Application of Cloud Computing Technology in Libraries

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ABSTRACT

Cloud computing is a technology that uses the Internet and central remote servers to maintain data, software and application. In other words, it is a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service to the external customers using internet technologies. It came up as a boon for libraries and is offering various opportunities for libraries to connect their services with clouds. After thorough literature search, in this paper author try to highlights the segments, types, and characteristics of cloud computing. Apart from the basic knowledge about cloud computing, this paper also deals with cloud computing initiatives for libraries and major cloud computing service providers. An attempt also made to know the application of cloud computing in libraries along with its benefits in LIS domain.

Keywords: Cloud Computing, Segments and Characteristics. Cloud computing and libraries.

Introduction

Cloud computing is a new technique of computing service offered over the internet, which has completely changed the way one can use the power of computers irrespective of geographic location. Cloud computing provides a shared pool of resources, including data storage space, networks, computer processing power, and specialized corporate and user applications. It helps peoples to access their e-mail, social networking site or photo service from anywhere in the world, at any time, at minimal or no charge. It is also attracted and adopted by various organizations and enterprises such as Google, Yahoo, Microsoft, Amazon, etc. adopting for infrastructure solutions. Libraries are not exception to it. Cloud computing contains features of different technologies including utility computing, grid computing, unified computing, web 2.0, service oriented architecture and so on. Nowadays, it is emerged as one of the most popular virtual technology for libraries to deliver its services in an effective manner. After thorough literature search, in this paper authors try to highlights the segments, types, and characteristics of cloud computing. Apart from the basic knowledge about cloud computing, this paper also deals with cloud computing initiatives for libraries and major cloud computing service providers. An attempt also made to know the application of cloud computing in libraries along with its benefits in LIS domain.
What is Cloud and Cloud Computing?

In cloud computing, the word “Cloud” is used as a metaphor for the Internet, based on the standardized use of a cloud-like shape to denote a network on telephony schematics. The “Cloud” element of Cloud Computing can be seen as an acronym that stands for:

C ⇒ Computing resources,
L ⇒ that is Location independent,
O ⇒ can be accessed via Online means,
U ⇒ used as an Utility &
D ⇒ is available on Demand\(^1\).

Cloud computing means cloud based networking environment. It is a kind of computing technology which facilitates in sharing the resources and services over the internet rather than having these services and resources on local servers/ nodes or personal devices. The combination of servers, networks, connection, applications and resources is defined as ‘cloud’. In other words it means internet-based computing in which large groups of remote servers are networked so as to allow sharing of data processing tasks, centralized data storage, and online access to computer services or resources. It is acting as a resources pooling technology for accessing infinite computing services and resources as per demand of users and can be compare with models of pay as you use or utility model same as used for mobile services usages and electricity consumption.

According to Wikipedia\(^2\), cloud computing is the delivery of computing as a service rather than a product, whereby shared resources, software and information are provided to computers and other devices as a utility (like the electricity grid) over a network (typically the Internet).

The Christy & Carina\(^3\) of Gartner Group define cloud computing as ‘a style of computing in which massively scalable and elastic IT-enabled capabilities are delivered as a service to external customers using Internet technologies’.

U.S. National Institute of Standards and Technology (NIST)\(^4\) defines “Cloud computing is a model for enabling 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. This cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models”.

Buyya\(^5\) defined “Cloud computing is a parallel and distributed computing system consisting of a collection of inter-connected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on Service Level Agreements (SLA) established through negotiation between the service provider and consumers”.

Segments of Cloud Computing

The three different segments of Cloud computing is as follows as shown in figure 1 given below:

![Figure 1: Segments of Cloud computing.](http://www.ijlis.org)
**Application**: It is the first segment without which a concept of cloud computing cannot be survived. It is the part of internet technology which is proved already as the constructive and helpful model.

**Storage**: It is considered as the backbone of the main concept of Cloud Computing also called as infrastructure. All the vendors will permit the users to create their own cloud applications within the limited space.

