

# CLOUD COMPUTING IN LIBRARIES

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**Abstract:** Cloud computing is an emerging technology which facilitates access to shared resources on demand. In cloud computing virtualized resources and applications are provided as services over internet. This paper discusses the concept of cloud computing, its evolution, the technology, features, types and applications in library services.

**Keywords:** Cloud Computing, Private Cloud, Public Cloud, Hybrid Cloud, Virtualization, Saas, PaaS, IaaS, Cloud storage

**1.0 Introduction:** Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be provisioned and released with minimal management effort or service provider interaction (National Institute for Standards and Technology (NIST)). In cloud computing the services are hosted remotely and accessed over network.

## 1.1 Review of Literature

Cloud Computing is used in libraries in order to reduce cost and increase productivity. Nooshinfard and Ghorbani (2014) investigated the effectiveness of cloud computing in reducing cost, the threats to information security and career of IT experts. The results show that use of cloud computing can lower the costs and there will be threat for data security and relative down in career of IT experts.

Librarians in academic libraries though face challenges such as lack of expertise, time factor, and staff are actively implementing cloud computing in library services. Tritt and Kendrick (2014) examined the impact of cloud computing on librarians of small and rural academic libraries and how reliability, security, and proficiency of staff impact the use of cloud computing.

Most of the librarians in Indian central universities use cloud computing for library services. Yuvaraj (2013) explored the use of cloud services in these libraries and the study shows that the user's preference and cost are the main factors to use this technology. The librarians also have a concern over information security in cloud services.

Security and privacy issues are main factors in adapting cloud computing technology. Kothari (2013) discusses how resources are shared in cloud computing and the threats related with it.

The usage of cloud computing diminished due to the security issues. Khan (2016) presented a review of security threats and its countermeasures. Different kinds of intrusion detection mechanisms are compared and various mechanisms to address the security issues are analyzed.

## 2.0 History of Cloud Computing

Various computing models existed earlier were peer-to-peer, client-server, grid computing, etc (Jayaswal et al, 2014). In peer-to-peer architecture the communication control is decentralized. Each host acts as a server of certain services. In client-server architecture client depends on servers for various services. In grid computing, a group of computers work together to perform a common task. In cloud, users have the access of shared pool of resources, such as servers, storage, etc over internet.

The evolution of cloud computing is shown in the given diagram.

