PROSPECTIVES OF CLOUD COMPUTING IN LIBRARIES OF INDIA

(AN OVERVIEW)

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Abstract:

As most of the people are already using cloud computing in the forms of Facebook, Flicker, Apple's iTunes, Googledocs, iPhone, YouTube, Slideshare and bookmarking sites such as Delicious, etc without even knowing about the concept. This paper tends to help librarians about the concept, so that they can improve their services and connect with rapidly changing user demands in terms of technologies. Many libraries in India are facing the problems of dwindling budgets and inadequate infrastructure to provide good services to their users. Is it possible for them to provide maximum services to their communities by investing minimum resources using cloud computing? Paper tries to find out the answer. This study could be helpful for our librarians in implementing cloud computing in their libraries.

Keywords: Cloud Computing, Types of Clouds, Cloud Computing in Libraries, Saas, Iaas, Paas, SLAs.

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Introduction

From powerful mainframes to PCs and networked computing to grid and cloud computing, technology has changed drastically bringing new possibilities in every sector of life either business or education or etc. If we talk about education sector then libraries are the heart of it and making new innovations in terms of providing services and resources in our libraries can bring complete user satisfaction and eventually the intellectual growth of whole country. Cloud computing is a buzzword today in the Internet field. Every person using Internet in true sense is using the cloud computing in one and another way whether knows about it or not. Cloud computing has become a great solution for providing a flexible, on-demand, economic, and dynamically scalable computing infrastructure and services in many fields. The cloud computing is getting so much of popularity in every field is just because of its ability to do more with less i.e. it increases the capacity of your IT infrastructure while at the same time reducing the need of staff, hardware and software which are required to support any IT system. Our Indian libraries suffering from the problem of dwindling budgets may also be benefited from the vast possibilities in the cloud computing.

Cloud Computing

Cloud computing is using Internet based remote services and resources which are being hosted by other. There are some characteristics that can help to understand the concept in a better way:

- Fully managed by third party who provides services.
- Security and quality of services are maintained by following standards.
- Choice of services from very few to large numbers
- Demand based services and pricing is based on usage based capability
- Resources can be shared among cloud service users and resources are scalable over several data centers.
- Requirement by the side of consumer are so simple, a Personal Computer and Internet access.

Definition of Cloud Computing

Acoording to NIST(National Institute of Standards and Technology) "Cloud computing is a model for enabling ubiquitous, 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."[1] .

Types of Clouds

According to NIST there are four types of clouds on the basis of their deployment characteristics:

"**Private cloud:** In private cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise.

Community cloud: In community cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). The organizations or a third party may manage it and may exist on premise or off premise.

Public cloud: In public cloud the cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.

Hybrid cloud: In hybrid cloud, cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

NIST has also given the service models of clouds that may also be considered as types of clouds depending on the services provided by the third parties, are as follows:

"Cloud Software as a Service (SaaS). The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as a web browser (e.g., web-based email). The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

Cloud Platform as a Service (PaaS). The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers,

Operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations typically through a pay-per-use business model.

Cloud Infrastructure as a Service (IaaS). The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly limited control of select networking components (e.g., host firewalls)."[2]

Cloud Computing Platforms

All Cloud Computing platforms must have some capabilities such as databases, storage, computing fabric, development environments, and security. Major players in cloud computing are like Salesforce, Amazon and Google. EC2 from Amazon, Azure from Microsoft, AppEngine from Google, Blue cloud from IBM and so on are all the cloud-computing platforms in use. In India these facilities are being provided by BSNL-IDC, NEC, NetMagic etc.

Security in Cloud Computing

Security, integrity and confidentiality of data stored in Cloud are the main concern in any type of cloud.

Encryption of data, use of reverse proxies, who allows authenticated, individual access to data on the cloud and also maintains the encryption status of the data at the same time. Rackspace Server Backup offers robust encryption. Even then problem is not completely solved and vulnerabilities exist.

