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# Application of cloud computing technology implementation framework on higher education libraries in the digital environment

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**ABSTRACT**

Cloud computing is a web based computing where shared resources, applications and information are provided to the set of computers and other devices on demand using web technology. Cloud computing is based on internet; generally the internet is commonly visualized as a cloud. This chapter defines cloud computing basics and shows how it is different from other types of computing. This paper overviews the basic concept of cloud computing and the use of cloud computing in libraries and how cloud computing actually works is illustrated in this communication. This paper attempts to demystify the intricacies involved in cloud computing. Benefits of cloud computing and its effective implementation for higher education is emphasized. This paper has been attempted to explore how cloud computing can extend Library services for better sustainability. Finally, the paper concludes with a set of useful links about cloud libraries and additional links for future work.



## Introduction

Cloud computing is an agile, secure, reliable, cost effective and scalable method for delivery of computing and delivery of data. End users access cloud based applications through a web browser or a light weight desktop or mobile app while the business software and data are stored on servers at a remote location. In this program we will cover everything about cloud computing, virtualization, private clouds etc. We also cover popular cloud services including AWS, Google app engine and Windows Azure. Fill the inquiry form to download our course module.[3]

## Meaning of cloud computing?

Cloud computing can be understood as a way to use off-site computer processing power to replace content creation and servers that were traditionally hosted onsite. In layman's terms this means "using Web services for our computing needs" (Kroski, 2009). Cloud computer allows content creation to be made "when data and software applications reside on and are drawn from the network rather than locally on any one workstation".[11]

In recent years, cloud computing as a new kind of advanced technology accelerates the innovation for the computer industry. Cloud computing is a computing model based on networks, especially based on the Internet, whose task is to ensure that users can simply use the computing resources on demand and pay money according to their usage by a metering pattern similar to water and electricity consumption. Therefore, it brings a new business model, where the services it provides are becoming computing resources.[9]

## Cloud service providers:

**Software as a Service (SaaS):** It offers finished applications that end users can access through a thin client (typically, but not necessarily, a web browser). Prominent examples of SaaS include Gmail, Google Docs, and Salesforce.com. Other Examples of SaaS include: Google Apps, Microsoft Office 365, and Onlive.

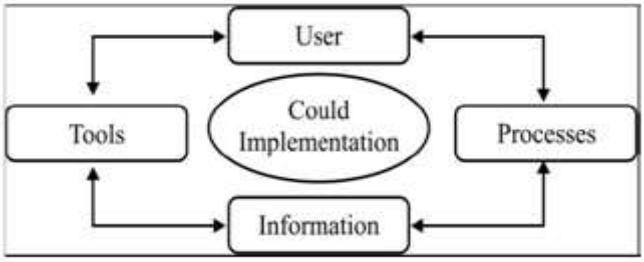


**Figure.1: Cloud Service Implementation Framework**

**Platform as a Service (PaaS):** This offers an operating system as well as suites of programming languages and software development tools that customers can use to develop their own applications. Prominent Examples of PaaS include: Amazon Elastic Beanstalk, Cloud Foundry, Heroku, Force.com, EngineYard, Mendix, Google App Engine, Windows Azure Compute and OrangeScape.

**Infrastructure as a Service (IaaS):** IaaS offers end users direct access to processing, storage and other computing resources and allows them to configure those resources and run operating systems and software on them as they see fit. Examples of IaaS providers include Amazon CloudFormation, Amazon EC2, Windows Azure Virtual Machines, DynDNS, Google Compute Engine, HP Cloud, Joyent, Rackspace Cloud, ReadySpace Cloud Services, Terremark and IBM Computing on Demand.[6]

## Related works:

This study refers to a variety of materials in order to carry out a thorough and comprehensive literature review in relation to cloud computing.

Liladhar R. Rewatkar Ujwal A. Lanjewar[12] has analyzed the implementation of cloud computing on web application. He also

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discussed the advantages of cloud computing and issues related to cloud computing on web application. Marinela Mircea, Anca Ioana Andreescu[13] have found out alternatives to use information technologies while leading universities to improve agility and obtained savings. The paper also provided strategies for the use of cloud solutions in universities by improving knowledge in this field and providing a practical guide adaptable to the university structures. Amrit Shankar Dutta[1] has provided educational cloud architecture and use of cloud computing in education. He has also provided many examples through the world where educational institutes have taken initiatives in cloud computing to better serve their faculties, students and researchers. He has also suggested the benefits of cloud implementation in education. Nan –Chou Chen[14] has studied the feasibility of the adoption of cloud computing in the development of Information Systems in IT Firms in Taiwan.

