

# Management of Information and Knowledge Centres in Cloud Computing Environment: Opportunities and Challenges

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## Abstract

Cloud computing is a new technology model for IT services which many libraries and organizations are adopting. It allows them to avoid locally hosting multiple servers and equipment and constantly dealing with hardware failure, software installs, upgrades and compatibility issues. For many organizations & libraries, cloud computing can simplify processes and save time and money. This article defines changes of libraries in cloud computing environment opportunities and challenges. It also discusses how cloud computing solutions could be beneficial to libraries in three basic areas: technology, data and community. Information Centers are contemporary name of library and similar foundation and this paper talks about Cloud Computing application in Information Centers.

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## Introduction

Cloud computing has made revolution in computing as a service. With the ability to provide on-demand computing resources dynamically, with this new way of computing technology there are lots of benefits for the users such as User-Centric access On-demand services provisioning, Qos guaranteed offer, Autonomy, Scalability, Flexibility and security. Cloud computing utilizes massively scalable computing resources delivered as a service using Internet technologies. Cloud computing allows computational resources to be shared among a vast number of consumers to allow for a lower cost of ownership of information technology. A computing Cloud is a set of network enabled services, providing scalable, Qos guaranteed, inexpensive computing platforms on demand, which could be accessed in a simple and pervasive way.

The basic motivation of the cloud computing is to increase the computing resource utilization in IT companies. Most resources of them are reserved for peak time usage. Therefore, during the non-peak time most of resources are idle. In order to make best use of these idle resources cloud computing was proposed. Cloud computing provides software, platform, and infrastructure as services. Customers pay for the services in a pay-as-you-go model. Cloud computing as “the long-held dream of computing as a utility and having the potential to transform a large part of the IT industry, making software even more attractive as a service.”

### Cloud Computing Concept

Cloud computing is developed on the basis of distributed processing, Parallel processing and Grid computing. In other words it is a reality that these computer science concepts have been applied in business field. Because its principle is similar to the Grid Computing it is a kind of supercalculation model based on Internet. It takes the large amounts of data stored in many distributed computer to work with computer processor resource. As a new method of the shared infrastructure can link a huge system pool together to provide various services. Based on this architecture, it can polymerize the scattered knowledge resources in seamless connection. It also can make the library resource available at any time and switch on the application of need to anywhere. Thus it can make the user access the computer and storage system according to their own need, read and edit information on line. Then it has been stored in their own personal digital library as the knowledge increment, and this library is established in the Cloud server.

### Perspectives on Cloud Computing

The types of cloud computing technology can be viewed from two perspectives: capability and access. In this section, we look at three types based on capabilities provided and two based on who can access resources (see Figure 2).

#### Software as a Service (SaaS)

Applications or software is delivered as a service to the customer who can access the program from any online device. Some of these Web-based applications are free such as Hotmail, Google Apps, Skype, and many 2.0 applications, while most business-oriented SaaS, such as Salesforce, is leased on a subscription basis. There is usually little customization or control available with these applications. However, subscribers benefit from low initial costs, have access to (usually 24/7) support services, and needn't worry about hosting, installing, upgrading, or maintaining the software.

