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IMPLEMENTATION OF A MOBILE CAMPUS USING OPEN SOURCE SOFTWARE

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Abstract- The next step of online learning is considered as mobile learning, by incorporating mobility as a key requirement. In fact, the current wide spread of mobile devices and wireless technologies brings a huge potential to e-learning, in terms of ubiquity, pervasiveness, personalization, flexibility, and so on. Thus Mobile Learning is attracting significant research efforts including a variety of learning settings, from schools and universities to workplaces and cities. The term of Virtual Learning Environments (VLE) is used to refer to the on-line interactions of a variety of kinds that take place between learners and instructors. This paper compares different open source VLEs. Then the focus is given on development of learning applications using mobile devices in open source virtual learning environment. To this end, proxy and proxyless architectures are considered as way to extend traditional virtual campuses with mobile clients. The objective is two-fold: to access learning materials and to support learning activities. A prototype of a Virtual Campus is then introduced using the Mobile Learning module of Moodle, the open source software. The proposed Virtual Campus enables mobile clients to perform online learning activities and is a step towards achieving the "anytime, anywhere" paradigm .
Keywords- Open Source Software (OSS), Moodle, Mobile Learning, Pervasiveness, Virtual Learning Environment (VLE).

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Introduction

Nowadays there is a successful usage of mobile technologies in learning environments [3]. One of the reasons of this success is the fact that mobile devices such as mobile phones, smart phones, and personal digital assistants (PDAs) have an enormous technological development. The development in the mobile computing has changed the way of communication and working. The new generations of these devices not only are becoming increasingly more powerful in terms of processing speed, storage capacity and operating time but also have essential functionalities such as short message service, multimedia message service, web browsing and integrated components such as card readers. These technologies enable the construction of applications of mobile learning (m-learning) [3]. In fact, with the advances in emerging wireless and mobile computing technologies and advanced learning theories, mobile learning has been widely admired in various domains in the modern world [3].

M-learning is a technology with enormous potential to be used in distance learning. There are various explanations for the meaning of m-learning in the academic community. M-learning can be defined as a form of learning that occurs when the learner takes advantage of learning opportunities offered by mobile technologies (like mobile phones, smart phones, PDAs) or any form of learning that occurs when the learner is not in a predetermined and fixed location [3]. M-learning is used to provide a learning environment without space and time limitations. Students may study according to their wishes and are able to manage their own studies without impositions to be in a classroom with strict learning schedules [3].

In developing on-line environments for supporting mobile learning, several concerns must be taken into account in order to guarantee full support to the online learning students. One key issue is mobility in correspondence with the current mobility learners and the widespread of mobile devices and wireless technologies [5].

Indeed, the increasing number of mobile phones and other handheld devices has transformed mobile learning to an everyday activity, whereby mobile personal tools help people learn everywhere. However, m-learning is still in its early stages and many challenges are to be addressed before being fully benefited from incorporating mobility to day-to-day collaborative learning [1].

Mobility is seen by researchers and pedagogues [8] as a new opportunity for education since it provides more chances for learners to personalize their learning process, enhance the social interactions, learn more effectively and more autonomously, and collaborate with other peers and teachers at anytime and from anywhere, inside and outside the formal collaborative learning [1] circumstances. Indeed, both the capabilities of mobile devices and their wide context of use contribute to their tendency to encourage interaction and collaboration. Mobile devices can easily communicate with other devices of the same or similar type, enabling learners to share data, files and messages [1]. They can also be connected from anywhere at anytime to a shared data network, further improving possibilities for communication. These devices are also typically used in a group setting, and so interactions and collaboration will tend to take place [1].

Learning Management System (LMS) are applications used for learning content delivery and facilitation of learning process. This software offers electronic access to course materials and carries out assessments. In addition to managing the administrative functions of online learning, some systems help create, reuse, locate, deliver, manage, and improve learning content.

A great variety of challenges arise though when using mobile devices for learning, ranging from technical - such as how to manage devices with very small screens and keywords, which do not facilitate easy access to text and obstruct input or addition of explanatory notes- to educational - such as how to manage small learning groups in the classroom.