**Why is it significant?**

- Cloud computing encourages IT organizations and providers to increase standardization of protocols and processes so that the many pieces of the cloud computing model can interoperate properly and efficiently.
- Cloud computing's scalability is another key benefit to higher education, particularly for research projects that require vast amounts of storage or processing capacity for a limited time.
- With cloud computing, organizations can monitor current needs and make on-the-fly adjustments to increase or decrease capacity, accommodating spikes in demand without paying for unused capacity during slower times.
- Cloud computing allows college and university IT providers to make IT costs transparent and thus match consumption of IT services to those who pay for such services.

**Cloud computing initiatives:**

Many universities, vendors and government organizations are investing in research around the topic of cloud computing.[4]

- In October 2007, the Academic Cloud Computing Initiative (ACCI) was announced as a multi-university project designed to enhance students' technical knowledge to address the challenges of cloud computing.
- In April 2009, UC Santa Barbara released the first open source platform-as-a-service, AppScale, which is capable of running Google App Engine applications at scale on a multitude of infrastructures.
- In October 2010, the TClouds (Trustworthy Clouds) project was started, funded by the European Commission's 7th Framework Programme. The project's goal is to research and inspect the legal foundation and architectural design to build a resilient and trustworthy cloud-of-cloud infrastructure on top of that. The project also develops a prototype to demonstrate its results.
- In July 2011, the High Performance Computing Cloud (HPCCLoud) project was kicked-off aiming at finding out the possibilities of enhancing performance on cloud environments while running the scientific applications - development of HPCCLoud Performance Analysis Toolkit which was funded by CIM-Returning Experts Programme - under the coordination of Prof. Dr. Shajulin Benedict.
- In June 2011, the Telecommunications Industry Association developed a Cloud Computing White Paper, to analyze the integration challenges and opportunities between cloud services and traditional U.S. telecommunications standards.

**Using cloud computing in higher education:**

The efficiency of using Cloud Computing in higher education has been recognized by many universities among which we mention University of California, Washington State University's School of Electrical Engineering and Computer Science, higher education institutions from UK, Africa (Sultan, 2010), U.S and others.[17] For Example is Kuali Ready (Bristow et al., 2010)[2], a community-source project chartered to provide a business continuity planning service and it is also an example of higher education institutions organizing themselves to provide cloud services. Kuali Ready is a good early example of some key principles that are emerging to guide cloud developments.

**Notable Online Education Services:**

- **Intel AppUp Center:** The Intel AppUp Center at www.appup.com/ applications provides a resource center and catalogue for cloud based mobile services. This site can also serve as a model for how an education services catalog could be created for the development and distribution of education cloud services.
- **iTunes-U:** Another example of a catalog of education services is iTunes University at www.apple.com/education/itunes-u. This site is a large-scale distribution system for lectures, language lessons, films, labs, audio books, tours, etc.
- **Skoool.com:** An example of content services that can be integrated into an education cloud can be found at www.skoool.com. The site offers a number of learning objects freely available for use via the Internet, as well as a set of toolkits for open-ended learning.
- **Education elements:** An example of professional development services can be found at www.intel.com/education/elements, which features a set of online, self-paced courses that focus on helping teachers become proficient with project-based learning, student collaboration and 21st-century skills development.

