

Secure Architecture for Mobile Cloud based Learning

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Abstract - Mobile cloud computing is the fast growing technology in the modern world, having applications in almost every field including education. Mobile learning is the implementation of learning using mobile devices which traditionally requires lot of infrastructure investments. Mobile cloud computing is the finest technology to implement mobile learning since it does not require a great deal of investment. The paper investigates the work that has been done relating to the adoption factors of mobile cloud computing in the higher education sector. From the study, it was found that providing data security is an important issue while taking the decision to adopt mobile cloud based learning. To overcome this barrier, an improved secure architecture for mobile cloud based learning that supports data security is proposed.

Key Words: Cloud Computing, Data, Security, Higher Education, Mobile Cloud Computing, Mobile learning

1. INTRODUCTION

In the current world, the technology associated with the Smart phones are growing at rapid phase, resulting in more classy smart mobile devices whose capability can be compared with the personal computers[1]. The modern Smart phones are equipped with a lot of features and applications. They have the capability of being used moving anywhere and accessing the data any time. With their ability of accessing the web anytime and anywhere, the smart mobile phones can be readily connected to the cloud emerging in a new computing paradigm called Mobile Cloud Computing. Thus mobile cloud computing is a highly promising technology for the future of mobile computing.

Today, a mobile user may require a number of services keeping the mobility factor intact. Mobile cloud is very well suited for these users who wish to avail these services while moving using their mobile devices. Mobile cloud can be used for mobile transactions, learning new things and even for listening music anytime and anywhere.

This new technology seems to be a major step in mobile application development. Mobile cloud computing provides benefits for every stakeholder within the mobile devices and applications sector. It expands the market, reduces the price of programs, reduces hardware requirements and provides unique chances for network operators.

When mobile web capabilities get to the levels of its desktop counterpart, mobile cloud computing is likely to become a very popular technology in developing, distributing and

using mobile applications. As mentioned by Khan et al. [2], mobile cloud computing is being used in a wide range of applications in almost every field of day to day life including education.

Education is the vital phenomena to any country for its development. Every nation is trying to implement new technologies in the education sector for the betterment of quality education [3]. The mobile cloud computing provides an inexpensive platform to the educational institutions that helps the migration of traditional education system to modern education system.

Mobile learning is a smart phone based learning system, to maintain, ease and enhance learning [4]. Its use is not proposed to reinstate the present education system; however it aims to improvise it. Mobile learning has the ability to alter the system of education to suit the needs of new generation.

In the existing mobile learning systems which use internet, the system creation, infrastructure and maintenance are to be performed by the organization itself. This needs a lot of investment and results in loads of maintenance overhead. Hence, the institutions are required to discover new techniques that provide superior and economical services for learning.

On the contrary, mobile cloud based learning system offers several advantages. On the one hand, the developers can use their own technical skills to build a learning system having good quality performance, many functions, and many features.

In the education scenario, the data in the form of lecture materials reside in the mobile cloud and the users can access the data by gaining access to the cloud by using his mobile device. This enhances ease of access and convenience as the user can access the study materials from anywhere and anytime.

On the other hand, institutions are free from developing and maintaining the learning system; they can focus on using the learning system in an enhanced manner in order to advance the education quality [5].

This paper starts with discussing cloud based learning systems used in higher education. The section 3 identifies the main barriers involved in the cloud based learning systems used in higher education. Finally, the last section proposes a secure architecture for cloud based mobile learning that overcomes the barrier of data security.

2. MOBILE CLOUD IN EDUCATION

Modern smart phones have the facility of working anywhere and accessing the data any time. With the ability to access the web any time, the smart phones can be connected to cloud emerging in a new computing paradigm called mobile cloud computing.

The Mobile Cloud Computing Forum defines mobile cloud as follows [6]: Mobile cloud computing is a system in which both the data processing and data storage are performed outside the mobile equipment. It performs the computations and storage of data in the cloud and out of the mobile, bringing applications to not just sophisticated mobile users but a wide broader range of mobile users.

In spite of many barriers and challenges, the mobile cloud computing has gained popularity and being widely used by the users all over the world. Today mobile cloud is being used in a variety of applications including education [7].

In [8], the authors have thought about introduction of mobile cloud computing in the education sector and discussed about the possible benefits and drawbacks.

