

Cloud Computing Adoption Journey within Organizations

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Abstract. Cloud computing is slated to create a paradigm shift in computing experience. Cost savings and control over employee access by the IT groups within corporate, government, and educational institutions are some of the major drivers for the adoption of cloud computing. However, there are limitations to the extent to which workflows are moved to the cloud. The major roadblocks to extending the adoption of some of the workflows to the cloud include concerns about control over the (critical) data, compliance across geographies, and security issues. The paper will explore cloud computing life cycle and concerns about cloud computing from interviews with IT decision makers.

Keywords: Cloud computing, security, networking, compliance, technology adoption, green technology.

1 Introduction

The adoption of cloud computing that has moved some of the activities and workflows from traditional computing have been termed a paradigm shift (Voas & Zhang, 2009). Cloud computing has been defined variously by different sources concentrating on specific sub-set of attributes. NIST has provided the most elaborate definition of cloud computing while acknowledging that is still an evolving paradigm. According to NIST, cloud computing is a model for enabling ubiquitous, 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. This cloud model promotes availability and is composed of five essential **characteristics**, three **service models**, and four **deployment models**. The five essential characteristics include on demand self-service, broad network access, resource pooling, rapid elasticity, and measured service. The service models include Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). The four deployment models include private cloud, community cloud, public cloud, and hybrid cloud. For practical purposes, the industry recognizes private, public, and hybrid clouds (Mell & Grance, 2011).

The private cloud is deployed for only one organization, the public cloud is open for use by multiple tenants, and a hybrid cloud encompasses both the private and the

public cloud allowing data transference through connectors (Baars & Spruit, 2012). A community cloud is shared by multiple organizations with shared goals and managed either jointly or by one of the stakeholders on behalf of all.

The journey to cloud computing is complicated by various factors including perceived cost savings, security concerns, compliance, issues of management, and control over the data. These concerns are exacerbated particularly when there is a potential legal challenge that leads to subpoena of data where questions of ownership of the data can swing between the owner of the cloud and the creator or lessee of the cloud.

2 Methodology

We overviewed the landscape of cloud computing domain broadly and how this domain was perceived by savvy consumers from a variety of organizations. We interviewed 8 decision makers from the industry and educational institutions to obtain their perspectives about cloud computing. These stakeholders were invited to provide their input and their insights are integrated within the findings from a synthesis of the cloud domain. All the participants had adopted cloud computing solutions within their organizations.

3 Factors in the Cloud Adoption Journey

3.1 Terminology and Absence of Standards

Cloud computing is the new holy grail – companies are aspiring to attach this terminology to their product offerings. Interestingly, there is a significant diversity in the understanding of the phrase cloud computing. It is however associated with modernity and being in step with the future. Most of the key vendors have embraced the term *Cloud* without defining it. Underscoring the complexity in defining cloud comprehensively, the NIST definition that is considered as being holistic, is fairly extensive covering all the attributes that constitute it, with multiple service and deployment models.

One of the biggest factors in discussing cloud computing has been the general lack of agreement on what it means. Woo (2010) noted that McKinsey & Co. reported at least twenty-two different definitions of cloud computing. Some of the participants that had implemented virtualization solutions that met some of the requirements of the NIST cloud definition, considered that they had implemented cloud solution. Some of the organizations that had implemented cloud solutions in-house did not always turn on their metering or chargeback feature. When the participants were interviewed and asked to define cloud computing, their responses ranged from e-commerce including auction sites as being cloud solutions and any application that ran on the Internet as being a cloud-based solution, to the ability of an IT Administrator being able to provision virtual machines remotely and scale their capacities with agility as representing cloud computing.