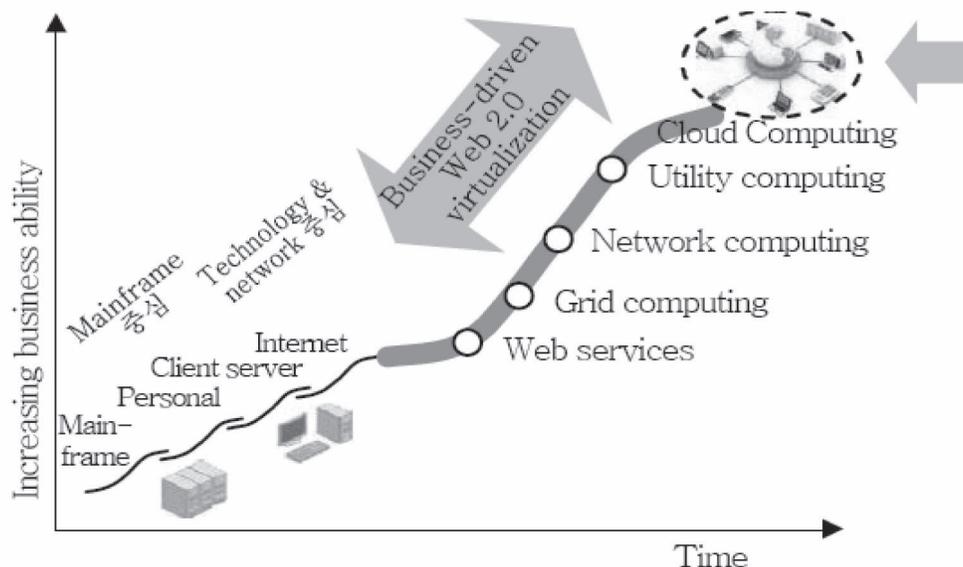


Figure 1: History of computing

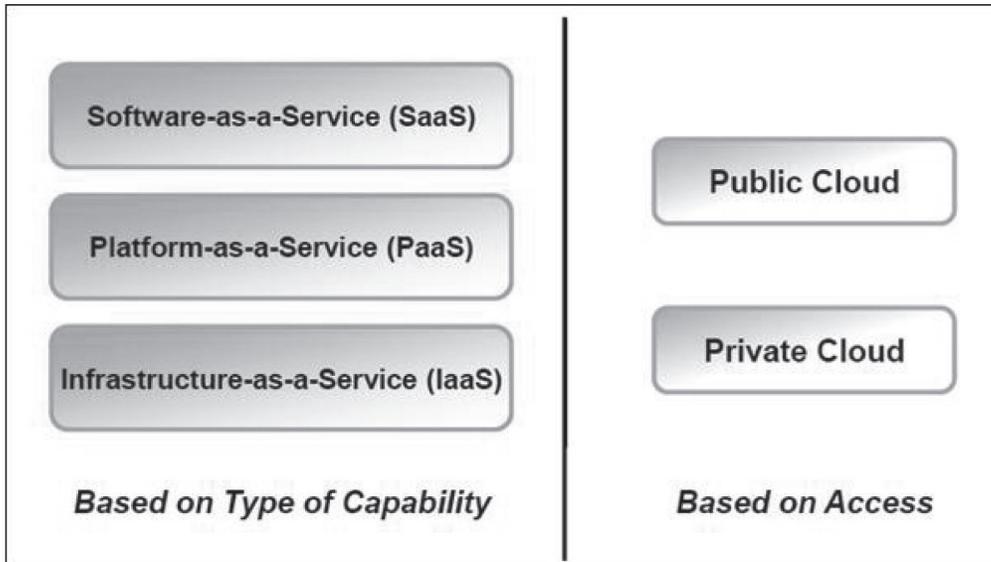


Figure 2: Cloud Computing Types Based on Capability and Access

**Platform as a Service (PaaS)**

With PaaS, a computing platform is provided which supplies tools and a development environment to help companies build, test, and deploy Web-based applications. Businesses don't need to invest in the infrastructure required for building Web and mobile applications but can rent the use of platforms such as Windows Azure, Google AppEngine, and Force.com. Applications which are built using these provider's services, however, are usually locked into that one platform.

**Infrastructure as a Service (IaaS)**

This type of cloud computing is also sometimes referred to as HaaS or Hardware as a Service and it involves both storage services and computing power. Amazon's Web Services, one of the major players in this area, offers two main products including the Elastic Compute Cloud (EC2), which provides computing resources, and Simple Storage Service (S3) for data storage.

**How is Cloud Computing Different?**

For much of the past 25 years, software development and system engineering has centered primarily on the personal computer. The PC era was characterized by monolithic, proprietary operating systems and programs that had long development times and release cycles. In that environment, the design of software was isolated and all attention focused on a single application.

With cloud computing, hardware and functionality traditionally installed and run in a local environment is now performed on the network, in the Internet cloud. In essence, the Internet cloud becomes the development platform and the operating system to which programmers write reusable, constantly updated software components that are delivered over the network and that can be embedded or loosely coupled with other Web applications.

