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**CLOUD COMPUTING -
A POTENTIAL PARADIGM CHANGE
IN INFORMATION MANAGEMENT**

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Abstract:

Since the paradigm shifts in the business landscape due to the uncertainty of economy, shortage of space, intensifying competition and a more demanding customer base, new priorities are arising for all organizations. Everything points to Cloud computing (CC) as the next game-changer in Information management.

This paper address the complex issues that could impede the efficiency of Cloud services adoption if not addressed in the early phases of cloud strategy development and design. The first paragraph critically analyzes the existing three service models.

Next, major Cloud computing benefits and issues are summarized, along with specific considerations regarding the financial aspects of the implementation. In the final paragraph, realities are examined, both from a customer and vendor perspective. It is underlined that in the governmental or military case, the most significant factor when choosing a CC service provider must be the availability and capability of it to respond to certain questions regarding legal/contractual protections for unexpected outages/loss of data.

Key words: cloud computing, cloud services, security analysis, information management.

“If you have five guys dedicated to running your e-mail system, is that really the best use of those five guys?”

1. Introduction

Cloud computing represents one of the major trends over the last decade. It represents a potential paradigm shift, that propose a rethink of the usage of standard classic computing equipments (networks, operating systems), having in mind the usual concerns regarding privacy aspects, information security and hardware/software/service reliability.

Cloud computing offers new possibilities for organizations and allows them to acquire new information age capabilities at a substantial reduced financial price. In present, there are an increasing number of organizations that realize and harness the “power of the Clod” through the usage of applications, computing solutions, storage space and networking power located outside of their network perimeter (Everything-as-a-Service - XaaS, where X virtually stands for... anything).

Cloud computing puts new demands in front of the CIOs - as Information Management leaders, because it require an abstract approach to the understanding of operational environment (Information Technology infrastructure and it’s management).

There are a lot of cloud computing providers differentiated mainly only by the reliability of services and prices offered. The main advantage for the customers is that instead of a physical device, cloud computing offers an abstraction of a server, file system,

storage, network, database, etc. that means each subscriber will receive a tailored environment. Moreover, congruent with the customers' needs, dynamic allocation of resources could be offered.

IT organizations like Google (through Gmail) and Facebook introduced people to the cloud long ago and because the services just worked, that was enough to the customers to embrace it without second thoughts and without paying too much attention to the new way the services were offered. Since then more big tech competitors appeared on the market (HP, Apple, Amazon and Microsoft), each launching marketing messages claiming they are more effective, reliable and secure than ever before.

2. Cloud Computing as a Game-Changer

With the line between private and business use of computers and networks blurring, organizations need to keep a close eye on their employee's activities on their IT infrastructure and ensure that their security is not at risk.

By itself cloud computing is simply a set of enabling technologies. The always-connected IT devices became ubiquitous and as a consequence mass adoption of the cloud based services, storage and applications seems to be imminent in order the users' expectations to be satisfied.

The main challenge is to design a cloud computing experience that is invisible and seamless for the average users and also for organizations. We should start by clarifying the meaning of acronyms and difference between all those different "-as-a-Service" terms: SaaS, PaaS and IaaS.

In the next paragraphs I'll briefly explain the meaning and the differences between Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) and Infrastructure-as-a-Service (IaaS).

a) Software-as-a-Service

Software-as-a-Service (SaaS) is a new term for an old thing, because it was around in one format or another for many years. Web mail is the best example of a SaaS, even if most people don't think of it as such.

In contrast to the approach when customers buy software as licenses and run it on their own computers, SaaS is a Web-based offering, where a company provides a service (e.g. web mail, accounting and payroll services, customer relationship management) in an on-demand manner.

The biggest advantage is that the development, maintenance, updates, backups and so on are the responsibility of the provider. But this is also a downside, because it means that if the provider fails to perform well, those problems will be outside of your control.