3.2 Messaging and Branding

Advertising messaging of various cloud vendors emphasize the word Cloud. Since crystallizing the concept of cloud universally was difficult, the vendors found it easier to embrace the term cloud without defining it. Various offerings in the Cloud domain of IaaS, PaaS, and SaaS, include Google AppEngine (SaaS), VMware's vCloud Suite (IaaS), SpringSource (PaaS), Amazon's Elastic Compute Cloud (IaaS), Microsoft's Azure Services Platform (PaaS), Force.com (PaaS), Microsoft's System Center



Fig. 1. Messaging and Positioning of various vendors aimed at heightening the Cloud Brand

Configuration Manager (IaaS), Salesforce.com (SaaS), SAP's HANA (PaaS), and Workday (SaaS) although most of the advertisement messaging tends to focus primarily on the overarching Cloud brand. This tends to provide a halo effect of the cloud brand to the vendor and simultaneously exacerbates end-users bemusement about the concept of Cloud.

There is however significant consistency in the major vendors seeking to be attached to the cloud computing brand. Interestingly, most of the advertisement messaging appears to be interchangeable with the key differentiator being the name of the vendor. After being targeted with a multitude of messaging about various cloud offerings, customers' confusion on what represents cloud is understandable.

The term cloud has such high positive value proposition, that organizations that have deployed cloud solutions advertise that they are powered by the cloud. These include financial institutions like NYSE, airlines such as Southwest, and even cosmetics firms such as Revlon.



Fig. 2. Customers attaching the brand value of Cloud to obtain positive value proposition

3.3 Culture and Organizational Structure

Organizations that adopted cloud computing early tend to be more innovative and open to adopting or experimenting with new solutions. These organizations tend to either have decentralized pockets of power where a mid-level manager encouraged innovation or a centralized power structure where a key c-staff member embraced innovative solutions.

Although in both scenarios, cloud computing was adopted early, the extent to which it was deployed within the organization tended to be limited when the locus of control was at a relatively lower level. Unless cloud computing obtained the active approval of a c-staff member such as the Chief Information Officer or other c-staff officer such as the Chief Finance Officer that had the Information Technology (IT) group under its purview, the extent of proliferation of cloud computing to various workflows within the organization tended to be limited.

When IT departments are viewed as business units instead of cost centers, there tends to be greater innovation and speed in the adoption journey. Demonstrating value

proposition to the business is central to the degree new technologies are adopted and proliferated within organizations.

When organizations are unable to keep pace with the requirements of the consumers' computing needs within organizations, some employees have proactively found solutions without obtaining requisite permissions. When they are unable to wait for the bureaucratic process to obtain the hardware to meet their needs, they have sometimes circumvented the chain of approval and obtained computing resources from cloud vendors such as Amazon's EC2. This poses challenges especially when they are working on sensitive projects that need to meet the requirements of various contingencies. While cloud computing allows organizations to be agile and meet computing requirements expeditiously, it also allows employees to take initiative and circumvent checks and balances of data management that present potential challenges to the organization.

The speed of adoption of cloud computing within organizations, particularly large enterprises and mid-size companies depended on the effectiveness of the evangelizer's ability to demonstrate value, and the culture of willingness to adapt quickly to changes.

	IT - Business Center	IT - Cost Center
Technical knowledge of key Decision Maker is relatively high	<ul style="list-style-type: none"> • Early Adoption • Rate of Adoption tends to be fast 	<ul style="list-style-type: none"> • Early Adoption • Rate of Adoption tends to be relatively less fast
Technical knowledge of key Decision Maker is relatively low	<ul style="list-style-type: none"> • Moderate or late Adoption • Rate of Adoption tends to be relatively slow 	<ul style="list-style-type: none"> • Late Adoption • Rate of Adoption tends to be very slow

Fig. 3. Model of Adoption of Cloud Computing

Management of Computing Expenses. The metering ability or the chargeback for the resources consumed by specific cost centers within an organization makes the management of the expenses more efficient. The IT department can divest itself of some of its responsibilities of a cost center and instead play the role of an active business unit or an active partner of business units. However, when business units are the cost centers paying for computing resources, there is sometimes a tendency to inflate their requests for computing resources. There appears to be a challenge to shift from the paradigm of purchase from non-cloud computing where resources are planned on a three-year timespan to the new cloud paradigm where resources can be deployed in an agile manner on a need-by basis. Consequently, there is an inefficient hoarding of storage and networking resources unless the IT department is empowered to keep track of usage and reclaim unused resources for redeployment. Clearly, efficient

utilization of cloud adoption requires restructuring and political reorganization as well as clear setting of expectations.

