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Review

Cloud computing implementation in libraries: A synergy for library services optimization

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Cloud computing is an internet based, remote driven and service oriented technology emerged to provide infrastructure as a service (IaaS), platform as a service (PaaS), software as a service (SaaS) among others. By implementing cloud computing, libraries will significantly reduce cost of maintaining systems, save energy, register a global outlook on the web, expose library patrons to multi-variant information resources and optimize their services. This study tries to provide understanding on the general relevance of cloud computing to libraries and how libraries can be transformed into smart institution in order to implement the cloud technology. Five facilities such as digital resources, internet service, thin client architecture, wireless access point and digital librarian are considered as prerequisites for cloud computing deployment. It is recommended that libraries can revive and maintain their relevance by integrating with the cloud computing technology, which will make them part of Internet of Things (IoT) experience that will soon dominate the activities of every educational sector.

Key words: Cloud computing, library, information technology, thin client, wireless access point.

INTRODUCTION

The nature and extent of library services in the face of wide spreading Information Technology is continuously forming a subject of discussion among educationist, library professionals, archivists, documentalists and governmental agencies. The reason being that most services relating to information resources dissemination and delivery traditionally provided by libraries are either duplicated or replicated by World Wide Web (WWW) and facilitated by Internet.

The debates is centered on the best way to win the hearts of information searchers as well as researchers back to the libraries, because it is observed that patronage of library clientele is dwindling due to the availability of alternatives such as Internet, World Wide Web and cloud computing technologies, accessible through smart phones, laptops, workstations and other wireless and browser supported devices. Worse still, the attempt of some libraries to reinforce their presence on the web is challenged by the constant reduction of budgetary allocation, technical know-how and cost of Internet access, network tools, database and infrastructural facilities.

The emergence of Library Without Walls (LWW) concept and Library 2.0 technology (Yeo and Crawford, 2015) are librarians' progressive response to a changing information environment and the need to interact directly

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with a multitude of information providers and the networks that connect them so as to enhance library services (Fu and Fangai, 2014). These interactions have not been without challenges because of the fact that data that are created in different contexts and from different metadata traditions need to be merged to provide a wholesome uniformity for easy identification and access. The vision could have been realised in no time but many librarians started considering themselves the only true experts both in bibliographic metadata creation and in service to information seekers, behaving condescendingly to others newer to the information enterprise, thereby halting the support that could have been earned from computing technology experts. Nowadays, library clientele are speaking with their keyboards or keypads, overwhelmingly preferring non- traditional and non-library sources of information and methods of information discovery (Zhang et al., 2014; Kim, Kim and Lee, 2014). Efforts to change library user interfaces are a belated attempt to catch up with services that users have already come to take for granted from other providers, such as the immediate access to full text and user determined ranking and clustering of retrievals.

Even though the goals of digital librarians in building new interconnected library services deserve highest esteem, there is need to achieve that in short order if libraries are to retain their users' loyalty. It does not seem to matter to most clienteles that libraries currently are the only conduits for a wealth of published literature that is not available for open access on the public Internet. Generally, clientele will engage with services that provide materials quickly and with the least effort. The "invisible library," like the dark web, is of no interest to those who do not know that it exists (Ouahabi et al., 2014).

One alternative bail out for libraries is to incorporate cloud computing technology and engage in full-fledged web based information service provision (Kepes, 2011; Chad, 2015). The first step is to understand how cloud computing services fit into library services in the information economy and integrate the technology in order to transcendently remain relevant in information resources dissemination arena.

CONCEPT OF CLOUD COMPUTING

Cloud computing is referred to by scholars to mean different services provided remotely over Internet. Scholars try to connect cloud to anything suspended at an altitude to which remote access is required to operate with it (Mell and Grance, 2011).

Rana (2010) defined cloud computing as a pool of abstracted, highly scalable, and managed compute infrastructure capable of hosting end-customer applications and billed by consumption. National Institute of Standard and Technology (NIST) in Mell and Grance (2011) defines Cloud computing as a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (for example, networks, servers, storage, applications, and services). Suciu et al. (2013) conceptualised cloud computing as the delivery of computing and storage capacity as a service to a community of end-users. They also reiterated that cloud computing also extends the concept of IT services by combining user data, software and on-demand computation resources over a network.

