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Cloud Computing Technology for Library and Information Science Field

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ABSTRACT:

In the current era of information and advanced technology, a fully equipped library serves as the core of higher education and plays a crucial role in contributing timely information for the development of the national economy. The impact of technological advancements extends beyond altering the format and origins of information to also influencing the reference services offered by libraries. Libraries are transitioning to a digital landscape, marking a novel approach to information dissemination. It is accurate to assert that the forthcoming trajectory of libraries is inherently digital. In recent times, cloud computing has unmistakably demonstrated itself as an enduring technological advancement poised to further increase in adoption. This endeavour seeks to delve into the perspectives of academic libraries regarding cloud computing and its integration with library services. Libraries have undergone automation and networking, progressing toward paperless or virtual setups. This technology can be employed to expand the storage capacity of libraries, encompassing functions such as content creation, storage, e-learning, archives, and more. Data storage constitutes the fundamental responsibility of any library. To understand challenges in the librarian profession and achieve efficiency in information management, librarians are utilizing various platforms in the field of Library Science. This paper provides an overview of the emerging area called cloud computing, discussing its fundamental concepts and the utilization of cloud computing in libraries and an explanation of its functionality are outlined in this communication.

Keywords: Cloud Computing, Library Science, Information Management, Communication, Digital Landscape

1. Introduction:

In today's information age, information technology plays a crucial role in library science, encompassing activities such as collection, storage, organization, processing, and analysis of information. The field of library science faces numerous challenges due to the integration of information technology, prompting the adoption of new concepts and technologies to streamline practices and meet the evolving needs of the knowledge society.

The automation of libraries has become a fundamental necessity for advancement, followed by the establishment of networks, with increasing emphasis on virtual libraries. The rise of e-publications, digital libraries, internet usage, and the application of web tools in library services, along with consortium practices, further propel developments in the library profession. A notable trend in library science is the utilization of cloud computing for various purposes, aimed at achieving efficiency and cost-effectiveness in library functions.[1]

Cloud computing represents a novel technology model for IT services, widely embraced by numerous businesses and organizations. It enables them to steer clear of hosting multiple servers and equipment locally, alleviating the constant challenges associated with hardware failures, software installations, upgrades, and compatibility issues. For many organizations, the adoption of cloud computing offers a streamlined approach to processes, resulting in significant time and cost savings. As an emerging field, cloud computing has garnered considerable attention in its potential applications within libraries [2].

Cloud computing has the potential to revolutionize the construction of systems and the delivery of services, presenting libraries with the chance to broaden their capabilities. It introduces a new paradigm in computing, reshaping the processes of invention, development, scaling, updating, maintenance, and payment for applications and their underlying infrastructure. In the realm of cloud computing, data and services are housed in highly scalable data centers accessible through a web browser. It involves the provisioning of diverse services on virtual machines, drawn from a substantial physical pool situated in the cloud.[3]

Cloud computing represents a computing model rather than a standalone technology. In this model, "customers" connect to the "cloud" to access IT resources that are priced and provided on-demand. Essentially, IT resources are leased and shared among multiple users, similar to the way office space, apartments, or storage units are utilized by tenants. Accessed over an Internet connection, the "cloud" serves as a replacement for a company's data center

or server while delivering the same services. The emergence of cloud computing became a practical and optimized solution following the global infrastructure development of the Internet. It evolved as the "connect" command ceased to be a barrier to accessing clouds, especially with the widespread adoption of smartphones. These devices, equipped with Internet connectivity, enable users to seamlessly interact with various information and files on the network, particularly multimedia content [4].

Libraries utilize computers to operate various services such as Integrated Library Management Software (ILMS), websites or portals, digital libraries, or institutional repositories. These services are typically managed either by the parent organization's computer staff or by library staff. However, maintaining these services requires investments in hardware, software, and staff to handle tasks such as backup and upgrades when new software versions are released. Library professionals, often lacking training in server maintenance, may struggle with these tasks without support from IT staff within or outside the organization [5].

Cloud computing has emerged as a new trend in the library field, offering a solution to these challenges. It allows libraries to run different ICT services with ease, as third-party services manage servers, handle upgrades, and perform data backups. This shift to cloud computing alleviates many of the difficulties associated with traditional server management, providing libraries with a more efficient and cost-effective solution.

The main contributions are,

1. Investigating the understanding of cloud computing concepts within library settings.

2. Assessing the potential extent of cloud computing adoption in libraries.

3. Analyzing the opportunities and challenges faced by Library and Information Science (LIS) professionals arising from the emergence of cloud computing platforms.

