Cloud computing: Tool for storage in the 21st century libraries

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Summary

This paper examined cloud computing as a tool for storage in the 21st century libraries. The paradigm shift in library and information science profession is quite visible particularly from print resources to electronic resources. Moreover, there is rapid growth and demand of information and as well as frequent changes in information and communication technology. The use of advanced technology to carry out library operations is vital in the present 21st century libraries to reached out to the patrons irrespective of the discipline of human endeavour. Cloud computing is one of the technological innovative device that is used to carry out routine operations and provide services to library users in order to meet their information need without necessary coming to the library environment. Cloud computing is a computing paradigm, where a large pool of systems are connected in private or public networks to provide dynamically scalable infrastructure for application, data and file storage with the advent of this technology, the cost of computation, application hosting, content storage and delivery is reduced significantly. Cloud computing is a practical approach to experience direct cost benefit and it has the potential to transform a data centre from a capital intensive set up to a variable priced environment.

Keywords: Cloud computing, cloud storage, libraries

Introduction

The library working environment is fast changing and the present scenario of web based technologies developed on virtual platforms and generating large opportunities and virtual paths to use their services for the various purposes. In recent time, cloud computing emerged as one of the most famous virtual technology for libraries to rendered services in an efficient and effective manner. Cloud computing contains features of different technologies such as utility computing, grid computing, unified computing, web 2.0, service oriented architecture and among other. Cloud computing technology offered numerous 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 anywhere any time and so on. At present, libraries are using cloud computing technology to enhance their services thereby adding more values, attracting the clienteles and cost effectiveness (Kaushik and Kumar, 2013).

Cloud computing as viewed by Suman and Singh (2016) is a conjunction of technologies and tendencies that are making infrastructures and applications more dynamic, more flexible and replaceable. Applications such as e-mail, web conferencing, customer relationship management (CRM) all are tracked in one cloud. Cloud computing is a combination of technology with trends

that makes infrastructures and applications more dynamic, flexible and usable. It assist the libraries to maintain the record data, private and delicate data. Cloud computing helps libraries by showing their presence on the web. Libraries are adopting this technology for electronic journal access, hosting digital libraries, tracking of statistical data and also integrating library hosting. However, this chapter will be organised in the following manner: Historical development of cloud computing, concept of cloud computing, functions of cloud computing in library services, features of cloud computing, types of cloud computing storage, service models and conclusion.

Historical Development of Cloud Computing

Cloud computing was invented by Joseph Carl Robnett Licklider in the 1960s with his work on ARPANET to connect people and data from anywhere at any time. In 1983, CompuServe offered its consumer users a small amount of disk space that could be used to store any files they choose to upload. Consequently, the first use of cloud computing in its modem context occurred on August 9, 2006, when then Google CEO Eric Schmidt introduce the term to an industry conference. Recently, cloud computing was inherently thought of as public and the focus for many IT organisations included providing software applications as well as providing innovative ideas for the emerging cloud technologies that could make use of that new model for delivery and consumption of services and resources. As security concerns and the potential for data to be compromised in public cloud infrastructures increased, the focus shifted towards creating private clouds that could address many of the security concerns of public clouds, while still providing all the same services and resources. Cloud infrastructures naturally evolved into supporting what is now termed "hybrid cloud", which provide the best of both worlds. Hybrid clouds are particularly advantageous for businesses became it affords them the opportunity to take advantage of an internal network of storage as well as a public data loud that can be accessed from any location with Internet access. Cloud computing viewed a new supplement, consumption and delivery model for IT services based on Internet protocols and it typically involves provisioning of dynamically scalable and often virtualised resources. It is a byproduct and consequence of the ease of access to remote computing sites provided by the Internet. The major benefit of cloud computing is that, the average user does not need a computer that is extremely powerful to handle complex database indexing tasks that server farms can. Instead, with the use of broadband, users can easily connect to the cloud, which would commonly be referred to as the point of contact with the larger network.

Meaning and Definition of Cloud Computing

Cloud computing is the conveying of on request computing services from application to storage processing power commonly over the internet on pay as you exploit basis. According to National Institute of Standards and Technology (NIST) cited in Mell and Grance (2011) defined Cloud computing as a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources such as networks, servers, storage, applications, and services that can rapidly provisioned and released with minimal management effort or service provider interaction. Similarly, Sahu (n.d.) defined Cloud computing as an internet based computing platform where virtual shared servers provide software, infrastructure, platform devices and other resources and hosting to customers on a pay as you go basis. The author further stated that all information that a digitized system has to offer is provided as a service in the cloud computing model and users can access these services available on the "Internet Cloud" without having any technical know-how on managing the resources involved.