Matt (2010) in Chukwhu and Lawal (2013) referred to cloud computing as a style of computing in which massively scalable and elastic IT-enabled capabilities are delivered as a service to external customers using internet technologies., and Gireesh et al. (2011) understood that cloud computing is the improvement of distributed computing, parallel computing, grid computing and distributed databases. And the basic principle of cloud computing is making tasks distributed in large numbers of distributed computers but not in local computers or remote servers. Arokia et al. (2012) see cloud computing as a style of computing where computing resources are easy to obtain and access, simple to use, cheap, and just work. According to them, Cloud is not a point product or a singular technology, but a way to deliver IT resources in a manner that provides self-service, on-demand and pay-per-use consumption. Dialogic (2010) believes that the term ―cloud‖ has its origins in network diagrams that represented the internet, or various parts of it, as schematic clouds and that ―Cloud computing‖ was coined for what happens when applications and services are moved into the internet ―cloud.‖ More currently though, cloud computing refers to the many different types of services and applications being delivered in the internet cloud, and the fact that, in many cases, the devices used to access these services and applications do not require any special applications (Dialogic, 2010).

Cloud computing are provisioned and discharged with minimal management efforts with the support of service provider interactions (Malhotra and Jain, 2013). Cloud computing is an evolving paradigm that offers opportunities to individual or group of users that need to provide limitless and without time or location bound services. According to Yuvaraj (2013), cloud computing is nothing more than the collection of computing software and services that can be accessed via the internet rather than residing on a desktop or internal server. Blokdijk and Menken (2009) stated that the origins of the term cloud can be traced to the concealing nature of this technology's framework; the system works for users yet they really have no idea of the inherent complexities that embodies the system activities. The means of communication between client and cloud have been termed middleware and depend very much on formation of images of virtual machines (Neumann, 2014) represented as cloud symbol.

Pandya (2012) explained that cloud computing uses the web (Internet) and central remote servers to maintain

data, software, and application. Cloud computing allows users to use applications and systems through internet access in a way that enable them access their personal and official files on any computer without installation in their local machine. Gartner (2015) asserts that cloud computing is a style of computing in which massively scalable and elastic IT-enabled capabilities are delivered as a service to external customers using Internet technologies.

Frost (2014) believed that cloud computing is a paradigm shift whereby details are abstracted from the users who no longer have need of, expertise in, or control over the technology infrastructure ―in the cloud‖ that supports them. In information technology arena, cloud computing can be described as a new supplements, consumptions and delivery model for IT services based on the Internet, and it typically involves the provision of dynamically scalable and often virtualized resources as a service over the Internet. Cloud computing is a mega change that has robbed IT of its traditional obligations and empowered the end users with on-demand utility computing.

FEATURES OF CLOUD COMPUTING

The power of cloud computing could be explained in terms of their characteristics or features as discovered and appreciated by vendors, clients and scholars.

Tritt and Kendrick (2014) reiterated that with efficiency improvements and large savings in operational cost as well as upfront capital costs for tech-startups, cloud computing carries the characteristics of a disruptive general purpose technology with a potential to greatly impact the economy as a whole. Saya et al. (2010) in Yuvaraj (2013) pointed that the characteristics of cloud computing include scalability, cost effectiveness, accessibility and lack of security as a principal factors in growth, abandonment and deferral.

Mell and Grance (2011) came about with five basic characteristics of cloud computing, which includes On-demand self–service, broad network access, resource pooling, rapid elasticity and measured service. Gosavi et al. (2012) listed seven characteristics of cloud computing such as self-healing, multi-tenancy, linearly scalable, service-oriented, SLA driven, virtualized and flexible. Malhotra and Jain (2013) break down the various characteristics of cloud computing. According to them, public based cloud computing is characterized with freedom of self-service, pay for what you use, availability and reliability; private cloud has features such as enhanced security measures, dedicated resources and greater customization; hybrid cloud is noted by its optimal utilization, data centre consolidation, risk transfer and availability. As indicated by Madhusudhan (2013) cloud computing has enormous features that transcend or cut across various access patterns, needs structure, intended goals, location of clienteles and coverage of services, which make it capable of supporting different users. The features of cloud computing can well be explained under services and deployment models as described below.

