Main Aspects of the Adoption of Cloud Solutions in Managing Service-Oriented Organizations - the Case of Higher Education

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The present day context of information and communications technology (ICT) raises the need for better online products and services for users. Organizations that implement ICT on a large scale meet an important hurdle: the need to continuously configure and parameterize the computing systems. This arises from the limited storage space, maintenance resources, the need to re-qualify the personnel and replace software licenses. Cloud Computing solutions may provide a way around this problem. Basically, Cloud Computing solutions provide services to users though a web browser. An immediate consequence is opportunity to downscale the software costs. Also, Cloud Computing creates great opportunities for business intelligence application like predictive analyses and large data storage, presenting itself as a good data source [4].The advantages of Cloud Computing solutions for managing service oriented organizations are obvious. This is supported by the categories of characteristic users of Cloud Computing: common user (SaaS – Software as a Service), application developer (PaaS – Platform as a Service), and system administrator (IaaS – Infrastructure as a Service).
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1 General Framework

The full blown development of information and communications technology (ICT) impacts all aspects of human life, with a special emphasize on the forms of association for economic activities, both in the traditional and the digital context. Thus, economic organizations go through profound transformations regarding the nature of work, managerial paradigms, organizational culture, new work factors etc.

Large scale adoption of ICT by organizations led to the emergence of service oriented architectures (SOA) as a new model to create distributed applications. In this context, at the border between SOA and Business, a new paradigm of service oriented organization management rises. Also, overlapping the functional concepts of intranet and extranet, the new bipolar ICT-business instruments evolve towards internal, hybrid or external Cloud Computing solutions.

1.1 Characteristics of Cloud Computing

Cloud Computing is the technology that uses internet to manage data and applications. It allows organizations to use applications without local installation, as well as access to personal files from any computer connected to internet. Quoting Chan (2009), the concept may be defined starting from its name (cloud) as "common, location-independent, online, utility that is available on demand" [1]. This approach emphasizes the fact that any shared resource is statistically multiplied on several applications and clients. Thus, no matter where the client is geographically located, he can access the information in the "cloud". The "on demand" feature means resources have to be dynamically allocated.

The cloud can take many shapes, including SaaS (Software as a Service), PaaS (Platform as a Service) and/or IaaS (Infrastructure as a Service). These shapes describe the Cloud Computing architecture and are associated to certain categories of users (see table 1). From a management perspective, SaaS level allows the organization to store applications in a "cloud" from where they can be accessed via internet.

Table 1. Cloud architecture – types of users

User type	Cloud Computing
Common user (user level)	SaaS (Software as a Service)
Application developer	PaaS (Platform as a Service)
System administrator	IaaS (Infrastructure as a Service)

Application developers are involved in designing, building and testing applications that will work on the Cloud infrastructure and will be delivered to users connected to provider servers. System administrators ensure a faster processing of data, unlimited storage space, management and administration of databases as well as other resources and applications accessible via internet.

1.2 Cloud Computing & Service Oriented Organizations Integration

Service oriented organizations management model highlights various types of clouds (see figure 1). The private cloud (or internal – see intranet) consists of a network of computers or a data center that provides services hosted for a limited number of users. Public service cloud (or external) consists of storage service providers (free or charged) and web application for the public (for example: Amazon Elastic Compute Cloud, Cloud Sun, IBM Blue Cloud, Google AppEngine or Windows Azure Services Platform). The hybrid cloud (internal and external)is an environment that includes several providers, both for internal and external cloud. A good example is IBM, which had a partnership with Juniper Networks, which facilitated the implementation of a hybrid cloud [2].

From an evolution perspective, we may say that the last decade is represented by the development of SOA. The main characteristic of SOA is the ability to be reused in various applications, services communication with each other by sending information [3]. The idea of exposing resources as web services, making them accessible, is older but building the components, tools and infrastructure to accomplish this was more difficult. Development of VMWare in organizational environment allowed hooking up applications with various operating systems, enhancing the portability. This was the starting point for the development of Cloud technologies, mainly since 2010.

