Feature Article : Cloud Computing and Its Impact on Library Services

Cloud computing is a buzz word now a days in the world of ICT. The concept has made huge impact in the technological application especially pertaining to the database and software applications. The cloud computing can be effectively implemented in various library application too. Different services and applications being used in library for providing services to the users are influenced with cloud computing. Shri Yatrik Patel, Scientist C (CS) of the Centre touches upon the topic of cloud computing in his article entitled "Cloud computing and its impact on library services"

"Cloud Computing" sounds like a new term, actually it is not, infact the term "Cloud" evolved with history of Internet itself. The idea of an "intergalactic computer network" was introduced in the sixties by J.C.R. Licklider (aka "Lick") , who was responsible for enabling the development of ARPANET (Advanced Research Projects Agency Network) in 1969.

According to Larry Roberts, the primary ARPANET architect *"Lick had this concept of the intergalactic network which he believed was everybody could use computers anywhere and get at data anywhere in the world... He didn't have a clue how to build it. He didn't have any idea how to make this happen. But he knew it was important, so he sat down with me and really convinced me that it was important and convinced me into making it happen."*

Other experts attribute the concept of cloud computing to computer scientist John McCarthy who proposed the idea of computation being delivered as a public utility which date back to the sixties.

In the past, computers were clustered together to form a single larger computer as common industrial practice that allowed users to configure computers to talk with each other using standard protocols to balance the computational load across the machines. As a user, one need not care about which CPU ran the program, and the cluster management software ensured that the "best" CPU at that time was used to run the code.

In the early 1990s, Ian Foster and Carl Kesselman came up with a new concept called "Grid". With analogy to the electricity grid where users could plug into the grid and use a metered utility service. The same was applied for computing resources in case of grid computing where in a user plug into a grid of computers and pay for what he/she uses. Grid computing expands the techniques of clustering where multiple independent clusters act like a grid due to their nature of not being located in a single domain.

The main bottleneck for moving cluster computing to grid computing was "data residency". The computers in the cluster were usually physically connected to the disks holding the data, where as in grid the computational nodes could be situated anywhere in the world. It was fine having all that CPU power available, but the data on which the CPU performed its operations could be thousands of miles away, causing a delay (latency) between data fetched and its execution.

To avoid this bottleneck and to take grid further at the level of service, concept of the cloud computing was introduced, as such concepts of grid computing was evolved to a service offered by data centres.

In short the concept of "cloud" does not only involve computers but also encompasses

- First cloud around networking (TCP/IP abstraction)
- Second cloud around documents (WWW data abstraction)
- The currently emerging cloud abstracts infrastructure complexities of servers, applications, data, and heterogeneous platforms.

The Cloud Computing

In generic term, cloud computing can be defined as *"a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable 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."* (NIST)

As far as a user is concerned, a cloud is a service that satisfies all of the following conditions:

- it is delivered over a telecommunications network;
- users place reliance on the service for data access and/or data processing;
- the data is under the legal control of the user;
- some of the resources on which the service depends are virtualised, i.e. the user has no technical need to know which server is running or which host is delivering the service, or where the hosting device is located; and
- the service is acquired under a relatively flexible contractual arrangement.

The fundamental elements of cloud computing can be categorised as follows:

Primary	Secondary
• Virtualisation	• Autonomic Systems
• Grid technology	• Web 2.0
• Service Oriented Architectures	• Web application frameworks
• Distributed Computing	• Service Level Agreements
• Broadband Networks	
• Browser as a platform	
• Free and Open Source Software	

The conceptual model of cloud promotes availability and is composed of five essential characteristics, three service models, and four deployment models.

Essential Characteristics of Cloud

- **On-demand self-service** (i.e. automated response by servers to direct requests by clients)
- **Broad network access** (i.e. from anywhere, using any device)
- **Resource pooling** (i.e. the provider allocates resources according to demand, rather than assigning resources to particular clients)
- **Rapid elasticity** (i.e. resources are scalable according to demand)
- **Measured service** (i.e. resource usage is metered)

Cloud Service Models

Software as a Service (SaaS)

The applications are accessible from various client devices through a thin client interface such as a web browser (e.g., web-based e-mail). The user 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)

PaaS provides an application platform, or middleware, as a service on which developers can build and deploy custom applications. Common solutions provided in this tier range from APIs and tools to database and business process management systems to security integration, allowing developers to build applications and run them on the infrastructure that the cloud vendor owns and maintains.

Infrastructure as a Service (IaaS)

It is the capability provided to the user to enable processing, storage, networks, and other fundamental computing resources where the user is able to deploy and run arbitrary software, which can include operating systems and applications. The user does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly limited control of select networking components.

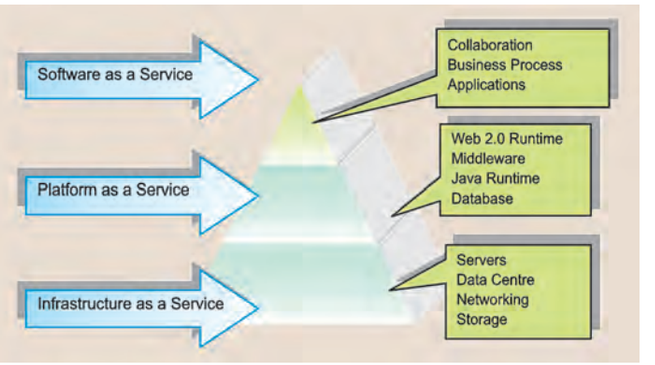

Figure: Cloud Service Models

Cloud Deployment Models

There are four primary cloud deployment models. Each deployment model necessarily exhibits the previously discussed essential characteristics. The basic differences lies in the scope and access of cloud services, as they are made available to end users.