SERVICE MODELS OF CLOUD COMPUTING

Various services are provided through cloud computing. Each service is significantly independent and connected to other services in a more virtually inclusive manner. The services are based on applications, data, runtime, middleware, operating system, virtualization, servers, storage, and networking (Geoffrey, 2016). In the relationship between vendors and clients, the level of control of each of the services determines the model of the cloud computing. While levels of control are shared between the vendors and client, it should be understood that the degree of management really affect the control magnitude. All the products available on the cloud are provided as a service because they are ultimately influenced by the availability and strength of as well as access to Internet. Suciu et al. (2013) asserts that a service model defines the purpose of the Cloud and the nature of how the Cloud is located.

Chukwhu and Lawal (2013) described service cloud model as a system that promotes availability of resources and creates powerful distributed computing system with global reach and super computing capabilities. They list eight (8) service models that are available for anybody to subscribe to, such as infrastructure as a service (IaaS), platform as a service (PaaS), hardware as a service (HaaS), software as a service (SaaS), computing as a service (CaaS), data as a service (DaaS), network as a service (NaaS) and human as a service (HuaaS).

In the same view, Nagalakshmi (2013) reports that they are nine (12) public cloud computing service models that can be benefited from. According to him, they are: Infrastructure as a service (IaaS), Platform as a service (PaaS), Software as a service (SaaS), Storage as a service (STaaS), Security as a service (SECaaS), Data as a service (DaaS), Database as a service (DBaaS), Test environment as a service (TEaaS), Desktop virtualization, API as a service (APIaaS), Backend as a service (BaaS), Infrastructure as a Service (IaaS).

Cloud computing services are based on the facts that every single service session can be distinctively provided on the network once connection is established. As explained by Das (2013) cloud computing resources are available immediately as soon as the agreement with the service provider is executed. Under the utility model of service provision, users are charged only for what they use, for the memory, CPU, data transfer, I/O requests, storage space and so on. Usually, cloud services are based on the Internet which are accessed, transported and used over the Internet in user`s web browsers (Li

and Wang, 2014).

DEPLOYMENT MODELS OF CLOUD COMPUTING

Cloud computing deployment is a process of establishing and bring into use, a system or an application. It is a preparedness that establishes a connection between vendor and client based on agreement to access whole or part of the cloud technologies via Internet and in line with needs and demand of the users (Kim et al., 2014). Basically, deployment model of cloud computing can be categorised into four, which are, private cloud, community cloud public cloud and hybrid cloud. Cloud computing operate within the realm of public, private, community and hybrid deployment models. Each model of deployment has its basic characteristics, capabilities, extent of operation and targeted clients.

Private cloud

Arokia et al. (2012) explained that private cloud is based upon a pool of shared resources, whose access is limited within organizational boundaries. According to Suciu et al. (2013), the private cloud deployment is a kind of cloud infrastructure that is provisioned for exclusive use by a single organization comprising multiple consumers (for example, business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exists on or off premise. Chukwhu and Lawal (2013) confirmed that in private cloud, a cloud infrastructure is being deployed, maintained and operated for a specific organization. Based on private cloud model, the resources are accessed over a private and secured intranet, and are all owned and controlled by the company's IT organization. Characteristically, private clouds, as pointed by Database (2015), are operated by the cloud provider exclusively for a specific client and are very customizable; there are more options regarding where the servers are physically located (at a data center or on-premise), and private cloud providers are also able to offer more flexibility in meeting specific application related or security and privacy requirements.

Community cloud

Malhotra and Jain (2013) related that community cloud infrastructure is shared between the organizations with similar interests and requirements whether managed internally or by a third-party and hosted internally or externally (Huang et al., 2014). The infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (for example, mission, security requirements, policy, and compliance considerations). Community cloud could be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combinations of them, and it may exists on or off premises (Chukwhu and Lawal, 2013).

Public cloud

The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider (Mohanty et al., 2014; Huang et al., 2014).

Hybrid cloud

Ouahabi et al. (2014) explained that the cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (for example,, cloud bursting for load balancing between clouds). Some vendors combine different cloud deployment strategies in order to accommodate large poles of clients and as well main high level of efficient that is obtainable from balance support of cloud based systems (Madhusudhan, 2013).