3.4 Value Propositions

Cost of Real Estate to House Servers. Typically, being able to demonstrate value propositions such as savings in cost (Linthicum, 2010), and effectiveness of cloud solutions in being able to deploy computing requirements resourcefully were key to its proliferation. Cloud computing allows consolidation and efficient deployment of resources, thereby reducing the amount of space required to house servers that can translate into significant cost savings especially when the data warehouses are located in areas where the cost of real estate is high. These considerations are less important when the servers are located in low rent areas.

Cooling Costs. With consolidation of computing resources, there is a significant amount of savings (Boroujerdi & Nazem, 2009) in the maintenance of servers' cooling costs. Although for IaaS cloud computing, the consolidation ratios can be high, some of the organizations opt for a more conservative approach. Even when there is a consolidation ratio of 10:1, the amount of savings in cooling is down to one-tenth. It meets the standards of green technology by leaving a small carbon footprint. This in turn has a positive impact on the overall brand of the organization that can be perceived as being environmentally responsible.

Cost of Hardware. While cost savings *after* the adoption of cloud computing are significant, the cost of the adoption itself can be a determining factor (Lin & Chen, 2012). When organizations have already purchased significant hardware, the incentive to adopt cloud computing that could potentially reduce their costs through consolidation does not apply, whereas the software cost to deploy IaaS cloud can be relatively significant at least in the short term. However, when the hardware is obsolete and the cost for the purchase of new hardware is significant as can be the case in some educational institutions and small medium businesses (SMB) that are not focused on IT, the cost of adoption of IaaS cloud makes business sense.

Administrative Cost. The cost of managing IT departments can be reduced with the adoption of cloud computing. These are significant especially for organizations that are resource constrained. By placing workloads on the public cloud or through clouds managed by Internet Service Vendors such as Terramark, Savvis, and Bluelock, the number of in-house IT Administrators can be reduced and they can be reassigned to work on products and support.

3.5 Challenges to Cloud Adoption

Loss of Control. Perceived loss of control over the data is a major concern for organizations' adoption of cloud computing and if they have already adopted it, to extend it to workflows that have critical data. This is particularly applicable to the public clouds. When data has been deleted, there is crisis of confidence if the data continues

to reside in a backup server for disaster recovery. These have long term implications for both privacy as well as the lifecycle of the data itself.

Data Ownership and Legal Ramifications. When there is a legal issue and subpoenas are given out, it is not clear if the creator of the data and subscriber of the public cloud storage owns it or the vendor of the public cloud is responsible. In the recent Petraeus scandal involving the CIA director's indiscretions, the federal government asked Google to turn over the email accounts. Although in this case arguably, the Gmail account was free, a similar situation could prevail even in the existence of a paid subscription. Organizations that are functioning in the areas of confidentiality may want to protect themselves against such actions where they have little control over the situation.

Compliance. There are several issues with regard to compliance that pose challenges to the journey to cloud particularly the public cloud. The lack of absolute knowledge of where the data resides can raise auditability issues (Baars & Spruit, 2012). In addition, the requirements of privacy of data are different in various geographies and information on the cloud can complicate compliance with national laws. For instance, data privacy requirements are considerably more stringent in European countries than they are in the USA. In addition, there are various compliance standards such as HIPAA for Healthcare industry and PCI for Financial industry that can pose significant challenges to extending these workloads to the public or hybrid clouds.

Security. Security is the single biggest concern in cloud adoption (Chen et al., 2010). Even when organizations deploy workloads into the clouds, at least initially they are more likely to port relatively less critical data. Breach of data by hackers and the ability of public cloud vendor's administrators' ability to view the data are cause for consternation. Although security solutions by McAfee, Trend Micro, VMware's vShield, Neticitadel, and other vendors are working on security offerings to address consumers' concerns, there are real and perceived threats that negatively impact cloud adoption. The implementation of security solutions that can abate consumers' concerns is critical to their journey in porting mission critical workloads on the cloud.

