

Digital Cloud Libraries for Ethiopian Universities

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Abstract—Information and communication technologies (ICT) have become common place entities in all aspects of life. Across the past twenty years the use of ICT has fundamentally changed the practices and procedures of nearly all forms of endeavor within business and governance. Investment in Information and Communication Technology (ICT) in Ethiopia is considered to be one of the highest in the world, taking into consideration the prevailing poverty levels. Currently, Ethiopia's "committed" investment in ICT accounts for 10 percent of overall GDP, and the government has invested over \$14 billion in this sector for over the last decade. The ICT mission of the policy was to develop "...Ethiopia into a socially progressive and prosperous nation with a globally competitive, modern, dynamic and robust economy through the development, deployment and exploitation of ICT within the economy and society". Within education, ICT has begun to have a presence but the value of ICT is not affordable. The basic principle of cloud computing entails the reduction of in-house data centers and the delegation of a portion or all of the Information Technology infrastructure capability to a third party. Universities and Colleges are the core of innovation through their advanced research and development. Digital Cloud Libraries may soon be building and managing their own datacenters. This prototype would let libraries maintain more control over the applications and data stores that contain sensitive, private information about patrons. Provisioning and maintenance of infrastructure for Web based Digital Cloud library present several challenges. In this paper we discuss problems faced with digital libraries in Ethiopia and development efforts to overcome that problem. Infrastructure virtualization and cloud computing are particularly attractive choices which is challenged by both growth in the size of the indexed document collection, new features and most prominently usage. With the purpose of applying Cloud Computing to university library, the paper describes the current status of user service prototypes in university libraries. Then it proposed to improve current user service prototype with Cloud Computing. This paper explores some of the security issues surrounding data location, mobility and availability.

Index Terms - Cloud Computing, Digital Cloud Libraries, ICT, Service prototypes.

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I. INTRODUCTION

There is no alternative of library for the enrichment of human civilization. A library is not only a collection of books, which has treated as the source of knowledge and information but also comes as the reflection of any community. We have seen the rapid advancement in the field of communication, science, and technology, which has a great impact on many issues. The concept of digital library is nothing new, but cloud computing has brought new opportunities for the advancement of digital library. Digital library is a development-oriented hardware and software integration platform, through to technical and the product integration, each kind of carrier digitization, carries on the effective deposit and the organization, provides the network the effective assistance. After Digital library technology popularization, provided the high grade information service but simultaneously also to expose all sorts of questions unceasingly, because the zones of different the current economic condition limit presented the development not balanced phenomenon, the regional resources shared with difficulty, form each one information isolated island or the resources are redundant, create the resources the waste, satisfied the aggregate demand with difficulty, the cloud computing possibly provides a good plan day by day for this kind of phenomenon.

In Ethiopia different preliminaries are working as part of a national capacity building program that includes schoolNet, WoredaNet that aims to provide connectivity and specialized applications for schools and local governments. The Ethiopian Education and Research Network (EthERNet) was launched in 2001 to build and deliver highly interconnected and high performance networks for Universities and other Educational and Research Institutions in Ethiopia. More specifically, EthERNet was aimed to build and deliver high performance networking that connected these institutions with each other and similar institutions in the world, and by doing this to enable them to share educational resources and collaborate both within Ethiopia and globally.

Cloud Computing is a completely new IT technology and it is known as the third revolution after PC and Internet in IT. To be more specific, 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. In other words, by collecting large quantities of information and resources stored in personal computers, mobile phones and other equipment, Cloud Computing is capable of integrating them and putting them on the public cloud for serving users. The end user does

not have to worry about the resource or disk space in cloud computing. Cloud computing has already proved its necessity, which has considered as the upcoming pattern of computing in coming days. Here, I will emphasize on the issue of cloud computing and its role for digital libraries. The Cloud Computing trend of replacing software traditionally installed on campus computers with applications delivered via the internet is driven by aims of reducing Ethiopian Universities (EUs) IT complexity and cost. In the EUs ICT is providing internet and communication technology to support Cloud Computing Technology. Cloud Computing could be a technological innovation that both reduces IT costs for the EUs and eliminates many of the time-related constraints for students, making learning tools accessible for a larger number of students. Teachers and learners will no longer have to physically carry their documents and data around them; instead they will be able to access them in the cloud anywhere from any connected device. There are many benefits of Digital Cloud Libraries for educational institutions.