In 2010, Sultan [9] has coined the idea of using cloud computing technology in education and discussed about the possible benefits.

The authors of [10] have developed the mobile learning system using mobile cloud computing. They developed the system using high performance computing clusters for mobile distance learning.

In [11], the authors built a new model of mobile learning system in cloud computing environment extended by the power of high performance cluster infrastructure. A validation of the model was also performed.

The authors of [12] have developed architecture of cloud based mobile learning system for higher education. The advantages and drawbacks of the proposed architecture were also elaborated.

The authors of [13] have developed a mobile cloud based learning system for practice oriented education. The system was basically used for teaching games such as table tennis.

In [14], the authors have studied the mobile learning in the cloud and analyzed how the use of this technology leads to educational success. In their opinion, the success of cloud in education can be attributed to the acceptance of cloud by everybody in the field of education with good support by government.

The authors of [15] have developed a framework for mobile learning in the cloud that can be adopted by the higher education institutions for effective learning.

The authors of [16] have studied the cloud based mobile learning system and analyzed different privacy issues arising by the use of such a system.

In [17], the authors have studied extensively the security issues that arise when cloud computing is used in mobile learning system.

A solution for the security problem in the mobile cloud based learning system was proposed by the authors of [18]. They proposed an usable authentication method that is user friendly for the smart phone user and secure enough also.

To overcome the security problem in the mobile cloud based learning, a mutual authentication framework was developed by the authors of [19].

The literature shows that little work has been done concerning the adoptions factors of mobile cloud in the education sector. Hence it becomes necessary to investigate the primary factors which are involved in the decision to adopt the mobile cloud by the educational institutions and propose some solutions so that the colleges are motivated to adopt this new technology.

3. BARRIERS IN MOBILE CLOUD BASED LEARNING

The realization of mobile learning using the mobile cloud poses numerous issues and challenges. These issues and challenges as discussed by the authors of [20] are:

Privacy: Since user data resides in the cloud storage, it leads to data privacy problems. The private data will be exposed in the cloud.

Compliance: Most of the data compliance laws and regulations assume that the data resides with the user. But in the case of mobile cloud, data will be stored in the cloud storage itself. This results in compliance issues.

Interoperability: When using the mobile cloud, the users may use a range of mobile devices. Developing applications to suit all such devices is a difficult task for the developers.

Security: The use of mobile devices for accessing the cloud poses several security challenges including virus, malwares, and Trojan horses.

Thus, while implementing mobile learning using cloud computing, it is required to provide protection both at server and at the client side [21]. For this purpose suitable security policies and procedures have to be followed in order to face any probable security threats. To provide security for the learner various security mechanisms such as, authentication, authorization and safeguarding the learners from attackers have to be implemented.

In mobile learning, learners will be moving most of the time and they will be using a number of versatile devices which will be getting connected through wireless networks. Since wireless networks are principally insecure in nature, they are prone to attacks and it routinely exposes the private user data at risk.

Hence it is evident that the use of mobile cloud in the process of mobile learning poses several data security issues such as integrity, confidentiality and privacy of the user data. Some examples of important sensitive data to be protected in mobile learning include student records, assessment data and study materials provided by the educators.

An extensive survey on security issues involved in the implementation of mobile cloud computing has been done by

the authors of [22]. They have discussed a number of security problems associated with mobile cloud and have also suggested some solutions.

The various security issues encountered while implementing mobile learning using mobile cloud computing include:

Low security in the cloud: The cloud service providers usually provide minimum security to the users. This may lead to situations where the intruders misuse the facilities provided by the cloud and access the important user data.

Insecure software: The users may use certain API's and interfaces while accessing the cloud services. The API's may be insecure in nature as they were not written for this purpose and thus may lead to some security threats.

Insider attacks: There might be an employee in the cloud or in the user site to perform insider attacks and steal the precious user data and learning materials.

Loss of Data: The cloud provider might store the user data in an unreliable storage media, which may result in loss of data. Sometimes data may be lost due to operational error either by intension or unintentional.

Hijacking: The weak security supported by the cloud may lead to hijacking of the user account, which may lead to fraud and software misuse.

Other Risks: Since mobile learning in the cloud is a new technology, a number of hidden issues and risks may be involved. The users should keep this mind before using the learning technology. They should have all the information about the technology and the associated security. For example, they should know how their data and files will be stored in the cloud.

