Cloud Computing for ODL Institutions – An Overview

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Abstract
Cloud computing as a new kind of advanced technology accelerates the innovation for the computer industry in recent times. Recently the All India Council for Technical Education (AICTE) has signed an MOU with Microsoft for cloudy wares, for its seven million students and half a million staff hook up to the Redmond cloud. In shortly more than ten thousand technical colleges around India will be connected with Office 365 and Live@Edu. AICTE adopts Cloud to Improve Technical Education and prepare students for the workforce of tomorrow. The irony about cloud computing is that most people have already been using it to some extent but may not even realize it. Gmail and Yahoo Mail and Facebook are some examples for cloud based application. Industry forecast predicts that cloud computing will account for 33 percent of all data center traffic by 2015 - tripling the current percentage and about 12 times the total current volume [(1)]. The Open and Distance Learning institutions cater to millions of people scattered all over a particular region. This paper discusses the advantages and disadvantages of adopting cloud computing technologies in an Open University scenario, with particular reference to Tamil Nadu Open University, Chennai.

Key Words
Cloud Computing, Open and Distance Learning, Open University

Definition of a Cloud
The cloud can be described as on-demand computing, for anyone with a network connection. One may access the applications and data from anywhere any time from any device. Clouds such as Flickr and Facebook act as digital repositories for data. From consumer point of view, the storage of digital images is somewhere in the cloud.

Cloud Computing
It is a computing model based on the Internet. It ensures that users can simply use the computing resources on demand and pay money according to their usage. It is equivalent to the metering water and electricity consumption. It is defined as a set of technologies that provide computing resources and services delivered over the Internet in real time and it brings new business models. Storage, computing capacity, software and hardware are provided by a vendor, so all that is needed is a browser.

Reasons for the sudden increase in Cloud Computing
Cloud computing is becoming increasingly popular and is growing in the education market. Major Service providers such as Apple and Amazon have led the way. Two major reasons for this trend are:

- ★ Cloud computing substantially reduces hardware, software licensing, personnel costs, space, repair, and electrical costs.
- ★ It provides new capabilities without incremental costs for equipment or support. Keeping current option is a much more viable one. This includes collaborative efforts such as allowing multiple admissions personnel to view the same student application simultaneously.
- ★ The explosion in mobile devices has spurred the availability of 24/7 computing accessible from anywhere with no downtime.
- ★ There is an avalanche of data that needs to be stored and analyzed.
- ★ Decreasing budgets and increasing number of students make cloud computing as a cost effective solution, a simpler, affordable and practical option.

Stacks in Cloud Computing
Cloud Computing consists of three layers of Cloud Stack, also known as Cloud Service Models or SPI Service Model. These services are broadly divided into three categories:

Infrastructure-as-a-Service (IaaS)
This is the foundation layer for the other two layers. The keyword behind this stack is Virtualization. Our application will be executed on a virtual computer. We have our choice of virtual computer, i.e., a configuration of CPU, memory and storage that is optimal for our application. The organization outsources the whole cloud infrastructure viz. servers, routers, hardware based load-balancing, firewalls, storage and other network equipment. The customer buys these resources as a service on an as-needed basis. The characteristics of IaaS are as follows:

- ★ Utility computing service and billing model
- ★ Automation of administrative tasks
- ★ Dynamic scaling
- ★ Desktop virtualization
- ★ The whole cloud infrastructure, including servers, routers, hardware based load-balancing, firewalls
- ★ Storage and other network equipment, is provided by the IaaS provider. IaaS delivers computer and
- ★ Web infrastructure through virtualization.

Platform-as-a-Service (PaaS)
IaaS delivers computer and web infrastructure. But infrastructure is of no use without a platform. PaaS is the middle layer of cloud stack. It is a way to rent hardware, operating systems, storage and network capacity over the Internet. The major characteristics of PaaS are:

- ★ Operating system features may be changed and upgraded frequently.
- ★ Geographically distributed development teams can work together on software development projects.
- ★ Services are obtained from diverse sources from various countries.
- ★ Using services from a single vendor may be cost effective. It avoids maintaining multiple hardware facilities, duplicate functions and incompatibility problems.
- ★ Unification of programming development efforts may minimize overall expenses.