**Useful links on Cloud COMPUTING and practice**

- NIST – Collaboration on Cloud Computing Reference Architecture development –http://collaborate.nist.gov/twiki-cloud-computing/bin/view/CloudComputing/WebHome
- OGF – Open Cloud Computing Interface (OCCI) –http://occi-wg.org/doku.php?id=start
- Storage Networking Industry Association (SNIA)
- Cloud storage - http://www.snia.org/cloud
- SNIA Cloud Data Management Interface (CDMI) v1.0 http://www.snia.org/tech_activities/standards/curr_standards/cdmi/CDMI_SNIA_Architecture_v1.0.pdf
- OASIS – Identity Management for Cloud –http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=id-cloud
- Distributed Management Task Force (DMTF) –Cloud Management - http://www.dmtf.org/standards/cloud –DMTF Virtualization Management (VMAN) - http://www.dmtf.org/standards/vman
- IEEE - WGs on InterCloud issues and Cloud Profiles
- IEEE ICWG/2302 WG - Intercloud WG (ICWG) Working Group http://standards.ieee.org/develop/wg/ICWG-2302_WG.html
- CPWG/2301 WG - Cloud Profiles WG (CPWG) Working Group http://standards.ieee.org/develop/wg/CPWG-2301_WG.html[25]

**Benefits of cloud computing implementation:**

**1. Reduce cost:** By implementing the cloud services in higher education, the cost of hardware configurations and software purchasing is reduced, as the whole responsibility of providing hardware and software services is of the cloud service provider. Higher education institute don't need to purchase the licensed softwares for a fixed period of time, instead for these services

they have to pay as per the usage and they only require low configuration computers in their campus.

**2. Simplicity:** As it is simple to use and set up all the services, higher education institutes do not have to worry about resource management and other hassles that come with infrastructure set up and management.

**3. Reliability:** Network and data access are guaranteed to be reliable as they are maintained by the experts from the service provider and such reliability is backed by some kind of money back guarantees or penalties for providers in the event if they have a down time.

**4. Security:** Standard encryption and decryption has been used and there is no need to worry about the security of the applications in educational clouds.

**5. Manpower:** By providing the training to the users of higher education organization, it becomes easy for them to utilize the cloud services .They do not need to recruit new employee especially for utilizing the cloud services as well as managing them.

**6. Collaboration and Flexibility:** User of higher education have the universal access to projects, applications, documents so they can work collaborately using the collaboration tools provided by the cloud services through SaaS. Also the cloud services are flexible to use anywhere and can be transferred to any location in case of failure or system crash.[10]

**User service models:**

In the past, most libraries insisted that their service is based on their own library resources. So librarians scarcely considered users' demands. But today, modern libraries have changed this viewpoint. And librarians usually need to collect as more information as they can their users' requirements. Finally, they will provide them for users in some certain technical methods. However, services in modern libraries will increasingly focus on users' demanding in future. And the ultimate goal of modern library is to offer appropriate, comprehensive and multi-level services for its users. User service models are mainly WWW service model, FTP service model, BBS and E-mail Service model, etc.[16]

**1. WWW Service Model:** WWW (World Wide Web) is based on client-server model. It presents all kinds of information browsing systems with the bases of HTML language and HTTP protocol. The specific division is: WWW Servers are in charge of linking web pages by hypertext links and WWW clients are responsible for displaying information and sending requests to servers. And the most significant feature of WWW service is its high degree of integration. In other words, it can connect all kinds of information and services seamlessly and provide users with vivid graphical user interface finally. In general, WWW provides new means of searching and sharing information for people around the world.

**2. FTP Service Model:** FTP (File Transfer Protocol) is a widely used communication protocol. And it is comprised of various rules that support file transfer on the Internet. As such rules can permit online users copy files from one host to another, it brings great convenience and benefits to users. Just as other Internet services, FTP are also based on client-sever model. Meanwhile, it's easy to learn to use FTP service. Launching FTP service in university library network system is a good type which brings great convenience for users and library as well. By using FTP service in university library, users can make their own password, such as using their Email address, and this can let librarians obtain users visiting records easily. Furthermore, according to users' visiting records, librarians can offer corresponding services for them and improved users' satisfaction

**3. BBS and E-mail Service Model:** BBS (Bulletin Board Service) is a kind of electronic information service system on the Internet. It is just like a public blank board on the Internet; all users can write their thoughts or release information on this board. And E-mail is just another kind of information service on the Internet. In a word, E-mail provides a very quick, simple and economical way of communication for the Internet users in the whole world. Through BBS system, library users can ask and consult librarians at any time. Usually they can get their response in a very short period of time. Meanwhile, librarians can communicate with more users at a time through BBS. What's more, university libraries can open lectures, release announcements and provide online help for users by BBS system.