4. Identifying the practical applications of cloud computing within library environments.

In this paper, section 2 presents review of Literature,

2. Review of Literature

In Espades [6]' discussion on the advantages of cloud computing for providing on-demand resources, the need for specific automation remains apparent, particularly in the deployment and scaling of platforms within virtualized environments. This necessity is particularly evident in the case of Software-as-a-Service (SaaS) platforms and their applications, where fluctuations in workload lead to both underutilization and overutilization of resources. Typically, the number of virtual machine instances deployed for scaling applications is determined based on the maximum simultaneous users. To address this issue, a tenant-based model is proposed to mitigate overutilization and underutilization when deploying SaaS platforms on cloud computing infrastructures.

According to Buyya [7], cloud computing is characterized as a parallel and distributed computing system. This system comprises an array of interconnected and virtualized computers that are dynamically provisioned. It is presented as one or more unified computing resources, a configuration established based on Service Level Agreements (SLA) negotiated between the service provider and consumers.

In a study titled "Cloud Computing for Education: A New Dawn," Sultan [8] delved into the emerging computing paradigm of cloud computing. This paradigm holds the promise of delivering diverse computing services in unprecedented ways. The article demonstrated how organizations, irrespective of size, are capitalizing on the advantages offered by this technology, encompassing not only cost benefits but also improvements in efficiency and environmental impact. Cloud computing relies on several existing technologies, including but not limited to the Internet, virtualization, grid computing, and Web services.

Ghosh [9] endeavored to unravel the complexities associated with cloud computing, placing emphasis on the models of cloud computing and its efficient implementation tailored for mid-sized organizations. The exploration extends to how cloud computing can enhance library services to achieve improved sustainability.

3. Cloud Computing Concepts

Cloud computing is a form of internet-based computing that offers shared computer processing resources and on-demand data access to computers and devices. It presents a model facilitating ubiquitous, immediate access to a shared and configurable pool of computing resources, including computer networks, servers, storage, applications, and services [10]. These resources can be swiftly provisioned and released with minimal managerial involvement. Cloud computing and storage solutions equip users and enterprises with diverse capabilities for storing and processing data. This can occur in privately owned data centers or those operated by third parties, potentially situated anywhere from across a city to across the globe.

4. Segments of Cloud computing

Cloud computing is comprised of diverse components, and each of these elements needs to be fine-tuned to ensure a secure and efficiently operating cloud application. The segments of cloud computing is demonstrated in figure 1.

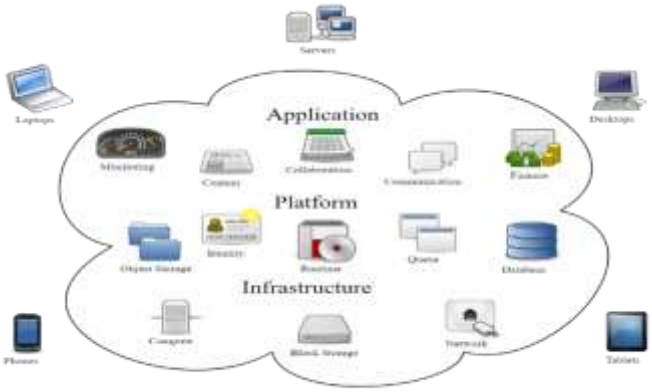

Figure 1 Segments of Cloud Computing

4.1 Service:

The service [11] is frequently perceived as synonymous with the application. While this viewpoint is somewhat accurate, considering that services deliver functionalities, it's crucial to recognize that the application itself is a distinct entity. It is within the application that the service is actualized. Software developers need to concentrate on guaranteeing the proper functionality of the application. The optimization of the application relies on the coding practices employed by developers. Thorough testing, encompassing load handling, security, and functionality, ensures that the application performs as intended.

4.2 Platform:

In traditional websites or applications unrelated to cloud computing, the application is directly linked to the server. However, in cloud computing, the application is typically deployed to an intermediary entity known as the platform. This platform is often represented by programming languages such as Ajax or Ruby on Rails. For those opting to engage with cloud computing providers, adherence to specific programming languages compatible with the chosen platform becomes essential. While many programming languages can function across various platforms, the prerequisite for cloud computing is a robust application with real-time updating capabilities.

4.3 Infrastructure:

Every function, service, and the capacity of storage to furnish required data relies on a well-optimized infrastructure. This infrastructure can be perceived as the underlying platform supporting storage, aiding in addressing load-related issues. The infrastructure [12] functions as a platform that evaluates the storage's capability in handling requests. Through features like load balancing and efficient management, the infrastructure possesses the capacity to make necessary adjustments.