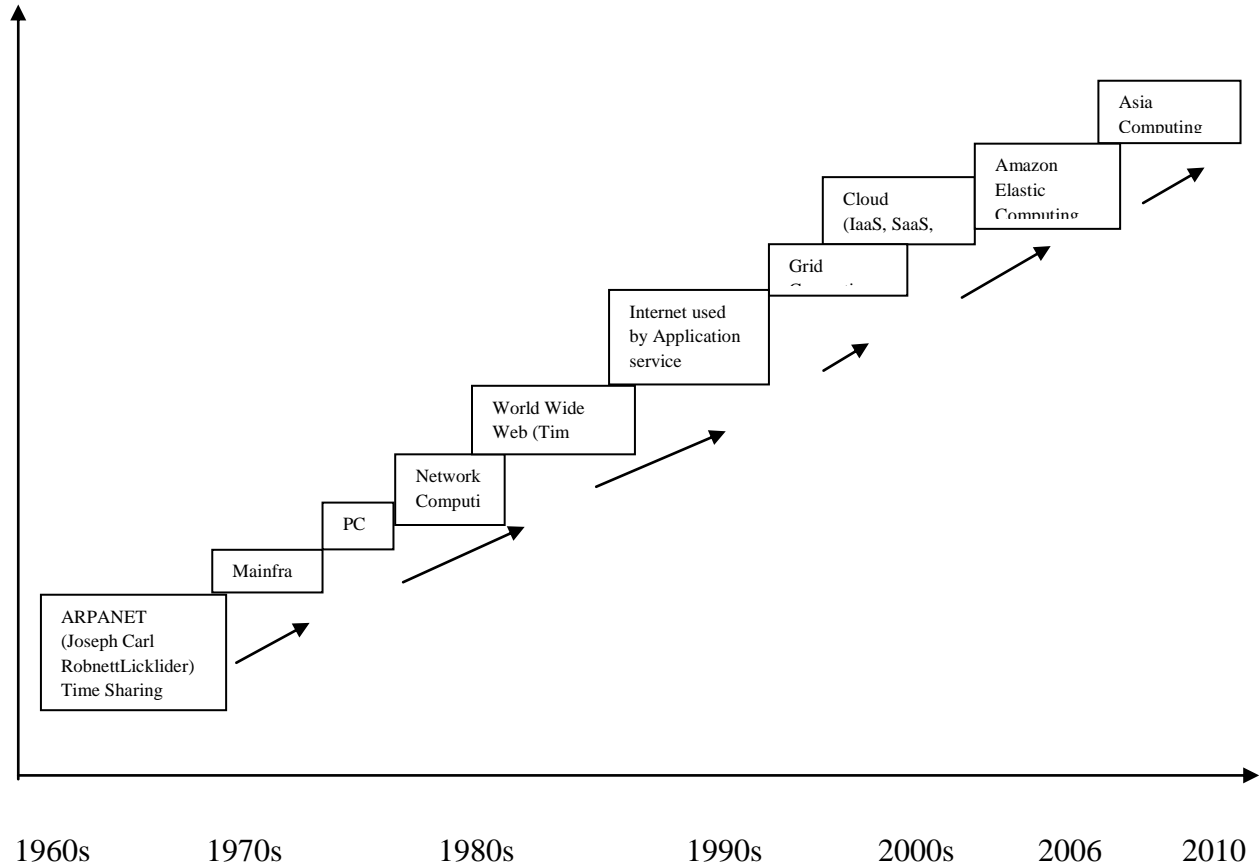


Figure 1: Evolution of Cloud Computing (Source: Cloud Computing Black Book)

### 3.0 Technology

The technologies that enable cloud computing are: virtualization, service oriented architecture (SOA) and web service (Furht and Escalante, Eds., 2010)

### 3.1 Virtualization

Virtual machines are replicas of computing resources. A physical server is divided into several isolated virtual environments called instances. The software used creating these instances is called hypervisor. Virtualization is the process of creating virtual machines. Multiple virtual machines may be running in a single physical machine (Baun et al, 2011).

#### 3.1.0 Operating System Virtualization

In operating system virtualization, multiple run time environments run under one operating system. In this concept performance loss is less and security is higher. But it lacks flexibility.

#### 3.1.1 Storage Virtualization

In storage virtualization, physical storage systems are pooled and applications use these pools for storage requirements. A storage area network is used for data transfers. In storage virtualization distributed mirrors are created to avoid system failures

### **3.1.2 Network virtualization**

Network virtualization enhances security. In cloud environment, the resources are implemented as web objects. Traffic load can be balanced by network virtualization. Distributed resources can be pooled together in a single logical network.

### **3.1.3 Application Virtualization**

The user level programs and operating systems are executed on applications that serve as physical machines. Virtual machines are created which works separately at the application level. These machines must have an operating environment in the form of hosted.

## **3.2 Service Oriented Architecture (SOA)**

Service Oriented Architecture manages web services inside clouds. In cloud computing, infrastructures, platforms and applications are implemented as independent services. SOA consists of distributed components.

## **3.3 Web services**

A web service is a software application identified by a URI whose interface and binding are capable of being defined by XML, support direct interactions with other software applications using XML based messages via internet based protocols (Baun, 2011)

## **4.0 Components of Cloud Computing**

Components of cloud computing are: clients, distribute servers and data centre.

### **4.1 Clients**

Clients are devices through which the end user access information from cloud. There are three categories of clients (Velte et al, 2010).