In this paper, an analysis is carried out from technological perspectives, the development of learning applications using mobile devices. A prototype of Mobile Virtual Campus in MLE-Moodle is then introduced.

Related Work

Many mobile learning approaches, initiatives and projects have appeared over the last years. Some representative efforts are:

SMILE (Sussex Mobile Interactive Learning Environment), is a mobile learning initiative that gave flexibility to learners in creating their own learning experiences [7]. Students were loaned mobile devices which had PDA capabilities, mobile office tools and always-on Internet connection. Students were asked to explore opportunities for using mobile devices for collaboration and communication. In this project, there was little work done towards automating or enhancing the process of accessing content as much as it was directed towards assessing the potential of the devices in enhancing the learning experience.

The EXPLOAR project [2] demonstrates an innovative approach that involves visitors of science museums and science centers in extended episodes of playful learning. The EXPLOAR approach considers informal education as opportunity to transcend from traditional museum visits to a ”feel and interact” user experience, allowing for learning ”anytime, anywhere”, open to societal changes and at the same time feeling culturally conscious. A set of demonstrator learning scenarios are being implemented employing advanced and highly interactive visualization technologies in personalized ubiquitous learning paradigms.

However, the technical and institutional problems faced by existing m-learning initiatives has led many researchers to suggest that an integration with existing Virtual Learning Environments (VLEs) used by institutions can be beneficial. Engage [6] is an interesting project that aims to enable access of personalized learning material on mobile devices from several VLEs such as Domino, Moodle and uPortal.

In this paper, a further example of integrating mobile access with the VLE of Moodle is introduced. M-Learning is a specific module of Moodle platform [4]. By using this module it is possible to enable the online learning through MLOs (Mobile Learning Objects). The content can be stored in the mobile device and to which the user can have access to at any time. The contents created range from simple text to audio and video [1].

Comparative Study between Different OSS VLE Platforms

Table 1 [10] shows the comparison of OSS VLEs that includes Moodle 1.8**,** Claroline 1.6**,** OLAT and Sakai 2.3.1**.** The comparison is divided into different tools and has two answers, Y or N; Y means the product has the feature and N means the product does not.

Table1- The Comparison between Selected OSS VLE Platforms

Tools \ Product Name	Moodle 1.8	Claroline 1.6	OLAT	Sakai 2.3.1
Communication Tools				
Discussion Forums	Y	Y	Y	Y
Discussion Management	Y	Y	Y	Y
File Exchange	Y	Y	Y	Y
Internal Email	Y	Y	Y	Y
On-line Journal	Y	N	Y	Y
Real-time Chat	Y	Y	Y	Y
Video Services	Y	N	N	N
Whiteboard	Y	N	Y	Y
Productivity Tools				
Bookmarks	N	Y	N	Y
Calendar	Y	Y	Y	Y
Orientation	Y	N	Y	Y
Work Off-line	Y	N	Y	Y
Student Involvement Tools				
Community	Y	Y	Y	Y
Student Portfolios	Y	Y	N	Y
Hardware/Software Tools				
Client Required	Y	N	N	Y
Database Requirements	Y	Y	Y	Y
Unix Server	Y	Y	Y	Y
Windows	Y	Y	Y	Y
Pricing/Licensing Tools				
Company Profile	N	N	Y	N
Costs	Y	Y	Y	Y
Administration Tools				
Authentication	Y	Y	Y	Y
Authorization	Y	Y	Y	Y
Course Delivery Tools				
On-line Grading	Y	Y	Y	Y
Student Tracking	Y	Y	Y	Y
Total Features	24	24	24	24
Total Available	22	17	20	22
Total Missing	2	7	4	2

From this table, it can be seen that the best products are Moodle (1.8) and Sakai 2.3.1, which have missed just 2 out of 24 features [10]. Thus we have chosen Moodle as our LMS.

