Delivering Secure Education Content through a Mobile Cloud Environment

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ABSTRACT

With online education becoming popular, it is necessary to explore security measures necessary to deliver education content in an environment designed for distance learning. Since a majority of people own mobile devices, the idea of creating a cloud with them is feasible. The focus of this research is the incorporation of security measures in a mobile cloud environment that provides educational services. The mobile cloud has been developed in prior work but security is not present. This cloud computing environment, developed using mobile devices, was improved, tested, and documented. Different types of security methods were identified for a mobile cloud environment and further tested to verify the validity of the security measures. Practical scenarios for where this kind of environment can be useful were also identified. The scenarios that were demonstrated by this research effort involve the offering of educational services through a cloud environment.

Keywords
Mobile Cloud Computing, Mobile Learning, Computer Security, M-learning

I. INTRODUCTION

Cloud computing allows sharing of information without users investing too much money in under-used resources. One can access data remotely that is stored on a server (e.g. Google Drive, Dropbox, iCloud). Mobile cloud computing is cloud computing where a mobile device is involved. These mobile devices can actually deliver cloud computing services in an ad hoc configuration without use of large data centers. This would be helpful in special circumstances such as locations without an internet provider. This research effort demonstrates a low cost way to develop an m-learning cloud while using existing resources of wireless devices. Mobile cloud computing in education allows software for education to be installed without being on every computer. M-learning is very useful in the sense that it can be done outside of the formal setting of a classroom. If one sees something in nature that they are interested in learning about, they may be able to snap a picture of it and immediately look up information on it. This would allow students and educators to have their information available while they travel, but resist the use of large, resource-intensive servers.

An m-learning cloud, developed only with mobile devices, has been created by instrumenting the mobile device that acts as the server with software to deliver educational content. The platform for sharing was created using Serversman and WebDAV. Offering of the mobile learning experience on the platform was designed. The scope of this project includes demonstrating educational use scenario for the mobile cloud and identifying security measures necessary to deliver the education content within a mobile cloud computing environment.

Importance

Mobile clouds are useful where no internet exists and for people on the go. To make the clouds more practical, security needs to be present. K12 and higher education require essential security measures to guarantee delivery, availability of information and confidentiality of participants in virtual education environments. For this reason, it is important to identify the hardware and software technology that will make it possible to ensure authentic educational content and privacy of the users’ personal data.
Research Goals and Questions
The goal of this research is to build a prototype of a mobile cloud environment for connecting mobile devices to form an ad hoc cloud environment and to design an m-learning environment. The following lists three sub-goals the architecture aims to provide.

- To promote sharing of web services between mobile users who may not have access to a direct cloud server due to mobility or non-existent internet connections.
- To provide an educational service mashup platform with applications that use and combine data, presentation or functionality from two or more sources to create new services for mobile clients.
- To assess the security of several m-learning tools that are available for mobile devices.

This research project aims to answer the following questions:

- Can a sustainable cloud environment for web server operations and data storage be created with mobile devices such as smartphones?
- Is it possible to build an affordable mobile cloud environment that delivers secure educational content?
- What educational scenarios will the mobile cloud work for and what technology is needed?

II. RELATED WORK

Mobile Cloud Computing
W. Fuller used two android devices to create a mobile cloud web server and storage environment in order to demonstrate its feasibility. This showed that a mobile cloud can be built using the mobile devices as servers [2]. Fuller’s work involves building of the mobile cloud. This research work extends that concept by building a prototype of a learning management system using the mobile cloud as a platform.

G. Huerta-Canepa and D. Lee developed a mobile cloud network configuration where the user was at a fixed location. When a computing task was required and insufficient resources were unavailable, the system listened for ad hoc nodes in its current vicinity [1]. This research project, however, does not require the user to be in a fixed location and in fact demonstrates the advantage of being in separate various locations when using a mobile cloud.

Education in Mobile Learning Environments
Education on mobile clouds has some great benefits. For scalability, the deployment of mobile applications can be performed and scaled to meet the unpredictable user demands due to flexible resource provisioning. Service providers can easily add and expand an application and service without or with little constraint on the resource usage. A specific example of MCC applications in learning is “Cornucopia” implemented for researchers of undergraduate genetics students and “Plantations Pathfinder” designed to supply information and provide a collaboration space for visitors when they visit the gardens [4].