Software-as-a-Service (SaaS)

It is a software distribution model in which applications are hosted by a vendor or service provider and made available to customers over a network, typically the Internet. SaaS is a popular delivery model as underlying technologies that support Web services and service-oriented architecture (SOA) mature and new developmental approaches, such as Ajax, become popular. SaaS is closely related to the ASP (Aapplication Service Provider) and On Demand Computing. Some characteristics of the SaaS are given below:

- ★ Easier administration
- ★ Automatic updates and patch management (acquiring, testing, and installing multiple patches
- ★ Compatibility: All users will have the same version of software.
- ★ Easier collaboration
- ★ Global accessibility.

The traditional model of software distribution, in which software is purchased for and installed on personal computers, is sometimes referred to as software as a product

Technical organization of a cloud

Many of the perspectives on the cloud adopt a layers view to describe it. There are two types of clouds; private clouds which exist within an organization and public clouds which are used to provide services to users outside an organization.

Table 1 – Comparison between Traditional Computing and Cloud Computing

S.No.	Model	Traditional Computing	Cloud Computing
01	Acquisition Model	Buy Assets Build Technical Architecture	Buy Service Architecture included
02	Business Model	Pay for Assets Administrative Overhead	Pay for use Reduced Admin Function
03	Access Model	Internet Networks Corporate Desktop	Over the Internet Any Device
04	Technical Model	Single – Tenant, non-shared Static	Multi-tenant, Scalable, Elastic, Dynamic
05	Delivery Model	Costly, Lengthy deployments Land and expand staffing	Reduced deployments time Fast ROI

Educational Uses

Cloud computing changes the ways people do personal learning, interactive learning and many-to-many learning, in primary, secondary and higher education. Un-tethering students and teachers from desktops is only part of it. It meets the needs of the distance learners such as adult illiterates, who had never gone to the school, workers transferred overseas who want to continue their education, people with disabilities, pregnant women who want to study from their home, people seeking new job skills, middle- and high-school students seeking refuge from bullies, etc. The key benefits of cloud computing in Higher Education are as follows:

- ★ The maintenance of infrastructure and software is taken care of by the service provider. So, the institution can concentrate on academics
- ★ Students can work, communicate, collaborate with peers, study and submit assignments on the cloud from anywhere anytime. They are not left behind.
- ★ With SaaS and PaaS and IaaS, a limited budget is sufficient to provide the latest technology infrastructure to all the students.
- ★ Pay-as-you go model.
- ★ Institutional branding is possible with custom domain email IDs.
- ★ Quick & Effective Communication with Anytime Anywhere Access.
- ★ Collective intelligence & creativity as students may work on their project document at the same time.
- ★ Not all the cloud are open. Google Apps is in compliance with FERPA (Family Educational Rights and Privacy Act).
- ★ Go Green. No need for notebooks, papers, printing etc.
- ★ Easy to deploy.
- ★ Enables students, parents, faculty and the management to access applications remotely via the web application delivery that typically is closer to a one-to-many model (single instance, multi-tenant architecture) than to a one-to-one model.
- ★ Data security is ensured through Asymmetric Key based encryption algorithms.
- ★ Scalability is easy and does not involve any additional cost.
- ★ It gives greater longevity to information by storing it in the cloud
- ★ It allows students to interact and collaborate with an ever-expanding circle of their peers, regardless of geographical location
- ★ Free online content as Open Educational Resources
- ★ Cost effective, consistent, and easy to distribute and update

In the following sections, let us discuss how cloud computing can be used in an Open University atmosphere.

