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An Overview of Cloud Computing Solutions in Library Services

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Abstract: *This article intends to provide a comprehensive overview of the current applications of cloud computing services in libraries. This study investigates the ways in which cloud-based information systems and services can administer library records in a cloud computing environment and support the evolving needs of library patrons. The authors endeavor to rectify the identified deficiency, advantages, and prospects associated with the integration of cloud storage at the Infrastructure as a Service (IaaS) level with the remaining two tiers of cloud computing Platform as a Service (PaaS) and Software as a Service (SaaS).*

Keywords: Cloud Computing, Library Services, Digital Libraries.

I. INTRODUCTION

A transformation has commenced in the realm of computing, with numerous organizations increasingly opting for cloud computing. By 2020, up to 15% of the information in the digital universe may be a component of a cloud service, according to IDC. Although a considerable portion of this data may not meet the criteria for preservation, there is a growing trend of storing business and administrative records in the cloud. Cloud computing is an umbrella term for any process that entails the provision of hosted services via the internet. It is a model of computing delivery that operates on the principle of providing resources, software, and information to computers and other devices in the form of a service rather than a product. In some ways, cloud computing is a "hyped" and relatively novel concept. This indicates that no singular definition has been agreed upon as of yet. For the purpose of this paper, we have formulated the following four attributes to serve as a definition of cloud computing:

- Cloud computing is a scalable, abstracted platform utilized for the delivery of services.
- Existing technologies that are utilized by cloud computing are described using a layered model.
- Internet users are granted access to the platform and its services on a pay-per-use basis.
- The number, quality, and availability of services are provided in accordance with contractual arrangements with a cloud service provider.

Through a published application programming interface and a network, cloud computing provides centralized services that utilize the available data, software, and computation. End users retrieve business software and data from servers located in remote locations by utilizing a web browser or a lightweight desktop or mobile application.

Service and performance levels offered by cloud application providers aim to be comparable to, if not surpassing, those achieved when the software was deployed locally on end user devices.

Cloud computing provides strategic alternatives and enables ubiquitous application access to facilitate communication among all organizational components. Additionally, it facilitates connections with valuable learning opportunities that circulate within communities created by service users. One advantage of cloud computing is the ability to accomplish more with fewer resources, which is advantageous for a strategic, agile adopter of its rapidly evolving technology and service. This feature enables users to select from a collection of hardware, software, and networking infrastructure that are either internally managed by the organization or externally managed by a vendor. These infrastructure, platform, or service-based computing capabilities are offered on a pay-per-use basis and are typically utilized to deliver business applications via the World Wide Web.

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Layers of Cloud Computing in Brief

An prevalent method of differentiating various cloud services is through the implementation of layering, as illustrated by SaaS, PaaS, and IaaS. Each layer in a layered model provides services to the layer above and builds upon those provided by the layer beneath it. To provide particular functionality, each layer employs its own information types.

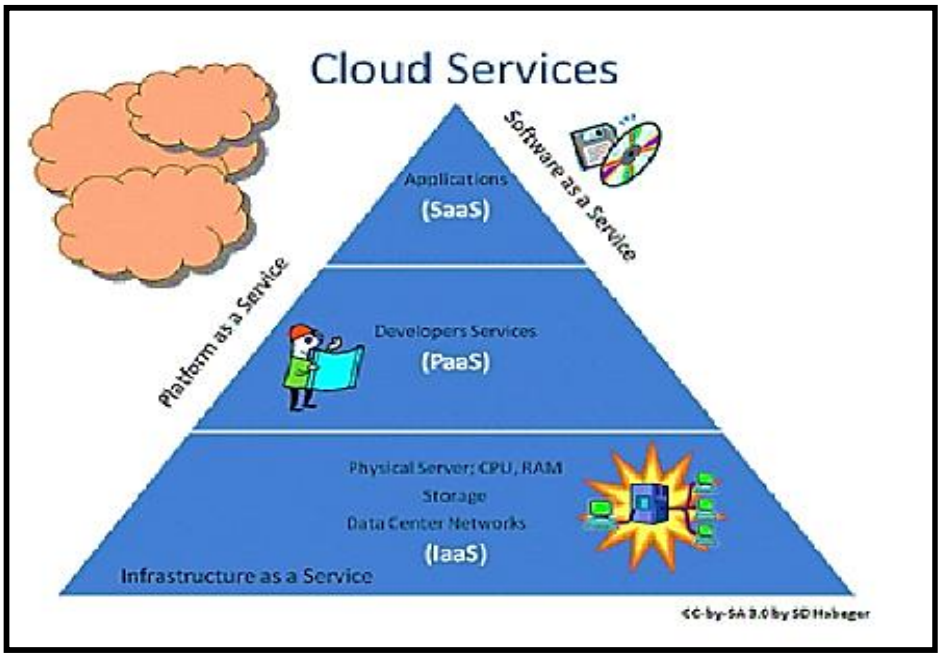

Figure:1 Three layers of Cloud Computing services

SaaS: At this pinnacle of abstraction in the cloud, applications are delivered as a service via the World Wide Web. This stratum of cloud services provides an extensive array of applications, spanning from office-oriented productivity applications to enterprise-oriented functions like email hosting, supply chain management, and enterprise resource planning.