**Connectivity**: It is the important part of the cloud. Without high speed internet connectivity there will be no use of application and storage. Therefore, the high speed leased line internet connectivity is necessary to connect with the cloud. All above three segments are inter-related with each other and out of three if, anyone is missing then a concept of cloud will remain unfulfilled.

**Types of Cloud Computing**

The different types of Cloud computing is as shown in the figure 2 given below:

On the basis of service
Infrastructure: Infrastructure is referred as resource clouds. It is being provided by third party as service to the users to use them the way they want. For example: Amazon S3(Amazon Simple Storage Service)

Platform: Basically, platform is a set of computational resources using which one can use the infrastructure. In other words, it is a set of computer application developed and hosted on the cloud to access and manage the data. For example: Google App Engine, Windows Azure (Platform)

Services: They are the set of applications developed by the service provider to use cloud infrastructure and platform. For example: Google Docs

![Types of Cloud Computing](image)

**Figure 2: Types of Cloud computing**

On the basis of Usage

Private clouds: They are available only to the members of the organization. They facilitate user to store and disseminate their data on respective cloud. For example: Institutional cloud, ebay etc.
Public clouds: Any institute may use cloud service from third party which may available free or with cost can be considered as public cloud. For example: Google apps, Windows Azure

Hybrid clouds: As public cloud allow any organization to outsource their part of infrastructure to service provider, at the same time organization would lose the control over resources and data management. In this type of cloud a part of cloud will be given public for use. For example: Google Apps

Community clouds: They are specifically organized clouds and are limited for specific group. For Example: Institutional Gmail of Google Apps

Special clouds: They are extensions of normal cloud system to provide additional services. For Example: Google App Engine

**Characterstics of Cloud Computing**

Some of the important characterstics of Cloud computing is as follows (as shown in figure 4):

Self Healing: Any application or any service running in a cloud computing environment has the property of self healing. In case of failure of the application, there is always a hot backup of the application ready to take over without disruption. There are multiple copies of the same application - each copy updating itself regularly so that at times of failure there is at least one copy of the application which can take over without even the slightest change in its running state.

Multi-tenancy: Cloud computing supports multi-tenancy i.e., multiple tenants can use any application at the same instant of time. The system allows several customers to share the infrastructure allotted to them without any of them being aware of the sharing. This is done by virtualizing the servers on the available machine pool and then allotting the servers to multiple users. This is done in such a way that the privacy of the users or the security of their data is not compromised.

Linearly Scalable: Cloud computing services are linearly scalable. The system is able to break down the workloads into pieces and service it across the infrastructure. An exact idea of linear scalability can be obtained from the fact that if one server is able to process say 1000 transactions per second, then two servers can process 2000 transactions per second.

Service-oriented: Cloud computing systems are service oriented - i.e. the systems are such that they are created out of other discrete services. Many such discrete services which are
independent of each other are combined together to form this service. This allows re-use of the different services that are available and that are being created. Using the services that were just created, other such services can be created.

SLA (Service-Level Agreements) Driven: Usually organizations have agreements on the amount of services. Scalability and availability issues cause clients to break these agreements. But cloud computing services are SLA driven such that when the system experiences peaks of load, it will automatically adjust itself so as to comply with the service-level agreements. The services will create additional instances of the applications on more servers so that the load can be easily managed.

Virtualized: The applications in cloud computing are fully decoupled from the underlying hardware. The cloud computing environment is a fully virtualized environment.

Flexible: Cloud computing services are flexible. They can be used to serve a large variety of workload types - varying from small loads of a small consumer application to very heavy loads of a commercial application.

Cloud Computing Service Providers.

