

Cloud Computing for Higher Education

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Abstract: Advances in technology offer new opportunities in enhancing teaching and learning. Many advances in learning technologies are taking place throughout the world. The new technologies enable individuals to personalise the environment in which they work or learn, utilising a range of tools to meet their interests and needs. Cloud Computing increases the flexibility and access of educational users to a wide range of educational resources. This includes access to infrastructure, software, hardware, and platform at any time in any place provided there is internet access. The users of cloud computing in higher educational institutions include students, lecturers, administrative staff, faculty staff, developers, programmers and researchers. Due to the prevailing financial crisis and the growing needs, higher education (HE) institutes are facing challenges in providing necessary IT support for educational, research and development activities. Cloud Computing (CC) environment can rescue HE institutes from the above mentioned challenges. The HE institute must exploit the opportunities afforded by CC while minimizing the associated security risks to allow access to advanced IT infrastructure, data centers, and applications and protect sensitive information. In this paper, CC architecture for HE institute containing the various deployment models, Service Models and user domain is proposed. For smoothing the migration from traditional system to CC based system a five phase strategy is presented. We finally provide the recommendations for a successful and efficient migration from traditional to cloud based system.

Keywords: Cloud Computing, Cloud Architecture, IaaS, PaaS, SaaS

I. INTRODUCTION

Although the concept of “cloud computing” has been around for over a decade, the terminology is only lately gaining popular traction. Technical aspects of cloud computing is certainly out of the scope of this paper. However, it is essential to provide certain salient features that are relevant to academics. The concept of “computing in the cloud” is about the delivery of IT services that run in a web browser; the type of services range from adaptations of familiar tools such as email and personal finance to new offerings such as virtual worlds and social networks. Storage of digital data is an important service among these [1][2].

Cloud computing is a computing platform that resides in a service provider’s large data centre and is able to dynamically provide servers the ability to address a wide range of needs of clients. The *cloud* is a metaphor for the internet. Some people call it the World Wide Computer. Technically, it is a computing paradigm in which tasks are assigned to a combination of connections, software and services accessed over a network. This network of servers and connections is collectively known as *the cloud*. Physically, the resource may sit on a bunch of servers at different data centres or even span across continents. Actually, it is designed to work like a whole computer in the cloud and aimed at a wider audience, including those who can't afford their own computer. Computing at the scale of the cloud allows users to access supercomputer-level power. Instead of operating their own data centres, firms might rent computing power and storage capacity from a service provider, paying only for what they use, as they do with electricity or water. This paradigm has also been referred to as “utility computing,” in which computing capacity is treated like any other metered utility service—one pays only for what one uses. Users can reach into the cloud for resources as they need from anywhere at anytime. For this reason, cloud computing has also been described as “on-demand computing.”

[3][4][5]The role of Higher education (HE) for overall development of society is fully acknowledged. The collaboration between universities, government and industry, researchers and students has proven their contribution to the transformation of society and the entire world economy. During the last few years, the universities offering higher education are making transition to research universities and these universities use IT infrastructure as foundation for their educational activities and Science research. Higher education (HE) landscape around the world is in a constant state of flux and evolution, mainly as a result of significant challenges arising from efforts in adopting new and emerging technologies and pedagogies in their teaching and learning environments. This is mainly as a result of a new genre of students with learning needs vastly different from their predecessors, and it is increasingly recognised that using technology effectively in higher education is essential to providing high quality education and preparing students for the challenges of the 21st century. However, an unresolved challenge to the effective use of technology in education is *the continued dominance of traditional didactic pedagogy despite the critical need for a paradigm shift from the passive teacher-centred approach (transmission of information and skills) to student-centred constructivist approaches whereby students construct knowledge through interaction and collaboration with peers as well as teachers. The bulk of today’s elearning systems still consist of simple conversion of classroom-based content to an electronic format while still retaining its traditional distinctive knowledge-centric nature.*

II. BENEFITS AND CHARACTERISTICS OF CLOUD COMPUTING

[6][7]The HE institution must weigh the pros and cons of trying new technologies, especially those having limited budgets. The benefits of cloud computing solutions over traditional technologies are:

a. Mobility: Nowadays students extensively use mobile devices to access data. Students want to refer textbooks, syllabi and even do their homework online via their Smartphone, laptop or tablet. Cloud-based classroom applications are the best way to facilitate this exchange between student and faculty.

b. New Services: Many colleges and universities today are starting to offer virtual classrooms via online learning and video conferencing. Cloud servers allow institutions to offer these innovative teaching methods that can be accessed by students from anywhere via tablets, computers or mobile devices.

c. Storage: Scalable cloud storage offers colleges and universities the ability to quickly expand storage capabilities. HE institutions have huge data to contend with, including everything from student and faculty information to course material. This data can quickly overwhelm traditional on-site storage options. Additionally, if a natural disaster happens or if a server fails, colleges and universities can quickly lose data that may never be retrievable again. Cloud storage also offers business continuity and disaster recovery.

d. Efficiency: Institutions of higher learning are looking for new ways to make their organizations more efficient. A recent survey by Faronics in their "State of the Cloud" report indicated that nearly 55% of institutions want increased efficiency and believe that cloud computing is the best way to make this happen.