CLOUD COMPUTING IN THE LIBRARIES

Cloud computing, though being around since the invention of Internet, has becomes wide spread because of remote storage and access technologies. Cloud applications have assumed an important role since their implementations to the extent that scholarly journals and the software that provides access to these contents are more frequently cloud-based. Whenever information resources are stored away from the physical Information Technology tools and accessed remotely over Internet, it is believed that cloud computing has taken place. Missions of library are now been fulfilled and manifested by the presence of cloud-based solutions due to its support and facilitation of online electronic resources and services provision (Nagalakshmi, 2013; Madhusudhan, 2013).

Ultimately, cloud computing in libraries is demonstrated by the Online Computer Library Center WorldCat, which has been around for generations (Mcmanus, 2016), where it is indicated that cloud computing is already playing a very large role for research libraries. Surprisingly, people hardly notice that cloud computing is part of their activities until they are engaged in and committed to carrying out their transactions in the cloud, such as emailing and accessing resources on Internet. The benefits of cloud computing for libraries services

provision is increasingly attracting attention of library professionals and librarians.

Cloud computing services covers many libraries management services, including linking, circulation, acquisitions and dissemination (Sahu et al., 2016; Mcmanus, 2016). The cost efficiency of deploying cloud computing in libraries cannot be underestimated. That is why Mcmanus (2016) presumed that libraries can cut cost to a minimal level through cloud computing implementation. It is pointed out that the reasons why cost of implementing cloud based services will minimize library expenditure are that:

1. Without hardware or software to install on-premise, there are fewer fees associated with hardware, software licenses, installation, training or updates for libraries;
2. The majority of cloud providers have pay-per-use billing, meaning that companies, including libraries are only charged when actively using cloud services;
3. The multi-tenancy of cloud computing is advantageous because the cost for one cloud is shared among the different clients using it and therefore, libraries can optimised its budget for a better product;
4. With cloud providers, there is no need to worry about training in-house IT personnel. Rather, libraries only need to concern themselves with training users; and
5. Switching over to the cloud will open up physical space in the library that was previously occupied by shelves and other types of hardware.

Nagalakshmi (2013) reiterated that as information were exploded in recent age and the usages are been increased, cloud became a platform to store the information in one place that is, in a common server and distribute the same to all the users whenever required via web based systems. This is much like an alternative to physical storage facilities owned and controlled by libraries. Cloud computing is basically a unified library consortia that can help libraries champion their courses of outbound services provision (Fu and Fangai, 2014; Zhang et al., 2014).

Cloud computing is applied to the library through automation with multi user (client), federated search via web using Online Public Access Catalogue (OPAC), Integrated library system (ILS), web hosting, global OPAC, Online resources sharing, digital library and interlibrary and intralibrary loan (Ouahabi et al., 2014).

Breakthroughs in library services provision can be viewed based on the degree of access to the volume of knowledge contents that library allow access to. That is why it is necessary that library in this modern societies need to champion their efforts to promoting knowledge sharing via cooperation facilitated by cloud computing.

Libraries can adopt and use cloud computing to provide qualitative services to their patrons through switching from acquisition and storage to services oriented system (Kaushik et al., 2013). Applications of cloud computing to library operations can take several turns. Libraries use cloud computing to build digital libraries or repositories, searching library data, website hosting, searching scholarly contents, file storage, building community power, and library automation.

Some services that libraries can provide through cloud computing are tied to some applications such as office applications, operating systems, forums, social networking, mailing services, storing services, software and applications, calendar services, information collection services, sharing services, video and presentation services.

BENEFITS CLOUD COMPUTING TO LIBRARIES

Cloud computing forms a bedrock of cooperation. It serves as an engine that allows different institutions and private organization invest in information resources consortium, applications and infrastructure that benefit all. By forming cooperation libraries can exploit the resources in the cloud computing, refocus their times, money, services and avoid duplication of efforts/ resources acquisition, thereby assisting one another for better service provision.

Educational institutions have a lot to benefit from cloud computing if implemented. Das (2013) believes that cloud computing technology infrastructures can help educational institution, especially universities, open their massive research endeavours to businesses and industries for research advancements. Universities would be positioned to handle their ever-growing resource requirements and energy cost. University institutions would be able to teach students in new, different ways and help them manage projects and massive workloads; and therefore, students would better be familiar with global workforce which would expose them to the value of new technologies. Yuvaraj (2013) and Tritt and Kendrick (2014) observed that some libraries have jumped and are increasingly stepping into the realm of digital librarianship as well as platforms that extend information technology obtainable capabilities, and this at length depends on using the cloud facilities.