Some important Cloud computing service providers are as follows:

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<tr>
<th>Sl No.</th>
<th>Cloud Computing Service Provider</th>
<th>Web Address</th>
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<tbody>
<tr>
<td>1.</td>
<td>Salesforce</td>
<td><a href="http://www.salesforce.com">http://www.salesforce.com</a></td>
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<tr>
<td>5.</td>
<td>Oracle</td>
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<td>7.</td>
<td>Softlayer</td>
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<td>Rackspace</td>
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Cloud computing initiatives for Libraries

Some important Cloud computing initiatives for libraries are as follows:

OCLC Webscale: OCLC has set an example for making use of cloud computing for libraries. Years together OCLC has been functioning as a cloud computing vendor because they provide cataloguing tools over the internet and allow member institutions to draw on their centralized data. Its worldshare management services (WMS) allows libraries to manage entire collection management life cycle in a cloud-based application^9^.

Ex-Libris Cloud: Ex-Libris is a leading provider of cloud-based solutions that automate library operations. Over 5300 customers in more than 80 countries, including 175 of top 250 universities worldwide and over 40 national libraries deploy Ex-Libris solutions to create a unified platform for both the management and discovery of library resources. Ex-Libris cloud-based solutions allow libraries to lower operational costs, enhance efficiency, and extend their value to the organization through diverse new services and collaboration with other libraries and organizations. It provides streamlined access to all the library’s collections—whether online journals, e-books, printed resources or digital material^10^.
Duraspace Cloud: Duraspace provides open source repository solutions by undertaking turnkey projects for organizations and libraries to enable them to share scholarly literature using D-Space and Fedora Commons. Its new service Dura Cloud provides digital preservation support services in the cloud, which is cost effective and simple for libraries. Dura Cloud helps libraries to move content to the cloud and store it with different service providers to eliminate the risk of data loss. The cloud solutions offered include online backup, preservation and archives, media access and online sharing.\(^\text{11}\).

7.4 OSS(Open Source Software) Labs: OSS labs from India is using Amazon’s elastic cloud computing platform owing to the various capabilities of Amazon such as high durability of data, strong information security based on ISO standards, scalability, and flexibility. It is expected that the OSS labs will be able to provide robust open based solutions to demanding customers. Using Amazon’s cloud services, it is offering Koha ILS and DSpace institutional repository hosting and software maintenance subscription services for libraries.\(^\text{12}\).

Application of Cloud computing in Libraries

Libraries are shifting their services with the attachment of cloud and networking with the facilities to access its services anywhere and anytime. In the libraries, the following possible areas (as shown in the figure 4) were identified where cloud computing services and applications may be applied.

Building Digital Library/Repositories: In the present situation, every library needs to build a digital library to make their resources, information and services at an efficient level to ensure access via the network. Therefore, every library is having a digital library that developed by using any digital library software. Cloud computing software help libraries to build an effective and efficient digital library and digital repositories. For example:, Duraspace is a cloud based digital library software is having two software’s namely D-space and Fedora Commons acts as a complete solutions for developing digital libraries/ repositories with standard interfaces and open source codes for the both software.
Searching Scholarly Content: Cloud computing facilitates platform to discover and share the scholarly content. It acts as collaborative platform to empower libraries for dynamic searching and also for single point search interface, maximizes the usage of all e-resources, customized search across selected sources reduces noise and highlights relevant content and tools to support the complete research lifecycle. For example: Knimbus is cloud based research platform. It is a Knowledge Cloud which is dedicated to knowledge discovery and collaborative space for researchers and scholars. It is a collaborative platform for researchers to discover and share knowledge with peers and facilitates to find and access millions of journal articles, patents and e-books, for the users tagging, sharing and discussing of these contents with their peers.

File Storage: cloud computing presents number of services to access any files on the internet such as Flicker, Dropbox, Jungle Disk, Google Doc, Sky Drive and so on. These services virtually share the files on the web and provide access to anywhere and anytime without any special software and hardware.

Library automation and house-keeping activities: Cloud computing services also supports for library automation and house-keeping activities. For example: Polaris provides variant cloud based services such as acquisitions, cataloguing, process system, digital contents and provision for inclusion of cutting edge technologies used in libraries and also supports various standards such as MARC21, XML, Z39.50, Unicode and so on. Now-a-days many of the software vendors such as Ex-Libris, OSS Labs are also offering this service on the cloud and third party services offering hosting of this service on the cloud to save libraries from investing in hardware for this purpose. It is a cost-benefit approach to make the libraries to be free from taking maintenance namely, software updates, backup and so on.