PaaS: It represents the subsequent tier of abstraction, encompassing critical application infrastructure services including computation, messaging, connectivity, access control, and more, in addition to technical abstraction. The conventional in-house computing model requires a team of specialists in network, database, and system administration to ensure the continuous operation of the system. However, with the advent of cloud computing, these functions are now executed remotely by cloud providers operating beneath this layer.

IaaS: The lowest tier of cloud computing comprises this stratum. As services, IaaS providers abstract infrastructure resources for information technology, including memory and storage. A cloud service provider is responsible for the management of the physical infrastructure as well as the provisioning of virtualized operating system infrastructure to the end user. In this case, the user is granted full ownership of the virtual image, which can be customized to suit their needs. The services provided via this layer encompass the remote provisioning and assistance of an entire computing infrastructure, including virtual servers, storage devices, and more.

For network communication, the open system interconnection reference model is a well-known instance of a layered model. One advantage of utilizing a layered model is the ability to abstract layers after data types and services have been specified. That is to say, the inner workings of the layer beneath can be disregarded when examining a particular layer. Additionally, due to their networked and scalable character, cloud services are simple to integrate with multiple systems. An instance of this would be a records-producing institution that collaborates with the archive to which it submits records for storage. This would benefit both parties through the elimination of redundant service provision.

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Cloud Computing Services in Libraries

Library and information centers create, manage, and disseminate information. Most libraries use integrated library management systems and have websites. Repositories provide digital collection access and data storage. A search of library and information science literature on cloud computing services and libraries from public to university libraries included websites to repository systems. Most libraries have used SaaS and IaaS services since 2009 and want to use them for everyday tasks including office software, Google Docs, Calendar, Scheduling, and cloud storage for file synchronization and backup. Second, most libraries use IaaS for websites, repositories, and online backup. IaaS is a new phenomena in LIS, hence there is little literature on its deployment, challenges, comparisons to Simple Storage Services (S3) and Google Cloud Service, updates and backup, etc. However, this article attempts to briefly describe these services.

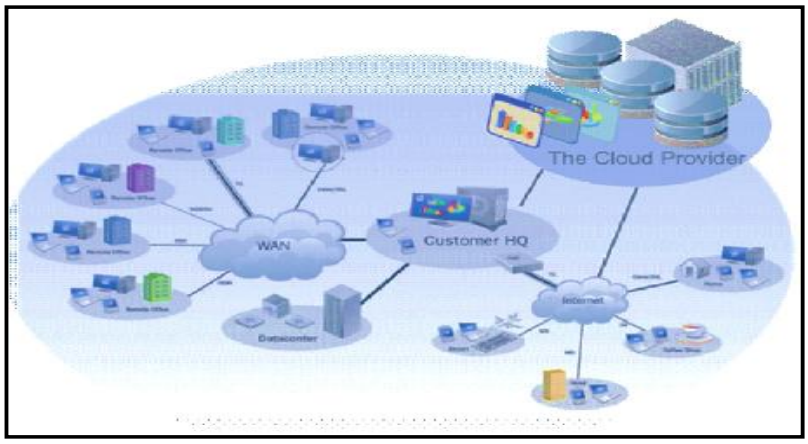

Figure 2: A Model of Cloud Computing Services

SaaS Services in Libraries

SaaS is used in most library tasks, from teaching to office application scheduling. Libraries and information centers utilize Gmail, Google Calendar, Google Docs/Drive, Dropbox, and OCLC World Share Management. Dropbox utilizes S3 for storage, while DuraSpace combines S3 and Microsoft Azure. Public usage dominates SaaS services. Apple iCloud, Amazon Cloud Drive, SugarSync, and Microsoft SkyDrive are prominent SaaS cloud storage services. A few SaaS cloud storage companies are built on IaaS.

