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A MULTI-CHANNEL APPROACH FOR COLLABORATIVE WEB-BASED LEARNING

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INTRODUCTION

The delivery of learning materials on electronic devices termed e-Learning has aroused great interest in educational institutions and research communities of late. Several other forms of e-Learning exist including distance learning, online learning and web-based learning. Web-based learning entails content (not just activities) in a web-based browser, and actual learning materials delivered in web-based format. However, all these forms of learning have been absorbed or replaced by the term e-Learning (Ritzel, 2008). E-Learning has been very supportive to the research community in the process of collaboration and team working.

One of the things that can further widen the research community is interaction between teams within a university or universities/research institutions in a country, continent or among developed and developing nations in a worldwide environment. Such synergy provides a basic platform for learning and also permits the sharing of costly equipment between geographically distant laboratories.

It provides students in remote locations access to scarce scientific instruments for carrying out experiments in another laboratory. This collaboration, which is based on a virtual community service concept between teams, has put new requirements on e-Learning applications such as the need for an application to be developed once and run from any browser involving WAP Phones, Laptop/ PC, Pocket PC and PDAs, amongst others.

The goal of this study is to engage a multi-channel based approach to develop an e-Learning application. Multi-channel is a term used to describe the process of writing an application once and run from a range of devices or browsers. Topland (2002) defined multi-channel as the technology which is using a framework on how the content should be distributed such as web, WAP, phone and fax.

Multi-channel work with a web-based e-Learning application to provide a range of services including video on demand, chat, white board, virtual laboratory, file transfer and video conferencing.

The rest of the paper is organized as follows. Section 2 describes some of the researches that relates to the work in this paper. Section 3 enumerates the research methodology adopted in the study. Section 4 presents the architectural framework of the proposed system. The components and a prototype implementation of the system are presented in section 5. Section 6 contains the concluding remarks.

REVIEW OF RELATED LITERATURE

A number of e-Learning systems related to the work described in this study have been reported in literature. Some of them address e-Learning based on a multi-channel approach using eXtensible Markup Language (XML) and Extensible HyperText Markup Language (XHTML). This approach involves writing an XML based module to carry out individual transformation for each of the client's browser. Development of a multi-channel web-based e-Learning applications using 'write once run in any browser' model is still an open area of research. Existing studies based on mobile e-Learning systems, multi-channel solutions and web-based e-Learning applications are presented in this section.

Mobile e-Learning Systems

Alimadhi (2002) carried out a study that focuses on the encounter between the World Wide Web (WWW) and mobile Internet. It discusses the need to provide gateways between web resources and mobile technology. A prototype was designed and implemented to study the possibilities of making existing web resources available to mobile devices. The focus of the study by Topland (2002) was the challenge of developing multi-channel e-learning services on Internet in which the content is located at the same node. The prototype that was developed shows that older devices or browsers do not support multi-channel services. Avenoglu (2005) developed a mobile learning portal for students on web-based instruction. This portal included a mobile discussion forum and a course information system.

Multi-Channel Systems

The work presented by Gardner, et al (2004), showed an overview of developing an ubiquitous computing framework to allow access to applications from multiple devices. It introduces an Application Session Teleportation (AST) framework, designed to support the movement of application sessions between devices in Personal Area Networks (PANs) and the Internet.

JELD, the Java Environment for Learning Design was presented by Marco, et al, (2004), it is an online distance learning system designed to implement different kinds of approach to learning. The system is a Java 2 Enterprise Edition that supports research innovation. JELD allows users to define teaching strategies, learning approaches and educational goals using Learning Design Specification. At the moment, the system uses a subset of Learning Design Specification that allows a knowledge-building process to be run in a collaborative learning environment. Moreover, JELD can adapt learning activities to the client device; in particular, modules for PCs, PDAs and mobile telephones were developed.