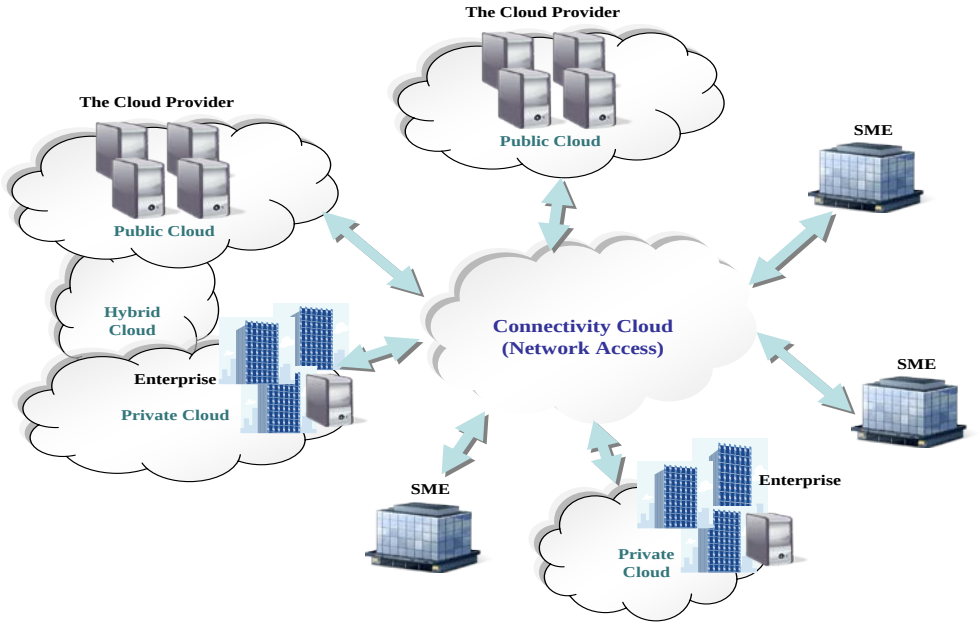

Fig. 1. Cloud types (Source: http://www.mohamedfawzy.com/?p=31)

Thus, cloud solutions for the management of service oriented organizations are the future. Integration can take place on a personal computer or a corporative data center, from data storage to e-mail communication. At the same time with the development of Cloud Computing solutions, there is a further development of ICT industry. The attention goes towards developing applications and technology usable via internet and on building new equipment that can handle the increasing flow of data transmitted online.

2 Management of Service Oriented Organizations through Cloud Computing Solutions

From the management point of view (management of resources in order to maximize the profits), cloud solutions have many advantages for all categories of users. These advantages are obvious for service oriented organizations.

- *Downsize of costs for maintenance, upgrade or purchase of new computing systems.* Users do not need a powerful computer (with a high price tag) in order to run Cloud Computing applications. Since they will run inside the cloud, not on the PC (Personal Computer), the PC needs little computing power and hard disk space, compared with traditional software. There is no need for acquisition of expensive software, many of them being provided free of charge by the cloud (see Google Docs suite).
- *Downsize of capital and personnel expenses.* A consequence of the above advantage goes to lower need for capital and specialized personnel. This is why cloud solutions are appealing for organizations (where work force requires the largest part of expenses). Even more, although the number of specialized personnel decreases, the visibility and importance of the department for the business environment increases.
- *Increased performance of computing systems* is a direct consequence of reduced number of programs and processes being run at the same time.
- *Automated software update.* There is no longer any need to update the software. Every time a user connects to the cloud, he has access to the latest version of the software. The update takes place inside the cloud, transparent to the user.
- *Newest version of documents is available.* When connecting to the cloud, users access the newest version of the documents, possibly modified by other authorized users.
- *Increased teamwork efficiency.* Cloud solutions create advantages for users working on projects or on shared documents. Since documents reside inside the cloud and not on individual computers, team members can easily collaborate, by accessing the documents via internet.