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The National Institute of Standards and Technology (NIST) has been working on the security and privacy issues of cloud computing issued guidelines for managing security and privacy issues in cloud computing. "*Guidelines on Security and Privacy in Public Cloud Computing* (SP 800-144) provides an overview of the security and privacy challenges for public cloud computing and presents recommendations that organizations should consider when outsourcing data, applications and infrastructure to a public cloud environment"[3]

Security issues can also be discussed by the cloud community to the NIST Cloud Research Working group on the new NIST Cloud Computing Collaboration site on the Web http://collaborate.nist.gov/twiki-cloud-computing/bin/view/CloudComputing/.

Review of Literature

There is variety of literature available on cloud computing and its applications in various fields like businesses, Education, etc.

Wikipedia, Special Publications of NIST (National Institute of Standards and Technology) about Cloud computing, some other sites and the book "Handbook of Cloud computing" edited by Borko Furht and Armando Escalante, and some other books gave me thorough understanding of the concept of cloud computing.

Literature search about the applications of cloud computing in libraries of world reveals few articles, which are very recent.

Valdo Pasqui, 2010[4] has discussed about Benefits for libraries using cloud-computing concern the quality of services, saving of cost in infrastructure and management activities, and in digital preservation. He also discussed the negative aspects like strong dependency on Internet, data safety and security, and lack of standards.

Ms. Ellyssa Kroski, 2009 [5] has described about the cloud computing, it's types, its increasing role in the business sector, she also discussed the clouds in the context of libraries. She mainly puts the emphasis on the safety of library data on cloud. Highly sensitive data in libraries like users records may be kept away from the cloud and other less sensitive information like hosting library websites, backing up media collections, or storing and accessing bibliographic data may be managed by the clouds. She also stated some libraries of the world that are adopting cloud services for increasing their efficiencies.

Erik Mitchell, 2010 [6] discussed the experience of Transformation of IT Infrastructure to Cloud-based infrastructure.

Feng Xiaona and Bao Lingyun, 2010 [7] described a current user service model of universities libraries and proposed a new user service model based on cloud computing.

Matt Goldner, 2010[8] discusses how cloud-computing solutions could be beneficial to libraries in three basic areas: technology, data and community.

Indian authors (given below) have also presented some case studies and discussed about the implementation of cloud computing in libraries in India, their benefits, constraints, etc.

Rupesh Sanchati, Gaurav Kulkarni, 2011 [9] have discussed about problems of digital libraries in India and how these problems can be solved through cloud computing. They presented a new user service model by applying cloud computing in university libraries.

Pradeep Teregowda, Bhuvan Urgaonkar C. Lee Giles, 2010 [10] discussed constraints and choices faced by a digital library search engines like CiteSeer by exploring in detail aspects of placing CiteSeer into current cloud infrastructure offerings. They also implement an ad-hoc virtualized storage system for experimenting with adoption of cloud infrastructure services. Their results show that a cloud implementation of CiteSeer may be a feasible alternative for its continued operation and growth.

Prateek Bhanti , Sushma Lehri , Narendra Kumar, 2011[11] focuses on the future scope of cloud computing for universities in India and how by means of cloud computing various compenents of Indian universities like labs, libraries and research facilities can be benefited.

VasanthaRaju N., 2012 [12] discusses about how cloud computing architecture can help colleges to automate their libraries? And he also discussed about cloud Computing ServiceProviders, Issues involved in cloud computing and examples of implementing cloud computing in libraries.

MiteshKumar Pandya, 2012 [13] has given the merits and demerits of clou computing in libraries on the basis of SWOT analysis.

Somesh Kumar, 2013 [14] have discussed about migrating the libraries of rural educational institutions on cloud.

Nand Kishore et al. 2012 [15] tell about the use of cloud computing in libraries.

Objectives of study

1. To put present status of cloud computing in libraries worldwide.
2. Finding possibilities of cloud computing applications in Indian libraries with dwindling budgets.

Libraries in the world implementing cloud computing

Cloud computing is steadily gaining momentum in world's libraries. Many libraries have taken initiatives in the direction of implementation of cloud services.

