment with the chosen subjects (previously enrolled) and their associated resources.
- Pay only for the time used.

In this phase we take the *business Model* of any university as a starting point and carry out three activities: *Analysis of the university*, *Identify*

educational processes, and *Action description*.

Analysis of the Organization (University)
Here we study the university for which the project is being carried out. We identify resources aimed at university management, both administrative and educational. For example we have: students, professors, department, and offers of higher studies such as: bachelors, masters, doctorates.

Identify the Business Processes
After analyzing the main elements that support our educational model, we identify processes and user types. In this example we only focus on the following user types: admin, professor and student.
- *The admin* has the task of managing educational resources using the *Resource Management process*.
- *The professor* has the task of to include teaching resources in the development platform using the *Subjects Elaboration process*.
- *The student* uses the subjects with its associated devices using *Creating Student Profile process* and *Using Student Profile process*.

We represent this through a UC diagram, we propose a UC for each process. In Figure 11 we observe this.

Actions Description
For every business UC defined in the previous activity (Figure 11), we explain the corresponding actions using an activity diagram.

Due to space constraints, we only define two processes: *Creating Student Profile*, which allows students to choose didactic units they wish to enrol in and also the payment method.
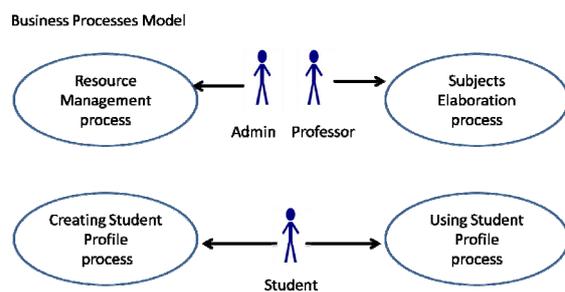

Figure 11: Identification of business processes and users.

Using Student Profile once the student has a profile, he can use contents of subjects that he has enrolled in and its associated resources. In addition he can increase credit according to his or her needs.

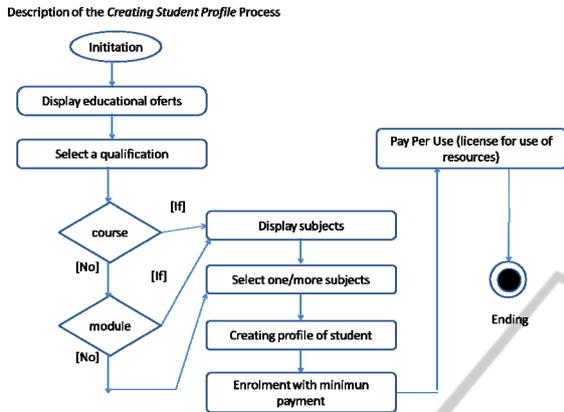Figure 12 show examples of the actions that should perform these processes.

Figure 12: Activity diagram of the UC/process named "*Creating Student Profile*".

4.1.2 Design Phase

In this phase, we perform four activities for each process defined previously: 1) *Identify* and categorize services. 2) *Discover* existing services. 3) *Specify* services. 4) *Define* the Orchestration of services.

Identify and Categorize Services
This activity aims to identify the business services needed to perform each business process. Figure 13 shows some services identified in the "Using Student Profile" process.

Discover Existing Services
This activity aims to find the business services that may be already implemented, and they can be reused. For example the Accounting service and Gateway bank service are identified in the "Using Student Profile" process. We see this in Figure 14.

Specify Services
This activity aims to specify the business services that were previously identified. For example: For "Using student profile" process, we can have the following services: subject, topic, resource and dossier.
In the following we do not include the figures that represent activities due to lack of space. But it seems that the usefulness of our methodology is clearly reflected.

Services Orchestration
Here the orchestration defines the sequence of operations that allow for the interaction between business services.
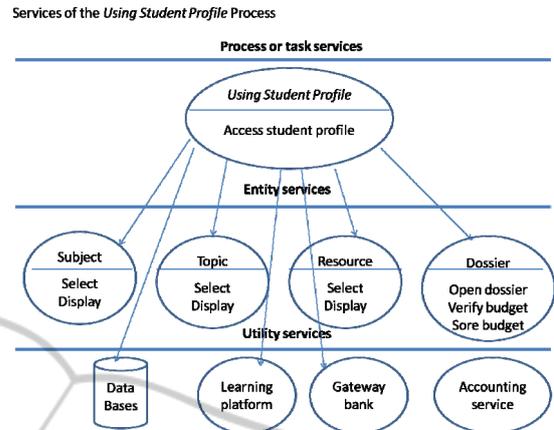

Figure 13: Identification and categorization of services of the *Using Student Profile* process.

Figure 14: Discovery of existing services for its reuse in the *Using Student Profile* process.

4.2 Exploitation

In this part, phases and activities are specific chosen programming languages and specific Cloud platforms. Therefore we are not going to develop this step. Though we recommend you consider the wants and needs of the university regarding the Cloud resource acquisition. So, depending on the choice for each university centre we can use IaaS, PaaS or SaaS, and so on.

5 CONCLUSIONS AND FUTURE RESEARCH

With new business modernization trends and using the Internet to give a quick response and to be very competitive, there is a new Cloud computing company concept, which means giving companies the ease of using all kinds of technologies or computer tools, to manage their own organizations, without having to invest in them. The advantage of this Cloud concept is that the company will only pay for what it needs, because they can use more or less resources pursuant to their needs, both in hardware and software, thus preventing obsolete technologies and avoiding further maintenance. In this paper we

have presented a methodology for the development and externalization of business models in the Cloud using SOA. *Regarding the development* we have proposed guidelines to define a business model based on the objectives and strategies of any company or organization. This model identifies the business processes. Business processes are specified in several stages to obtain a model of business services, which can be implemented using the Web services technology. For the modelling of processes and services we have used UML diagrams. *With regard to externalization* of a Business Model (which is defined as business processes and services) in the Cloud, we propose a SOA governance model integrated with a BPM. And we consider a Cloud Government integrating: Governance SOA, Cloud architecture and SLAs. Finally to validate our approach we present a study case that clearly illustrates the application of our methodology. Also the example used seems, in our view, timely and useful for solving the new challenges that, education in general and the university in particular, face. We believe that "*Education on demand and pay per use*" is one more step towards the removal of the time and space barriers as well as the economics that currently prevent many students access to higher education provisions. We think this paper can be considered as a useful guide to undertake development projects and the outsourcing of companies into the Cloud.

Our future research is directed towards defining in more detail the outsourcing phases of our proposal. Also, we plan to define rules and patterns to develop business models aimed at their outsourcing and deployment in the Cloud. In addition in the near future we intend to make a tool that automatically observes all phases of our methodology.

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