The effects of adopting cloud solutions are also visible on the level of management itself. The modern paradigms of management science – holonic, fractal, anthropocentric – are easier to implement. Cloud solutions stimulate using the individual abilities of employees and sharing of resources, contributing to a redefinition of organizational culture.

3 Security Aspects

Implementation of cloud solutions in service oriented organizations must take care of ensuring service security. There are several levels of security required for a cloud environment:

- *Identity management* –this type of security means that any service for applications or hardware components may be accessed only by authorized users or groups of users.
- *Controlled access* –access to the cloud must be controlled to ensure resource security.
- *Authentication and authorization* – there must be a way to allow only authorized users to modify data and applications.

From this perspective, there must be a global security infrastructure for all levels and types of services in the cloud. Also, developers need instruments that can provide security for the services created with the purpose of being delivered though the cloud. Security is the highest priority of IT (Information Technology) managers when they decide to implement a cloud solution. Every Cloud Computing provider has its own security management system and this may concur or conflict with the organization security strategy. An organization must balance protection, confidentiality, administration and accessibility to key resources, either through a traditional data center, a private or hybrid cloud. Security measures for monitoring controlled access, identity management and network must be constantly maintained in the internal data center and hybrid cloud.

The fact that the cloud provider is also responsible for the environment security makes the importance of security in a cloud computing environment even more obvious. If the provider does not have a good security strategy, all the companies using its services are in jeopardy. Also, security is hard to monitor and problems usually arise only when something does not work right, which makes it harder to plan for such situations. Another problem is comparing the quality of security services of various providers because most of them do not allow the clients to know the infrastructure.

A non-standard methodology for preventing and reducing attacks (direct or passive) against security requires completion of specific steps:

a) Authentication for all users accessing the network.
b) Verification of access permissions (rights);
c) Authentication of the software used on any computer (including software components running in the cloud) and all updates. The cloud provider must automate and authenticate all software patches and configuration changes and manage all security patches. This is very important because most services interruptions are caused by faulty configurations. If a provider does not update the security policies, the intellectual property of all clients is in jeopardy.
d) Formalization of the process to require access to information or applications. This rule must be applied both on internal systems and services that require the transfer of information inside the cloud.
e) Monitoring of network activity and recording of unusual situations. In most cases intrusion detection technologies must be implemented. Also the cloud provider may allow the monitoring of activities inside its environment, an independent monitoring is also recommended.
f) Recording the activity of all users and applications and analyses to discover unusual and atypical activities.
g) Encrypting the confidential information that requires a higher level of protection.
h) Regular verification to discover vulnerabilities in all software applications exposed to internet or external users.

Classic solutions that exist on ITC market are rather *point-solutions* that cover specific vulnerabilities like:

- Firewall–protect the internal network against the internet
- Antivirus software – protect individual computers against known viruses
- Virtual Private Networks – prevent external connections to a network

These products reduce some of the risks but they cannot create a high level of security. There are some products that bring a significant contribution to an integrated IT security platform. They fall under 3 categories: identity management, specific security products and data encryption applications.

Identity management is about managing information concerning the identity of the users accessing the resources, applications, information and services and also strict control over the access rights. The benefits of using identity management for increased security include:

- Increased productivity: cloud computing solutions provide a simplified sign-on interface and the possibility to modify a users access rights on the fly;
- Improved services for clients and partners, ensuring a safe environment for access to data and applications;
- Reduced costs – fewer calls to technical support department concerning forgotten passwords; also identity management means automation of the process of granting and revoking access rights to systems and applications.

An identity management solution includes specific aspects materialized in the following features:

a) *Centralized information*. Most of the times information are distributed on several systems. From the cloud perspective, it is recommended that they reside in a single database.

b) *Integration*. An identity management system must be integrated with all other systems in the cloud so that there are a direct interfaces with the human resources department (where all personnel changes are operated), product management systems (if providers and partners use such systems) and with client database (if they need to access some systems from the cloud).

c) *An advanced authentication procedure*. This means going beyond the classic password authentication by adding biometric systems (fingerprints, palm prints, eye scan etc.) or token generated codes.

d) *Automation of rights granting and revoking*. When the status of a user changes, all rights changes have to be automatically sent to all other connected systems. This reduces the possibility of a user having more rights than he should.

e) *Single sign*-on. The identity of a user is verified and transmitted to all the other systems in order to establish the access rights. The rights are not granted to a person but to a role and they capture administrative hierarchy information as well. This kind of authentication can be seen in the case of web interfaces that grant access to all the applications the users has rights on.

f) *Security management*. Identity management reduces security management costs by automating many of the security administrators' tasks.

g) *Data analyses*. After centralizing the information about users, various reports can be generated about the usage of resources and applications. Security audits are also easier to perform.