Recently OCLC under its OCLC Web-scale Management Services (WMS) is providing cloud-based library management services. 37 academic, public and special libraries committed to the full adoption of WMS, and In addition to these 37 libraries in the United States, BIBSYS, the Norwegian consortium of more than 100 libraries, signed an agreement with OCLC to base its new library management system on WMS. These services are effective from July 1st 2011.

Ellyssa Kroski 2009 [16] has given few examples of Libraries in the world "who have already begun to adopt cloud services.

The OhioLINK library consortium is using the Amazon's Web Services to host a handful of their Digital Resource Commons repository instances such as Kent State's Centennial Collection, and is testing server administration in the cloud, as well as the limits of DSpace repository software.

The District of Columbia Public Library is using Amazon's EC2 service to host their website and according to Director of Information Technology, Chris Tonjes, "This provides us with rapid scalability, [and] redundancy (if one Amazon data center fails, a mirrored version of our site is on another and can come online in less than 30 minutes)."

They are also using Amazon's S3 service to backup their ILS, their upcoming digital repository uses Flickr, and Amazon EC2, and the District of Columbia government will soon be adopting the GAPE version of Gmail as its enterprise mail platform. Tonjes adds that "Server virtualization + cloud computing give us great speed and flexibility and typically are significantly cheaper than enterprise data centre-based infrastructure.

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The Eastern Kentucky University Library is using Google Docs to collect responses to web forms, Google Calendar for instruction and meeting rooms, and Google Analytics to collect statistics about their website, catalog and blogs.

At Western State College in Gunnison, Colorado, they are using Google's App Engine for their ELibrary, and have also migrated two Microsoft Access databases that they used for serials circulations and government publication management to that service.

In addition to these libraries, the Library of Congress has entered into a partnership with Duracloud for a one-year pilot program testing out cloud storage capabilities and OCLC has announced a new Web-scale, cooperative library management service." (http://www.libraryjournal.com/article/CA6695772.html)

In India

Indian libraries are not moving with same zeal towards the cloud services like libraries in foreign countries due to data security points and may be because the major players of cloud computing are from US, UK and others so with their data centers are also placed there which may cause some concern about our valuable data to be placed in their data centers. While searching for efforts, which are being done in India for taking the advantage of endless possibilities offered by cloud computing in libraries, I found that arrangements have been made for hosting the database of KOHA (open source library management software) in cloud computing environment with Amazons elastic cloud computing platform by informatics (India) Limited.

Mysore University Library have adopted open source library automation system KOHA for all their house keeping activities including OPAC and the same has been made available in cloud hosting environment. Anybody can access his or her OPAC on Mobile at site http://mopac.mysore-univ.org/

How the libraries in India can be benefited from the cloud computing

Cost savings

In India where most of the libraries struggle with dwindling budgets cloud computing can prove to be a boon to them. Sharing of pooled resourecs on cloud, and collabration in activities of acquisition, cataloguing, digitization and archiving can bring down the budget of public libraries in India. Many public libraries are not having any IT infrastructure due to financial crisis. Clouds presents a new ray of light in the direction of setting up of their own IT infrastructure with

minimum budget by just having an internet connected computer terminal with just enough processing power to run the middleware necessary to connect to the cloud system. There is no need of a large hard drive because you'd store all your information on a remote computer.

In most big organizational libraries where they run their own inhouse servers are not fully utilized to their maximum capacity as in some hours work demands decreases and it does not require that much of capacity. As in cloud computing we know "you pay as you use" can help provide the libraries to customize and extend or cut off their services according to the requirements means we only have to pay for processing power, bandwidth and storage space and application software not for purchasing and maintenance of software, server and infrastructure.

According to a cloud computing use cases white paper 2009 [17] "In the cloud-based version of the application, processing time for the payroll task was reduced by 80%. As an added benefit, two servers formerly dedicated to processing payroll were freed up for other tasks."