Integration of Mobile Devices with Existing Technologies

We can make use of existing technologies for integrating mobile devices in them. These are discussed below:

Integration with Web Technology

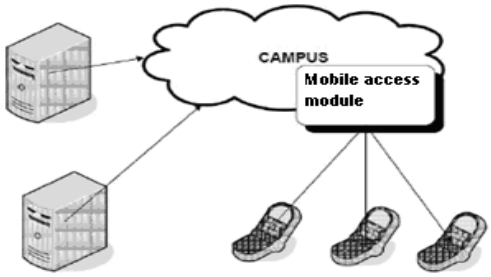

Fig. 1- Integration of Mobile Devices with Web Architecture [1].

One of the most used technologies to integrate mobile devices is the Web technology (see Fig. 1). Web applications are based on centralized Client/Server architectures, where a server application provides services to Clients [1]. Clearly, the difficulty in developing mobile clients, lies in the limited capacity of mobile devices. Additionally, the lack of standards as well as the variety of browsers makes it even more complex to integrate mobile devices into existing Web applications. In order to overcome these complexities of integrating mobile devices into Web applications, it is necessary to design and implement a module to support the specific characteristics of mobile devices. That module should offer web services accessible for mobile devices [1].

Integration with P2P Technology

Most of nowadays online learning systems are web-based, which as centralized systems, show several limitations such as maintenance cost, scalability and having a single point of failure. P2P technologies are an important alternative to develop decentralized online learning systems in which students can be more than mere clients and can use their own computational resources for task completion during online learning process. Similarly as in the case of Web technology, there is no straightforward integration of mobile devices into P2P applications (see Fig. 2) [1].

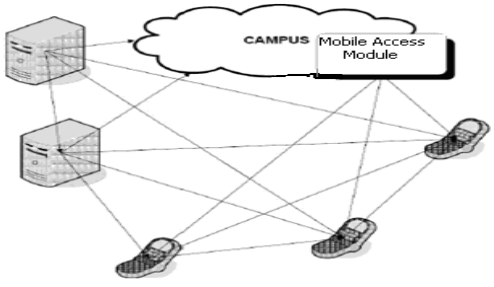

Fig. 2- Integration of mobile devices with P2P technology

Architecture of Mobile Campus

An important issue in developing Mobile Campus is the connection of mobile devices to the Campus server(s). The two most common approaches, namely proxy and proxyless architectures are analyzed below.

Proxy Vs. Proxyless Access

Mobile devices can be connected to servers either using a proxy or a proxyless architecture.

Proxy Access

Proxy is a computational device that acts on behalf of another computational entity. Thus, a proxy permits computational to indirectly connect to the networks. Clearly, the access to resources goes through communication with the proxy. In fact, in some cases the use of proxy is the "only" solution to connect small computational devices to server applications. Using proxy architecture also enables to design richer applications for mobile and wireless devices [1].

There are several advantages of using a proxy architecture (see Fig. 3, left), briefly described next

1. Control: The proxy side deals with workload burden, thus enables the development of lightweight functionalities at the mobile device.
2. Efficiency: Requests for resources by different mobile clients can be efficiently managed by proxy. Also, it can use responses to previous resource requests for forthcoming requests, assuming that resources are still available [1].
3. Filtering: Proxy can filter and eventually prohibit some incoming requests from mobile clients [1].

There are however some disadvantages as well.

1. Security and trust- Proxy could modify/falsify client's information and behavior. Also, during communication of clients with the server, proxy can see any information, thus security can be a concern. This is a concern in case of sensitive data, especially when such data is cached and stored at proxy side [1].
2. Anonymity- Because mobile clients are connected through proxy, this makes difficult from the resources to distinguish their distinctiveness. This is a concern for the development applications based on trustworthiness [1].
3. Inconsistency- Conflicting states could be produced by proxy when it uses cached data (advertisements, user sessions, etc.) that might have expired.
4. Network stability- Proxy could become a bottleneck for the application. In fact, if proxy goes down, the mobile clients connected to it would remain disconnected from the network [1].