- Mobile clients include smart phones, tablets, etc.
- Thin Clients are computers in which there no internal storage. All the works are done by the server and the outputs are displayed.
- Thick clients are computers which use browsers to connect to the cloud

### **4.2 Distributed servers**

Servers are placed in different locations. If something happens to one server the services can be accessed from another server. Network connects the user and the cloud services.

### **4.3 Data Centre**

Data centre is collection of servers where the required applications are stored. Several virtual servers can be run on one physical server.

## **5.0 Features of Cloud Computing**

According to NIST, the features of a cloud are:

**5.1 On-Demand Self-service:** A user can set up computing facilities such as network storage, as needed without ant communication with each service provider

**5.2 Broad Network Access:** Computing capabilities are available over network and can be accessed through various devices such as laptops, mobile phones, etc

**5.4 Resource Pooling:** The provider's computing resources are pooled to serve multiple users

**5.5 Location Independence:** The user has no knowledge of the location of the resources. But they will be able to specify the location for example, country or state.

**5.6 Rapid Elasticity:** Cloud computing capabilities can be provided to meet user requirements

**5.7 Measured Service:** In cloud computing, resource usage can be monitored and controlled with transparency

#### **5.8 Other Features are:**

- Cost Effective
- SLA (Service Level Agreements Driven)
- Multi tenancy: Numerous customers run the same application.
- Scalability: Provisioning one or more services`
- Persistence by providing a separate cloud storage facility, when the server is off.
- Disaster Recovery

### **6.0 Types of Clouds**

#### **6.1 Service Models**

**6.1.0 Software as service (SaaS):** In this model, the cloud providers install applications in cloud infrastructure and the users can use the applications. Eg: Google Docs

**6.1.1 Platform as a service (PaaS):** In this model the applications developed using programming languages by the provider. The end users can use cloud as a platform to run the software and other tools over the internet without managing the infrastructure. Eg: Google App Engine

**6.1.2 Infrastructure as a service (IaaS):** In this model, computing resources are provided as a service. One can use cloud based hardware resources. It eliminates the cost by provisioning process, storage, networks, etc. Eg: Amazon Web Services

#### **6.2 Deployment Models:**

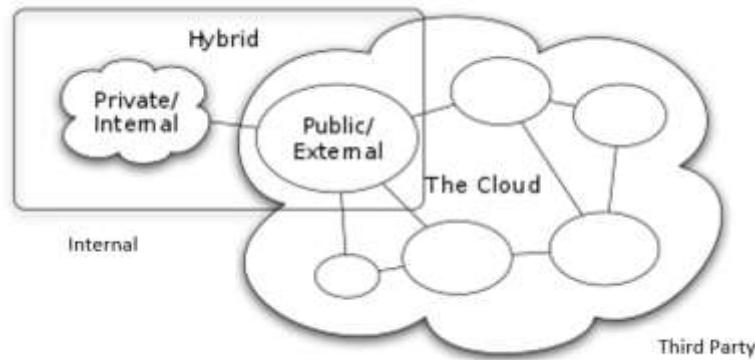
According to NIST, there are four types of clouds.

**6.2.0 Private Cloud:** Private cloud is the cloud infrastructure operating for an organization. Private clouds are highly secure.

**6.2.1 Community cloud:** In community cloud, infrastructure shared by a group of organizations with similar requirements.

**6.2.2 Public Cloud:** When the services offered by cloud infrastructure are made available over network that is open for public, it is called public cloud. Eg: Amazon Web services, Google's App Engine

**6.2.3 Hybrid Cloud:** Hybrid cloud is the cloud infrastructure as a combination of two or more clouds (private, community, or public)



(Figure 2: Cloud computing deployment models. Source: Wikipedia)

## 7.0 Applications of Cloud Computing in Libraries

### 7.1 Developing Websites

Websites can be developed using clouds. Google site is one of the best services. Weebly, Duracloud are also used for creating websites. Fig 3 and 4 shows examples of websites developed using google sites. Each activity can be viewed in the link 'Recent site activity'. The date of creation is visible even after many activities in the site. More than one person can edit it sitting in different locations.