Data Ownership: Since the user's data resides in the cloud, any other person can download it and use it for illegal purpose. This leads to piracy of digital content such as video, image and textbooks and results in ambiguity in ownership of the downloaded data. Mobile cloud provides scope for such illegal usage of user's data and is an important security concern. To provide solution for this problem cloud has to implement certain encryption and decryption techniques, so that only authorized users can use the data.

Data Integrity: Data integrity deals with correctness and completeness of data. If the data is stored personally one can be sure of data integrity. However when user stores his data remotely in the mobile cloud, there will be some doubts about the completeness of data. Damage to the user data can occur in the cloud, since cloud does not have proper integrity control mechanisms. Hence for successful mobile cloud implementation, suitable integrity control measures have to be taken by the cloud provider in order to ensure user's data integrity.

Authentication: Authentication is a process in which one entity verifies and confirms the legitimacy of another entity. The authentication can be achieved in many ways; using something that user knows such as user name and password, using something that user has such as Personal Identification Number (PIN) or using something that user inherently is such

as finger print of the user. For providing strong security, the mobile cloud should have proper as well as a strong authentication mechanism to make sure that illegal user does not enter into the system [23].

Authorization: Authorization is the process in which the system makes sure that the user has proper right to certain resources. Generally each valid user will be given certain access rights to certain resources. For example a valid user after authentication process can withdraw money from ATM machine. However he is authorized only to withdraw money which is within a maximum amount fixed by the bank. For providing strong security, the mobile cloud should have proper authorization mechanisms to make sure that illegal users can not access restricted resources.

Thus data security is the major security concern of the companies that are willing to adapt mobile cloud. Many of these security issues arise due to the fact that the company does not have any control over the data stored in the cloud. Web browsers and web services add up the security concern in the cloud since the cloud is accessed through the internet. Proper security mechanisms have to be developed for the cloud computing environment to secure the data that can be accessed through the mobile devices.

From the previous discussions, it is evident that the primary barrier in the adoption of mobile cloud in the education sector is the threat of data security. Hence, it becomes necessary for the researcher to provide some solution to this barrier in the adoption of mobile cloud in higher education institutions.

4. IMPROVED SECURE ARCHITECTURE

From the literature, it is clear that the major issue in implementing mobile learning in the cloud is data security. Hence while implementing mobile learning using cloud; it is required to provide protection of the systems at the server side. Keeping this in mind, a simple architecture for mobile learning in the cloud with data security is proposed.

In the proposed architecture, the primary stakeholders are students, teachers and service providers. The framework is composed mainly of three components: the android application, the interface between the android application and the cloud server, and an educational system server for back-end support and integration.

The teachers upload the study materials including lecture notes and video lectures to the cloud. The students can download the study materials and video lectures as and when required and make use of them. The service providers will provide other educational services to the students.

To induce trust about the cloud, it is strongly required to provide data security and the proposed framework uses the concept of user authentication to achieve the same. The proposed secure architecture is shown in Fig.1.

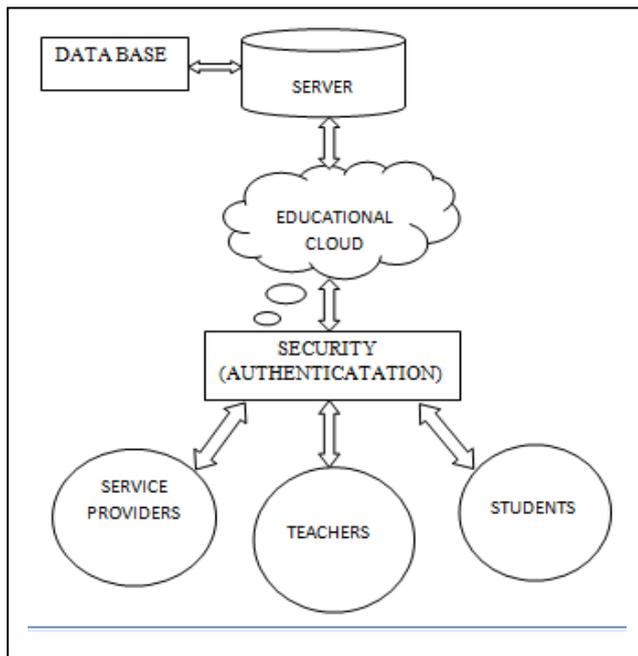


Fig -1: Improved Architecture for mobile cloud learning

In order to implement mobile learning in the cloud, an android application was developed at the client side. Using this application the client is able to connect to the cloud server, which is a local server installed on a desktop system.