Management. Managing and monitoring resources on the cloud can be challenging (Lee, 2012) particularly when organizations have solutions from multiple vendors. Suboptimal or absence of interoperability of cloud offerings poses challenges to managing resources. This is especially critical for monitoring CPU, I/O, storage, and network loads to ensure the workflows are running optimally and to set alerts of possible issues in a timely manner to enable troubleshooting and prevent or minimize loss of efficiency. Although there are a few widely used Management solutions, this area is still at a relatively infancy stage.

Current vendors that provide Management Solutions include BMC's Cloud Lifecycle Management, CA's Application Performance Management Cloud Monitor, HP's Matrix Operating Environment, Redhat's ManageIQ, Oracle's Enterprise Manager, and IBM's Tivoli.

User Experience. Given the relative complexity of these solutions, the user experience of the product can have an adverse impact on cloud adoption. This is particularly true for IT staff from small and medium businesses as they are already under significant pressure to manage the IT requirements within their organizations. The extra time required to educate themselves on cloud computing may not be available. A sub-optimal user experience when they explore cloud computing may lead to their re-commitment to the existing physical infrastructure.

3.6 Path to Cloud Computing

The journey to cloud computing from existing traditional infrastructure could either originate from public cloud to private cloud to a hybrid cloud or the reverse. When individuals within organizations take the initiative to obtain computing resources either with or without the permission of their management for a temporary period of time to fulfill their needs, their journey to the cloud can end there. When the decision to adopt the journey to the cloud is taken at an organizational level with a well-staffed IT department, there is a tendency to take a conservative approach. These organizations are likely to start their journey to the cloud with a private cloud in a sandbox environment and then extend their journey more extensively. Subsequently they may adopt the public cloud and hybrid cloud.

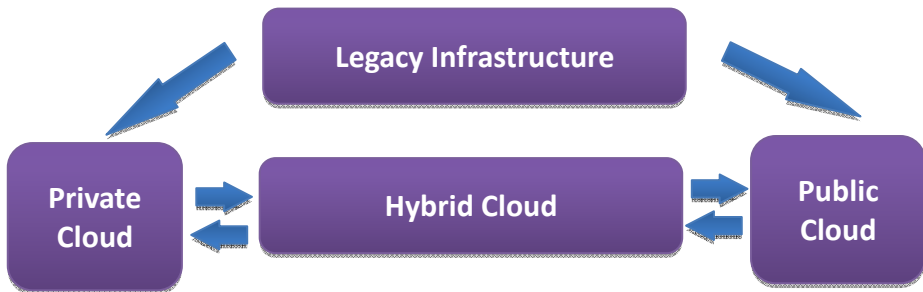


Fig. 4. Journey to the Cloud

For organizations with outdated hardware and skeletal IT staff, the first step to cloud computing could start with the public cloud. They may potentially add a private cloud when their resources allow such a deployment.

Typically, during early adoption phases, organizations tend to migrate non mission-critical workflows initially and progressively tend to migrate more important workflows on the cloud. However, even organizations that are mature in the lifecycle of cloud computing tend to keep some of their workflows in a non-virtualized environment. These include legacy applications, applications that require multiple authentications, and large workloads that do not accrue cost benefits by placing them on the cloud.

4 Conclusion and Future Directions

With the advantages of cost savings, scalability of deployment, and low carbon footprint afforded by cloud computing, it would seem that the journey to the cloud should be obvious. However, the various challenges such as security concerns, management of the computing resources both cloud-based and physical infrastructure, and compliance requirements prove to be roadblocks to the extensive adoption of cloud. Compliance and legal hindrances may be more difficult to overcome. In the areas of security and management of the cloud, innovations through research and development can potentially address significant issues of current and future cloud adopters. For instance, creating a Management solution that can effectively monitor both cloud computing and non-virtualized computing resources with a great user experience would accelerate the journey farther into the cloud.

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