Here are some popular and most used examples of SaaS:

- Google Docs;
- 37 Signals (Basecamp, Highrise, Backpack and Campfire);
- Salesforce - a suite for customer relationship management (CRM);
- Drop box - a online storage suite;
- Box.net

The primary benefit of SaaS is the reduced cost for customers and vendors. The customers will pay less than for a full word processing, spreadsheet, or other end user suite by simply paying monthly rental fees to access the online service. Software vendors would simply maintain a central online copy of the product and do not have to invest in expensive customer services.

The main downside of using SaaS (and cloud computing) is that users must trust in the vendor's capability to operate the service without major disruptions. In case of a glitch, the customers will be held "hostages" because all of their files and databases are now in the vendor's hands. A related concern regarding using SaaS is the security and protection of the users' data and also its portability. The question is if you can get your data out of the vendor's solution and move it in another place?

In conclusion, when organizations switch to SaaS and cloud computing, the administration cost to use cloud computing software will be reduced, but there will be an increase in the risks concerning service disruption, continuous connectivity and online security.

b) Platform-as-a-Service

A classic organization has its own software applications installed on its own IT infrastructure. In this approach the IT department and the CIO must worry about how many servers to deploy, how to handle load balancing, failover, managing the operating system that the software is deployed on and installing security updates.

For organizations that want to operate without worrying about the entire underlying infrastructure, want to write their own software and but ignore the infrastructure layer, the PaaS is the way to go. Some PaaS solutions are development platforms for which the development tool is hosted in the cloud and accessed through a browser. With PaaS, developers can build web applications without installing any tools on their computer and then deploy those applications without any specialized systems administration skills.

One of the reasons to embrace PaaS is it gives organizations more flexibility in terms of moving away from the service.

c) Infrastructure-as-a-Service

The term Infrastructure-as-a-Service (IaaS) refer companies that provide infrastructure, such as Amazon Web Services (AWS), that provide utility computing service (and not just a platform or ready made software). The users can run instances of Windows, Linux and other operating systems on virtual machines located "in the cloud", provided as a service.

The advantages are multiple: organizations do not have to worry about investing and managing the hardware infrastructure and could increase their compute power without a lot of financial investment. Like in the previous "aaS", the primary disadvantage is the lack of control. You don't have direct control as in the case you possess your own network.

Here are some examples of IaaS:

- Amazon Web Services (AWS);
- Rackspace Cloud;
- Vcloud ecosystem from VMware and
- OpenStack.

d) Infrastructure-as-a- Platform

The latest terms that need to be explained is Infrastructure-as-a-Platform (IaaSP). This trend is yet in his infancy. Roughly speaking, the concept of IaaSP is providing cloud infrastructure that can be dynamically scaled the same way that applications can scale on PaaS.

3. Considerations about working in the Cloud

In my opinion, cloud computing is a great opportunity primarily for small and medium organizations to unburden the inconvenience and costs of IT management, but only as long as they can live with the disadvantages.

3.1. Cloud Computing Benefits

Here are the major Cloud computing benefits along with general considerations:

- Cloud services free businesses and individuals from having to invest in hardware or install software on their own equipments; they reduce maintenance and hardware upgrading needs; older computers can be used to access cloud services, because the solutions are all web-based;
- Cloud computing provides flexibility - individuals can work from any computing device and from any location as long as they have access to the Internet - using mainly mobile devices; it also makes collaboration easier (a distributed team can work on shared information stored centrally “in the cloud”); “*As more consumers and businesses adopt tools such as smart phones and tablets, the ability to host data in the cloud and access it from just about anywhere on the planet is quickly becoming vital*” [1];
- Cloud computing lets you start up / grow your small business quickly; it’s a lot faster to rent a cloud computing application than to buy a server and install software on it; because you don’t need to buy hardware and software, your start up or expansion is also cheaper.

The transition to Cloud computing also offer *financial advantages* [2]:

- You no longer have to pay an in-house IT team to install and update software, install and manage email servers, run backups; all of the business of maintaining the service / application is the responsibility of the cloud provider;
- You no longer have to buy software; using cloud applications instead can be cheaper, at least on a short term;
- You may consolidate your separate application needs into one multi-application cloud computing service (e.g Google Apps for Business includes email, a calendar scheduling application, Google Docs for creating documents, presentations and forms and using online file storage and Google Sites for creating websites);
- You save money using someone else’s servers to store the data, consequently freeing up your own computer equipments for other purposes;
- You don’t have to spend time (and money) to update computing applications; using cloud computer applications give you the advantage of having access to the latest features and functions of an application;

3.2. Cloud Computing Disadvantages

There are also some issues when adopting cloud computing, such as: availability, security, trust and reliability.