The following major libraries use SaaS services for various purposes:

- The District of Columbia Public Library used Google Docs for Staff (Tonjes, 2010).
- New York City College of Technology used Google Calendar for instruction scheduling and daily work (Leonard, 2011).
- Eastern Kentucky University Library used Google Docs and Google Calendar for instruc- tion (Kroski, 2009)
- The University of Wisconsin-Eau Claire used Google Forms for reference and instruction

Uses of PaaS AND IaaS Services in Libraries

Since 2009, libraries and information centers have explored on-demand cloud storage systems including Amazon, Simple Storage systems, Google Cloud Service, Rackspace Cloud Files, and Microsoft Azure. Amazon EC2 and S3, Google App Engine, GCS, RackSpace Cloud Files, and Microsoft Azure are prominent PaaS and IaaS services. Large IT companies including Apple, Amazon, Google, Nirvanix, Rackspace, and Microsoft offer cloud storage. Google and Microsoft are well-known SaaS and IaaS cloud storage providers. Virtual machine service EC2 is IaaS-scalable. It is the most common IaaS solution for library websites, repositories, and management systems. Users have full control over virtual resources and can scale effortlessly. It serves as a hub. However, PaaS-IaaS connection needs programming and database management. Integration still requires technical expertise and assistance, even when system management

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is no longer needed. Using an API for corporate applications, Iaas lets developers store and retrieve data. IaaS cloud storage is used for backups, archiving, and huge data.

Benefits and Opportunities of Cloud Computing Services

Cloud computing has a multi-tenancy value: On a server, a solitary instance of specific software operates, with the capability to concurrently cater to multiple consumers. Through the implementation of multi-tenant architecture, every software application is configured to partition its data virtually, and every client interacts with a pre-configured virtual application instance that is specifically tailored to their needs.

Cost effective: By utilizing a shared infrastructure, the overall cost of ownership is diminished. Cloud computing is perpetually reliant on service providers, also known as cloud providers, to administer and provide service levels at various levels at a low level for the infrastructure and multi-user applications. As a result, capital expenditures are reduced via the pay-as-you-use model. Certain SaaS services are provided at no cost, while IaaS services operate on a "pay only for what you use" model. Nevertheless, this service is more economical in comparison to those hosted locally, and users are advised to contemplate the overall ownership expenses.

Lowered expenditure with elastic IT services: In two ways, cloud computing reduces IT expenditures. By initially capitalizing on a virtual suite comprising pre-integrated cloud-based applications and infrastructure, it streamlines the intricacies associated with conventional IT services. Secondly, by facilitating on-demand provisioning, it optimizes utilization of information resources and reduces costs associated with infrastructure management and monitoring. It is available for acquisition at any moment, offering a wide selection of services; libraries are no longer constrained by their internal IT resources.

Scalability and Convenient: Rapid scaling of capabilities is possible in response to fluctuations in workload. Rapid scalability is feasible, particularly for events of brief duration. The process of augmenting or establishing a fresh instance can be executed effortlessly, devoid of any downtime. In order to prevent library patrons from being dissatisfied with an email notification of system outage.

Availability: Large information technology companies possess substantial financial and technical resources, which enables them to maintain Cloud computing services with significantly greater availability than locally hosted servers.

Access anywhere, any time: Through the network, capabilities are accessible via a variety of devices, such as mobile phones, laptops, and PDAs.

Additional functions: Community actions and plug-in applications and tools can facilitate rapid access to additional functionalities.

Easy End-user Startup: Individuals have immediate access to computing capabilities without having to await the completion of comparable internal initiatives. New features are immediately accessible to users. At this time, cloud-based services have become fundamental software features, and an extensive range of applications are now accessible globally and continuously.

Gaps Observed

Security and Privacy: Libraries are responsible for safeguarding sensitive information, as circulation records must be protected. Additionally, readers must keep in mind that security is a significant concern. Securing sensitive data in the cloud requires adherence to policies and implementation of encryption protocols. Implementing encryption protocols for sensitive data and including suitable contractual clauses with cloud computing service providers are recommended strategies for ensuring data security.

The policies and procedures governing the storage of data are contingent upon various factors, including the format and duration of the data, its magnitude, and more.

Concerns regarding data security, dependability, velocity, precision, and the inexorably accumulated legacy that accompany the implementation of cloud computing services must be resolved.

II. CONCLUSION

Cloud computing in libraries and information centers changes how libraries pay for and use IT services. Well-developed libraries and information centers provide IT service providers and outsourced vendors additional options.

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Cloud computing will transform outsourcing firms' tactics to embrace cloud services to stay up with IT services market trends. They should try cloud services to see which models work for their users. This will help them find cloud computing-related business prospects. As IT outsourcing firms add cloud computing capabilities, the IT services market looks promising. However, numerous growing developments may affect IT services and cloud computing, including the integration of new services. Demand for cloud-based apps and dependable worldwide delivery mechanisms is rising. New novel cloud services with compelling business models will increase customer satisfaction and LIS cloud service adoption. The cloud computing service providers should also know that most institutions prioritize security. R&D firms are hesitant to utilize cloud computing due to data security and privacy concerns. Current issues include building appropriate compliance and security standards, lowering risk by developing strong infrastructure for dependability, high availability, and performance guarantee.

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