Resource sharing

The main advantage of cloud based data is easy sharing of data and applications among users. It provides more resources for more users. Like OCLC Web scale management services the libraries in India can also share their data by cooperative collection building, preservation and digitization of data on clouds. Other materials and applications of libraries can also be shared when on clouds and in result leading to more time and more services for their users

Customization of library services

Library management services can be customized on occasions of high demand by using new services and applications available on an open cloud platform. Librarians can concentrate more on providing better and better resources and services to users in the format required without worrying about security issues, hardware and software requirements and disaster recovery system. This will lead to a need based flexible architecture where the resources will increase or decrease with little configuration changes.

More choices to manage libraries

Cloud computing has allowed libraries to make strategic choices about the allocation of resources and to offer better services which could not be possible through existing in-house infrastructure. Libraries can expand and cut off their services according to the budget allotted to them as the cloud computing provides pay as much as you use facilities.

Space problem can be solved for keeping servers and digital storage devices in libraries through clouds as they provide their own servers to store a huge amount of data of any library.

Easy and remote access to library resources

Users (i.e. members) of the library can easily get access to library resources while being in remote places. They can visit the shared resources by any terminal equipment such as PC, mobile phone or PDA only if have access to the Internet.

Agility

Cloud computing has the ability to quickly adjust our IT infrastructure to meet the changing needs and demands of the users typically provides the greatest benefits over time.

More quick and accurate Reference service

This technology will aid Librarian in answering queries faster and accurately. The Reference Librarian and users communicate over e-mail, instant messaging, video conferencing, chatting etc. This allows more focus of our librarians on providing services further develop capabilities that can facilitate more users in more better ways.

Ability to handle large amount of non-textual data

In academic libraries of some reputed institutions like IITs, NITs and universities in India where a large amount of data is in digital form, institutional repositories having their scholarly materials, digital archives having rare artifacts presents a need of complex and strong IT Infrastructure to manage storage, security and access to all these. Cloud computing may be the solution. Digital libraries of such institutions spend major percentage of their budget on

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acquiring of electronic journals and databases. Shared clouds can help them to reduce the purchase cost of electronic resources.

Saving of other expenditures

Such as expenditure in maintaining and operating the data center, supporting staff providing infrastructure support, in turn it saves the building related expenditures i.e. power and cooling.

Applications of three types of cloud services in libraries

Three types of cloud services Iaas, Saas and Paas can benefit our libraries in different ways. Networking, storage, security problems, operating systems, applications and software, all requirements of libraries can be fulfilled. Libraries having their existing infrastructure can also take the additional advantages from it.

Software as a service (Saas) KOHA, DuraCloud, SerialSolutions etc. are examples of Saas. The vendor provides them and Librarian only have to use these application softwares without bothering about their maintenance and management.

Platform as a service (Paas) provides a platform for application software of libraries either running on cloud or locally developed. Server, Operating systems and Database support is provided by Paas. Google Apps Engine, "Windows Azure" platform from MS, Google Big Table, Plesk are examples of Paas

Infrastructure as a service (Iaas) provides computing and storage facilities on cloud hosting environment. Amazon's Elastic Computing (EC2) offers IT infrastructure for organizations to launch differently sized servers using a variety of operating systems, including several flavors of Linux and Windows. And S3 provides organizations with essentially unlimited storage.

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Prerequisites for implementing cloud computing in libraries

a. **Need of a well effiecient IT Professional**:

Althogh many applications available in the cloud require much less in-house IT support because the hosting provider takes care of installs, upgrades, backups and standard maintenance for you. If the library professionals do not have much knowledge and competency then we need IT professional for evaluation of competing vendors on variety of criteria like data storage, bandwidth, access time, security, management and monitoring and optimization services and who can talk on SLAs that holds vendors to certain standards with regards to reliability and security of their services.

b. **Service Level Agreements:**These are necessary because you access information, data, applications and other services on-line and without these it can be difficult to continue working effectively. According to Wikkipedia[18] SLA is "a negotiated agreement between two parties wherein one is the customer and the other is the service provider. A definition of services, priorities, responsibilities of performance measurement, problem management, customer duties, warranties, gauranties, disaster recovery, termination of agreement is the main points to be discussed before dealing with cloud vendors."