Notably, most libraries deploy computer systems that are built on a pre-web technology. Systems spread across the web using pre-Web technology are harder and more costly to incorporate together. Most academic libraries store and maintain the same data hundreds and thousands of times with their accompanying huge cost. This invariably contributes to the weakness of libraries to satisfy their clientele, and their presence on the web is at stake due to scatter data across secluded systems. The dangers of this kind of system of operation rub libraries of collaboration and consistent cooperative agendas at the characteristics of information seekers, building a unified interface that enshrines common approach to information use will give libraries common benefit of optimized

service provision and promote flexible workflows. This is made possible through cloud computing.

Another common trend in the utilization of system available in the libraries is that, not up to 10% of the capacities of the system are ever used. For example, hard disk space, amount of RAM, Processor requirement, Operating system as well as office package applications are never used to their fullest capabilities. This constitutes a waste of resources due to duplication of system capacities (Ranchal et al., 2010). One advantage of climbing to the cloud system as emphasized by Gartner (2015) in Romero (2012) is the ability of reuse, economy of resources and maximization of utilities through reduced cost associated with waste of resources, management and maintenance of physical facilities and reinvestment of available funds to optimal services provision. Deployment of cloud computing can help library reclaim clientele patronage and win sponsors encouragement.

Cloud computing has the propensity to uniquely empower libraries to fully satisfy the needs of their respective clientele to the unimaginable magnitude, due to the fact that Cloud computing paradigm is independent of location and can be accessed on any media having network connectivity and browsers. With cloud computing, information is not stranded on individual machines, it is combined into one digital cloud available at the touch of a finger from many devices (Hamm, 2009).

Yuvaraj (2013) enlisted thirteen (13) benefits that libraries would derive from deploying cloud computing. According to him, in the meantime libraries would optimise their services by deploying cloud computing through high computing power, location and device independency, high scalability, Less maintenance, Less indulgence in library activities, unlimited storage capacity, diverse support, faster deployment and development, greener library services, ubiquitous availability of library services, pay-per-use, reduced technology obsolesce and no capital investment. With cloud computing, the meagre budget of libraries can sustain the libraries to provide maximum information services.

Lowry et al. (2009) emphasized that libraries need to deliver services and resources to the virtual environment used by students, faculty and researchers or risk alienating their clienteles. In this information and technology age, libraries need to provide services that run on the media used by the library users, such as mobile phones, smart phones, tablets, laptops, and personal computers (PC). Goldner (2010) asserted that the rationale for libraries to step fully into cloud computing is to use it to deliver library resources, services and expertise at the point of need, within user workflows and in a manner that users want and understand. Moreover, libraries would be freed from managing technology and therefore exert its focus on collection building, improved services and innovation.

AGE OF SMART LIBRARY: A PREREQUISITE FOR LIBRARY SERVICES OPTIMIZATION

Information technology's support for every human activities and relationships including cultures, geographical boundaries, languages, economy, politics, education, to mention but few is overwhelming testimony of persistence transformational world. Now that Internet of Things (anything and everything connected to Internet and interact seemingly), is rearing its head across educational domain, the relationship between library and cloud computing should be consolidated in a more vibrant manner. In recent time, it was foretold that library need to fight hard and fast to sustain its roles as an enabler of information accessibility otherwise its relevance will dissipate (Tritt and Kendrick, 2014). Koziol et al. (2004) predicted that in information age a single digital copy of an article or book can be delivered to multiple users anytime, anywhere and that there will be a single catalog of books (and non-books), which can be searched at the word level, leading users to library holdings and purchase opportunities. In line with the above prediction, the concept of smart library was introduced.

Smart library is an improved quality of a library service in the face of technological advancement. It is a manifestation of an expert usage of hardware, services and Internet that brings about qualitative changes in the user-librarian interaction (Du Rand, 2009; Gosavi and Shinde, 2012). Smart library promotes electronic information resources through wireless nodes thereby making it seemingly possible for smart phone and other computer users to take advantage of fast information provision services. Smart library helps in showcasing library services vis-à-vis information infrastructure in a manner that the needs of users are put into cognizance, as they play important role in the development of the library operations through enabling smart wireless access to the e-resources.

