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A Study of Mapping Educational Institute with Cloud Computing

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ABSTRACT

Our lives have considerably transformed with the use of technology, the way we interact, communicate, learn and work. Most of the business is carried out through internet now and one seems to be handicapped today without technology. Similarly, education system also is benefited by use of technology, the way information is disseminated and knowledge is shared between students, researchers and faculty. Faculty-student interaction is not limited to class room only. Students demand transparency and efficiency in their academic processes particularly their admission and examination related. Universities transforms its traditional manual processes through e-based systems. All these are processed using compute power and universities need to have a reliable information system in place which not only is available round the clock but also has high reliability and accessibility. Such a system which is robust, scalable to meet the growing data and traffic especially during peak loads. Keeping the services up round the clock, throughout the year with high reliability and efficiency is a challenging task and is now achieved with the advent of technologies such as "Cloud Computing". Cloud computing is a new way of accepting and providing services over internet. To achieve an optimal or sub optimal allocation for immediate cloud services, the cloud environment with security is the best option. The use of cloud has to be done in a remarkable potential to provide cost effective, secure, high reliable, easy to manage, elastic and powerful resources on fly, over the internet.

Keywords: Cloud Computing; Cloud Services; Hybrid Computing; educational cloud; Universities; Mapped Computing.

I. INTRODUCTION

In academia, cloud computing is a powerful tool that offers great scalability and flexibility, making it possible for students, staff, faculties, administrators, and other campus users access file storage, databases, and other university applications anywhere anytime (Jain and Pandey,2013). The cloud computing technology has been termed as the "silver bullet" in the field of educational technology (Mell & Grance,2010).
Cloud based e-governance represents an emerging paradigm for distributed computing of e-governance applications that utilizes services as fundamental elements in building agile networks of collaborating applications distributed within and across government boundaries (Smitha et al., 2012). e-Governance with cloud computing offers integration management with automated problem resolution, manages security end-to-end, and helps budget based on actual usage of data. At a global level, cloud architectures can benefit government to reduce duplicate efforts and increase utilization of resources. This helps the government going green, reducing pollution and effective waste management. It offers integration management with automated problem resolution, manages security end-to-end, and helps expenditure control based on actual usage of data. At a global level, cloud architectures can benefit government to reduce duplicate efforts and increase utilization of resources. This helps the government going green, reducing pollution and effective waste management.

II. CLOUD COMPUTING

Cloud Computing is considered to be the fifth generation of computing next that helps the users to share the resources through communication mediums after mainframe computing, personal computing, client-server computing and the web. According to a widely accepted definition of the US National Institute

for Standards and Technology (NIST), cloud computing is a model for providing ubiquitous, adequate and on-demand network access to a shared pool of configurable computing resources (e.g. servers, networks, storage, applications and services) with minimal effort and service provider interaction (Mell and Grance, 2011). The European Community for Software and Software Services (ECSS) defines cloud computing as the delivery of computational resources from a location other than your current one [7]. In simple words cloud computing can be defined as a distributed computing environment that enables the users to access and exchange their resources (applications and data) remotely and provides services to use the remote hardware and software within a network without the knowledge of technological infrastructure.

University of California Berkeley, Armbrust et. al (2009) summarized characteristics of cloud computing

i) illusion of infinite computing resources
ii) the elimination of an up-front commitment by cloud users; and
iii) the ability to pay for use as needed.

Vaquero et. al (2009), have stated and defined cloud computing 'clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and services)'. These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure

III. CLOUD ARCHITECTURE

The cloud providers actually have the physical data centers to provide virtualized services to consumers through Internet or through Virtual Private Network (VPN). The cloud providers often provide separation between application and data. The figure 1 below depicts the cloud scenario. The underlying physical machines are generally organized in grids and they are usually geographically distributed. Virtualization plays an important role in the cloud scenario. The data center hosts provide the physical hardware on which virtual ma-chines resides. User potentially can use any OS supported by the virtual machines used.