c. **Training to staff:**

To Implement the cloud computing in our Indian libraries and to make the libraries successful in terms of services and resources with a low budget, it is necessary that librarians should be familiar with concept of cloud computing and its applications before implementing it, however big players in this provide good documentation about their services. University Grants Commission (UGC) should include the topic in regular refresher courses for the university and affiliated college library staff.and other Associations of library science in India like IASLIC should conduct training programs and workshops to provide the practical knowledge of cloud computing and its real potentials for use in the library context. This will help librarians developing new competencies and skills to evaluate cloud based infrastructures, platforms and software for their library.

d. Some legal and operational issues:

As cloud computing offers remotely the subscription based services so it opens new challenges of legal and operational issues to organisation adopting them.Trustworthiness of various cloud computing platforms in terms of their data confidentiality and safe and secure access only to the authenticated users are also the major issues, government regulations and policies regarding above issues should be taken into consideration before implementing cloud services. BSNL-IDC (Bharat Sanchar Nigam Limited-Internet Data Center) with its six data centers across the country also gives the alternative to librarians who don't want to put their valuable data on data centers of cloud vendors like Amazon in other countries due to safety reasons.

Ellyssa Kroski (2009) has suggested the middle solution of these problems that "libraries may choose to continue to host some of their own systems while using the cloud for less sensitive processes such as hosting library websites, backing up media collections, or storing and accessing bibliographic data."[19]

Libraries can build their own hybrid cloud (Eucalyptus, an open source platform) in order to fight the problem of security, privacy and reliability. According to Chris Peters, 2010 "A hybrid cloud is primarily based in a privately-owned and operated data center, but it can shift some of its traffic and data processing requests to public cloud vendors such as Amazon or Rackspace on an as needed basis. This hybrid model would let libraries maintain more control over the applications and data stores that contain sensitive, private information about patrons. Moreover, libraries can continually adjust and fine-tune the

balance between the tight control of a private IT infrastructure, and the flexibility and savings of cloud-hosted infrastructure."[20]

e. Finding right vendor:

Finding right vendors / cloud hosting organizations might be a big concern in front of any library professional going for cloud implementations. Solution to find the right vendor according to the location, size of library and resources already available to library lies in some independently owned and operated professional hosting review websites like

WebHostingTop, Conjugo, etc. that can enable Librarians to take right decision in selecting according to their needs and budget.

Conclusion

With the introduction of Cloud Computing to Indian libraries, services of libraries with low budget also will have a new leap in the near future. Services provided by libraries will become more user-centric.

Putting more sensitive data of library like user records etc. in the control of library's own local system and less sensitive on clouds presents the solution of security and safety of data and also gives an opportunity to the librarians to slowly deploy cloud services by finding its pros and cons. Although Map reduced frameworks (Apache Hadoop, an open Source version of Google's Map Reduce) in clouds which process vast amount of data (Multi-tera bytes data sets) in parallel on thousands of nodes in a reliable and fault tolerant manner which takes care of scheduling the tasks, monitoring them and re-executes the failed tasks. There is also the solution of having multiple remote hosts that can solve the problem of damage of remote host due to any disaster. At initial stage cloud application should be treated as a support or extra advantage to the present IT System in library and should be implemented over time with thorough consideration and budget planning. With cloud computing, libraries can monitor current needs and make adjustments to increase or decrease capacity of their IT system without paying for unused capacity during slower times.

University libraries and libraries of big and reputed institutions like IITs, IIMs or NITs etc. where electronic journals, electronic databases need a heavy budget to maintain their subscription shared clouds can prove to be beneficial. It not only reduces the purchase cost of electronic resources repeatedly among allied libraries. Users can also access these shared resources by any Internet connected terminal such as PCs, mobile phones or PDAs.

Besides all above to squeeze the full potential of this new technology in Indian libraries our professionals need to be well trained and supported by the well-laid out policy and programmes of updating and equipping with this technology by different associations of libraries and government bodies in education sector in India.

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