To get the better of a cloud service, a reliable and significant Internet connection is necessary (availability), mainly due to the fact that otherwise your data may not be accessible at all. But this is not enough - you may have Internet connection and still the cloud service itself experience disruptions. Some cloud applications (e.g. Gmail) have offline capabilities that sync your work to the cloud the minute the Internet connection become available again.

Another issue with cloud computing is security. Organizations and individuals working with sensitive, proprietary or simply private information may not be comfortable storing on someone else’s server on the Internet.

Before considering moving your business in the cloud, issues like trust and reliability should also be addressed, mainly through the usage of encryption technologies for privacy protection and solutions for offline accessibility.

In my opinion the top five *disadvantages of cloud computing* (along with their possible effects on organizations) are as follows:

1) Security issues

People have the tendency to confide more on the activities they could supervise and to trust people they work along them. Applying this principle to Cloud computing means that you will trust less on your vendor, because the service provided is in the cloud. Consequently, you should not use cloud computing applications that involve using or storing data that you are not comfortable having on the Internet.

Also, reliable cloud computing vendors must possess the latest data security systems to survive on the market, expand and make revenues. Some authors argue that for small organizations, switching to the cloud can actually improve security. *“Because large cloud computing companies have more resources, he says, they are often able to offer levels of security an average small business may not be able to afford implementing on its own servers”* [1].

2) Cost

At first sight, cloud computing appears to be a lot cheaper than a particular software solution run in-house. But some other considerations (beside common sense) should be taken into consideration, such as if the cloud application have all the features that the local installed software offer.

The total cost of cloud computing usage also needs to be analyzed. Many cloud computer providers pretend that they charge only for the time the applications are actually used, but in fact, in most cases a company must sign a predetermined contract independent of actual use [3]. Also the cost savings of cloud computing is a one time activity and primarily occur when an organization first starts using it. According to Gartner, for SaaS applications the total cost of ownership in the first two years is lower, because large capital investment for licenses or support infrastructure is not required.

3) Rigidity

When choosing a cloud computing provider we must be cautious not to become dependent on the use of proprietary applications or formats. Also find out if you can add or delete cloud computing users as necessary.

4) Downtime

Even the most reliable cloud computing service providers suffer server outages. So being dependent on the reliability of your Internet connection or Cloud computing provider may not be such a good idea for yourself or your business [4].

5) Deficit (or absence) of support

Some cloud based applications offer delayed or no customer support. These quotes should be relevant for this idea. *“The bottom line: If you need handholding or if you are not comfortable trying to find advice on user forums, the cloud probably is not ideal”* [5] and *“Customer service for Web apps leaves a lot to be desired -- All too many cloud-based apps make it difficult to get customer service promptly – or at all. Sending an email and hoping for a response within 48 hours is not an acceptable way for most of us to run a business”* [6].

The number one concern for small and medium organizations seem to be the security issues related to having their commercial data “out” on the Internet. At present, the greatest beneficiaries of cloud computing may be remote workers that use mobile devices such as smart phones.

4. Cloud computing - Realities

As a matter of fact, Cloud computing is not applicable for every organization in the same way. It became increasingly important for the CIOs to plan and set their own Cloud vision and strategy to facilitate operational excellence and cost efficiency.

Since the paradigm shifts in the business landscape (the uncertainty of economy, shortage of space and power, new emphasis on green technology, intensifying competition and a more demanding customer base) new priorities are arising for all organizations. Consequently, a large scale adoption of Cloud Computing is to be predicted for the near future. Everything points to cloud computing as the next game-changer in Information management.