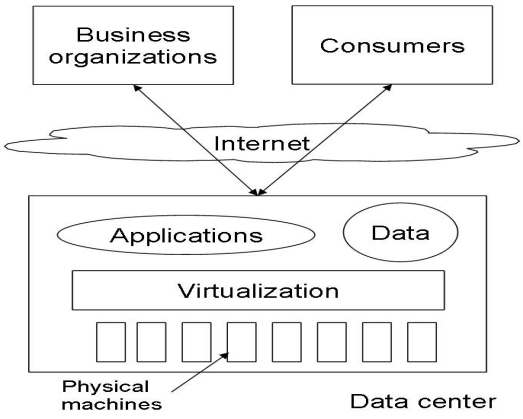

Figure 1: Cloud Computing basic architecture

The building blocks of cloud computing are hardware and software architectures that enable infrastructure scaling and virtualization. The new paradigms aimed is providing a huge amount of computing power in a completely virtualized manner, by combining all computing resources and services in a single system. The cloud computing environment with the virtualization concept fulfils these requirements. National Institute of Standards and Technology (NIST), identified the following characteristics that every cloud service must have:

- It must be an *on-demand self-service* in which a customer can self-provision compute, storage, etc., without human interaction.
- It must contain *broad network access* with reachability and platform options (including thin and thick clients, phones, tablets).
- It must be a *multi-tenant (pooled resources)* environment fostering location-independence.
- It must support *rapid elasticity* with the ability to grow and shrink based on policy, with no impact to applications or users.
- It must be a *measured service*, metered by performance with a pay-as-you-go pricing model.

IV. LITERATURE REVIEW

In this paper, we do a literature review to understand the cloud computing models for educational institutes and try to find out the prototype which can yield higher reliability and efficiency with privacy and cost efficiency.

Traditional computing to cloud computing is the continuous improvement process till attaining

objectives. In 2010, Rastogi investigated problems with the present architecture of e-government, proposed a model based framework to implement cloud computing in e-governance. His model was based on the prototyping model of the software engineering and comprised of four steps, learning, organizational assessment, cloud prototype, cloud assessment and cloud rollout strategy.

Mukherjee and Sahoo, in 2010 proposed a framework for e-governance based on cloud computing, consisting of grids of commodity servers and a software layer (Hadoop) & role of each component was specified later by Naseem (2012), proposed a framework of e-governance based on cloud computing by putting forward the different components of Haloop and then specified the role of each components of Haloop. Haloop is at the top which is being accessed by thin clients or commodity hardware. Further, commodity hardware consists of active commodity hardware and idle commodity hardware. The idle commodity hardware plays the role of volunteer node. An intelligent layer that helps the Haloop to behave as an expert system on a specific domain is also initiated.

Khmelevsky and Voytenko (2010), evaluated the successful implementations of cloud computing models at educational institutions and developed a research and education prototype of a cloud computing model. They demonstrated a real-life prototype of cloud computing infrastructure which was developed for effective sharing and utilization of computing resources available with King's University College and Okanagan College, Kelowna, Canada.

Sultan (2010), provided adequate answers to those questioning the feasibility of implementing cloud computing by discussing how the main users of IT services in a typical university can be migrated to the use of cloud computing environment. He noted that students, lecturers, administrators can use SaaS and IaaS, while developers can use PaaS. Furthermore, he also dealt with the economics behind the existing IT support and highlighted about the flexibility and cost reduction that can be obtained by migrating to cloud computing. He demonstrated the same using the case of University of Westminster, UK.

Alabbadi (2011), proposed a conceptual framework called "Education and Learning as a Service" (ELaaS) to highlight the utility of Cloud computing within education sector. The IT activities in the educational and learning organizations were classified with respect to the two criteria: mission criticality and sensitivity. Both criteria are categorized as Low and High and each class is then mapped into the appropriate position in the proposed Complete Cloud Computing Formations (C^3F) resulting in a conceptual framework for ELaaS. ELaaS is a hybrid approach, including cloud and non cloud based solutions.

Manro *et al.* (2011), attempted to answer whether the services of cloud computing are significant in the education sector – especially in the Indian scenario and concluded both the private and public educational institute can adopt the same. They noted that the educational institutes thus can outsource non-core services (i.e. the IT services) and better concentrate on offering students, teachers, faculty and staff the essential tools to help them succeed.

Tan and Kim (2011), demonstrated how "Google Docs", an application that is enabled by cloud computing technology is utilized by the group of students pursuing a higher degree on Master of Business Administration (MBA) in a University at North Eastern US for carrying out their project needs. They found that it was really helpful for the students, who expressed they would be willing to these technologies quite often in the future too.

A government private cloud for critical and sensitive government information and for general services, where government has less control over how the services are provided, and public cloud model was proposed by Khan et al., (2011), On the demand side, they suggested that the Universal Service Fund can be utilized to exploit the potential advantages of cloud computing for addressing the digital divide problem within the country.