Figure 3: Example 1(sites.google.com/site/dcadigital)

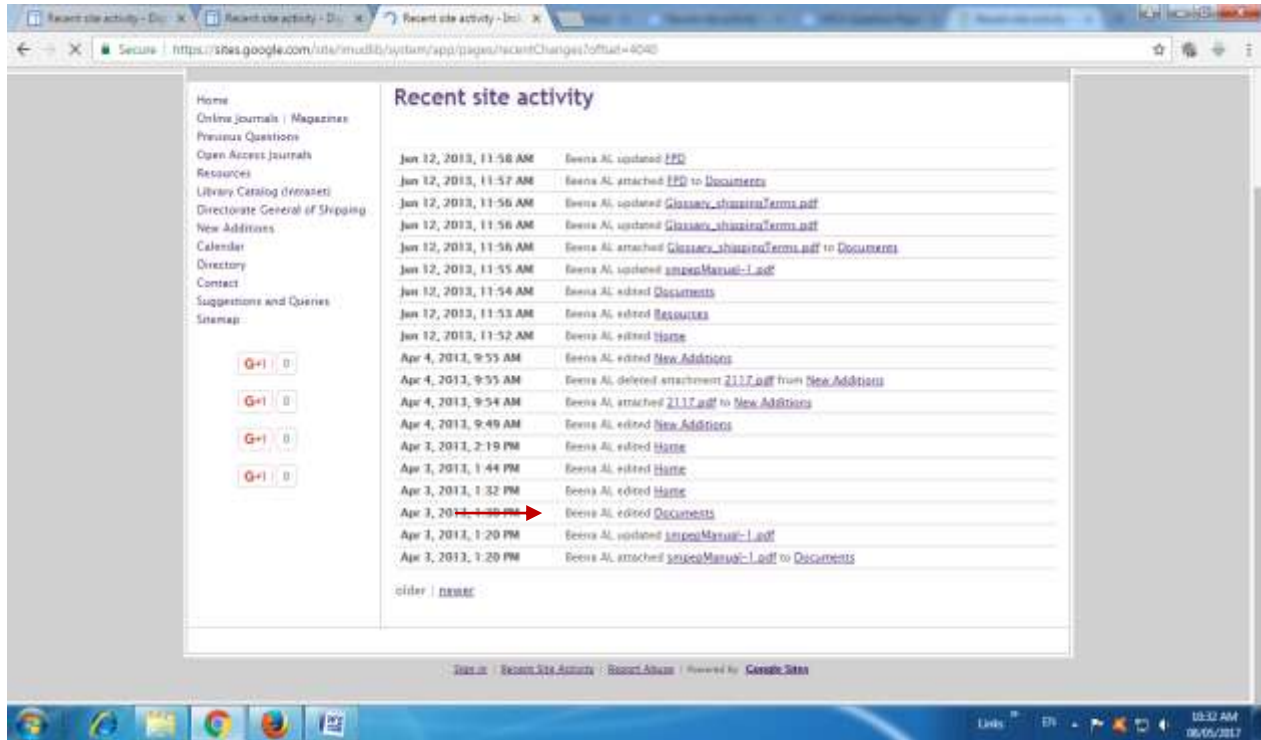


Figure 4: Example 2 (sites.google.com/site/imudlib)

### 7.2 File Storage

The files can be saved in clouds so that they will not be lost. Services such as dropbox, google drive, mega upload, slide share, etc can be used for file storage. Files can be shared if access is given over network. For eg, Fig.5 shows how to give access in google site. The sharing of files can be given, global as well as within the same domain. ie, if access within the domain is given, the people having the account in same domain only can access the document. If global access is given, anyone can access the document.

The queries regarding the access to files can be viewed from the email account attached to the google site and the access can be directly be given through mail to the particular user.