Various Divisions of TNOU

Tamil Nadu Open University consists of the following divisions:

Student Support Services Division

The Tamil Nadu Open University consists of various Regional Centres, Learning Resources Centres, Computer Centres and other special centres.. It has many Programme Study Centres for conducting B.Ed., and other vocational study centers. The main functions of Student Support Services Division are as follows:

- ★ Satisfying the learning needs of the students
- ★ Establishment, network and management of Regional Centres and Learning Centres
- ★ Identification an appoint suitable academic counsellors
- ★ Organizing orientation programmes for part-time functionaries of Learning Centres.
- ★ Pre-enrollment counseling
- ★ Quality assurance
- ★ Information management to the students

Material Production and Distribution Division

It is responsible for the planning of instructional Material Requirement. It involves the following responsibilities:

- ★ Planning for the instructional materials
- ★ Printing / Production
- ★ Storing and inventory control
- ★ Delivery of assignments,

Student Registration and Evaluation Division

This division takes care of admissions, examinations, evaluation and certification. It executes the following functions:

- ★ Running of academic programmes
- ★ Conduct of term-end examinations and evaluation
- ★ Certification of the successful students
- ★ Choice based credit management and transfer

Administration Division

It takes care of:

- ★ General Administration
- ★ Establishment, Personnel and Services
- ★ Purchase, Stores and Materials Management
- ★ Governance of the University

Instructional System

It is the most unique system for any ODL system. Computer-media materials, interactive CDs, teleconferencing sessions, radio interactive, phone-in sessions, etc., are used for the courses. The instructional system at TNOU comprises the following:

- ★ Printed materials in self-learning format
- ★ Face-to-face contact classes in the form of counseling/tutoring sessions.
- ★ Continuous assessment of learner progress through assignments.
- ★ Term-end examinations
- ★ Only limited face-to-face instruction is available to Distance Education students and, in certain cases, there may be no face-to face instruction at all.

Table 2 – Infrastructure of Tamil Nadu Open University, Chennai

S.No.	Type of Centre	Description	Number
01	University Coordinating Centers (UCC) at District Head Quarters	Manage many Learning Centres under them	10
02	Learning Centres (LRC) within Tamil Nadu	Act as nodal agencies of TNOU – Provide information to the students and organize instructional process.	144
03	Learning Centres (LC) situated at other states	Equivalent to LRC	30
04	Computer Programme Centres (CPC)	Provide Computer and IT education	159
05	B.Ed. Programme Study Centres (PSC)	Manage B.Ed. course	10
06	B.Ed.Special Education Programme Study Centres	Manage B.Ed. Special Education	10
07	Community Colleges	Provide community related courses certified by TNOU	124
		Total Centres	**473**

Table 2 clearly shows that there are 473 centres managing the Teaching Learning Process of TNOU courses. If each Computer Programme Centre has to spend Rs. 10 Lakhs and other centres spend on an average Rs. 5 Lakhs for IT infrastructure, the amount totals as Rs. 31 Crores (Rs. 15.9 Crores plus 15.7 Crores) on infrastructure alone.

Not only will TNOU be able to outsource email services for its 1,00,000 + students, as well as its staff, taking away the maintenance burden from the university, but it will also be able to use the large document storage facilities offered by cloud computing systems.

Cost Benefit Analysis

The primary advantages the cloud is its cost and efficiency. The capital costs of computing can be minimized if an organisation relies on the public cloud, buying virtual server time and storage space on demand. IT expenditure is operational, rather than capital. The physical space required for racks of servers and the energy costs for running and cooling them is no longer necessary. The barrier for large scale computing power is removed and even small businesses can easily access it. Large capital purchases are removed as costs are incurred on a per use basis. Scalability allows the organisation to add capacity as and when it's needed and to scale down and up, driven by demand.

Costing

Amazon's Elastic Cloud Compute (EC2) service allows the rental of virtual servers by the hour, with a variety of processing and OS One standard Instance is defined as follows:

- ★ Small Instance (Default) 1.7 GB of memory, 1 EC2 Compute Unit (1 virtual core with 1 EC2 Compute Unit), 160 GB of local instance storage, 32-bit or 64-bit platform
- ★ Medium Instance 3.75 GB of memory, 2 EC2 Compute Units (1 virtual core with 2 EC2 Compute Units each), 410 GB of local instance storage, 32-bit or 64-bit platform
- ★ Large Instance 7.5 GB of memory, 4 EC2 Compute Units (2 virtual cores with 2 EC2 Compute Units each), 850 GB of local instance storage, 64-bit platform
- ★ Extra Large Instance 15 GB of memory, 8 EC2 Compute Units (4 virtual cores with 2 EC2 Compute Units each), 1690 GB of local instance storage, 64-bit platform