Libraries have been using some cloud computing services for over a decade. Online databases are accessed as cloud applications. Large union catalogs can also be defined as cloud applications. However, a look outside libraries is warranted to better understand the value proposition of cloud computing.

### **Libraries and the Cloud**

Libraries will want to consider what types of information or processes they want to trust to the cloud. Eric Lease Morgan also spoke about the responsibility of libraries to preserve information at the Top Tech Trends panel, making the point that outsourcing its preservation in effect relinquishes that obligation.

Libraries will need to consider not only this type of ethical quandary, but also practical ones such as the privacy of sensitive information such as patron records, and concerns about records retention requirements. But it needn't be an all-or-nothing decision as 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.

### **What can Cloud Computing Solutions do for Libraries?**

So turning to cloud computing and libraries, are their real problems that can be solved? The answer is yes. The library community can apply the concept of cloud computing to amplify the power of cooperation and to build a significant, unified presence on the Web. This approach to computing can help libraries save time and money while simplifying workflows.

A brief list of potential areas of improvement could include:

- Most library computer systems are built on pre-Web technology
- Systems distributed across the Net using pre-Web technology are harder and more costly to integrate
- Libraries store and maintain much of the same data hundreds and thousands of times
- With library data scatter across distributed systems the library's Web presence is weakened
- With libraries running independent systems collaboration between libraries is made difficult and expensive
- Information seekers work in common Web environments and distributed systems make it difficult to get the library into their workflow
- Many systems are only used to 10% of their capacity. Combining systems into a cloud environment reduces the carbon footprints, making libraries greener

These improvements can be grouped into three basic areas: technology, data and community. Each offers some general and some unique opportunities for libraries. Looking first at the technology that most current library systems employ several benefits of cloud computing solutions surface.

### **Technology Improvements for Library Management System**

Cloud computing solutions at their essence are built on current technology and should be architected to allow for technology shifts. Looking at the explosion of mobile devices one sees how businesses and organizations operating in a cloud environment are able to adapt and deliver their services to the new devices much more quickly and less expensively. The mainstay of libraries is the library management

system (LMS, also known as the integrated library system or ILS). Library management systems were developed before the Internet and Web existed and are generally closed proprietary systems. It has been difficult and costly for these closed systems to take advantage of new technologies as they emerge. It is also challenging to integrate to external systems and libraries must rely on their vendors to do any such integration.

Over time libraries have needed to add more systems to manage their changing collections which moved from strictly physical collection management to a combination of physical, licensed and digital collections. Since each of these systems has stood alone integrating them has been difficult and at times not possible. What can change in a cloud environment for managing core library services?

First would be the possibility of open service oriented architecture. Many cloud solutions offer this type of openness with published application program interfaces (APIs) that any programmer can take advantage of. This means if a new service or technology emerges libraries will not always be dependent on a vendor or other third party to start taking advantage of these services and technologies. Existing library systems have used APIs to connect to external services but they have remained closed proprietary systems making it hard to integrate them into external services. As Andrew Pace stated it, "...demands fall short by merely asking that local systems avail themselves of other Web services rather than establishing themselves as services in their own right." When library systems are deployed as open cloud solutions then the library community itself can step up to create extensions to their core services and more importantly share them throughout the community using cloud solutions. This makes it possible to integrate two services once and re-use it across the community.

Secondly libraries can get out of the business of technology and focus on collection building, patron services and innovation. Servers can be decommissioned and no longer require replacement every five years (or less). Staff no longer has to maintain the complex software stack necessary to run local systems and worry about compatibility of the stack during upgrades. Instead technical skills can be re-deployed for extending cloud services into their environment and their environment into other cloud services.

### **Data Stored in the Cloud**

When data is stored in the cloud it offers several advantages. Common data can now be easily shared among services and users. The need for local storage, maintenance and backups is removed. Agreements can be forged to share data that normally would be considered private to a single business or organization. And finally libraries can achieve Web scale when they massively aggregate data and users, something a cloud environment makes possible.