III. Uses of cloud computing in Higher education

As academics, what we are most interested in is its networked data storage capability. This paper explores its potential for storage and dissemination of intellectual work in the form of digital scholarship to other members of the professional community such that they can, in turn, peer-review, critique, and further, build up on it[8][9].

The typical uses of cloud computing to academics are:

- It can be used as a personal workspace;
- A convenient tool to engage in the scholarship of teaching and learning;
- Personal Learning Environments (PLEs) used by many people as an alternative to institutionally controlled Virtual Learning Environments (VLEs)/LMS with different personalised tools to meet their own personal needs and preferences; as teachers we are always learning;
- Provides opportunity for ubiquitous computing;
- No need for backing up everything to a thumb drive and transferring it from one device to another;
- No need to copy all stuff from one PC to another when buying a new one. It also means you can create a repository of information that stays with you and keeps growing as long as you want them;
- Provides large amounts of processing power comparable to supercomputer level;

However, the cloud raises some thorny issues about who controls clients' data. Besides, it raises a range of important policy issues, which include issues of privacy, security, anonymity, telecommunications capacity, government surveillance, reliability, and liability, among others. These will have to be worked out for the cloud to gain popularity and wide acceptance[10][11].

IV. HIGHER EDUCATION AND CLOUD SERVICES

With the evolution of technology, number of educational services migrates from traditional form to the online form. These educational services, requires an adequate IT infrastructure using the proper technologies, guaranteeing the access of large number of users, fast and secure service access. The HE landscape around the world is in a constant state of flux and evolution, mainly as a result of significant challenges arising from efforts in adopting new and emerging technologies[12][13]. It is increasingly acknowledged that using technology effectively in HE is essential for providing high quality education. The adaptation of new technology is very slow mainly due to the cost implication. The transformation requires massive funding and investment, which are difficult to come at the times of deep recession and depleted budget reserves of government and private institutions. The funding offered to HE institutes has sharply decreased in times of economic slowdown, leading to financial crisis in HE institutions. To address their financial shortfall, HE institutes are resorting to a variety of cost-cutting measures, including significant cuts to IT budgets[14][15].

a) Infrastructure as a Service (IaaS): It can be used to satisfy the infrastructure needs of the students, faculties or researcher globally or locally with some specific hardware configuration for a specific task. It provides a remote virtual hosting server for file storage, as it enables a user to save all of their file types in a virtual host and retrieve them from anywhere with an internet connection. Examples of IaaS are Google Compute Engine, Google Cloud Storage and Google Big Query.

b) Platform as a Service (PaaS): certain providers are opening up application platforms to permit customers to build their own application without the cost and complexity of buying and managing the underlying hardware and software layers. PaaS provides the entire infrastructure needed to run applications over the Internet, PaaS is based on a metering or subscription model so users only pay for what they use. Examples of PaaS are Google App Engine, Force.com and Heroku.

c) Software as a Service (SaaS): the application service provider is hosting the application which runs and interacts through web browser, hosted desktop or remote client. It eliminates the need to install and run the application on customer own computer and simplifying maintenance and support. Organizations that operate on SaaS are not burdened with the time-consuming and costly task of managing software updates, security patches and a host of other administrative duties for on-premise software solutions. SaaS ensures that these tasks are managed quickly, efficiently and affordably on the back-end.

V. PROPOSED ARCHITECTURE FOR HE INSTITUTES

[16][17]The IaaS is the foundation of all cloud services, with PaaS build upon IaaS, and followed by SaaS build upon PaaS as shown in the architectural diagram. A clear understanding of the relationships and dependencies between various CC models is important for understanding security risks. The capabilities and security risk are inherited from layer to layer. IaaS contains the infrastructure resource and the hardware platforms. IaaS provides the physical and logical connectivity between the hardware resources. IaaS contains a set of APIs which allow management and other forms of interaction with the infrastructure by consumers. PaaS provides additional layer containing programming environment, middleware capabilities, database, messaging, and queuing. This allows cloud users/developers to build their applications on the cloud platform. The SaaS is build upon the underlying IaaS and PaaS stacks. SaaS provides the application level capabilities to users. It includes functions for presentation, application, and provides management capabilities. It should noted that there are significant trade-offs to each model in terms of integrated features, complexity vs. openness (extensibility), and security.

a) Strategy for Implementing Cloud environment in education Moving towards the cloud needs a well defined strategy. It is important that it is aligned with the organization strategy. We propose a strategy for successful cloud implementation involving five phases:

Phase 1: Preparation Phase can be implemented in five steps.

Step 1:- Understanding the Cloud. This step consists of developing the knowledge by participating in seminars, conferences, discussions with the consultants, experts and Vendors. Success depends on the support by the institutes in terms of allocation of budgets for the research. It is also necessary to understand the functioning of cloud its benefits, the risks, and best practices.

