Cloud computing technology came up as a boon for libraries and is offering various opportunities for libraries to connect their services with clouds. The paper presents an overview of cloud computing and its possible applications that can be clubbed with library services on the web based environment. This study may be helpful in identifying and generating cloud based services for libraries.


**ABSTRACT**

Cloud computing technology came up as a boon for libraries and is offering various opportunities for libraries to connect their services with clouds. The paper presents an overview of cloud computing and its possible applications that can be clubbed with library services on the web based environment. This study may be helpful in identifying and generating cloud based services for libraries.


**INTRODUCTION**

In present scenario, web enabled technologies developed on virtual platforms and generating large opportunities and virtual paths to use their services for the various purposes. Nowadays, cloud computing is emerged as one of the most popular virtual technology for libraries to deliver the services in an effective manner. Cloud computing contains features of different technologies including utility computing, grid computing, unified computing, web 2.0, service oriented architecture and so on. Cloud computing technology is offering great advantages for libraries to connect their services not only promptly but also in new formats with the flexibilities such as pay as you use model, access any where any time and so on. Nowadays libraries are using cloud computing technology for enhancing the services by adding more values, attracting the users and cost effectiveness. In the cloud computing environment, clouds are vast resource pools with on demand resource allocation and a collection of networked features. The new concept of cloud and libraries has generated a new model called cloud libraries. Though the usages of cloud computing may vary with the libraries nature, services and information needs but most common usages of cloud computing with in libraries can be development of digital libraries, corporate cataloging, acquisition, storages and sharing the resources on virtual environment on the web. The need of cloud computing may occur due to the information explosion, problems in accessing the information, save the time of the users and staff, resource sharing problems, problems in library resources management, complex demand of users and attraction of users towards cutting edge technologies.

**What is Cloud Computing?**

Cloud computing is not a new technology that suddenly appeared on the web but it is a new form of computing. Cloud computing 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’. Cloud computing 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.

Wikipedia\(^1\) claimed that the concept of cloud computing was emerged back to the 1960s, when John McCarthy opined that computation may someday be organized as a public utility. Chellappa gave the first academic definition of the term Cloud Computing in 1997 and later on, in the year 2007 the term cloud computing came into popularity and firstly was used in this context when Kevin Kelly opined that eventually we will have the inter-cloud, the cloud of clouds.

NIST\(^2\) provides a very good definition of cloud computing as cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction. This definition applies to all cloud computing models – public, private, and hybrid – in that it identifies the core attributes, characteristics, and capabilities that define cloud 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.’ Buyya4 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.’

The common characteristics of cloud computing noticed from above definitions are:

- Pay Per Use (No Ongoing Commitment, Utility Prices)
- Elastic Capacity and the Illusion of Infinite Resources
- Self Service Interface
- Resources that are Abstracted or Virtualized.

**LITERATURE REVIEW**

Various studies were conducted on cloud computing and libraries related issues such as Khan4 provided the concept of cloud computing and also highlighted that how libraries can be benefited using cloud computing technology by providing some live examples. Pandya5 investigated the implication issues of cloud computing in libraries on the basis of SOWAT analysis and pointed out the strengths, weaknesses, opportunities, and threats associated with cloud computing and libraries. Goldner6 expressed the view with regard to cloud computing, how cloud computing is differed from the other computing and its advantages to libraries in three basic areas: Technology, data and community. Srivastava7 presented the vision of cloud computing with various commercially cloud services available on the Infrastructure as-a-Service (IaaS) and found that cloud computing is changing the way towards hardware and software for on-demand capacity fulfillment and development of web applications to make business decisions. Murley8 provided an overview of cloud computing and list of resources and services may attach with cloud computing technology particularly in law libraries and also stated that cloud computing is not new for law libraries. Sasikala9 argued the concept of cloud computing from the perspectives of diverse technologists, services and models available, cloud standards, cloud in government, enterprises and higher education, along with opportunities, challenges and implications on the basis past, present and future situation. Goyal10 defined the benefits and comparisons of cloud computing services on the parameters of pricing, maximum limit, data security, data backup. This paper also includes the advantages and disadvantages of cloud computing. Jordan11 expressed that cloud computing technology are clubbing with libraries services and web scale services are developing on the web in order to present the library services when and where required the users by example of Online Computer Library Center (OCLC) services. Wang12 examined the trends of cloud computing on the basis of extensive information systems literature, industry reports and practical experience reflections and also pointed out the significance of cloud computing and its implications for practitioner and academics.

