Cloud Computing and its Security in Higher Education

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Abstract

Interest in cloud computing has witnessed a significant surge in the past few years. The basic tenet of this concept entails the reduction of in-house data centers and the delegation of a portion or all of the Information Technology infrastructure capability to a third party. This holds the promise of driving down cost while fostering innovation and promoting agility. Three typical kinds of *cloud services* are: *Processing Clouds* that provide scalable and mostly affordable computing resources that run enterprise programs, *Storage Clouds* that offer an alternative to local file systems, and *Application Clouds* that allow a thin client to interact with services that are completely hosted on an external infrastructure. Institutions of higher education, such as universities and colleges, are the core of innovation through their advanced research and development. Unfortunately, some of the limitations that confront such institutions are not the lack of ideas but rather repeated budget cuts, limited on-campus computing resources, lack of a unified storage media, and application silos that are scattered around campus computers. Subsequently, universities may benefit greatly by harnessing the power of cloud computing, including cost cutting as well as all the above types of cloud services. However, before full adoption, universities must consider key issues, which include, among others, migration tradeoffs and security. This paper explores the application of cloud computing in higher education and touches upon some of its aspired benefits as well as its expected limitations.

Keywords: Cloud Computing, Higher Education, Security, Software as a Service (SaaS), Computing Resources.

1. INTRODUCTION

Cloud computing is a recent concept that is still evolving across the information technology industry and academia. Several definitions have evolved so far, including one by the National Institute of Standards and Technology (NIST), which defines cloud computing as "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" (Mell & Grance, 2009). Multiple research endeavors have been initiated to assess the aspired benefits that could be obtained by implementing cloud computing.

This paper addresses various aspects of computing requirements in general, and as applied to university settings in specific, and will attempt to tie these aspects to typical decision criteria to move to cloud computing, such as cost and security. The paper concludes with a set of recommendations and plans for future work.

2. THE CASE FOR CLOUD COMPUTING

Despite the fact that cloud computing is a relatively young concept with many questions still open, there is overwhelming consensus regarding the potential of this paradigm in advancing technology and providing new avenues for enterprises to explore that may cut cost and adopt better IT capabilities. Furthermore, new advanced network technologies make the move to cloud computing a logical choice (NIST, 2009).

From a financial perspective, purchasing, installing, and maintaining extensive hardware for high-powered servers contribute to some of the higher budgets that universities are currently forced to allocate. This is paired with the soaring cost of licensing for the plethora of software packages that are scattered across campuses. In contrast, adoption of a cloud environment relieves the institution of the need to acquire an actual costly server in order to conduct research. Researchers are provided with the ability to leverage the "rent-by-the-hour" or "pay-as-you-go" concept to rent computing and storage horsepower such as Amazon's Elastic Cloud Computing (EC2), which claims to provide "resizable compute capacity in the cloud" (Amazon, 2009). The elasticity in a cloud service like EC2 provides a researcher with the advantage to rent exactly the capacity that they need with the ability to adjust it on a need basis, which is typically challenging and costly in case of in-house servers. The Electrical Engineering and Computer Sciences Department at the University of California at Berkeley had a first-hand dealing with this matter. They indicated that their lab "has benefited substantially from the ability to complete research by conference deadlines and adjust resources over the semester to accommodate course deadlines." As adopters of cloud computing, they "were relieved of dealing with the twin dangers of over-provisioning and under-provisioning our internal datacenters." (Armbrust et al., 2009).

Adoption of cloud computing permits significant savings in the area of supportive technologies, such as the massive air conditioning that is typically installed in university in-house server rooms in order to maintain a required level of temperature. Furthermore, there are additional savings that could be achieved in terms of physical security requirements for such rooms, like fortified safes and advanced door locks.

Complexity can be reduced with cloud computing. The varieties of disciplines that are inherent within a university learning environment impose the need for a variety of hardware and software platforms that are installed on campus. This contributes to the increase in the complexity of such platforms and adds to the already challenging tasks of IT administrators, including those that manage network and software. This can be even more detrimental with the budget cuts that affect the allocation of sufficient IT staff, thus overwhelming these administrators even further. The adoption of cloud computing is hoped to relieve these administrators from such burden. However, adoption has to be planned carefully as different applications make different usage of resources. For instance, a research

endeavor that requires an extensive number crunching capability is more CPU-bound than a liberal arts application that requires the transmission of large amounts of multimedia data over the network and therefore requires large network bandwidth.

Availability is a key matter in cloud computing since typical cloud service providers have established their services and associated resources in multiple data centers that are mostly located in different geographical locations. This builds location independence and supports the normally challenging tasks of disaster recovery and business continuity.

Overall, any of the three flavors of cloud computing, namely processing clouds, storage clouds, and application clouds, offer benefits to institutions of higher education. However, there are also concerns that may arise, sometimes even overshadowing these benefits, which is the subject of the following sections.