Specific products for security allow prevention of attacks or, if they were not prevented in time, the possibility to detect the source and the weak points of the system. For cloud computing, these solutions mean recording the activity. The files recording these data can provide the information about how the attack was happened.

Most cloud computing providers implement infrastructure security through HIPS (host-based intrusion protection system) and NIPS (network-based intrusion protection system). These systems include elements like: monitoring systems log files (there are software products that search these files for traces of possible attacks). NIDS (network intrusion detection systems) monitors data packages transported through the network looking signs of harmful activities. DDS (digital deception software) is a class of software products used to deceive those that try to attack the network. WLS (white listing software) charges with identification of executable files and prevention of uncontrolled execution. Beside recording modification on the databases, it is also important to record the interrogations. Data auditing products take care of this.

There are numerous data encrypting applications and techniques. Information can be encrypted when it is written on disk or when it is transmitted through the network. Although this prevents some attacks, it also decreases performance; therefore it is recommended to encrypt only sensitive data requiring high protection.

4 Limitations and Perspectives

In spite of numerous advantages, Cloud Computing solutions are faced with some problems, be they of legal nature or disadvantages for users. First limitation is the need for permanent connection to internet. Cloud Computing is not possible without internet connection, since it uses internet to access both applications and data. Even more, this must be a high speed connection, otherwise access is difficult and slow, applications and data requiring broadband for download.

Other limitations of Cloud Computing are related to limited applicability for certain applications (presently many web applications offer limited features to users – see MS PowerPoint or Google Presentations), limited protection and risk of total data loss (some providers do not make public their practices on data manipulation).

An analyses performed by Appnor in 2010 [6] on Cloud Computing phenomenon shows that usage of IaaS, PaaS and SaaS has increased in the latest years and will become more popular (see figure 2). Of the three segments, SaaS is used by most companies, followed by IaaS and PaaS. More than 40% of the companies reported they use SaaS in some form. Small companies were the first to adopt SaaS, while large companies feared security and integration risks. SaaS proved to be viable and convinced large companies to start using it. The most popular SaaS segments are client services and support.

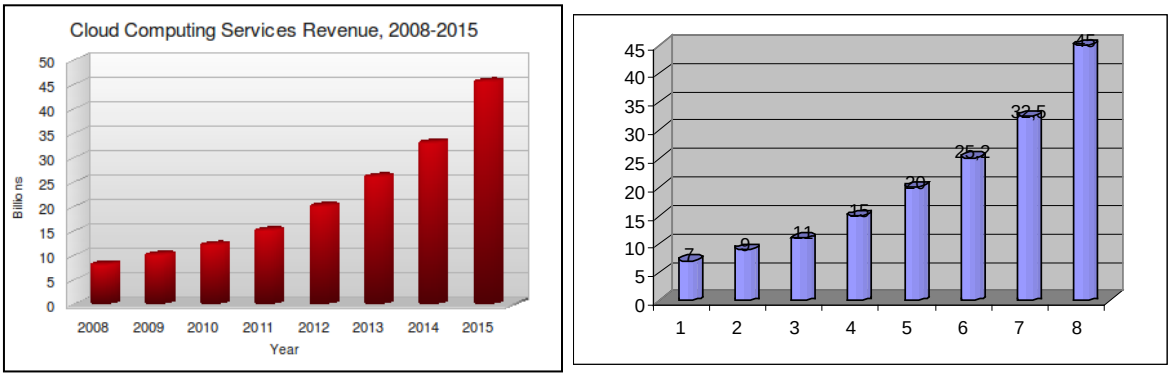

Fig. 2. Income from Cloud Computing services 2008-2015

In 2009 study carried on by Forrester [13] only 3% companies worldwide declared that they use IaaS services. Compared to SaaS, this segment is more popular with large companies then with small ones. PaaS solutions are relatively new, which explains why they are not used as much as IaaS and PaaS, but we can expect that more companies will adopt them in the future.