Mallikharjuna and Rao describe development of another type of mobile cloud computing education model where experts can put tutorials on the cloud for students to use. A similar concept is used in this project where existing tutorial work that may not have been designed for cloud usage is ported to a cloud. Issues addressed would be interface design and portability of legacy software to cloud environments. In addition, if these services are provided on a large scale for people (such as experts and tutors) who are outside the cloud, then security would have to be addressed [6].

Many educators, in considering mobile learning, must take into consideration what is needed in designing for mobile learners. Many have distinguished key design concepts needed. Shelley Terrell identified tips and mobile application resources necessary to deliver effective mobile learning. The learning should involve multimedia resources that allow users to capture images, record audio clips or videos, and text application for note-taking. Geo-location, the ability to map and share location-related information such as events and scenes with others, is another feature that should be present in mobile learning. Geo-location is often part of various applications and include technology such as Quick Response (QR) Codes, barcodes that are readable by a QR scanner, and Augmented Reality (AR), projection of an image into a learner’s physical space. Finally, there must be applications to conduct research [8]. Although, Terrell provides examples of separate applications that make use of the technology described, there is no mention of a learning environment to make use of all under one interface. The research for this project aims to identify and test such a system to determine if these items are indeed present or to propose design of one that includes the capability.
**III. METHODS**

The procedure to complete this research work is provided below.

**Use Scenario Identification**

One step in this project was to identify educational use scenarios for making use of the mobile cloud. The scenarios support the suggestions identified by Terrell (multimedia resources, Geo-location, Quick Response (QR) Codes, Augmented Reality (AR) but also address the requirements of learning (education, assessment, tracking, analysis) as identified by Prasad [4].

**Configuration of Mobile Cloud**

The Mobile Access Cloud Computing (MACC) architecture provides cloud computing storage and retrieval using mobile devices. Figure 1 shows an overview of the MACC and its main features. The architecture consists of three parts, the mobile clients, the middleware and the Cloud services. Since Cloud services are usually controlled by service providers, the middleware performs all the necessary adaptation to the mobile clients. It allows connection to Android phones without cables that are accessible through a browser or WebDAV, an easy way to save files from a phone to a PC and vice versa, publication and management of web pages from your Android phone, and capability to create and share multimedia material.

The tools required for this research project were two Android smartphones that run WebDAV application (T-Mobile Concord, T-Mobile MyTouch Slide) and an Android tablet (Samsung Galaxy Tablet). The software that was used are Serversman and WebDAV Navigator Lite, two software applications available on the Android market but also available for other mobile device platforms. The procedure for configuring the mobile cloud included installation of software and testing to ensure communication has occurred. The mobile cloud environment was replicated by installing Serversman on the tablet, installing WebDAV Navigator Lite on the phones, and linking the latter program to the former.

**Review and Assessment of Existing Learning Management Systems**

After configuration of the mobile cloud environment, various Learning Management Systems were reviewed to determine if there existed a LMS that can be used on mobile tablets and phones to deliver a mobile learning experience without use of a datacenter-base cloud. Different educational tools were deployed in the mobile cloud environment and testing of various actions on the two mobile cloud devices was performed and documented.

**IV. RESULTS**

The server was visible from the T-Mobile Concord and the other smartphone. It was also accessible from a PC computer using the URL.

**Mobile Cloud**

The mobile cloud architecture is depicted in figure 1. The server was visible from the T-Mobile Concord and the other smartphone. It was also accessible from a PC computer using the URL. We found that some security was provided by the Serversman software. Availability was supported by the back to the Serversman server with the option to back up to other mobile devices. Authentication using encryption and login/password settings is a part of the server as well.

**Education Scenario Identification**

The following scenarios are examples of the possible uses of a mobile learning cloud environment. In addition, the criteria need identified by Terrell are paired with the scenario.

- **Scenario #1 Geo-location**: The instructor needs to take attendance of users at remote locations.
- **Scenario #2 Geo-location and Multimedia Needed**: A lecture is being taught at a remote location during a field trip. You are using your mobile device to videotape the relevant portions. Using your smartphone or a mobile device, you can upload your video to a mobile cloud webserver and make it available immediately for your other classmates.
- **Scenario #3 WebDAV Capability, Multimedia**: You are an instructor teaching an online class. You are currently out of town and need to send the next course work to students. You can activate the mobile cloud webserver on your phone, upload your coursework and direct your students to the appropriate website.
• **Scenario #4 Multimedia Needed:** As an instructor, you wish to put your students in groups and give your students a project with tasks to complete and allow them to choose how to present the research, content, and tasks. Some might want to produce a video, some a story, some a multimedia magazine, and so forth.