1.1 The benefits of cloud computing for digital libraries

Cloud computing can take the library facility at the most convenient state to its stakeholders than other technical approaches. Digital Cloud Library automation solutions provide timely, efficient and effective enterprise library management services complete with easy-to-use library and knowledge management functionality. These transformative library services remove information access barriers, such as proprietary information silos, to seamlessly make information access equitable. The end result is open access throughout the organization to information assistances and resources such as: electronic journals, lab notes, databases, newspaper and other resources or other knowledge assets. Cloud computing can provide the optimum library assistances to the people by centralizing the resources and disk spaces of any digital library. This concept will open more doors and windows, which will let many people get their access to the library. Cloud computing can provide an uninterrupted service to its stakeholders. The social impact of cloud computing on digital library is also noticeable. Research and development regarding any issue will accelerate as people can get easy, efficient, faster and reliable services through cloud computing based digital library. And also it is environmentally friendly, using the cloud results in at least 30% less energy consumption and carbon emissions than using on-site servers.

II. DIGITAL LIBRARY PROBLEMS

Digital library for our study provides a convenient, along with the increasing knowledge level, the requirement of digital library and growing. But because of uneven economic development in different regions causes the digital library's resources to be relatively short, to university digital library as an example. Various colleges and universities while are raising the respective teaching level unceasingly, have established a digital library to purchase its own database resources, but because of the teaching focus and economic conditions, library resources between university's has the differences, meanwhile looked from the whole that the Digital library has certain flaw. Data resources between various universities are

relatively independent, building redundant projects possibility was high, has created the manpower, the financial resource and the resources waste, or some colleges and universities to use only part of database resources, inadequate use of resources, and cannot play resources maximum utilization.

Digital library representative one kind of new infrastructure and the environment, the defects of digital library can solve through the cloud computing, it may use resources more effectively.

a) Realization of Cloud Computing

Based on cloud computing in the cost calculation, flexibility, performance, team cooperation, disaster recovery, Security, Environmentally friendly and the advantages of the geographic location, because simultaneously the different application procedure has used the different mutually independent platform, each application procedure completes on own server. Using cloud computing can share the server in many application procedures, realizes the resource sharing, thus also reduces the number of server's, achieves the effect of reducing the cost and it saves from the environmental pollution therefore utilizes cloud computing in the Digital library, will give our work, the life and the study inevitably obtains a greater efficiency, see Fig 1.

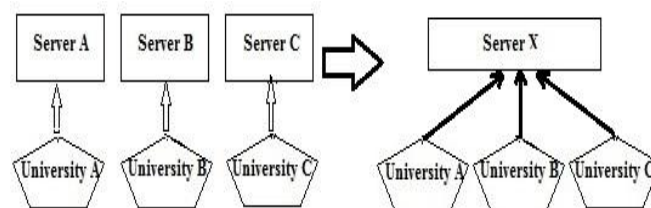


Fig 1: Server sharing plan

Every cloud computation's server may be the computation server, saves the server or the wide band resources and so on, in figure 2 every cloud represents any university Digital library database resources, every two clouds or more clouds may compose a bigger cloud, may divide the cloud or the composition cloud by the different regions either the different rank university. SaaS, Software as a Service, through the browser to the form of services provided to the applications, to users and suppliers to reduce costs. PaaS, Platform as a service, defined by the form of services provided to the developers application development and deployment platform, so that they can use this platform to develop, deploy and manage SaaS applications. This platform typically includes a database, middleware and development tools, all are in the form of services through the Internet. IaaS infrastructure as a service is defined by the form of services to provide servers, storage and networking hardware.

b) Realization of Permissions

In Fig2 cloud superintendent should be composed by university representative, government representative and service provider representative, its responsibility should be the management daily operation, provides the high grade service and the high security, the formulation agreement, the

coordinated all quarters' benefit and carries on sanction on the illegal user and the contrary operation.