5. Components of Cloud Computing

Cloud computing offers businesses the opportunity to enhance capacity and quality without the need to invest in new infrastructure, acquire licenses for new software, or undergo personnel training [13]. A cloud system comprises three primary components: clients, data centers, and distributed servers. Each component serves a distinct purpose and fulfills specific roles within the system.

5.1 Clients:

In a cloud computing architecture, clients resemble those found in everyday local area networks (LAN). These are the computing devices situated on end users' desks where front-end applications are installed. Clients encompass a range of devices such as laptops, tablet computers, mobile phones, or PDAs, serving as the user-side devices responsible for managing client information [14]. The physical specifications categorize clients into three main types:

- Mobile: This category includes devices like smartphones, tablets, or PDAs.
- Thin: These are terminals without local hard disk space, relying on servers for all processing activities. They primarily serve to display information.
- Thick: This type of client is a standard computer that utilizes a web browser such as Firefox or Internet Explorer to connect to the cloud.

5.2 Data Centre:

The data center constitutes a group of servers that host the applications subscribed to by users. A data center server may possess virtualized characteristics, wherein the software can be installed on the primary physical server but appears as distinct server identities to users. This configuration enables the operation of multiple virtual servers on a single physical server, allowing for increased efficiency.

5.3 Distributed Servers:

It is not mandatory for the data center to exclusively consist of a single server within our vicinity. At times, servers are strategically positioned in geographically diverse locations around the globe. However, from the end user's standpoint, it appears that data is sourced from a central server. In this arrangement, if one server experiences downtime or is temporarily unavailable due to congestion, etc., alternative servers activate to handle client requests. To ensure uninterrupted service for clients, the data across these servers is regularly synchronized.

6. Characteristics of Cloud Computing

On-Demand Self-Service: Users can provision and manage computing resources as needed, without requiring human intervention from the service provider.

Broad Network Access: Cloud services are accessible over the network and can be accessed by various devices such as laptops, smartphones, and tablets.

Resource Pooling: Cloud providers pool computing resources to serve multiple customers. Resources are dynamically assigned and reassigned based on demand.

Rapid Elasticity: Cloud resources can be rapidly and elastically scaled up or down to accommodate changing workloads. Users only pay for the resources they consume.

Measured Service: Cloud systems automatically control and optimize resource use. The usage of resources is monitored, controlled, and reported, providing transparency for both the provider and the consumer.

Deployment Models: Cloud services can be deployed in various models, such as Public Cloud, Private Cloud, Hybrid Cloud, and Community Cloud, providing flexibility and customization.

Self-Service Portals: Users can manage and monitor their own services through self-service portals, reducing the need for direct interaction with service providers.

Ubiquitous Access: Cloud services can be accessed from anywhere with an internet connection, providing users with ubiquitous access to computing resources.

Resilience and Redundancy: Cloud providers often implement redundancy and resilience mechanisms to ensure high availability and fault tolerance.

Security and Compliance: Cloud providers implement security measures and compliance standards to protect data and ensure regulatory adherence.

7. Cloud computing within the framework of libraries

Cloud computing represents a novel category of services accessible over the internet, fundamentally altering the way individuals harness the computational power, regardless of their geographical location. This innovation has introduced fresh opportunities for organizations and businesses to deliver services utilizing third-party hardware, software, or platform resources, resulting in cost and maintenance savings. The internet itself serves as a prime example of cloud computing. In the context of libraries, where information proliferation has surged, cloud serves as a centralized platform for storing and distributing information to users through web-based systems, enhancing accessibility and efficiency [15].

The acceptance of cloud computing in public libraries has been limited, primarily due to the absence of well-established service providers offering advanced technology solutions for library management. While many libraries contemplate the adoption of cloud computing, they encounter challenges related to standardized software, administrative procedures, budget constraints, and connectivity issues. Currently, some foreign companies are stepping in to provide cloud-based services. The primary advantage of transitioning to a cloud computing environment for libraries lies in the opportunity to explore new software without the need for substantial hardware investments. Additionally, the scalability of computing power to align with user demand is a key benefit. Embracing cloud computing allows a library's IT department to easily adjust the extent of cloud computing required by engaging with their vendor, eliminating the necessity to procure new hardware, software, and personnel to meet heightened demands. This approach not only saves the library money but also conserves valuable staff resources.