**Configuration of Mobile Cloud**
The mobile cloud architecture is given below.

![Figure 1. Mobile Cloud Configuration](image)

The screen shots of the configuration process for the server stored on the table are given below:

![Figure 2. ServersMan Screenshot](image)
The screenshot for the WebDAV Navigator Light application are given below:

![WebDAV Screenshot](image)

**Figure 3. WebDAV Screenshots**

**Review and Assessment of Existing Learning Management Systems**
Most learning management systems (LMS) are accessible from a web browser. To complete this work, it was necessary to review such system to determine the types of tools and features expected in such a system. Therefore, this research project included review of current open source project. A snapshot of LMS were reviewed and the systems and their features are identified in a table below.

**Table 1: Browser Based Learning Management Systems**

<table>
<thead>
<tr>
<th>Open Source LMS Apps</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>aTutor</td>
<td>Interoperable, Social Network, Accessibility, adaptability</td>
</tr>
<tr>
<td>Canvas</td>
<td>Teacher customizable, Graphic analytics reporting, media recorder, outcomes connection, ease of use, android compatibility, WebDAV support</td>
</tr>
<tr>
<td><a href="http://www.instructure.com">www.instructure.com</a></td>
<td></td>
</tr>
<tr>
<td>Onpoint Digital CellCast</td>
<td>Group-based messaging, social networking, forums, support for user-generated content, search, learning paths, branding, and customizable portal interfaces, multiple device support, spoken-work and text-based assessment</td>
</tr>
<tr>
<td><a href="http://www.mlearning.com">www.mlearning.com</a></td>
<td></td>
</tr>
</tbody>
</table>
| **Chamilo**  
 http://www.chamilo.org | Simple, Easy to use, provides basic e-learning tools such as chat, announcements, work groups, surveys, wikis, glossary, agenda, tracking, attendance |
| **eFront**  
 http://www.efrontlearning.net/ | Tools for content creation, tests building, assignments management, reporting, internal messaging, forum, chat, surveys, calendar, search engine |
| **Fedena**  
 www.fedena.com | Tracking of students and Employees, Examination creation, Analyzing student’s performance and attendance, student and staff reports based on filters, Attendance Marking and Attendance reports |
| **Moodle**  
 https://moddle.org | Extensive documentation support, Drag and Drop, multimedia support, badges for motivating students, restrict access, forums, wikis, self-grading quizzes, workshop support, WebDAV support |

From reviewing these systems, the following requirements stand out in terms of importance to users but that are lacking in any one system found.

- When instructors need to edit files that already exist on a system using third party tools, WebDAV support would save time and assist in performing deletion or movement of groups of files.
- Ability to re-use content from other systems
- Easy to use content authoring capability
- Rich in features

The benefits of implementing such a platform include

- Rich learning experience
- cost of mobile devices are less than PCs and laptops therefore providing inexpensive solution for learning
- Multimedia content delivery and options

The challenges of implementing such as system include the following:

- Connectivity and battery life
- Meeting required bandwidth for fast streaming
- Limited memory
- Number of file/asset formats supported by a specific device
- Content security or copyright issue
- Small screen size
- Multiple standards, multiple screen sizes, multiple operating systems
- Porting existing E-Learning materials for mobile platforms

V. CONCLUSION

The research conducted includes use of mobile devices to replicate an ad hoc mobile cloud environment. A mobile learning environment was developed using only mobile devices to demonstrate use and advantages of use of a mobile cloud in education-based exploration and group collaboration. This is especially important outside of a physical classroom setting and where no internet Wi-Fi is present. Investigation and incorporation of security measures and testing of this infrastructure to render m-learning cloud based web services was the focus of the continued work. Findings are that a secure m-learning
environment can be created using mobile devices. Further testing is required to assess whether the mobile cloud is as effective as a cloud datacenter rendering of the technology.

VI. REFERENCES