Step 2:- Understanding the User Requirements. As with all the software it is necessary to understand the user requirement here also. In this case one needs to understand the needs of the research faculty, staff, students, administrative department, the exam department and the network department within the institute.

Step 3:- Understanding the Project Feasibility. It is necessary to understand the economic and technical feasibility of the new approach, thoroughly before going further for deployment.

Step 4:- Analyzing SWOT.

Step 5:- Analyzing the return on investment.

Phase 2:- Analysis Phase

Step 1:- Analysis of users, software and hardware requirements. This phase may start from the categories of users who interact with the existing system and their requirements. The analysis of hardware and software from the perspective of cloud is done here.

Step 2:- Understanding the recent structure from IT perspective. Here evaluation of the structure is done from point of view of IT requirements and usage. The services that needs migration and the services that needs to kept with the institute are decided.

Step 3: Setting up Benchmarks. In this step benchmarks for security, legal compliance issues are set. The benchmarks are set up by comparing the internal practices of the organization as compared to the industry standards. Step 4: Preparation for Roll out and adoption plan. In this step before going for complete adoption of the cloud services, one has to decide whether to prototype the cloud services or whether to go for pilot projects.

Phase 3:- Migrating to the selected Cloud Platform

Step 1:- Selecting the Vendor based on set benchmarks. The outsourcing strategies are decided and the benchmarks are developed in the second phase are used to evaluate the vendor ability to provide service. Special care has to be taken to ensure that there will be no affect the organization service delivery.

Step 2:- Integration of the new systems with the existing system. In this step systems application integration is done to ensure that the candidate applications will be able to function with the internal applications that are not migrated to the cloud.

Step 3:- Contract development and signing of the contact. The final step is contract development and signing that vendor that meets the user requirements for using cloud service. The transition to the cloud may be achieved gradually starting from testing a pilot project in cloud and the finalizing the application chosen for the cloud.

Phase 4:- Concluding the Cloud Migration

Step 1: Discard or enhance the project to meet the user requirement.

Step 2:- Put the Roll Out into practice.

Step 3:- Migrate the data and applications to cloud.

Step 4: -Support and provide adequate training to all users for successful migration.

Step 5:- Monitor and control the project to ensure successful migration. Finally implement the operational cloud.

Phase 5: Contact Management, Vendor management, Ongoing maintenance and user support: Contact and vendor management should be planned and responsibilities should be assigned.

VI. PRACTICAL APPLICATION OF CLOUD COMPUTING IN HE

Cloud concept has significant implications as a communication medium. While it may not be highly interactive in a physical sense, it has strong potential for social interactivity. The goal of utilising this type of tool is the achievement of 'virtual communities' of educators, researchers and practitioners on the Internet working in small collaborative groups which may help to promote a more reflective metacongitive approach in tackling problems and advancing the practices.

In order to succeed in research projects and to develop quality work through iterative processes, the role of active collaboration with colleagues and experts in the field at its various stages of development cannot be overemphasised. Stages in research projects are mainly: *Setting Research Theme, Discussion and Collaboration, System Development, and Presentation and Publishing*. The 'cloud computing' provides an easy user-friendly environment / platform for this type of collaboration.

The cloud platform can support teachers to prepare teaching portfolio; presentation on teaching to a local audience; a conference presentation; a manuscript to be submitted for publication, etc. It may also include, for the purpose of critical review and evaluation, self-reported ePortfolios that summarise a teacher's major teaching accomplishments and strengths in the form of short descriptions of activities and achievements (e.g., what and how they teach—types of instructional methods, materials, and techniques, why they teach that way, and whether or not it works with evidences), feedback from peers based on teaching observation and peer review of related scholarly activities, feedback from students based on their views on instructional activities, and the end-of-course student evaluation instrument.

VII. CONCLUSION

Cloud computing is an emerging technology paradigm that promises to provide solution to the current financial crisis faced by HE institutes. The migration from traditional system towards CC would enable the HE institutions to cope with rapidly changing software and hardware needs at lower cost. It would help to standardize and update the educational content, and help enhanced collaboration between HE institutes. The HE institutes expect to cut 20% of their IT budget by moving most of its applications to the cloud. This presents a major shift in approach and provides a major opportunity to increase organizational efficiency, improve agility, and stimulate innovation. However, to support a smooth transition and optimal outcomes, HE institutes must first develop a comprehensive cloud computing strategy that addresses the challenges unique to each institution. HE institutes are at the beginning of a transition period during which they face many challenges with respect to cloud adoption. In this paper, we have presented a five phase strategy for implementing cloud computing in higher education. We have also proposed a CC architecture for HE institute containing the various deployment models, Service Models and user domain. The correlation and dependencies between these models is elaborated. Finally, we provide a comprehensive list of recommendations for a successful and efficient migration from traditional to cloud based system for a HE institute.

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