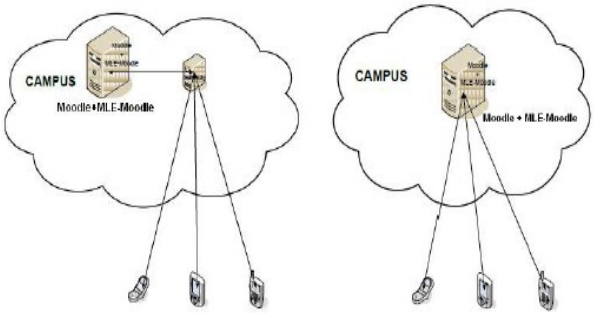

Fig. 3- Proxy access (left) and Proxyless access (right) [1]

Due to the nature of mobile devices, the proxy-based architecture is actually appropriate and efficient. The proxy can alleviate the communication burden of the mobile device with the Campus by substantially reducing the amount of data exchanged, making thus the application more efficient [1].

Proxyless Access

Proxyless architecture (see Fig. 3, right) solves some of the problems of proxy-based architecture, yet it is rather more difficult to integrate mobile devices in a straightforward way to server applications.

Proposed Mobile Campus

It comprises of two main steps as-

Developing Virtual Campus using Moodle

As a first step for developing mobile campus, a standard Virtual Campus in Moodle is to be developed. Moodle is an open source web-based software for developing online learning platforms following the constructivist learning paradigm [1]. A Moodle installation comprises the Moodle code executing in a PHP-capable web server; a database managed by MySQL, PostgreSQL, Microsoft SQL Server, or Oracle; and a file store for uploaded and generated files. All three parts can run on a single server; or they can be separated with many load-balanced web-servers, a database cluster, and a file-server; or anywhere between those extremes. Moodle distinguishes for easy configuration and maintenance as well as content course creation [1]. A great advantage of using Moodle is the easiness of content creation, including forum, questionnaires, tasks, wikis, chats, etc [1].

Developing Virtual Mobile Campus using MLE-Moodle

The Virtual Campus in Moodle is to be extended using the MLE-Moodle module, to support mobile clients. MLE-Moodle enables the access to the Campus of the mobile clients.

MLE is available in two versions. The first version is browser based and can be accessed directly through the mobile browser [9]. In this version the same content available on the Moodle server is accessible to the user on a different set of interfaces (which have been built exclusively for mobiles). The interfaces are very intuitive and easy to navigate [9].

The second version of MLE is a J2ME application which has a client and server components. The application needs to be installed on the mobile and the client component communicates with the server component for data transfer [9]. Some data is locally stored on the mobile, but as data storage and caching is limited on a mobile, the most of the content is transferred back to the server. A Gateway server (placed between the Moodle server and mobile device), optimizes the data from the server for easy display on the mobile screen [9].

Thus while using the second version of MLE, as mentioned above, the adaptation of learning environment and content to be accessible and visible by mobile clients becomes essential at this stage. This can be achieved by using two servers, namely, Gateway Server, which should be a proxy used by MLE to access the Campus, and, Message Server, which should be a server for the instant messenger for mobile clients [1]. For awareness purposes, the Mobile Campus can be endowed with a simpler version of awareness that consists in notifying learners of changes occurring in the virtual room (changes in objects, new messages, replied messages, etc.). For including the awareness features, advantage of the proxy architecture can be taken. In that, proxy will do the filtering of generated events and will broadcast it to mobile clients either in the form of simple events or summaries of events [1].

Finally, the contents are to be developed as Mobile Learning Objects, which can be accessed by mobile clients. The courses content may include Theory, Exercises, Discussion forum, Instant messenger, Questionnaires, Calendar and many more features.

Conclusion

With the current wide spread of mobile devices and wireless technologies, e-learning is taking a new aspect, that of mobility of learners. Mobile learning is now posing pedagogical and technological challenges. Pedagogically, mobile learning should achieve the ubiquity, pervasiveness, personalization and flexibility, by using mobile devices any time and anywhere. Technologically, the lack of standards in mobile devices as well as their limited capabilities poses difficulties in integrating mobile devices into learning environments.

In this paper, studies are carried out, for the development of on-learning applications using mobile devices with the help of open source software. For that, different open source VLEs are compared. Proxy and proxyless architectures are then considered as a way to extend traditional virtual campuses with mobile clients. In the end, a prototype of a Virtual Campus is introduced using mobile learning module of Moodle which enables mobile clients to perform online learning activities.

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