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Cloud Computing and its impact on Library

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Abstract - *Cloud computing is a new technology model for IT services which many businesses 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, cloud computing can simplify processes and save time and money. It also discusses how cloud computing solutions could be beneficial to libraries. Latest technological development has brought a dramatic change in every field, and library science is not an exception to it. Information technology has impacted positively on the library & information system along with the services that it provides for users. To meet such challenges in this profession, librarians have to seek innovative ways to support the integrated Library system via applying different platforms in Library science filed for attaining economy in information handling and communication. The use of cloud computing in libraries and how cloud computing actually works is illustrated in this communication. Cloud computing is an evolving technological paradigm that facilitates conveniently the on-demand network access, to a shared pool of configurable computing resources like virtual machines, servers, data storage, security mechanism etc. which are under provider's control. This paper addresses the various aspects of cloud computing.*

Key Words: Cloud computing, Multi-tenancy, Linearly Scalable, Cloud infrastructure, Virtualization.

1.INTRODUCTION

Cloud computing is currently the buzzword in IT industry, and many are curious to know what cloud computing is and how it works. More so because the term CLOUD is intriguing and it came from a network design that was used by network engineers to represent the location of various network devices and there inter-connection. The shape of this network design was like a cloud. In nutshell, cloud computing decreases the hardware and software demand from the user's side. Apart from businesses and organizational level successes, cloud computing has provided libraries an opportunity to extend their impact and services. Cloud computing has become a major topic of discussion and debate for any business or organization which relies on technology. Anybody connected to the Internet is probably using some type of cloud computing on a regular basis. Whether they are using Google's Gmail, organizing photos on Flickr or searching the Web with Bing, they are engaged in cloud computing. As Geoffrey Moore points out, the interesting thing about cloud computing is it did not start as a technology for the business enterprise, but was driven by the public with services like Facebook and Flickr. Over the last few years businesses have started to see the value of cloud computing causing it to become a major technology solution for businesses and organizations around the world. Looking across the information and broader technology landscape, it is not difficult to find success stories of switching to cloud computing, disaster stories, and a great deal of debate about what cloud computing is, or isn't. The purpose of this article is to look specifically at how cloud computing can be employed by libraries and what needs to be considered before moving into a cloud computing solution.

2.ESSENTIAL CHARACTERISTICS:

On-demand self-service: A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider. *Broad network access.* Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).

Resource pooling: The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, and network bandwidth.

Rapid elasticity: Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.

Measured service: Cloud systems automatically control and optimize resource use by leveraging a metering capability1 at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

3.SERVICE MODELS

The three major Cloud Computing Offerings are:

Software as a Service (SaaS): The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure2. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

Platform as a Service (PaaS): The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider.3 The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment.

Infrastructure as a Service (IaaS): The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls).

4.BENEFITS OF CLOUD COMPUTING

The following are characteristics of cloud computing:

1. Self-Healing
2. Multi-tenancy
3. Linearly Scalable
4. Service-oriented
5. SLA Driven
6. Virtualized
7. Flexible

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: With cloud computing, any application supports multi-tenancy - that is multiple tenants 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 vitalizing 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 all 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 Driven: Usually businesses 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: Another feature of the cloud computing services is that they 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 commercial application

5.VIRTUALIZATION AND CLOUD COMPUTING

The main enabling technology for Cloud Computing is Virtualization. Virtualization is a partitioning of single physical server into multiple logical servers. Once the physical server is divided, each logical server behaves like a physical server and can run an operating system and applications independently. Many popular companies' like VMware and Microsoft provide virtualization services, where instead of using your personal PC for storage and computation, you use their virtual server. They are fast, cost-effective and less time consuming.

For software developers and testers virtualization comes very handy, as it allows developer to write code that runs in many different environments and more importantly to test that code.

Virtualization is mainly used for three main purposes –

1. Network Virtualization
2. Server Virtualization
3. Storage Virtualization

Network Virtualization: It is a method of combining the available resources in a network by splitting up the available bandwidth into channels, each of which is independent from the others and each channel is independent of others andcan be assigned to a specific server or device in real time.