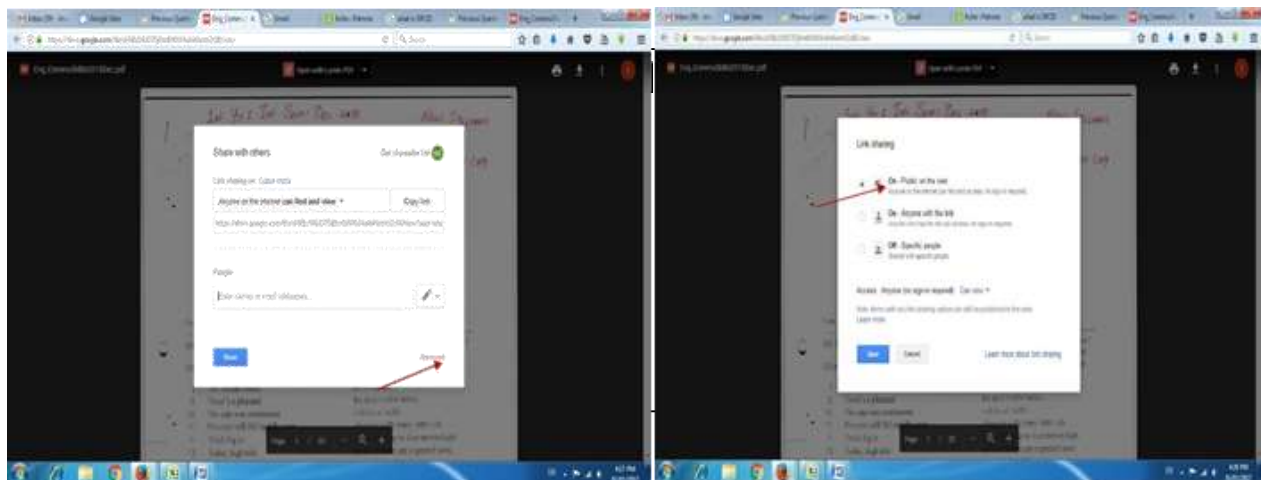


Figure 5: File Sharing

### **7.3 User Centric**

Services based on cloud computing are user centric. The user who wants access to a particular document which is uploaded in a site based on cloud, can request access and the request reaches to the administrator of that account and he can share access (Fig. 3). In google site, the file can be shared publicly as well as for a domain

### **7.4 Accessible 24/7**

The resources shared through cloud can be accessible any time over internet even though the server in an organization is turned off

### **7.5 Sharing Scholarly Content**

Online tutorial, videos, etc can be shared using clouds. Knimbus provides cloud based research platform. The word originated from the word nimbus, a type of cloud (Knowledge + nimbus). It is a platform for connecting researchers of the same community.

### **7.6 Paid cloud computing platforms:**

SaaS (Software as Service) model often provides on-demand software. These are priced on pay-per-use. Eg: Amazon EC2 provides the services and computing resources for the users and charges as per the use.

### **7.7 Cost Effective**

The libraries which have less technical infrastructure and without IT support staff can offer best services to their users with the help of cloud computing. Through the technology of virtualization the libraries can use the resources in the cloud.

### **8.0 Limitations of Cloud Computing**

- Data privacy and security
- Legal liability and compliance
- Malicious users inside an organization
- Non-availability of data: Data is prone to vulnerability and attack
- Bandwidth: Most cloud computing services offer a specific bandwidth. If an organization needs to use more additional charges be given
- Cloud computing is ideal for small organizations : for more storage space, the cloud service providers charge from the users

### **9.0 Security in Cloud Computing**

The principles of information security are: confidentiality, integrity and availability of data. Data is at risk when stored in cloud. Denial of service attacks, side channel attacks, eavesdropping (unauthorized interception of communication between two points), etc are some of the security issues. Using encryption data can be protected. Some cloud service providers offer certificates for authentication in addition to password protection. Trusted monitor is another tool which can be used for protection of data. This software is to be installed in the server of the service provider to make sure that the data is protected.