Library Website Hosting: Cloud computing technology also facilitates many organizations including libraries preferred to host their websites on third party service providers rather than hosting and maintaining their own servers. For example: Google Sites serves as an example of a cloud service for hosting websites outside of the library’s servers and allowing for multiple editors to access the site from varied locations.

Building Community Power: Cloud computing technology offers great opportunities for libraries to build networks among the library and information science professionals as well as other interested people including information seekers by using social networking
tools. The most famous social networking services namely Twitter and Facebook which play a key role in building community power. This cooperative effort of libraries will create time saving, efficiencies and wider recognition, cooperative intelligence for better decision-making and provides the platform for innovation and sharing the intellectual conversations, ideas and knowledge.

Searching library data: Cloud computing technology also facilitates libraries for searching and sharing its data for years together. For example, OCLC World Cat service is one of the popular service for searching library data using cloud computing technology. OCLC is offering various library activities pertaining to circulation, cataloguing, acquisition and other library related services on cloud platform through the web share management system.

Benefits of Cloud computing in Libraries

The application of Cloud computing technologies in libraries is beneficial in different ways, such as:

- Cost-saving: Cloud computing technology is paid incrementally. Libraries are only paying for the resources they actually use.
- Easy on installation and maintenance: Libraries are no need to worry about constant server updates and other computing issues.
- Increased Storage: Cloud can hold more storage than a personal computer or the servers available in the libraries and it is possible to extend as per the need.
- Highly automated: The library staff need not have to worry about keeping the software up-to-date. The cloud service provider takes care of updating software as and when new version is released. When the server is updated everyone using the service also get access to the new version without updating anything on their end.
- Flexibility: Cloud computing technology offers more flexibility to libraries to expand the services anytime, by requesting for an additional space on the servers.
- Better mobility: The staff and the users of the library can connect to the library servers from any place or from wherever they are, rather than having to remain present at their desks by having a PC and Internet access.
- Shared resources: Cloud computing technology facilitates a group of libraries can come together and can put their resources at one place, which in turn will enable them to provide access to more number of resources to their end users.

Disadvantages of Cloud computing

- Following are some of the main disadvantages of cloud computing:
- Data security and privacy: The biggest challenge in cloud computing are security and privacy. If the proper security model is not yet in place, then the data stored on the cloud is vulnerable to attacks from viruses, theft, etc. In addition to that, since the services are offered over the Internet it is very difficult to assess the physical location of servers and software and security audit is hard to undertake. Also, there is a risk of data loss owing to improper backup and systems failure.
- Network connectivity and bandwidth: Since the cloud computing is offered over the Internet, if the connection goes down due to any reason then the organizations suffer from loss of data connectivity till the time it is set. Also the service requires more bandwidth, as it may not work on low-speed Internet connections.
- Dependence on outside agencies: The cloud services being offered by third party services over the Internet, it is virtually difficult to have any control on the maintenance levels and the frequency. Also it is tough to assess the contingency.
procedures of the service provider in regard to backup, updates, restore and disaster recovery. Migration to other service provider is also an issue, if the uniform standards are not followed by the host\textsuperscript{14}.

**Conclusion**

Concluding it can be said that cloud computing technology provides libraries an opportunity to improve their services and relevance in today’s information society. It can bring several benefits for libraries and give them a different future. It helps libraries to deliver its resources, services and expertise at the point of need, within user workflows and in a manner that users want and understand. It should free libraries from managing technology so they can focus on collection building, improved services and innovation. The cloud computing model will encourage libraries and their users to participate in a network and community of libraries by enabling them to reuse information and socialize around information. It can also create a powerful, unified presence for libraries on the Web and give users a local, group and global reach.

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