The age of smart library is a manifestation of libraries' efforts coming closer to the scene of operation in conformity with the demand of information economy, where Cloud computing is initiated into library computing through wireless connectivity. Smart library is characterised with centrifugal activities that would drive every library towards global entity in which connecitivity and dependency will make library services ubiquitous. In retrospect, Mackenzie (1997) propounded that information age would be characterised with features that best explain the quality of smart library. According to him,

1. In the long term almost all information would bepublished and distributed in digital format.
2. The services of the library would be based mainly on digital
3. would be networked information rather than printed information or off-line digital products (for example, CD-ROMs)

4. Users would access the library through the network; distance access will become more important than on-site access
5. Most information would be stored on the network, and many search, access and delivery systems would also be embedded in the network
6. Emphasis would be on access rather than on the collection
7. Seizure of the current organization of libraries will predominantly be based on a spatial institutional model

Moradi (2005) disclosed that smart library will carry specific characteristics. He stated smart library will be established in such a way that the library space will be an indoor living lab, where students, researchers and entrepreneurs can develop, test and demonstrate smart technologies, analyze the collected data and conduct research-and student projects, while optimizing the indoor climate, lighting and acoustics and therefore boosting the chances of learning. The benefits of smart library are manifolds. As the case may be, library users will benefit from smart library in four broadband ways such as:

1. Personal comfort
2. Open data repository
3. Technological and environmental playground
4. Economic sustainability.

It can therefore be reiterated that smart library is both a comfort zone and learning zone for library users. Tiwari et al. (2016) states that smart library is basically characterized with touch screens that provides fast access to any and all types of digital media, with no text-bound interface getting in the way. Smart library connote a library with just electrical plugs on the wall and wire extensions for plugging laptops, phones and the like. A smart library has available wireless connectivity that support connections to Internet as well as intranet.

Library's efficient performance can well be determined by how it can accommodate and serve users with sitting materials and connections nodes for purpose of information access through Internet. A smart library advocates for digitised library with almost every single information relevant is disseminated in electronic form and can be accessed as and when demanded.

Wang (2013) explained that both smart library and digital library are based on digitization and networking, but the smart library has already combined these characteristics with such inherent features and essential pursuits as clustering, integration, collaboration, green development, and serving the general public. He argued that Smart library is the product of library digitization, networking, intelligence, cultural diversity and social informatization interacting with each other at a specific historical stage, and it is the continuation, integration and sublimation of the philosophy and practice of the digital library development.

Baryshev et al. (2015) enumerated four cardinal information technologies that testify to the presence of smart library. They believe that library is able to attain the level of smart library if its method of providing information, the way and manner in which users utilize the available information resources as well as the services being offered by the library in question encompass the following technologies:

1. Smart technology of content formation
2. Smart detection of knowledge
3. Smart interface (organisation of interaction with the user).
4. Smart services (for example, personal informing).

Smart library is a giant progress for libraries that wish to be part of information age wave. It is a transformation that is characterised with implementation of some information facilities. As will be explained below, smart library will provide optimised services and library patrons will find easy to patronise library for most of the educational information needs.

REQUIREMENTS FOR CLOUD COMPUTING IMPLEMENTATION

Library patrons can easily and quickly be provided with information they need if library is able to make information available seamlessly. In information age, libraries need to turn smart in their structure, infrastructure and service provision approach. Given that information sources and resources are easily available online and can be accessed at the fingertips of people through smart phones with internet access, libraries can assume a central role in the trend of web-based information provision by being smart. A library can only be smart if it can put in place the facilities such as high speed internet service, wireless access point, thin client architecture, digital librarian and digital resources. These facilities are prerequisites for cloud computing implementation.

The operations of libraries in information age need to shift beyond maintaining traditional service rendering by disposing themselves to using digital facilities to a higher extent. That implies making libraries smart. As indicated in Figure 1, smart library is a constituent of facilities such as Digital resources, Internet service, Thin client architecture, Digital librarian and Wireless access points. Library need to consider the importance of each of the facilities indicated in the diagram. Cloud computing implementation cannot take off if one of the facilities is missing or not put in place. Information age is embodied with technological tools that make library management and use easy, flexible and encouraging. Let us discuss these facilities in details.