**Role of cloud computing in library science:**

Cloud computing can help libraries collaborate with each other in a facile manner. Every library has its own electronic data resources. If the all the electronic data resources are put together in a single place which may be accessed by a group of libraries, the whole electronic data base will become huge. This space which contains all the electronic data can be some cloud, say, a library cloud. Library cloud will contain the digitized data of different libraries and hence, will help libraries integrate their data. The need for maintaining and backing up the data will be no more the responsibility of the libraries since all the data will be stored in the cloud which shall be managed by some cloud provider.

**Service Providers Of Cloud Computing For Libraries:**

**1) Ex Libris[8]**: Ex Libris is a well known cloud service provider based in USA. They are providing cloud solution in the field of library with all the software and hardware support needed to provide services to the users. Ex Libris is available for all type of libraries and also for consortia. Ex Libris is built on various standard and contains number of features like compatibility with Unicode font, flexibility, migration of data, customization etc.

**2) Polaris Library Systems[15]**: Polaris is one of the cloud based library automation system available in the market. The company also provides standard acquisition and processing system. Also, with a Polaris ILS Client License, the library can integrate various PC and print management systems at no extra cost. The systems uses number of well know standards like MARC 21 for bibliographic data, XML, Z39.50 for information retrieval, Unicode etc.

**3) Dura Cloud[7]**: Dura Cloud is providing cloud solution for digital library services. Dura Cloud is a sister concern of the Duraspace which is a collaboration of the Dspace digital library software and Fedora Commons. Dura cloud offers complete solution for digital library with standard software and hardware solution. It also provides open source code and the code needs to be installed on the machine.

**Additional Examples of Cloud Libraries:**

1. OCLC World share
2. Library of Congress (LC)
3. Scribd
4. Discovery Service
5. Google Docs / Google Scholar
6. WorldCat
7. Encore
8. Research Gate
9. Open class
10. Mendeley

11. Slideshare and
12. Library thing

**Benefits of cloud computing in libraries:**

1. Cost saving
2. Flexibility and innovation
3. User centric and Openness
4. Transparency and Interoperability
5. Representation
6. Availability anytime anywhere
7. Connect and Converse and
8. Create and collaborate

**Merits and limitations:**

The use of Cloud Computing in higher education must be analyzed both from the merits point of view, as well as from that of the risks and limitations (table 1). After the analysis, one or more models of Cloud Computing may be chosen to be used. The decision must take into account the real needs and be aligned with the university strategy.[18]

| merits | Limitations |
|---|---|
| Access to applications from anywhere | Not all applications run in cloud |
| Support for teaching and learning | Risks related to data protection and security and accounts management |
| Software free or pay per use | Organizational support |
| 24 hours access to infrastructure and Content | Dissemination politics, intellectual property |
| Opening to business environment and advanced research | Security and protection of sensitive data |
| Protection of the environment by using green technologies | Maturity of solutions |
| Increased openness of students to new Technologies | Lack of confidence |
| Increasing functional capabilities | Standards adherence |
| Offline usage with further synchronization Opportunities | Speed/lack of Internet can affect work Methods |

**Table 1: Merits and Demerits of Using Cloud Computing in Higher Education**

**Challenges of cloud computing:**

Many challenges of cloud computing for higher education relate to its relative newness and the underdevelopment of the marketplace for cloud services. For higher education, decisions to adopt cloud computing will be influenced by more than technical and cost considerations. Information is the lifeblood of higher education, and decisions on how to manage that information can have far-reaching political, social, and economic considerations. Adoption of cloud computing presents many of the same risks and challenges as deciding to use a more traditional outsourcing arrangement. The increased possibility that the service provider or its resources may reside outside of a government's legal or territorial jurisdiction, however, can make some of these concerns more acute.[5]

**Conclusion:**

In this chapter given an analysis of cloud computing solutions and discussed the benefits of cloud computing implementation at higher technical education libraries. This is very cost effective and efficient as compare to traditional computing structure. In the electronic age, Libraries have the opportunity to improve their services and relevance in today's information society. Cloud computing is one avenue for this move into the future. It can bring several benefits for libraries and give them an effective future. The cooperative effect of libraries using the same, shared hardware, services and data—rather than hosting hardware and software on behalf of individual libraries—can result in lowering the total costs of managing library collections and enhancing the both library user's experience and library staff workflows.

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