**OBJECTIVES**

- To define the concept of cloud computing.
- To discover the library services that are clubbing with cloud computing technology.
- To investigate present situation of Indian libraries in order to adopt cloud computing into their library services.

**Models of Cloud Computing**

**Service Models**

Though, there are various service models originated on the web but three service models widely used for delivering the different cloud based services that described below:

- **Infrastructure as a Service (IaaS)**
  
  This service model comprises a wide range of features, services and resources which support to build an virtual infrastructure for computing. Organizations can be developed entire infrastructure on demand. e.g. Amazon Web Services, Rackspace, Savvis, HP, IBM, Sun and Google Base.

- **Platform as a Service (PaaS)**
  
  Platform as a Service model helps in generating the computing platforms to run the software and other tools over the internet without managing the software and hardware at the end of user side. Amazon Elastic Cloud, EMC Atmos, Aptana and GoGrid are the examples of PaaS model which providing platforms to users in maintaining and supporting their IT infrastructure without spending huge amount for buying hardware, software and related technology.

- **Software as a Service (SaaS)**
  
  In this model, users can avail the facilities to access and use any software available with cloud vendors. However, it is not necessary for the users to buy the software, install and run, maintenance the applications on their own servers. The cloud users need not to manage the cloud infrastructure and platform on which the application is running. This service model provides online email applications, free services, limitless storage, and remote access from any computer or device with an Internet connection.

**Deployment Models**

Currently, four types of cloud deployment models have been defined in the cloud community:

- **Private Cloud**
  
  This kind of deployment model solely developed and managed by a single organization or a third party regardless whether it is located in premise or off premise. There are several reasons behind the development of private cloud for an organization some key reasons include optimize utilization of existing in-house resources, security concerns including data privacy and trust also make private cloud an option for many firms, data transfer cost from local IT infrastructure to a Public Cloud is still rather considerable, organizations always require full control over mission-critical activities that reside behind their firewalls and for research and teaching purposes.

- **Community Cloud**
  
  It is a joint venture of several organizations come together to
build a cloud infrastructure as well as policies through which cloud services will be rendered. This type of cloud deploy model helpful in developing of economic scalability and democratic equilibrium. In the community cloud model, cloud infrastructure may be hosted by a third party vendor or within one of the organizations in the community.

- **Public Cloud**
  Public cloud is meant for general public use and open to all. This kind of deployment model of cloud computing is developed by any cloud computing agency and having own policy, value, and profit, costing, and charging model. Some popular public cloud services include Amazon EC2, S3, Google App Engine and Force.com.

- **Hybrid Cloud**
  This type of cloud made from more than one cloud deployment models that may be public, private, community and other models also, bound together with standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds). The Hybrid cloud model is widely used by institutions and organizations because this model provides more facilities and flexibilities in making optimum use of their resources and accomplishing the tasks.

- **Applications of Cloud Computing In Libraries**
  Libraries are shifting their services with the attachment of cloud and networking with the facilities to access these services anywhere and anytime. In the libraries, the following possible areas were identified where cloud computing services and applications may be applied:

- **Building Digital Library/Repositories**
  In the present situation, every library needs 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. In connection to cloud based digital library software, Duraspase is having two softwares namely Dspace and Fedora Commons but Dspace is widely used for building digital libraries/ repositories relative to Fedora Commons. Dura cloud provides complete solutions for developing digital libraries/ repositories with standard interfaces and open source codes for the both software.