Weiwei, James et al (2011), in his research paper 'a threshold-based dynamic resource allocation' did a study of the resource allocation at the application

level, and proposed a threshold-based dynamic resource allocation scheme for cloud computing applications based on their load changes as per the application's actual needs. The scheme can dynamically reconfigure the virtual resources for cloud applications according to the load changes in cloud applications, so it can save resources and increase resource utilization. The proposed threshold-based dynamic resource allocation scheme is implemented by using CloudSim, and experimental results show the proposed scheme can improve resource utilization and reduce the user usage cost.

Dubey, proposed a cloud adoption strategy for the migration to cloud by higher education. He stressed that the success strategy depends upon the existence of a service-oriented architecture at the level of the institution that offers the necessary infrastructure for cloud implementation and suggested the five stages for migration to cloud : developing the knowledge base about cloud computing, Evaluating the present stage of the University, Experimenting the cloud computing solutions, Choosing the cloud computing solution and Implementing and management of the cloud computing solution. The main aim of the study was to identify the particularities of using cloud computing within higher education. The analysis of the data and the main activities that exist within a University was the starting point for.

Saidhbi (2012), in the research Cloud Computing Framework for Ethiopian Higher Education Institutions proposed the implementation of a central hybrid cloud computing infrastructure that combines both the current local infrastructure of the Universities as the private cloud and public cloud to enable the sharing of educational resources and collaboration within all universities in Ethiopia and the global educational community, so that Ethiopian higher institutions can enjoy the benefits of ICT in an efficient and affordable way. The research further states that by deploying the proposed hybrid cloud model, the risks of privacy and other security challenges can be avoided as critical and sensitive data will be housed in a private cloud.

Bansal, Sawtantar and Amit (2012), in their research paper ‘use of cloud computing in academic institutions’ discussed different views and solutions in the area of cloud computing infrastructure for academic institutions. They proposed a prototype for adoption of cloud computing in academic institutions. They prototype is designed and evaluated for successful implementation of cloud computing model. designed and evaluated The main goals of this prototype are : to share existing resources within and amongst other academic institutions.

Hashizume, Rosado et al (2013), analyzed security issues for cloud computing in their research paper. They presented security issues for cloud models : IaaS, Paas, IaaS, which vary depending on the model and described storage, virtualization, and networks as the biggest security concerns in Cloud Computing. One of the major security concerns being as Virtualization allows multiple users to share a physical server and that there are different types of virtualization technologies, and each type may approach security mechanisms in different ways.

Mansuri, Verma and Laxkar (2014), the authors in their research paper highlighted the benefit of cloud computing in educational organizational and online advantages provided by cloud. While giving insight about the benefits, they stated that the students and administrative personnel have the opportunity to quickly and economically access various application platforms and resources through the web pages on demand and that there is a great advantage for university IT staff to take away the responsibility of the maintenance burden in the University. Application of storage technology can significantly reduce the amount of cloud storage servers, thereby reducing system development costs and there is no need to employ highly technical personnel to maintain the IT infrastructure.

Pardeshi (2014 architecture and adoption model for cloud in HE), proposed a cloud based IT architecture consisting of various deployment & service models, the IaaS as a foundation layer, with PaaS build upon IaaS, and followed by SaaS build upon PaaS for implementing cloud in the Higher Education(HE) institute. A five-step framework based on Roger’s Innovation-Diffusion model has been suggested for adopting cloud in higher educational institutes. The model consists of five step knowledge, persuasion, decision, implementation and confirmation.

Lenk A., Tai S. (2014), Cloud Standby : presented a cloud standby and a warm standby approach for setting

up and updating a standby system in the cloud. . They describe the architecture of Cloud Standby and its methods for deploying and updating the standby system and show that by using Cloud Standby the recovery time and long-term costs of disaster recovery can be significantly reduced. Cloud standby method consists of several different components and methods : Primary System-PS, Standby System-RS, Cloud-C1 & C2, Data Backup, Deployment and Disaster Recovery.

Ramachandran *et al.* (2014), in their case study on 'selecting a suitable cloud computing technology deployment for an academic institute' used Multi-Criteria Decision Making(MCDM) model –namely, the Analytic Hierarchy Process(AHP) for the decision making process found that private cloud is the best suited for the case institute (Indian Institute of Management Kozhikode-IIMK, Kozhikode, India) as it would provide adequate cost savings, apart from providing necessary security to maintain confidentiality on student details, grades, etc. They concluded in their study that although applications of cloud computing technology are picking up in education sector across the world, it is no so prevalent in the developing countries such as India.