Suman and Singh (2016) defined cloud computing as the bigger picture, basically the broad concept of using the Internet to allow people to access technology enabled services. According to Pillai and Seena (2018), those services must be 'massively scalable to qualify as true 'cloud computing'. So according to that definition, every time I log into Facebook, or search for flights online, I am taking advantage of cloud computing." The authors further expressed the view with regard to how cloud computing is differed from other computing and its advantages to libraries.

Burford (2010) viewed cloud computing as a computing model where clients log into the cloud to access information technology resources that are priced and provided on demand. Information technology resources of cloud computing are essentially distributed amidst of patrons who are regarded as clients. However, cloud computing is mainly a service delivery model that enable sending, receiving, and disseminating data of different degree to users through the internet when the need arises.

Overview of Cloud Computing

The paradigm shift in library and information science profession is quite visible particularly from print resources to electronic resources. Moreover, there is rapid growth and demand of information and as well as frequent changes in information and communication technology. The

use of advanced technology to carry out library operations is vital in the present 21st century libraries to reached out to the patrons irrespective of the discipline of human endeavor. Cloud computing is one of the technological innovative device that is used to carry out routine operations and provide services to library users in order to meet their information need without necessary coming to the library environment. Cloud computing is a computing paradigm, where a large pool of systems are connected in private or public networks to provide dynamically scalable infrastructure for application, data and file storage with the advent of this technology, the cost of computation, application hosting, content storage and delivery is reduced significantly. Cloud computing is a practical approach to experience direct cost benefit and it has the potential to transform a data centre from a capital intensive set up to a variable priced environment.

Features of Cloud Computing

The vital features of cloud computing are as follows:

  i.   **On-demand self-service:** An organization will secure cloud-hosting services through a cloud host provider which could be clients usual software vendor. Organizations have access to client services and client have the power to modification cloud services through an online control panel or directly with the provider. According to Gartner Amazon Web Services (AWS), Microsoft, Google, IBM and Salesforce.com are the Cloud service providers that provide on-Demand self-services. AWS (NIST) is being used by New York Times and NASDAQ.

  ii. **Broad network access:** Cloud Capabilities can be accessed through standard devices such as mobile phones, laptops and PDAs. These devices can be used from any location through a simple online access point. This flexibility is vital for business as employees can keep an eye on their projects, contracts and customers 24 X 7 even when they are on the move or in the office.

  iii. **Resource pooling:** Resource pooling helps a user to use the resources from anywhere at any time. Multiple users can use this facility at a time. This system is most helpful in multilevel national companies, where work is divided in broad categories. And so many departments are involved to do the work. Resource pooling leads to economy in carrying out work.

  iv. **Rapid elasticity:** It is based on our needs. Anytime we can add or remove any type of software. Elasticity is the best option in cloud computing.

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v. **Measured service:** This service is also very helpful to run an organization. In cloud service this facility shows the measurement of utilization of resources. It has the metering capability which enables to control and optimize resource use. This helps to charge as per usage. According to this measurement one can choose that whether this software is worth or not. One can plan accordingly and can charge from users according to the usage, just like electricity department sell electricity and charge per unit and mobile companies charge for per call or pulse. This type of service provides transparency as both the user and service provider can check and control the use of resources (Suman and Singh, 2016).

Figure 1: Cloud Computing   Source: Suman and Singh (2016).

In cloud computing, shared resources, software, and information are provided to remote clients over a network. Cloud computing is a service, wherein Cloud resources are dynamically allocated to multiple users as per demand. The word "cloud" was used for the Internet, Like telephony schematics a cloud-like shape was used to denote a network, which was later used to show the Internet in network diagrams. Traditionally organizations were used to buy the dedicated hardware and use it, which was termed as CAPEX (Capital expenditures) model, but with the evolution of cloud computing organization are moving away to the OPEX (operating expenditure) model.

Types of Cloud Computing Storage

Types of cloud computing storage are as follows:

i. **Public cloud storage:** This type of cloud computing is the traditional model that everyone thinks of when they envision cloud computing. In this model, libraries dynamically allocate resources (hard drive space, RAM, and processor power) on a per-user basis through web applications.

a. **Unlimited access –** As long as you have internet access and a compatible device such as a smart phone or laptop computer, you can access the library resources anywhere.

b. **Unlimited data capacity -** Public cloud computing is flexible to meet your business' growing data storage and processing needs.

ii. **Hybrid cloud storage:** This model combines business' hardware with cloud computing. Generally, one of the business applications such as Exchange Server 2007 or Microsoft Dynamics will interact with a vendor-hosted service. For example: Cisco, traditionally recognized for networking hardware, offers Iron Port Email Security as their hybrid solution and Google, known for hosted solution, offers Postini email archiving.