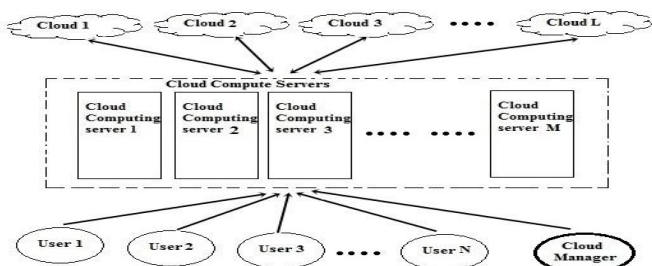


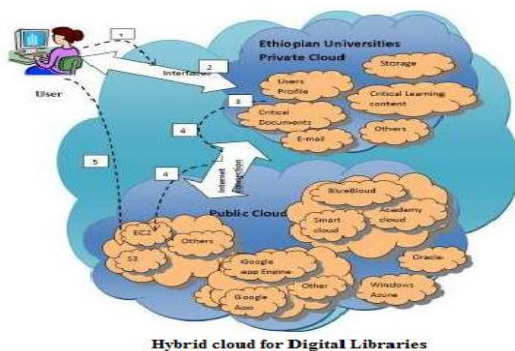
Fig 2: Implementation diagram of Cloud Computing

First, user requested to the Internet transmission, and between cloud platform and Internet continuous revision key, in order to protect the platform. Simultaneously the cloud platform defines an access rule to its user, the user transmits own status to the platform, the platform basis rule production user permissions statement.

C) Realization of Deployment prototype

Cloud services can be deployed in different ways, depending on the organizational structure and the provisioning location. Four deployment prototypes are usually distinguished, namely public, private, community and hybrid cloud service usage. Public cloud this computing system is characterized on the one hand by the public availability of the cloud service offering and on the other hand by the public network that is used to communicate with the cloud service. The cloud services and cloud resources are procured from very large resource pools that are shared by all end users. Private cloud computing systems emulate public cloud service offerings within an organization's boundaries to make services accessible for one designated organization. Private cloud computing systems make use of virtualization solutions and focus on consolidating distributed IT services often within data centers belonging to the company.

The chief advantage of these systems is that the enterprise retains full control over corporate data, security guidelines, and system performance. In a community cloud, organizations with similar requirements share a cloud infrastructure. It may be understood as a generalization of a private cloud, a private cloud being an infrastructure which is only accessible by one certain organization. A hybrid cloud service deployment prototype implements the required processes by combining the cloud services of different cloud computing systems, e.g. private and public cloud services. The hybrid prototype is also suitable for enterprises in which the transition to full outsourcing has already been completed, for instance, to combine community cloud services with public cloud services. The next figure shows an overview of the proposed Hybrid Cloud Computing prototype for Digital Cloud Libraries in Ethiopian Universities.



Hybrid cloud for Digital Libraries

The figure above shows an overview of the selected Cloud

and how the content could be arranged in the private Cloud. Within six steps, the user can use a resource and then release it; these steps are illustrated in the following points:

1. The user sends a request using the EUHDLC (Ethiopian Universities Hybrid Digital Library Cloud) interface
2. The verification of the authorization level will be checked using the user profile private Cloud.
3. The system will reject the user's request If the user is unauthorized to request such services; otherwise, the request will be sent to the virtual infrastructure manager to redirect the request to the appropriate location for either public or private Clouds.
4. It will establish a connection between the requested service from the Cloud and the user.
5. As long as the user needs the resource and does not exceed the maximum usage period, the system synchronizes the service delivery between the user and the resource.
6. When the user is done and no longer needs the requested resource, the system will terminate the session and disconnect the user from the target Cloud.