The proposed system includes two subsystems, one is the cloud server that is used to store the documents uploaded by the teachers and the other one is the client mobile. The client will connect to the server in order to access the learning materials. The materials might be text based documents, audio files and video lectures which will be retrieved from the cloud to the mobile user and available for download. The server will authenticate the user and only valid user is allowed to access the materials. The student can read the text documents, view the video lectures, listen to seminars and finally can take up self assessments.

This system helps to fulfill the concept of learn when you roam and also education for all anytime and anywhere. Experts can share their valuable tutorials to the cloud for the betterment of the education community.

The main advantage of the proposed system over the existing systems is the support for data security in the form of a usable authentication. The user who wants to use this system has to register and get his credentials stored in the cloud server and access is granted only to the legitimate user of the system. Another advantage is that the authentication is very much suitable for the mobile user and designed keeping the user convenience in mind.

In order to evaluate the proposed architecture, an experiment was conducted with the undergraduate students of Mangalore Institute of Technology and Engineering located at Moodbidri, Karnataka. A total of 60 students were selected

for this experiment. The students were asked to use the Android app developed for mobile cloud based learning and evaluate its performance.

Sixty (60) responses from the students were collected. The students had different thoughts about the application; however they made relevant ratings which were very significant for the evaluation. There were five levels of ratings based on the usability of the application. They are: Level1: Best, Level2: Good, Level3: Don't Know, Level4: Not Good, Level5: Bad.

The results of this experiment reveal that 73.33 percent of the students rated the app at Level5, while 16.67 percent rated it at Level4 and 3.33 percent students were undecided on the rating. At the same time, 5 percent and 1.67 percent students have rated the app at Level2 and Level1 respectively. The result of the questionnaire showing the response levels of the students is shown in Chart -1.

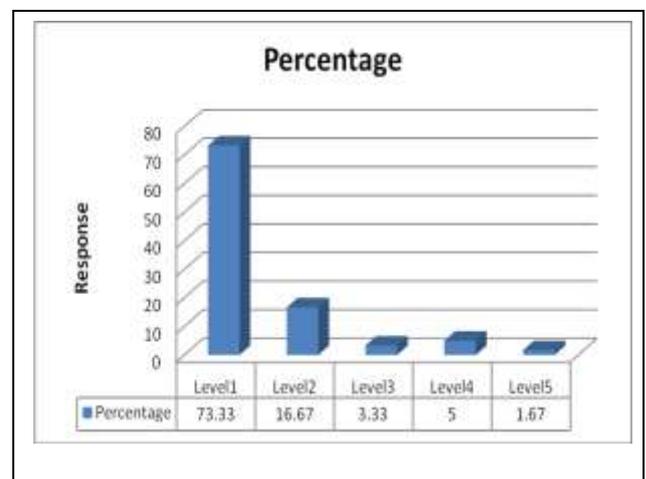


Chart -1: Response levels of the students

The above chart clearly shows that the mobile learning application developed using mobile cloud computing is easy to use and even after providing security it does not affect the user convenience.

5. CONCLUSION

Mobile Cloud Computing is one of the latest trends in the information technology sector, which combines the advantages of both mobile computing and cloud computing. It provides greater flexibility for the user to access the cloud resources. Mobile learning in the cloud offers an exclusive opportunity for teachers and students in diverse kinds of learning. If appropriately used, the system helps the students in a great way by providing classes on their mobile devices. Teachers also can provide better course delivery compared to the traditional classroom method. This paper attempts to identify the main factors that are taken into consideration by the educational institutions while deciding to adopt mobile cloud computing. It was found that providing data security is an important issue in cloud based mobile learning. Hence a improved architecture for cloud based mobile learning that

provides data security is proposed. The research work will definitely motivate the higher education institutions for taking favorable decision regarding the adoption of mobile cloud computing in the learning process.

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