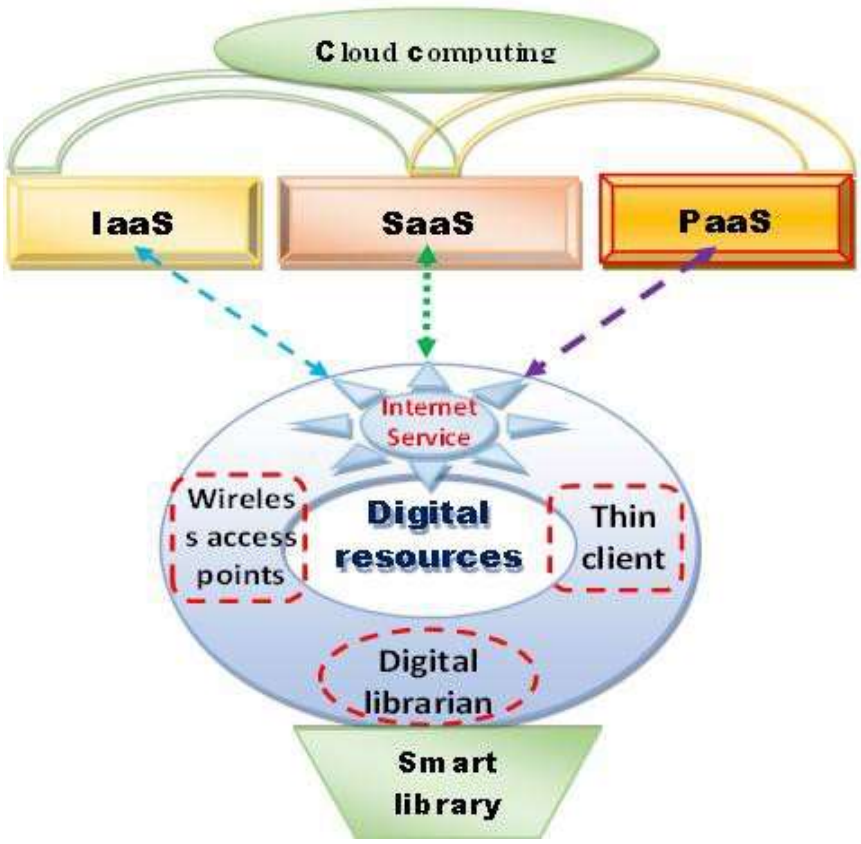

Figure 1. Structure of smart library in information age.

Internet access

Cloud computing host resources such as IaaS, SaaS, PaaS, etc. on machines that are remotely accessible through Internet technology. Internet service is a crucial medium through which resources can be accessed, shared and distributed among different people across the globe. Individual or institutions can subscribe to internet service through CA-Band, KU-band, C-Band, GSM broadband Internet providers or telephone network. Considerations in identifying and choosing the best ISP, cost of bytes (in mega or giga), timeframe as well as speed of the internet will significantly influence persistent quality of library services. Library can only access the cloud computing resources if it has a good internet connection and service. All resources, whether operating system or applications can only be accessed with the possibility of Internet connection and therefore is it a factor that must be considered with due technicality.

Thin client architecture

Thin client architecture requires that there should be a server and thin clients device attached to a monitor (displaying unit) for operation. Keyboard and mouse are plugged into the thin client device. In this Server—client relationship, a powerful Server with minimum of 3.0 GHz processor, 16 GHz RAM, 4 Terabyte Hard Dist, Gigabit Ethernet (Network Interface Card-NIC) is required—for faster, robust, efficient and long lasting operations. Thin client architecture is a multiple benefits derivative technology. Apart from centralization of critical services, the technology has the propensity to improve services and allows saving of both cost and energy among others. Right from the onset Thin Clients reduces cost associated with IT support costs, upfront purchasing costs, capital costs, use of space in data center, licensing costs as well as total administration and operating cost. Thin clients consume an average of 8 to 20 watts compared to a 150 watt PC, reduces carbon footprint, save electricity for further reinvestment.

Simplification of devices, applications and digital resources management are another core benefits of thin client. In the meantime, software and hardware upgrades, security policies, application changes, etc. can be carried out in the central data domain, IT staff are hardly needed to fix individual problems at the end user desktop location. Less downtime and high productivity in relation to end-users and IT staff of the library, centralized and

simplified back up of resources

In terms of security, thin clients are protected from the use of unauthorized software or the introduction of viruses, data are difficult or impossible to be copied to a disk or saved to any other location than the server, the processing, management and monitoring of the system are centralized with easiness. Security simplification, intellectual property protection, data privacy is highly ensure.