### **10.0 A Cloud Computing Model for Networked Libraries**

The following (Fig.6) is a systematic diagram showing how the resources in Libraries can be shared through cloud.

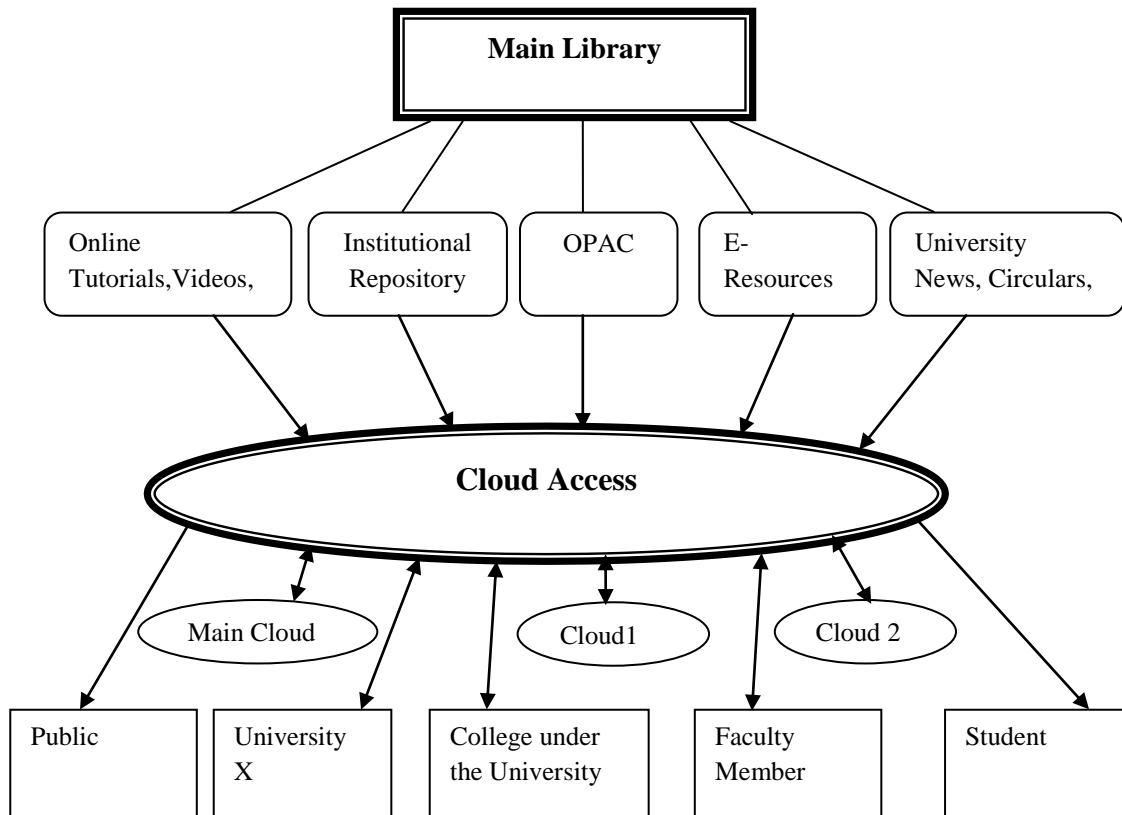


Figure 6: Cloud Computing Model for a networked Library

The input to the cloud can be Institutional repositories, University Newsletters, online tutorials, OPAC, E-resources, etc. Each user may be given different kinds of access. Public can only access the resources as per the authentication given to them. Access to other universities (University X) can be restricted. At the same time they may be given authentication to input resources with authentication. Colleges under the university can be given full access. A faculty member in the university can access the resources as well as upload resources. Students in the university can only access resources.

### 11.0 Conclusion

Using cloud services is cost effective as the resources are shared. Even though cloud users have limitations in management of their applications, most of the organizations use multicloud. Artificial Intelligence with cloud can play a major role in business environments in the future.

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