Storage Virtualization: It is the pooling of physical storage from multiple network storage devices into what appears to be a single storage device that is managed from a central console. Storage virtualization is commonly used in storage area networks (SANs).

Server Virtualization: Server virtualization is the masking of server resources like processors, RAM, operating system etc., from server users. The intention of server virtualization is to increase the resource sharing and reduce the burden and complexity of computation from users.

Virtualization is the key to unlock the Cloud system, what makes virtualization so important for the cloud is that it decouples the software from the hardware. For example, PC's can use virtual memory to borrow extra memory from the hard disk. Usually hard disk has a lot more space than memory. Although virtual disks are slower than real memory, if managed properly the substitution works perfectly. Likewise, there is software which can imitate an entire computer, which means 1 computer can perform the functions equals to 20 computers.

6.CLOUD COMPUTING IN LIBRARY AND INFORMATION SCIENCE

Today cloud computing has large potential for libraries as it offers many interesting possibilities for libraries that may help to reduce the technology cost and increase the capacity reliability, and promises better performance for some type of automation activities. Cloud computing has made strong inroads into other commercial sectors and is now beginning to find more application in library science. Such new concepts are being added to ease the practices in the libraries and is also accepting many new technologies in the profession as they suit the present information handling and they satisfy needs of the knowledge society. With the advent of Information technology, libraries have become automated which is the basic need towards advancement followed by networks and more effort are towards virtual. Since cloud computing is a new and core area, the professionals should be aware of it and also the application of cloud computing in library science. Libraries may put more and more content into the cloud. Using cloud computing user would be able to browse a physical shelf of books, CDs or DVDs or choose to take out an item or scan a bar code into his mobile device. All historical and rare documents would-be scanned into a comprehensive, easily searchable database and would be accessible to any researcher. Many libraries already have online catalogues and share bibliographic data with OCLC. More frequent online catalogues are linked to consortium that share resources.

However, the mainstay of libraries i.e. the library management system (LMS, also known as the integrated library system or ILS) which were developed before the Internet or even Web existence, 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. But over the last few years' as we all know that data storage, its backup and maintenance are the main concern of the service providers and something like cloud computing can only makes it possible via storing the data over cloud. 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.

Though, 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. So, cloud environment need to bring possibilities like providing an open service oriented architecture, multi-tenancy, data security etc. Yet, 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 andre-use it across the community. Furthermore, 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.

7.REAL WORLD EXAMPLES OF CURRENT LIBRARY CLOUD SOLUTIONS

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. However the advent of the Web has allowed libraries to extend this original vision in new ways. Extending these services beyond traditional library collections is well illustrated by the National Library of Australia's (NLA) Trove. It has used the Web to accomplish two tasks. This is done by first combining the collections of Australian libraries with other important Australian and international collections and information sources such a Wikipedia and secondly to open much of this content so the public can tag it, edit it, collect it and review it. European is gathering the digitized collections from Europe's galleries, libraries, archives and museums. What makes these aggregations and others like them important is their intent to allow their content to be mashed up into other services and re-used. 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."

8.CONCLUSION

Cloud computing builds on decades of research in virtualization, distributed computing, utility computing, more recently networking, and web software services. It implies a service oriented architecture, reduced information technology overhead forth end-user, great flexibility, reduced total cost of ownership, on demand services and many other things. In today's global competitive market, companies must innovate and get the most from its resources to succeed. Cloud computing infrastructures are next generation platforms that can provide tremendous value to companies of any size. They can help companies achieve more efficient use of their IT hardware and software investments and provide a means to accelerate the adoption of innovations. Cloud computing increases profitability by improving resource utilization. Costs are driven down by delivering appropriate resources only forth time those resources are needed. Cloud computing has enabled teams and organizations to streamline lengthy procurement processes. Cloud computing enables innovation by alleviating the need of innovators to find resources to

develop, test, and make their innovations available to the user community. Innovators are free to focus on the innovation rather than the logistics of finding and managing resources that enable the innovation.

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 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. Cloud computing implies is library is a growing organism with cloud computing, all of this is taken care of transparently for the library and user.

Among the benefits of a cloud computing approach:

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

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 tore use information and socialize around information. Itcan also create a powerful, unified presence for libraries on the Web and give users a local, group and global reach. 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.

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