For the clouds based on Asia Pacific region, based on Singapore, the tariffs are as follows:

Table 3 – Costs incurred in Amazon Cloud

Instance	Linux (Rs)	Windows (Rs)
Small	4.70 / hr	6.36 / hr
Medium	9.40 / hr	12.72 hr
Large	18.80 / hr	25.72 / hr
Extra Large	37.60 / hr	50.88 / hr

Source : Amazon.Com – EC2 Cloud Services

This means that for an University in need of 1000 computers may need 125 Extra Large Instances. If it works for 300 days, 12 hours per day, it costs around Rs. 1, 69, 20,000 per year for normal usage. There is no long term commitment and an organisation is only charged for what it actually uses. If more instances need to be added, it is literally a matter of minutes to configure new server instances. This is a standard version. Depending on the speed, and other computing powers, the tariffs change. For an educational organization of moderate size, if it goes for the Large On the other hand, if we calculate the purchase of 1000 PCs, servers, software, maintenance costs, personnel, etc, it will be a much higher amount.

Suitability of Cloud computing in ODL systems

The advantages of cloud computing in Higher Education, in particular ODL systems are far reaching. It can be used in planning, storing students' papers, financial aid, enrollment, and admissions. In the face of rising applicant pools, these areas need processes completed faster, better and cheaper to keep up with the competition, as well as meeting their own budgetary goals. It is rather simple to implement, and yields significant benefits. For smaller organizations, it can deliver a high-end functionality very quickly without significant investments in hardware, integration, administer ation, and consulting.

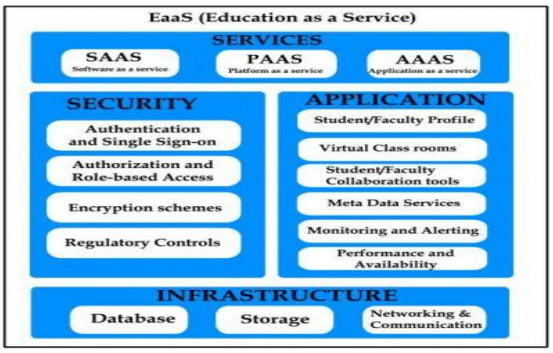

Fig. 1 – EaaS : Education as a Service

Source : Deepa et al – 2012

Advantages of Cloud Computing to Educational Institutions

Cloud Computing provides many advantages to Educational Institutions. The following are the major ones:

Virtualization

Ditching all physical servers and building a private cloud with virtualized servers and maintaining the physical infrastructure, can deliver large efficiency gains. A survey (The Economist 2008) suggests that, without virtualization, on average only 6% of server capacity is used. In private cloud approach an organisation can still take advantage of the on-tap computing power in the public cloud. 'Cloud bursting' is a service that provides 'overflow computing' for dealing with spikes in web traffic or processing load.

Multiple Locations

Many cloud providers provides the ability to place instances in multiple locations, composed of Regions and Availability Zones. Availability Zones are distinct locations that are engineered to be insulated from failures in other Availability Zones and provide inexpensive, low latency network connectivity to other Availability Zones in the same Region.

Virtual Private Cloud

VPC is a secure and seamless bridge between an Institution's existing IT infrastructure and the cloud. It enables institutions to connect their existing infrastructure to a set of isolated compute resources via a Virtual Private Network (VPN) connection, and to extend their existing management capabilities such as security services, firewalls, and intrusion detection systems to include their cloud resources.

Auto Scaling

It allows the user to automatically scale their cloud capacity up or down according to conditions he/she defines. With Auto Scaling, one can ensure that the cloud capacity he is using scales up seamlessly during demand spikes to maintain performance, and scales down automatically during demand lulls to minimize costs. Auto Scaling is particularly well suited for applications that experience hourly, daily, or weekly variability in usage.

Elastic Load Balancing

It automatically distributes incoming application traffic across multiple clouds. It enables users to achieve even greater fault tolerance in their applications, seamlessly providing the amount of load balancing capacity needed in response to incoming application traffic. It detects unhealthy traffic within a pool and automatically reroutes traffic to healthy routes until the unhealthy traffic has been restored. The users can enable Elastic Load Balancing within a single Availability Zone or across multiple zones for even more consistent application performance.