Like the advantages of technology deployed and accessed as cloud solutions, data storage in the cloud brings many benefits for libraries. The easy one to recognize is the same data being stored hundreds and thousands of times across libraries. Consider how many copies of the cataloging data there are for a serial publication such as the Economist. And if a change is needed to the cataloging data to keep it current each library must perform that change. When this data is maintained in the cloud, maintenance and backup of this data is now done once and if a change is needed, once one library performs the change all share it.

Another great benefit of data stored in the cloud is the opportunity for collaboration and cooperative intelligence. Libraries can agree to share pools of data for cooperative collection building, cooperative preservation or digitization, cooperative sharing of materials, etc. And with massively aggregated data new services can be created such as recommender services based on a broad base of usage data.

As stated above when library data is widely distributed across systems it makes library Web presence weak. When search engines such as Google, Yahoo and Bing can harvest from large data stores it opens the opportunity for the collective to work on search engine optimization, or the improvement of library collections appearing more relevant to search engines thus displayed higher in search results. This is a complex and ever changing task that would be prohibitive for individual libraries to accomplish. Further, aggregated data can attract a much larger aggregation of users who interact with the data, add to it and re-use it. The result is every user adds benefit for every other user.

### **Community Power**

Libraries have a somewhat unique opportunity with cloud computing, to create an online information community network. Such a community is really two communities, the internal community of libraries collaborating within a single institution and across institutions and the external community of libraries and information seekers. The value to libraries is the “network effect” that coming together in the cloud provides. The cooperative efforts of libraries will create scale savings and efficiencies, bring wider recognition for libraries, and provide cooperative intelligence for better decision-making, and provide the platform on which libraries can innovate.

Looking externally the first community cloud computing offers is taking advantage of social media. Businesses and organizations can both build social communities around their services and participate in existing social communities such as Facebook or Twitter.

The internal community formed through the cloud offers new possibilities and efficiencies for current workflows. Starting with a single organization the simple task of collaboratively working on documents and maintaining version control either requires extensive manual processes between colleagues or a locally installed system to assist in collaboration and version control. Many librarians have discovered the power of services like Google Docs to reduce the effort of working jointly. Services like these allow them to easily share ongoing work whenever they want and wherever they are.

The potential for collaboration between libraries is truly revolutionary in a cloud environment. When data and functions are shared in the cloud libraries can make joint decisions on collection development, preservation, digitization, in real time. As demonstrated by OCLC’s Question Point virtual reference service and its 24/7 cooperative a single library’s ability to assist patron’s is expanded beyond the constraint of its own walls and hours of operation to become a true cloud service (last year Question Point logged its five millionth answer to a reference question).

### **Library Solutions Through Cloud**

To date, the main focus of libraries moving into the cloud has been discovery services, the need to disclose their vast collections on the Web. Though library OPACs attract existing patrons they are not integrated with most information seekers common workflows. So a first step for libraries has been to start massively aggregating data about their collections into common pools. OCLC’s World Cat, the first example of this, is now forty years old and pre-dates both the Web and cloud computing. Other similar union catalogs have existed throughout the world most commonly supported by national libraries and large union catalogs, such as the National Library of Australia, the Bayerische Staatsbibliothek in Germany, and Bibsys in Norway. However the advent of the Web has allowed libraries to extend this original vision in new ways.

Other benefits growing from massively aggregated data about collections is the ability to aggregate user

opinion and use. Library thing is a good example of being able to build recommender services based on the aggregation of what thousands of people hold in their personal libraries.

However, there is no reason to extend cloud-based services only to libraries' end users. As Marshall Breeding points out, "We can't let the current focus on front-end interfaces make us complacent about the software systems that we use to automate routine library functions."

### **Opportunities and Challenges**

It is here that libraries can look to gain new efficiencies both internally and among the entire library community. When library software suppliers create the user personas that will use their software the focus is generally on external personas but there are also many internal personas that need to take advantage of new technologies and Web capabilities. One such example has been given with reference librarians now able to both better assist their patrons online but also to build a large network of librarians globally who can answer specific questions and be available 24/7. What other personas in the library can benefit from cloud solutions?