7.1 How it works

Cloud computing entails multiple interconnected cloud components that communicate with one another through application interfaces, predominantly web services. The UNIX operating system employs similar theoretical techniques for its tasks, dividing task complexity among various components to

achieve balanced and manageable outcomes. The most crucial components of cloud computing are the back end and the front end. The front end serves as the interface or primary screen visible to customers and users, enabling interaction with the system [16]. Users can access this interface through web browsers and utilize all applications available within it. Typically, this interface is based on a Graphic User Interface (GUI). In contrast, the back end encompasses all components, the entire architecture, and the programming techniques of cloud computing, remaining concealed from users. The back end comprises elements such as cloud servers, auxiliary computers, data storage media, and various connectors. The system alone has insight into the operations occurring behind each user request. The Cloud computing architecture for library services is illustrated in figure 2.

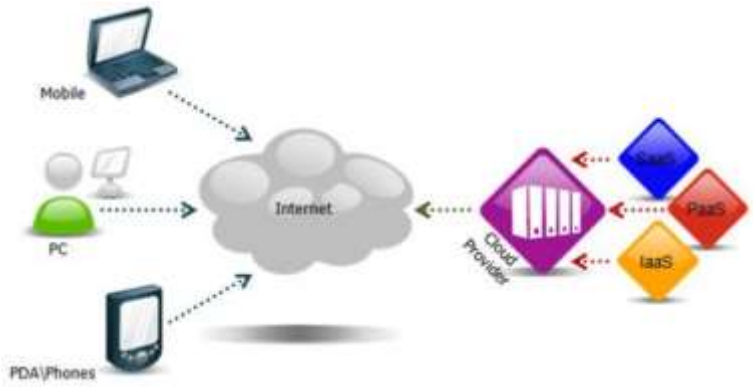

Figure 2: Architecture of Cloud Computing

7.2 Key Data Security Features in Library Management System

Data Backup: Backup of data plays a crucial role in safeguarding data and upholding the integrity of the library management system (LMS). Given that the LMS serves as a centralized repository for all library resources, including information on books, journals, and articles, the significance of data backup cannot be overstated. Nevertheless, challenges arise in terms of storage space and the time-consuming nature of activities like data restoration and recovery.

Secured Local Access: It is a straightforward yet impactful method to empower the library with greater control over its data while also ensuring that excessive information is not disclosed to third parties. The capability to store and manage data locally not only saves time and effort but also proves cost-effective by mitigating the necessity for expensive server infrastructure.

Cloud Data Encryption: Utilizing encryption, librarians can safeguard their collections against theft or unauthorized access. This security measure extends to the protection of users' privacy, ensuring that their personal information remains secure and inaccessible to unauthorized individuals.

7.3 Role of Cloud computing in libraries:

The role of cloud computing [17] in libraries encompasses several key aspects that contribute to the efficiency, accessibility, and management of library services. Some prominent roles include:

Centralized Data Storage: Cloud computing provides libraries with a centralized platform for storing and managing data, including catalog information, user records, and digital resources.

Cost Efficiency: Libraries can benefit from cost savings by leveraging cloud services, eliminating the need for extensive on-premises infrastructure and maintenance.

Enhanced Accessibility: Cloud-based systems enable users to access library resources from various locations and devices, promoting greater flexibility and convenience.

Automated Backups: Cloud services often include automated backup features, enhancing data protection and ensuring quick recovery in case of system failures.

Remote Access to Resources: Cloud computing allows library users to remotely access digital resources, e-books, and other materials without the constraints of physical location.

Improved Disaster Recovery: Cloud-based solutions offer robust disaster recovery mechanisms, ensuring data integrity and minimizing downtime in the event of unforeseen circumstances.

Efficient Resource Allocation: Libraries can allocate resources more efficiently with cloud computing, focusing on core functions rather than extensive IT management.

8. Conclusion:

Cloud computing builds upon decades of research in virtualization, distributed computing, utility computing, and more recently, networking and web software services. It embodies a service-oriented architecture, leading to reduced information technology overhead for end-users, increased flexibility, decreased total cost of ownership, on-demand services, and various other advantages. In today's globally competitive market, companies must innovate and optimize their resources to succeed. Cloud computing infrastructures represent next-generation platforms that can offer substantial value to companies of any size. They facilitate more efficient utilization of IT hardware and software investments, providing a mechanism to expedite the adoption of innovations. The model of cloud computing will promote active participation of libraries and their users in a network and community of libraries. This involvement enables the reuse of information and facilitates socialization around shared information. Additionally, it has the potential to establish a robust, cohesive presence for libraries on the web, providing users with local, group, and global outreach capabilities. Libraries are currently transitioning towards the adoption of cloud computing technology, capitalizing on cloud-based services, particularly in the domains of digital libraries, social networking, and information communication. Consequently, it is imperative for libraries to earnestly consider incorporating cloud-based technologies into their services, ensuring the delivery of dependable and prompt services to their users.

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