- **Searching Library Data**
  OCLC is one of the best example for making use of cloud computing for sharing libraries data for years together. For instance, OCLC World Cat service is one of the popular service for searching library data now is available on the cloud. OCLC is offering various services pertain to circulation, cataloguing, acquisition and other library related services on cloud platform through the web share management system. Web share management system facilitates to develop an open and collaborative platform in which each library can share their resources, services, ideas and problems with the library community on the clouds. On the other hand, the main aim of web- scale services is to provide cloud based platforms, resources and services with cost benefit and effectiveness to share the data and building the broaden collaboration in the community.

- **Website Hosting**
  Website hosting is one of the earliest adoptions of cloud computing as many organizations including libraries preferred to host their websites on third party service providers rather than hosting and maintaining their own servers. Google Sites serves as an example of a service for hosting websites outside of the library’s servers and allowing for multiple editors to access the site from varied locations.

- **Searching Scholarly Content**
  Knimbus is cloud based research platform facilitates to discover and share the scholarly content. Knimbus stands for Knowledge Cloud which is dedicated to knowledge discovery and collaborative space for researchers and scholars. Knimbus was started its journey in 2010 by the entrepreneurs Rahul Agarwalla and Tarun Arora to address challenges faced by researchers in searching across and accessing multiple information sources. Knimbus is currently used in over 600 academic institutions and R&D labs by scholars, researchers and scientists as well as over 50,000 researchers. Knimbus 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 ebooks, for the users tagging, sharing and discussing of these contents with their peers. At present, Knimbus proposed a free offer to get registered to empower the 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. Currently, Information and Library Network (INFLIBNET) Centre (http://www.inflibnet.ac.in) has been incorporated Knimbus cloud service into its UGC INFONET Digital Library Consortium in order to search and retrieve scholarly contents attached therein.

- **File Storage**
  To access any files on the internet, cloud computing present number of services 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. Therefore, libraries can get advantages of such cloud based services for various purposes. For instance, LOCKSS (Lots of Copies Keeps Stuff Safe), CLOCKSS (Controlled LOCKSS) and Portico tools are extensively used for digital preservation purpose by libraries and other organizations.

- **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 viz. 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.

- **Library Automation**

For library automation purpose, Polaris provides variant cloud based services such as acquisitions, cataloging, 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 which directly related to library and information science area. Apart from this, nowadays 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 (SaaS approach) on the cloud to save libraries from investing in hardware for this purpose. Besides cost-benefit, the libraries will be free from taking maintenance viz. software updates, backup and so on.

- **Present Situation of Indian Libraries**

In India, cloud computing in libraries is in development phases. Libraries are trying to provide to users cloud based services but in real sense they are not fully successful owing to the lack of good service providers and technical skills of LIS professionals in the field of library management using advanced technology. But some services such as digital libraries, web documentation and using web2.0 technologies are running on successful modes. Some good examples of successful cloud computing libraries include Dura cloud, OCLC services and Google based cloud services. Nowadays many commercial as well as open sources vendors (i.e. OSS) are clubbing the cloud computing technology into their services and products. However, cloud computing technology is not fully accepted in the Indian libraries but they are trying to develop themselves in this area.

**CONCLUSION**

This study provides cloud computing concepts and implications of cloud based applications in libraries in order to enhance their services in a more efficient manner. No doubt, libraries are moving towards cloud computing technology in present time and taking advantages of cloud based services especially in building digital libraries, social networking and information communication with manifold flexibilities but some issues related to security, privacy, trustworthiness and legal issues were still not fully resolved. Therefore it is time for libraries think seriously before clubbing libraries services with cloud based technologies and provide reliable and rapid services to their users. Another role of LIS professionals in this virtual era is to make cloud based services as a reliable medium to disseminate library services to their target users with ease of use and trustworthiness.

**REFERENCES**