Systems can be virtually preconfigured, packaged and put into operation within the shortest period of time. This therefore implies that thin client allows quick and flexible sup up of systems with little effort or assistance of high expert. This will lead to higher productivity, and the coverage of access to library resources or library supported application is virtually ubiquitous, a dynamic and flexible IT environment lead to stable and long lasting information technology infrastructures. Setting up a thin client architecture in the library will facilitate a successful implementation of cloud computing.

Wireless access point

Wireless access points are wireless fidelity that provides connection for wireless supported devices. Wireless access point is a station that transmits and receives data wirelessly within a Local Area Network It connects users to the server and as well to other users within the network. It serves as the point of interconnection between wireless and cable network. Wireless access point has the capacity to serve multiple users at the same time and if wireless access point wireless signal as intertwined they can serve as a platform for a wider access for a better usability of resources.

Library patrons can use the wireless technology in the library to access the resources provisioned on the cloud. In order to establish a Wi-Fi to cover a wider range beyond library building, WiMAX router could be deployed because it has the ability to transmit data at about 70 megabyte per second with the signal travelling over 5 to 15 km range, and can be positioned to provide 360° degree radius service.

There are lots of benefits for installing wireless access point in the library. Wireless access points are inexpensive to install and run, increase efficiency by reducing the amount of time required to attend to information accessibility, flexible and versatile because of their ability to easily extend network signal for access beyond immediate location, require low technical attention, easy to use. Thus, wireless access point facilitates easy document delivery and wide selective dissemination of information.

Digital resources

Digital resources in the library are information resources that are either converted into digital format or information acquired in electronic format. It is highly beneficial to possess electronic form of information in the library to make it easy for library patrons to easily utilize the resources. Digital resources cover a spectrum of Thesis and dissertations, book chapters, conference publications, journal articles, multi-volume books, patents, serials (journals, newspaper, periodical), technical reports among others.

Digital librarians

The manpower required for cloud computing deployment is minimal. Probably, two personnel skillful on IT having good knowledge relating to system installation, networking and Internet management are good prerequisite for managing the Server/Thin client workstations and wireless access points. The roles of the IT personnel spans from authentication, authorization, access (AAA) control and monitoring of the usage flows. Even though open access is the custom of library's information dissemination tag, it is however, necessary to institutionalise element of control on the use of library resources, in order to optimise use, facilitate access and guard against misuse.

CONCLUSION

Cloud computing is already part of everyday lives of everybody. Integrating libraries into the cloud computing technology will definitely transform library into smart library nomenclature and henceforth optimise and enhance library services in information age. Cloud based Library is now the world emerging eSmart Library category. Every library needs to build modernized information delivery infrastructure and conducive environment that viably supports research, learning and teaching. As a matter of fact, libraries need revive and maintain their relevance by integrating with the cloud computing technology, which will make them part of Internet of Things (IoT) experience that will soon dominate the activities of every educational sector.

RECOMMENDATIONS

Libraries' roles in information economy can be made more vibrant and encouraging. Libraries should reappraise their basic roles and make knowledge management a priority in addition to permitting clienteles to use the resources in one located entity. Since it is now possible to make one sort of information available to multiple and multitude of people at the same without recurring additional cost, libraries should be reformed to form a critical segment of the role players on the Internet and World Wide Web instead of whistle blowers.

Collaboration, cooperation, partnership and connectivity can leapfrog can libraries from the ideas of maintaining libraries' status quo by instituting smart environment, deploying smart systems and engaging in smart information delivery through cloud computing. Building an eSmart library will create a long standing value for libraries as they form part of Internet of Things (IoT). Digital librarianship should form 80% constituent of course curriculum in library schools. To avoid deprecation, library programmes should deeply incorporate Web design, Digital archiving and preservation, digital Cataloging, Metadata Indexing and Database management, Programming and scripting languages, XML standards and technologies, and Basic systems administration as core courses while juxtaposing professional training on Internet, Intranet, extranet, connectivity, networks and consortium as important courses. With these efforts, libraries can reduce dependency on other professionals to shoulder their basic roles.

CONFLICT OF INTERESTS

The author has not declared any conflict of interest.

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