- **Public Cloud** – A public cloud is a publicly accessible cloud environment owned by a third-party cloud provider.
- **Community Cloud** – A community cloud is similar to a public cloud except that its access is limited to a specific community of cloud consumers.
- **Private Cloud** – A private cloud is owned by a single organization.
- **Hybrid Cloud** – A hybrid cloud is a cloud environment of two or more different cloud deployment models.

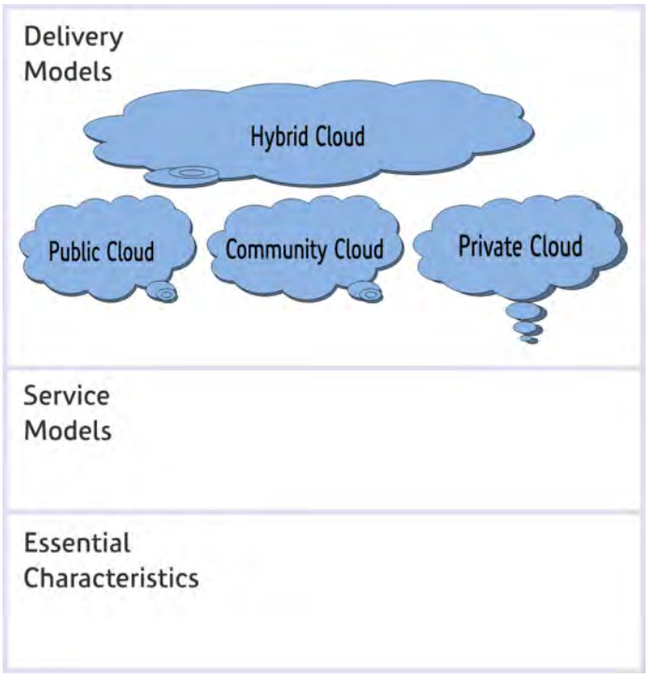

Figure: Conceptual Framework for Cloud Computing

Advantages of Cloud Computing

There are a number of advantages of cloud, though it depends on case to case basis, following are the general benefits:

- Assured maximum availability of your data, application and infrastructure;
- Need to pay only for what has been used (i.e. Bandwidth, Resources);
- Relieves burden of IT staff within organization, as routine jobs are being handled by service providers; and
- Easily scalable as per requirement of organization.

General disadvantages of cloud are dependent upon network connectivity, security, legal issues (ownership of data), latency etc. which needs to be carefully reviewed.

Cloud Computing and IT-Based Library Services

Most common library services can be divided into following three categories:

Data : Bibliographic, Technical, Access, Licence
Content : Collection, Subscription, Digital, Print, Publishing
Services : Library as a place, content-access, content-creation, research, preservation

As libraries are having service-oriented mission they are in a position to adopt cloud computing. Libraries (or librarians) are in constant search of finding proper solution within limited resources, moreover the outreach of service is quite dependent on support of external or internal computing (IT) support staff. It may also be noted that there are very few libraries that are having IT support staff with expertise on advance IT management. This situation makes SaaS, PaaS or IaaS approach tempting to move towards cloud computing for providing better library services.

Libraries have been adopting cloud-based solutions services like electronic journal access management, statistics tracking, digital library hosting and now trend is coming up for hosted library management systems.

The use of SaaS in libraries dates back to early 2000 with establishment of companies like SerialsSolutions (http://serialssolutions.com). There are also examples of availability of hosting platforms for Institutional Repositories and others (eg. http://duracloud.org; biomedicalcentral.com/).

In the IaaS, one of the pioneer i.e. Amazon Elastic Computing Cloud (EC2) offers IT infrastructure with differently sized servers using a choice of operating systems, including several flavours of Linux and Windows. EC2 provides organizations with unlimited storage using S3 service, the ability to take snapshots of both data and servers, and the ability to include EC2 servers in an organization's private network. A full catalogue of EC2 features is available on the EC2 website (http://aws.amazon.com/ec2/).

Conclusion

By using cloud, library services can be made online without worrying about correct versions of platforms or the underlying technology. It also gives facility to induce new applications quickly without having to focus on identifying available server space or configuration and IT-based library services can be delivered much more quickly than when using local-based hardware or software.

Libraries can make choices about the allocation of resources and to offer better services than would be possible if relying on in-house solutions.

At INFLIBNET Centre, strategies are being worked out to offer cloud based service for Indian academic organizations to support its mandate and promote scholarly communication. It would not be an exaggeration to state that the visionary scientist and educationist Prof. Yash Pal, knowingly or unknowingly applied combination of idea from John McCarthy and concept from JCR Licklider to build Information and Library Network Centre in 90s with a clear cut objective of leveraging the latest technology to create a virtual network of people and resources in academic institutions with an aim to "provide effective and efficient access to knowledge through perseverance, innovation and collaboration and to provide seamless, reliable and ubiquitous access to scholarly electronic resources to the academic community in all educational institutions with a focus on services and tools, processes and practices" (one of the objectives of INFLIBNET Centre) i.e. **the idea of delivering scholarly content as a public service !**

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