III. PRESENT USER SERVICE PROTOTYPES IN UNIVERSITY LIBRARIS

University library, as a most important academic and scientific research base, charges for providing information services for its users. In the past, most libraries insisted that their assistance is based on their own library resources. So librarians scarcely considered users' demands. But today, modern libraries have changed this viewpoint. And according to users' requirements librarians usually need to collect as more information as they can. Then they will analyze the information and sort out them. Finally, they will provide them for users in some certain technical methods. However, assistances in modern libraries will increasingly focus on users' demanding in future. And the ultimate goal of modern library is to offer appropriate, comprehensive and multi-level assistances for its users. At current user service prototypes are mainly FTP service prototype, WWW service prototype, E-mail and BBS service prototype, etc.

a) FTP Service Prototype

FTP (File Transfer Protocol) is a widely used communication protocol. And it is comprised of various rules that support file transfer on the Internet. As such rules can permit online users copy files from one host to another, it brings great convenience and benefits to users. Just as other Internet services, FTP are based on client-server prototype. Meanwhile, it's easy to learn to use FTP service. First, you only need to start the FTP client program to connect with remote host, then you should issue file transfer command to remote host and after remote host received the command, it will give respond and implement the correct operation. Launching FTP assistance in university library network system is a good type which brings great convenience for users and library as well. By using FTP assistance in university library, users can make their own password, such as using their Email address, and this can let librarians obtain users visiting records easily. Furthermore, according to users' visiting records, librarians can offer corresponding services for them and improved users' satisfaction

b) WWW Service Prototype

WWW (World Wide Web) is based on client-server prototype. It presents all kinds of information browsing

systems with the bases of HTML language and HTTP protocol. The specific division is: WWW Servers are in charge of linking web pages by hypertext links and WWW clients are responsible for displaying information and sending requests to servers. And the most significant feature of WWW service is its high degree of integration. In other words, it can connect all kinds of information and assistances seamlessly and provide users with vivid graphical user interface finally. In general, WWW provides new means of searching and sharing information for people around the world. Meanwhile, it gradually becomes the best means of dynamic multimedia interactive for people.

c) E-mail and BBS Service Prototype

E-mail system, users can obtain their needed information and knowledge resources more quickly and economically as they don't need to visit libraries personally. In the new information environment, various IT technologies updated timely. At some extent current user service prototypes are already out of date. What's worse, they may cause waste of resources and affect the quality of library services. BBSes were generally text-based, rather than GUI-based, and early BBSes conversed using the simple ASCII character set. However, some home computer manufacturers extended the ASCII character set to take advantage of the advanced color and graphics capabilities of their systems.

BBS (Bulletin Board Service) is a kind of electronic information service system on the Internet. It is just like a public blank board on the Internet; all users can write their thoughts or release information on this board. And E-mail is just another kind of information service on the Internet. In a word, E-mail provides a very quick, simple and economical way of communication for the Internet users in the whole world. Through BBS system, library users can ask and consult librarians at any time. Usually they can get their response in a very short period of time. Meanwhile, librarians can communicate with more users at a time through BBS. What's more, university libraries can Notices open lectures, release announcements and provide online help for users through BBS system.

IV. PROPOSED USER SERVICE PROTOTYPES IN UNIVERSITY LIBRARIES

With the rapid development of various IT technologies, user's information requirements are increasingly personalized. And now more and more libraries advocated user-centered services. So librarians should mine and study users' information requirements frequently. And only in this way, they can master the basic demands of their users. And furthermore, library can develop itself according to such information and improve users' satisfaction.

University library, as we all know, is famous for its academic and teaching influences. And IT technology has been the driving force of library development. What's more, librarians can keep using new technology to develop library and optimize library service. With the expansion of Cloud Computing application, this paper proposed to apply Cloud Computing in libraries. By establishing a public cloud among many university libraries, it not only can conserve library resources but also can improve its user satisfaction. And it can be illustrated in figure 3.