a. **Hardware:** Hybrid cloud computing requires that you have or purchase hardware to Interact with the hosted solution.

b. **Software:** In addition to hardware requirements, business will need to have or purchase the software to manipulate and store data.

iii. **Private cloud storage** Also known as "internal cloud computing", Private cloud computing is the next generation of virtualization. While similar to virtualization at the server, workstation and application levels, private cloud computing has enhanced features that appeal to many businesses. Two examples of private cloud solutions are VMware vCloud and Citrix VDI.

a. **Increased data security:** The business' are in control of security since data never leaves the network.

b. **Simple compliance enforcement:** Depending upon the vertical market, government regulations may prohibit business' from using traditional or hybrid cloud computing. Private cloud computing permits to take advantage of cloud computing features while keeping all regulated data onsite and secure.

c. **Customized IT network control:** By keeping the cloud private, they are free to customize their network to meet their specific business needs.

iv. **Personal cloud storage:** In personal cloud storage, data of an individual is stored in the cloud and this data can be accessed from anywhere. It is subset of public cloud storage. It is also called mobile cloud storage as in this type of cloud storage the stored data is synchronized and shared across multiple devices like tablet computers and mobile phones.

Service Models

The three service models defined by NIST are essentially a hierarchy. Furthermore, Suman and Singh (2016), elaborate the service model using a pictorial representation for better understanding of the readers.
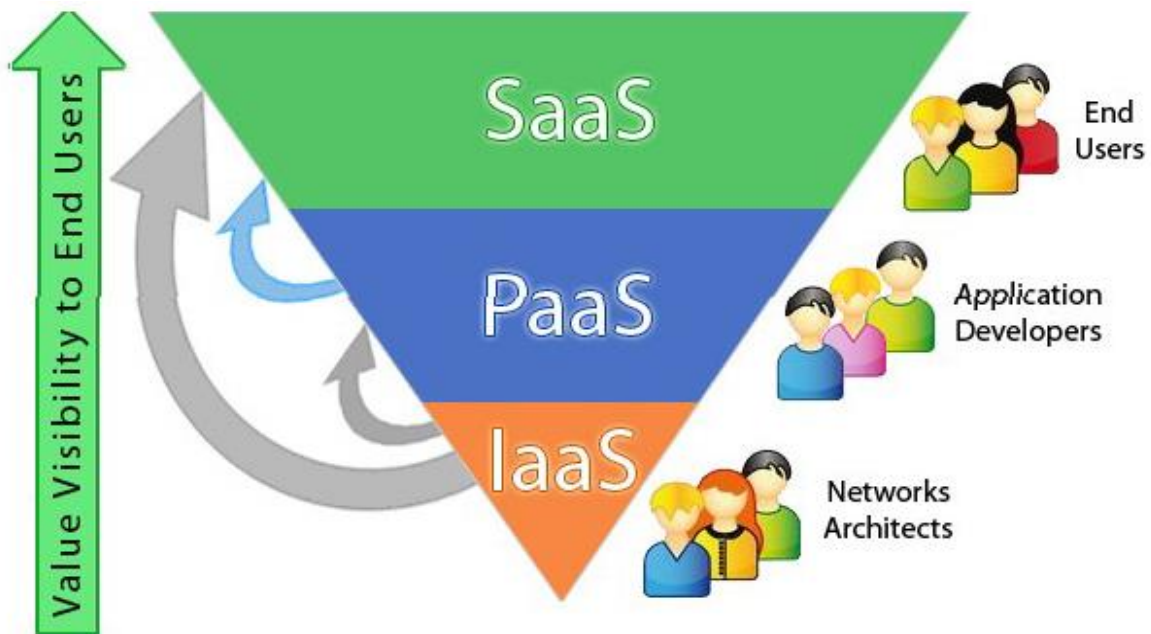
Figure 2: Service models Source: Suman and Singh (2016).

i. **Cloud software as a service (SaaS):** This is a cloud service providing remote access to software and its functions. Software is hosted remotely Users are not required-to purchase additional hardware. Organizations are not required to handle the installation, set-up and often daily upkeep and maintenance. SaaS is often referred to as software-on-demand and it can be termed as using it on rent rather than purchasing it. With traditional software applications, it is required to purchase the software package and install it on the computer before being able to use it. The software is used to store, back-up and transfer

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the data There is widespread usage of SaaS because there are usually no starting costs involved. Organizations need to pay only for the amount of storage space utilized. SaaS may also be called hosted storage. Examples of SaaS are: Google, Twitter, Facebook, Flicker etc. Benefits are: no additional hardware costs, pay for what you use, automated updates and accessible from any location.