3.CONCERNS OVER ADOPTION

There are several obstacles that cloud computing faces before it can be widely adopted. A research conducted by the IDC Enterprise Panel (NIST, 2009) in August 2008 concluded that the primary concerns, shown in Figure 1, which IT personnel at various levels expressed are:

1. Security: there are several concerns surrounding the implementation of security in cloud computing. The reader is referred to the following section, which is dedicated to the subject of security, especially in a university setting.
2. Performance and Availability: experiments that are required for research endeavors require extensive computing power. Some of the concerns include how to guarantee such performance from an outside vendor. Availability of services is another related concern in terms of the possibility of massive vendor outages. This is especially true since it may impact student learning or the timely delivery of research results, which are typically tied to strict timelines.
3. Integration with In-House IT and Customizability: University IT administrators typically use their own in-house applications with a considerable portion that is customized to their own IT lab structure. A paramount concern is the transitioning of such in-house applications to the cloud environment and how much of the customizability will be lost in that process.
4. Cost is another factor that may be introduced by additional vendor relationship management or possibly additional measures that are unique to cloud computing.
5.

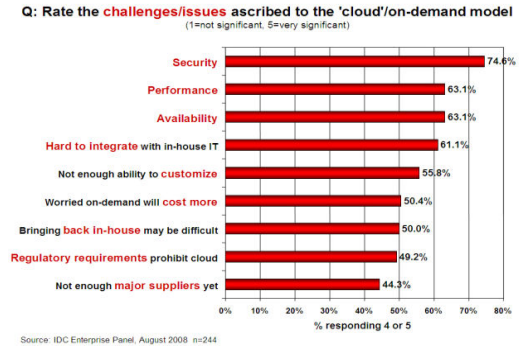

Figure 1. Challenges anticipated from adoption of cloud computing (NIST, 2009).

4.SECURITY

A primary concern that cloud computing adopters have is the security of enterprise information. Data placed in storage clouds, can potentially be located in, and sent across the communication channels of a totally different country, with potentially different data privacy laws, and therefore expose potentially sensitive data to the prying eyes of unauthorized individuals. However, in a sense, this is not much different than the current outsourcing endeavors that tend to make such information available to various users and administrators in an offshore location, such as in the case of call centers that are located in various countries. In fact, Creeger (2009) indicates that the majority of intellectual property breaches typically result from internal attacks and therefore do not impact the decision whether or not to adopt cloud computing. On the other hand, in a higher education setting, this can become more challenging especially with research projects that address issues of national security or hospital patients' confidentiality.

This requires enough trust to be placed into the vendors, along with strict Service Level Agreements (SLAs), in order to safeguard such information and prevent intrusion and data theft.

Integration of cloud security controls with university-wide departments and their various applications is another important challenge.. One concern is how seamless this integration can be and how effective it will be in maintaining the same level of information assurance of such applications, including their confidentiality, integrity, and availability.

Application problem resolution and auditing are part of yet another challenge to the adoption of cloud computing. The main question is how available the application and system logs will be to campus IT administrators and support staff, who usually create their own in-house scripts in order to scrape such logs and resolve these problems.

Compliance with existing laws, such as the Health Insurance Portability and Accountability Act (HIPAA), Sarbanes-Oxley (SOX), and Federal Information Security Management Act (FISMA) present several problems. The main question that arises in this respect is how the cloud vendor would ensure the implementation of all the provisions that stem from such government laws, such as the accreditation and certification of their information systems that is a requirement of FISMA and whether the consumer of such cloud services is held responsible for such implementation. Another related concern, which pertains to an earlier point about information security, is how to apply specific law requirements for data preservation and protection, such as the HIPAA requirements for Electronic Medical Records (EMRs) data in case of a university hospital research project.

Finally, a major concern to universities is moving their data to an external provider. While such sites are likely equipped with state of the art disaster recovery and business continuity capabilities, they may become an attractive target for attackers since they would potentially host the data for multiple institutions rather than the isolated nature of research labs that are typically found in universities.

5. CONCLUSION

Cloud computing paradigm is still relatively young in terms of maturity and adoption. The expectation is that it will undergo several changes in the future, in terms of resources, issues, risks, and ultimately best practices and standards. However, there are some sought advantages that it can potentially provide value for institutions of higher education. On-demand services can resonate positively with the current university tight budgets across the nation and other parts of the world.

Several benefits of the transition to cloud computing were pointed out in this paper along with concerns regarding the general implementation. The key question remains whether or not it makes sense from a business and strategic point of view to move to cloud computing and the answer is that it depends on various factors that were mentioned above.

One main conclusion that we draw from this research is that cloud computing may have considerable potential in improving the IT application and infrastructure at higher education institutions. However, since this field is still relatively young, it is strongly recommended that early adopters plan the transition carefully and keep in close contact with organizations that establish industry standards, such as NIST, in order to ensure a uniform and smooth transition. Another outcome is that it may be practical to follow a hybrid approach whereby, depending on the evaluation of the factors outlined above, university IT management and administration may decide to pursue a hybrid approach thus transitioning some application and data to cloud computing while leaving others to be served in-house. This should be based on a cost-benefit analysis study that follows an approach, which evaluates the real business needs. Adopters should also explore the possibility of pursuing a phased approach that is commensurate with the university's strategic direction and in concert with various departments of the university.

One final recommendation, especially for public universities that receive government funding, is to explore a nation-wide cloud computing offering for higher education institutions that is federally funded. This would ensure that adequate funding is furnished for further research that addresses the concerns raised earlier while encouraging the collaboration across various universities along with official institutions such as NIST and the establishment of standards that would lead to the maturity of cloud computing and its proper adoptions across the industry and academia.

The information assurance program at the School of Technology Studies at Eastern Michigan University plans to perform further qualitative as well as quantitative research in the future in order to evaluate the impact of transitioning to cloud computing.

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