The CIOs (IT directors) should be ready to cope with the consequences of Cloud Computing transformation. There are many considerations and complex issues that could impede the efficiency of cloud services adoption if not addressed in the early phases of cloud strategy development and design. It is crucial for any organization to have a clear understanding of the process and develop its own cloud roadmap adoption. Also an unclouded resolution of the following questions has to be attained:

1. Is Cloud computing for our organization?
2. Is our organization ready for Cloud Computing?
3. Which type of Cloud (private, public or hybrid) is suitable?
4. How can my organization adopt easily Cloud Computing?
5. What does it mean to the organization in due course?

The adoption of Cloud Computing will transform the way Information Management is conducted in present. The leading board of the organizations should think not only from a financial perspective, but also from broader perspective briefly described by the following key questions [7]:

- What would the impact be if the asset were to become public or widely distributed?
- How would you be harmed if an employee of the cloud provider accessed the asset?
- What if the process were altered or manipulated by an outsider?
- How would you be harmed if the process or function failed to provide the expected results?
- How would you be harmed if the information/data were to be unexpectedly changed?
- How would you be harmed if the asset were to be unexpectedly unavailable for a period of time?

Before moving to/from the cloud, a risk assessment, a data discovery and information inventory should also be conducted. Information suitable for the cloud must be identified, along with procedures for interaction with information in the cloud and plans for retrieval/destruction upon potential termination of cloud based service.

The Continuity of Operations (COA) should also not be neglected. There must be addressed at least the assessment of vendors plans for contingencies (back up/disaster recovery/continuity of operations), the reviewing of Service Level Agreements (to insure timely actions) and legal/contractual protections for unexpected outages/loss of data.

From a policy / legal point of view, the CIOs must review the operating policies for completeness/currency, substantiate whether the provider is available for audit, review the incident response plans, procedures and readiness and insure capability of vendor to respond to legal requests such as litigation holds or data searches.

In the governmental or military case, the most significant factor when choosing a service provider must be not only the price, but the availability and capability of it to respond to certain questions: 1) Does the contract adequately protect the buyer? 2) Are the results of internal and external audits available to customers at their request? 3) Are customers allowed to view the provider's third party audit reports? 4) Does the cloud provider conduct network penetration tests of its cloud service infrastructure on a periodic basis? 5) Does the provider document scenarios where data may move from one physical location to another? 6) Does the provider use encryption to protect data and virtual machine images during transport across and between networks? 7) Can the cloud provider logically segment and recover data for a specific customer in the case of a failure or data loss? 8) Does the provider encrypt user data at rest (on disk/storage) as well as in transit? 9) Does the provider have anti-malware programs installed on all systems that support the cloud service offerings?

In 2011, the Department of Defense CIO states that US military is not prepared for agency wide cloud computing and cautioned against jumping too quickly into cloud computing [8]. *"If we move to a cloud environment with today's technology, it would make the world worse, not better...from an enterprise perspective and from a security perspective. We're still at stage one. How do we make sure we're doing it in a way that's secure? We have to remember that cloud services have to fit into overall services"*.

A whole move to cloud computing requires a better organization and strategy, since the volumes of data spread throughout different places could prove difficult to find and access in a cloud environment. Nevertheless, in 2012, a Cloud Computing Strategy [9] was adopted aiming to enable the DoD to increase secure information sharing and collaboration, enhance mission effectiveness, and decrease costs using cloud services.

5. Conclusions

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

The model promotes availability and is composed of three service models (Cloud Software as a Service - SaaS; Cloud Platform as a Service - PaaS; Cloud Infrastructure as a Service - IaaS) and four deployment cloud models (Private, Community, Public and Hybrid).

The Cloud Computing model offers the promise of near-term cost savings, increased ability to quickly create and deploy enterprise applications, combined with increased Information Management agility. It is considered critical that most organizations begin the adoption of this technology in response to difficult economic constraints.

However, cloud computing technology challenges many traditional approaches as datacenters and enterprise application design and management. Cloud computing is currently being used on a large scale, but security, interoperability and portability issues are still major barriers to broader adoption. To shorten the adoption cycle, guidance should be provided regarding the cloud computing paradigm and strong leadership must be exercised, to catalyze its use within private and public organizations.

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