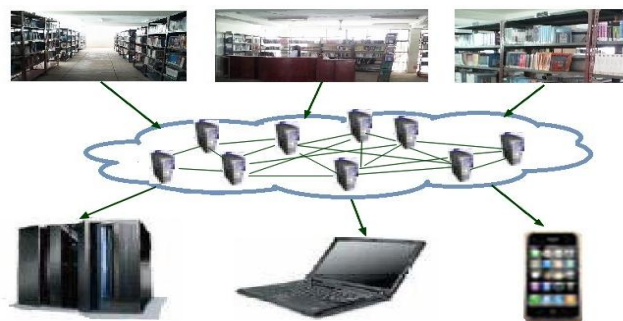


Fig 3: Application of Cloud Computing in University Library
A) UNIFIED SEARCH SERVICE PROTOTYPE

Although there are OPAC (Online Public Access Catalog) and ILL (Inter-library loan) services already, library users still cannot access to the shared resources through a uniform access platform. However, with the adoption of Cloud Computing in university library, the integrated library resources support distributed uniform access interface. At the same time, the uniform access platform can promote library resources, guide and answer users' questions by using high-quality navigation. As a result, users can grip more information retrieval methods and make better use of library resources

B) INTEGRATED CONSULTING SERVICE PROTOTYPE

Today almost every university library can provide its users with network reference by BBS or E-mail. But with the constant improvement of users' demanding, integrated digital reference service came into being. And driven by Cloud Computing, CDRS (Cooperative digital reference service) can realize the sharing of technology, resources, experts and services of university libraries. Furthermore, it will develop online accounting and Information system (QI A smart joint service system), and this will bring great conveniences for library users.

C) REAL-TIME ACCESS SERVICE PROTOTYPE

In the era of digital libraries, library users paid more attention to electronic journals, electronic databases and so on. This is really a big challenge for university libraries but by introducing Cloud Computing, university libraries can establish a shared public cloud jointly [81]. As shared cloud can have infinite storage capacity and computing power theoretically. It can bring obvious benefits to libraries. On one hand, allied libraries no longer consider the hardware cost; on the other hand, it can help reduce the purchase of electronic database resources repeatedly among allied libraries. Meanwhile, users can visit the shared resources by any terminal equipment, such as PC, 3G mobile phone or PDA only if you can access to the Internet

D) KNOWLEDGE SERVICE PROTOTYPE

In the context of the knowledge economy, knowledge resource has become the main resource affecting productivity development and university libraries are the main departments of storing, processing and spreading knowledge. So how to provide users with efficient transmission of information and knowledge services became urgent task for librarians today. However, the Emergence of Cloud Computing accelerated library's development. And the establishment of shared public cloud can save manpower and material resources greatly among university libraries. Therefore, with the aid of Cloud Computing, librarians won't have to maintain their own

equipments or deal with consultations personally. And librarians will have more time and energy to offer users with their needed knowledge-based assistances but not only information.

E) ALL-ORIENTED SERVICE PROTOTYPE

Comparing with foreign university libraries, we can find that foreign libraries are intended to provide services for all the people. Besides the professors, teachers or students, all the people of that country can access to the library resources. In addition, they also permit users access to many libraries' resources by handling related certificate of that library. And fortunately, domestic libraries can also do this in the cloud environment. Anybody who can through the legal network identity authentication has the right to visit the joint resources of university libraries on the Internet. In other words, university libraries will offer services for all the people with the help of Cloud Computing.

V. CONCLUSION

We know that library is not only a knowledge ocean; its ultimate aim is to provide satisfactory services for all the people. So in the new era, library should improve itself constantly by adopting many new IT technologies. And in this paper, we attempted to improve current user service prototype in Ethiopian University libraries by using Cloud Computing. Although study of Cloud Computing is not in the initial stage now, impacts brought by Cloud Computing are very good. With the introduction of Cloud Computing to university libraries, services of libraries will have a new leap in the near future. Services provided by libraries will become more user-centric, more professional and more effective, etc. And we all believe that libraries will create more knowledge benefit for this country with the help of Cloud Computing. Cloud environment is a highly developed network environment; it appears to the users of high-quality service and high security. The Cloud computing techniques and methods applied to digital libraries, not only can improve the utilization rate of resources to address the imbalance in development between regions, but also can make more extensive use of cloud computing to our work life.

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