For 2008-2013 (see figure 3), Gartner [14] anticipates a major evolution of the cloud computing market. SaaS has won a large share of the cloud computing market (89%), but PaaS and IaaS have a bigger potential for growth.

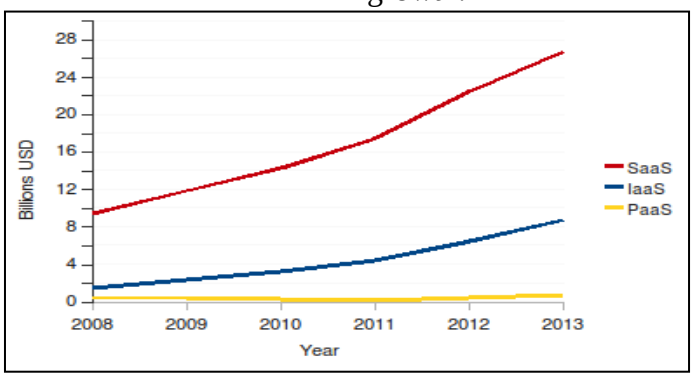

Fig. 3. Evolution of market share for SaaS, IaaS and PaaS

Every cloud computing provider offers various services, prices, delivery methods and support features. Main criteria used by clients when selecting a cloud solution are costs, scalability and expertise. Beside those, some other factors may influence the decision of a potential client, like:

- Services and support;
- Cloud hosted applications, information services, business process services;
- Provider experience and client portfolio;
- Security services: data protection during transactions and storage, encryption and decryption of data, recovery after disaster solutions, protection against intruders and firewall services, document security and certifications;
- Performance, availability;
- Billing options;
- Possibilities to leave the cloud;
- Provider flexibility – the ability to integrate and manage hybrid environments.

In Romania Cloud Computing solutions became an option only in 2010. The first cloud services integrator is Appnor, launched in February 2010, with support and assistance in Romanian language. Based on a partnership with Google they managed to integrate critical solutions for business and announced unlimited online backup.

In a survey by BRINEL, on a sample of 173 subjects (IT specialists), "cloud computing is a viable solution in Romania". 63% of the subjects consider that IT market in Romania is ready for Cloud Computing, mainly because of high speed internet connection available locally [5].

5 Adoption of Cloud Computing Solution in Higher Education Management

Rapid technology evolution offers numerous opportunities for higher education institutions but also creates hard to manage tensions and changes that are usually hard to implement [7]. One of the major challenges that face universities is university management. This involves learning from everywhere, anytime and anyway (especially for lifelong learning), as well as creating high level support processes with low expenses.

ICT related expenses combined with the current financial crisis and the limited resources of the universities require finding alternative solutions, like cloud computing. Using cloud computing involves a high level of SOA maturity in universities. SOA provides support for creation and management of distributed services so that common services, available to everybody can be operated inside the university and/or between universities/organizations. Also, SOA promotes using shared services, provided locally or through cloud environments. An efficient management of changes in the university is also required, which involves using business process management solutions (BPM), with implications on the process automation and SOA governance. The potential and efficiency of using SOA, BPM and Cloud Computing in higher education were recognized by many universities and researchers in the field (see [3] [7] [8]). Next we propose an approach on using Cloud solutions in order to improve university management in the context of current financial crisis.

In a solution based approach, Cloud is a continuous exposure of information as service in a university that adopted SOA on a large scale. Using shared services brings immediate benefits to the university like: reduced costs (because of sharing services), improved quality by using services from leading specialists, reduced costs for investments and fast integration of new technological versions.