Okai *et al.* (2014), proposed a road map for successful adoption of cloud computing for a safer and more enjoyable user experience at the university level. The road map consists of Planning, choosing the right deployment model, choosing the most suitable service delivery model, vendor selection, negotiating SLA, migration and integration for analyzing cloud computing adoption model at for universities.

Mohammed and Ibrahim (2015), while reviewing the literature on the proposed models of cloud computing for adoption in e-government systems, found 42% are component based models, 29% are layered based model, 17% are step based model and only 12% are conceptual / theoretical model. It revealed that there is a lack of theoretical models that empirically investigate the influencing factors on applying cloud computing in the e-government context.

Kashish and Alam (2016), proposed a cloud architecture which ensures privacy to cloud users and provides a low cost and secure cloud environment. The proposed architecture mainly consists of five modules : Privacy and security management module, Resource allocation and load balancing module, schedule module, cost estimation and negotiation module, and data storage and management module. The privacy and security management module is responsible for ensuring user privacy and security of cloud users, their data and their transactions and also determines the most appropriate policies that need to be enforces. Each module has a well assigned role. Resource allocation and load balancing module is responsible for allocation of resources to the cloud users, monitoring nodes that have potential to handle varied clients and also for load balancing and distribution of load at different nodes. The scheduling module consist of job scheduling managers that are in charge of maintaining pools of jobs, portioning of jobs amongst the different nodes etc. The cost estimation module is responsible for calculating the costs associated with the usage of resources depending upon the amount being used, the priorities and privileges associated with a particular user in a transparent manner such as execution speed and high priorities. The data management module is responsible for management and storage of data at the data centres. Each module has to be interoperable with each other lead to a dynamic, secure and more manageable cloud environment.

Mohammed *et al.*(2016), proposed a theoretical model to explore and measure the factors influencing cloud computing adoption as a part of developing countries' alternatives to implement e-government services. By considering theoretical constructs' literature, cloud computing characteristics and e-government context, they developed an instrument to measure IT experts' perspective of the fit and viability of cloud computing for e-government services. Their result show that the scale measurements meet the conventional criteria reliability and validity.

After going through the literature, the following inferences can be made:

I. It was found that applications of cloud computing are made for educational sector deployments, supporting e-learning facilities for facilitating students pursuing studies through interactive learning or internet-based learning methods. Resource sharing have been deployed for sharing across different institutions (Khmelevsky and Voytenko, 2010). SaaS and IaaS cloud models have been

suggested for students, lecturers, administrators, while PaaS for developers (Sultan, 2010), thus suggesting a hybrid model for educational requirements.

II. Outsourcing of non-core services (i.e. the IT services) and concentrating on offering students, teachers, faculty and staff the essential tools to help them succeed has been emphasized (Manro et al.,2011). Demonstration on how "Google Docs", an application that is enabled by cloud computing technology is utilized by the group of students pursuing a higher degree on Master of Business Administration (MBA) in a University at North Eastern US for carrying out their project needs was found really helpful for the students (Tan and Kim,2011).

III. Alabbadi (2011), proposed a conceptual framework called ELaaS for adopting cloud computing in Education and Learning organization. The framework is equipped with two principles (outward and inward) based on mission criticality and sensitivity. Accordingly, the author has categorized IT activities / services in the educational and learning organizations as low and high for simplicity and decision making. The universities can therefore identify sensitive and mission critical IT activities as low and high and accordingly move low sensitive and low mission critical services to cloud and keep continuing with high sensitive and high mission critical services on-premises. In order to implement such framework (ELaaS), need for applied prototype is felt.

IV. Saidhbi (2012), proposed the deployment of hybrid cloud model in higher education so that the risks of privacy and other security challenges can be avoided, as critical and sensitive data will be housed in a private cloud.

V. There is dearth of conceptual model/s for applying cloud computing in the education sector for their systems.

V. CONCLUSION

From the above study and discussion, it can be understood that all the academic institutions primary concern is to prevent privacy leakage and maintain the integrity of educational data especially confidential information such as student's details, grades etc. Identifying and analyzing the sensitive and mission critical IT activities carried out at the institution is essential, migration to cloud should be gradual and not all at once.

The models proposed so far are hypothetical lacking implementation. Organizations including academic institutions / universities have no concrete model for mapping on-premise deployments with cloud. There is a need to have a mapped prototype and algorithm for academic / university system, ensuring privacy of sensitive data, performance, apart from financially viable solution.

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