- Acquisitions librarians managing increasingly diverse collections
- Cataloging librarians seeking to describe an ever increasing body of information and information sources the library is managing
- Serials librarians working to maintain control and access to collections spidered across the Web
- Electronic resource librarians managing burgeoning collections, and ever-changing lists of vendor

The dramatic change in library collections often blurs the lines between traditional job roles in libraries. An acquisitions librarian probably also needs to manage licenses for electronic materials as well as manage purchasing for multiple formats, often for the same item. They need to access information from suppliers, reviewers, local constituency and other staff in a unified manner. This begs for an open system deployed where it can easily be accessed by external systems and pull in data and services in from those same systems. Cloud computing solutions can create the new work flows needed by librarians because it offers the opportunity for a cooperative platform for libraries to build on. There are four key principles of a cooperative platform:

- Openness, meaning that services and data are made available to support greater interoperability, not only within and between cloud services, but also with library developed and third-party applications;
- Extensibility, meaning that the platform can easily accommodate the addition of new services and applications, developed either by the service provider or by members of the community;
- Data richness, meaning that a library can interact with and expose a wide variety of information about purchased, licensed, and digital content through this platform; and
- Collaboration, meaning that libraries can harness the collective power of the community of libraries to innovate and share solutions.

And it is precisely this that the business world and social media have demonstrated can be done with cloud computing solutions. Through cooperative and community building libraries can have the same possibilities.

However, if libraries are to consider moving more of their services into the cloud there are certain questions that must be addressed. Foremost is whether this service will make the library more efficient and help it

offer better service to its constituency. It goes without saying that adopting technology for technologies sake is not a good management decision. Once it is determined a cloud solution does accomplish this for the library then considerations to look at are:

- Does the service have built-in scalability, reliability and security?
- Is it multi-tenancy?
- Who owns the data stored in the system and what rights does the library have to extract their data for other uses or even to leave the service entirely?
- Is it an open system so that external data and services can be economically integrated into this service and its services can be economically integrated to external services?

In discussions of cloud computing security and privacy are raised as serious concerns throughout the literature and especially by librarians. When considering a cloud application two aspects of security and especially privacy must be examined, technical and legal. Does the provider demonstrate the necessary technical expertise and explanation of their environment to insure there will be no unauthorized access to a library's data stored in the cloud? And have they considered the legal requirements of the government bodies the library is answerable to? This means it is also important to know exactly where the data is going to be stored since different countries have much different privacy requirements and standards. And since many cloud solutions are actually running on another suppliers cloud infrastructure due diligence is required. First to be certain where data is stored and secondly what the service level agreements for access to the data and preservation of the data are for the actual infrastructure supplier. Regardless, one important take-away remains data privacy and security are not mutually exclusive to cloud based solutions.

Data ownership cannot be overstressed. The library must know it has complete access to all their data while using the service so they can take it and re-use it as necessary, whether in another service or simply for reporting purposes. Just as important they must be certain they can extract all of their data at any point in the future should they decide to leave the service. It is also important to know what provisions are in place for data access should the supplier go out of business.

Finally a library must know that the service is truly an open, service oriented architecture which can truly change the future of libraries. This allows libraries to shift the use of internal technical expertise from maintaining software and servers towards innovative uses of cloud services in their local environment.

## **Conclusion**

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 a different 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.

While local library systems served an important purpose earlier in library automation they now represent a tremendous duplication of effort. Each library builds and maintains a database, buys equipment and installs and updates the software. In fact, some libraries can get stuck in perpetual upgrade mode, which involves lots of testing and retesting and time consuming customization.

With cloud computing, all of this is taken care of transparently for the library and user. Among the benefits of a cloud computing approach:

- Take advantage of current and rapidly emerging technology to fully participate in the Web's information landscape
- Increased visibility and accessibility of collections
- Reduced duplication of effort from networked technical services and collection management
- Streamlined workflows, optimized to fully benefit from network participation
- Cooperative intelligence and improved service levels enabled by the large-scale aggregation of usage data
- Make libraries greener by sharing computing power thus reducing carbon footprints

The vision is to use cloud computing to deliver library 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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