Considering the trend of universities (innovation), more and more universities seek to use modern technological solutions that will transform them into intelligent universities. A viable choice at this moment for improving university management is using innovative BI solutions combined with Cloud Computing. Leading specialists consider that for a long time both traditional software and SaaS will co-exist inside

organizations [12]. The problem of choosing a BI solution rises especially for universities that have an IT infrastructure.

Using Cloud solutions in university management (see figure 4) requires a special attention for cloud risks. According to [11], about 75% of Chief Information Officers and IT specialists consider security as the main risk of cloud integration. The security of Cloud BI solution is vital, as this involves transmitting decision support data between the cloud and the network. Therefore, the security standards for transmission of data are very important when choosing a Cloud BI solution [10].

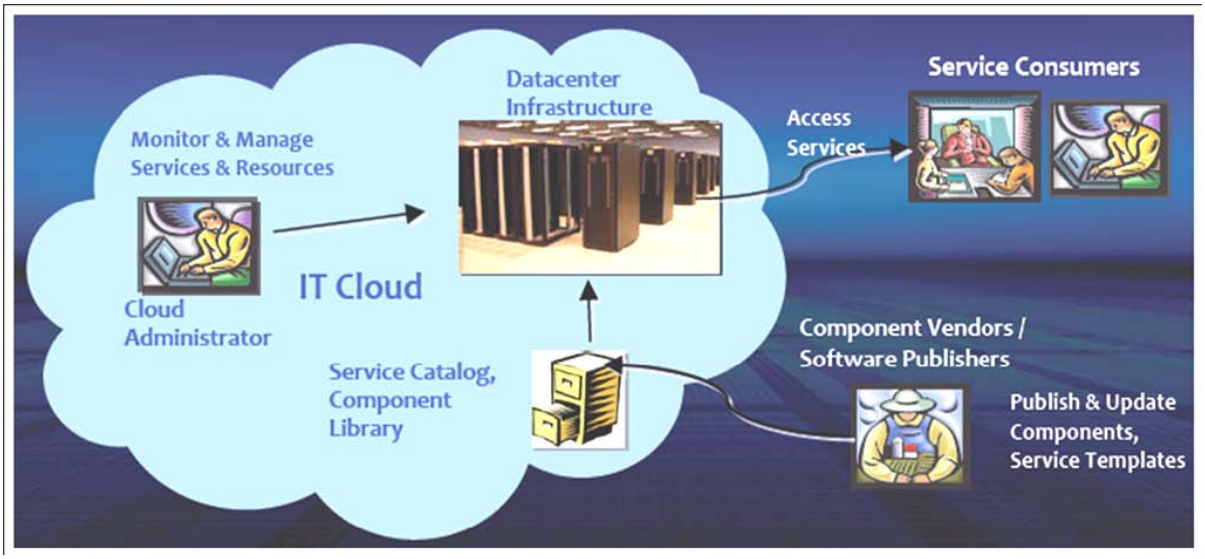

Fig. 4. Cloud Computing solution [9]

Adoption of a Cloud solution for university management involves analyses on university data and applications/functions/processes in order to determine the right cloud model (private, public, hybrid, community) and cloud services. Criteria for these analyses can be: mission critical, sensitivity, confidentiality, integrity, availability (for data evaluation) and mission critical, importance, availability (for functions/processes/applications evaluation). According to studies conducted in the recent years, most universities use hybrid cloud approaches, maintaining key infrastructure elements in house, under university strict control and only externalizing less sensitive components.

6 Conclusions

Cloud Computing offers convenient access to applications, independent of technology and geographical location. Users are free of tasks related to data storage on computers or mobile devices. They can access information fast and easy anywhere, through internet. With Cloud Computing applications, employees do not have to download or install specific software on their PC, freeing memory and reducing energy costs.

Adoption of Cloud Computing solutions in the management of service oriented organizations can be a sustainable answer to the current economic crisis. A small investment can have a positive feed-back that will ensure development and economic growth on business level. In other words, Cloud Computing can be viewed as a small modification of business input that leads to a significant modification of the output.

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