Operating Systems and Software

Most of the cloud providers offer majority of OS and Software which satisfy the needs of majority of the customers. are very useful. For an educational institution such as TNOU, the following OS and software may be useful:

Operating Systems

Red Hat Enterprise Linux, Oracle Enterprise Linux, Windows Server, SUSE Linux Enterprise, Ubuntu, Fedora, Gentoo Linux, an Debian

Software

Most of the cloud vendors provide a wide variety of commercial and free software from well-known vendors, designed to run on any virtual machines. The following are some popular software:

Databases

Microsoft SQL Server, MongoDB, Acunu Storage Platform, Apache Cassandra, TurnKey PostgreSQL - Object-relational Database System

Application Servers

IBM WebSphere Application Server, Tomcat Java Web Application Deployment provided by JumpBox, Tomcat on

Apache - Java Servlet and JSP Platform by TurnKey Linux, Zend Server, Couchbase Server

Content Management

WordPress provided by BitNami, Drupal 6 - Content Management Framework provided by TurnKey Linux, MediaWiki Wiki System provided by JumpBox

Business Intelligence

SAP BusinessObjects, JasperReports Server

Challenges

There is a litany of concerns related to security, reliability, confidentiality, and regulations at both the state and central level. All this information is being put on these machines out there "somewhere"; thus, the college administrator needs to know who is administering these machines and who has access to them.

Securing data in the cloud: The issue of security cannot be overstated in a cloud computing scenario. Since the institution's information is no longer running inside the four walls of the campus, any cloud vendor should address the security. In reality, security is less about how to protect the data than who actually owns the data and who has access to it. As all the information is put on machines somewhere, the institution administrator should know who is administering these machines and who has access to them.The applications and infrastructure for vulnerabilities are to be evaluated and ensured that security controls are in place and operating properly. Intrusion monitoring and prevention system, access and identity management, and security event log management to identify any security threats to the cloud implementation are must.

Adaptation

The organization's culture and how it responds to the adoption of new technologies are significant. It is difficult for University administrators to acclimate to the concept of letting go of their data and applications. The fact that the information is no longer inside the Institution's actual physical boundaries significantly impacts the faculty. How to protect one and to get the information are the primary concerns.

Technology compatibility

Depending upon the vendor, maintenance agreements, storage, networking and computing capacity, the users have to shift from the technology environment they have been accustomed to and comfortable to another operating system. Integration is another critical issue. If the applications are moved off campus, how do they integrate back to campus? When moving to the cloud, the institutions move from older PC-based platforms to more up-to-date ones capable of running browser sessions and multiple windows. The Rate Of Investments (ROI) in making these changes is significant.

Choice of the Cloud Vendor

The choice of the cloud vendor is important. As the field is relatively new, small incompetent businesses may become cloud computing vendors. They may position themselves as a knowledgeable cloud vendor. One should be careful in checking whether the cloud vendor really understand his business, do they have the proper expertise, infrastructure, certification and demonstrated success in educational environments to ensure that the business applications are managed properly. There are many basic questions to be answered. One of the primary concerns is how does a cloud vendor deliver an agile business solution to a higher education institution that traditionally has focused on other priorities.

Institutional Issues

The major problem in implementing Cloud Computing in academia is that of training the teachers and other staff of institutions. The following are some potential issues:

- Managing large amounts of instructional software used in schools
- Getting adequate IT support: With Software-as-a-service,(SaaS), this can be solved.
- Overcoming shortage of dedicated IT and instructional departments
- Securing reasonably priced bandwidth: Wherever government entities partner with private service providers to build the infrastructure, affordable broadband is available. But broadband is costly in areas where institutions rely solely on the private sector.
- Equipping each student with a device to access digital resources
- Training faculties and students using public Web 2.0 tools in the cloud to make the most of such resources.

Conclusion

The benefits of cloud computing are huge, and there are plenty of ways to move into the cloud that can enable an environment of business agility and cost reduction, a combination not seen before in education. If used properly and judiciously, cloud computing is one of the most advantageous IT solution to Educational Institutions, in particular ODL systems.

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