ii. **Cloud platform as a service (PaaS):** This can be defined as a computing platform in which web applications can be created quickly and easily without the need of purchasing and maintaining the software and infrastructure required for it. In this hardware, operating systems, storage and network capacity are hired over the Internet. In PAAS, the virtualized servers and associated services are rented by the customers to run the existing applications or to develop and test new applications. It is a software distribution model in which hosted software applications are made available to customers over the Internet. With PaaS, it becomes feasible to change and upgrade the operating system features frequently. Benefits are: one not have to invest in physical infrastructure, Teams in various locations can work together, Security, Adaptability.

iii. **Cloud infrastructure as a service (IaaS):** The cloud computing infrastructure servers, storage, network and operating systems are delivered as an on demand service. In IaaS, the equipment used to support operations, including storage, hardware, servers and networking components. are outsourced by organizations. The equipment is owned by the service provider and the responsible for housing, running and maintaining it also lies with the service provider. The client typically pays on a per-use basis. Benefits are: On-demand self-service, Broad network access, Measured Service

Functions of Cloud Computing in Library Services

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 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 (Goldner (2010). When data is stored in the cloud it offers several advantages. Common data can now be easily shared among services and users. Data storage in the cloud brings many benefits for libraries. Consider how many copies of the cataloguing data are there 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.

Libraries has a unique opportunity with cloud computing, to create an online information community network. Such a community are of two types, 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.

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 it's 24/7 cooperative a single libraries 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. Cloud computing according to OCLC (2010) perform the following functions in library services:

i. Enables the library to integrate and combine different library services together to increase efficiency and productivity.
ii. Cooperate intelligence and improved services levels enabled by the large scale aggregation of usage data and make libraries greener by sharing computing power thus reducing carbon footprints.
iii. Cost reduction

iv. Ability to increase or decrease the consumption of hardware or software resources immediately and in some cases automatically

v. Scalability- "Pay as you go" allowing a more efficient control of expenditures,

vi. Enables libraries to fully participate in the Web's information landscape,

vii. Increases visibility and accessibility of collections, reduced duplications of efforts from networked technical services and collection management,

viii. Streamlines the workflow optimized to fully benefit from network participation,

ix. Lower investment, reduced risk- Immediate access to the improvements in the resource proposed (hardware and software) and debugging, Support included- Enjoyment of the most advanced security procedures, availability and performance of providers with experience and knowledge in this type of service,

x. Greater security and accessibility- Access to resources from any geographical point and the ability to test and evaluate resources at no cost, Portability- since the service is available over the web, the service can be availed through browser from any part of the world, Adjustable storage- In the traditional system, if the server is less than what we have. The server should be replaced with the new one.

xi. Storage capacity can be adjusted according to the needs of the library, since the storage is controlled by the service provider, Cloud OPAC- Most of the libraries in the world are having the catalogue over the web. These catalogues are available with their libraries local server made it available over the web. If the catalogue of the libraries made it available through cloud, it will be more benefit to the users to find out the availability of materials.

xii. Access to large number of files stored by the library, can be accessed by users through any device when they are connected to the Internet. Thus there is no need for large internal storage system.

xiii. Collaboration of projects can also be done using library cloud computing platform, which is cost effective as compared to purchasing software and hardware.

xiv. It is compatible with most computers and operating systems.

xv. Cloud computing also serves as an innovative tool to help the library upgrade and increase value in it products and services.

xvi. File sharing: A user can save large files. Multiple types of files such as photos, videos, presentations, documents can be stored. Back-up facility is also provided by cloud computing.

Cloud computing is used to build a digital library and to automate housekeeping operations using third party services, both software and hardware. Cloud computing refers to both applications delivered as a package over the internet and the systems software in the data centers that provide services (Raghavendra, Indrani and Narayana, 2017).

Conclusion

Cloud computing is a computing paradigm, where a large pool of systems are connected in private or public networks to provide dynamically scalable infrastructure for application, data and file storage with the advent of this technology, the cost of computation, application hosting, content storage and delivery is reduced significantly. In the recent time, libraries are providing good number of services to their patrons to access various resources and computer applications from a single platform. This is an advantage of cloud computing. Many libraries are willing to adopt cloud computing but they are facing problems in relation to standardized software, administrative procedures, budget constraints, connectivity problems. Therefore, It is recommended that management of libraries should make Information Technology (IT) units or departments more flexible in raising the amount of cloud computing they require by contacting their vendor instead of physically having to acquire new hardware, software and manpower to meet increased demands so as to save cost, enhance information seeking and retrieval and increase efficiency and effectiveness of services delivery.

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