Web-based e-Learning Applications

For over a decade, there have been several numbers of web-based e-Learning applications, all providing e-Learning content and giving feedback irrespective of distance of the participants. Most of them address e-Learning using conventional architecture and a single device/ browser, mainly on PCs. One of such applications is Blackboard (http://www.blackboard.com). Blackboard was developed in 1997 to allow instructors and facilitators to build and manage learning content and provide an engaging environment for students. Tests, quizzes and assignments are easy to create and deploy using Blackboard. Blackboard also has a variety of tools for evaluating performance which contribute to instructor efficiency while providing timely feedback and reporting for students. Another application is Mindflash (http://www.mindflash.com/pages/home.asp). Mindflash's e-Learning software enables businesses, consultants and schools to create online courses using an

existing file. With Mindflash, (i) one can build high-quality, easy-to-navigate courses in minutes, (ii) combine course content in any format: Word, PowerPoint, Flash, PDF, audio, video and, and (iii) add quizzes and surveys to assess learner progress and incorporate scoring and certification requirements. WebQuizXP (http://eng.smartlite.it/en2/products/webquiz/index.asp) allows one to create on-line quizzes, tests and assessments in just a few minutes. ExamWeb(www.examweb.com) allows one to create, deliver and report on a variety of examinations for a variety of purposes.

Turnitin (http://www.jiscpas.ac.uk/turnitinuk.php) is used for electronic plagiarism detection, and over 80% of UK universities have adopted it, as well as a number of schools, colleges and professionals. Moodle(http://moodle.org) is a software package for producing Internet-based courses and web sites. It is an ongoing development project designed to support education. Moodle is provided freely as Open Source software (under the GNU Public License), GNU is an acronym for "GNU's Not Unix". Claroline(http://www.claroline.net) is a platform that allows hundreds of organizations from 86 countries to create and administer courses and collaboration online. In the MOICANE (Patrikakis et al, 2004) platform project, several e-Learning application modules were presented, such as use of the Video on Demand (VoD). By using VoD, students can attend video presentations during a class. The novelty of the approach presented in this work in contrast to existing approaches derives from the use of multiple communication devices to access a single e-Learning application in a web server, using the functionalities that is built into Microsoft Visual.NET platform.

STATEMENT OF THE PROBLEM

A growing number of students and researchers from universities or the research communities who may want to subscribe to web-based e-Learning application carry different communication devices, ranging from static to mobile devices including WAP Phones, Laptop/PC, Pocket PC and PDAs, etc, with different browsers.

The conventional approach to overcomming this challenge is to maintain multiple versions of an application, one for each device it is intended to run. But due to the large number of devices, that is no longer a viable option for software developers today.

This challenge may limits the scope of users of e-Learning services. This conventional approach was employed in the paper by Ariigo et al, (2004) on the usage of heterogeneous communication devices.

RESEARCH OBJECTIVES

The objective of this study is to create an architectural framework and web-based application that will improve learning processes using multi-channel technologies that connect students, faculty and the researcher community in a growing network of education environments, irrespective of the communication device such as WAP phones, Laptop/PC, Pocket PC and PDAs owned by a subscriber.

RESEARCH METHODOLOGY

The modular approach of programming which is a prominent feature of modern system of programming was applied in this study. This modular approach made the web-based program development process more flexible and it enhances easy modification and debugging.

The relevant facts or information on web-based learning were elicited through observation and study of important documents and information from the Internet. Using these facts, the design and a prototype implementation of the application was carried out.

The Microsoft Visual Studio.NET framework was employed in developing the prototype application. The application was written once and at execution time, the mobile controls automatically generated the correct markup language for the device that makes a request.

Microsoft development tool was chosen since it can be downloaded free from the Internet, and they are compatible since they are all from the same company (Wei-Meng, 2007). The prototype application was tested locally using Microsoft mobile device emulator built into Visual Studio.NET.

ARCHITECTURAL FRAMEWORK OF THE SYSTEM

This session contains the architectural framework of the proposed system. Figure 1 shows a multi-channel e-Learning 3-tier architectural framework involving four client devices accessing a single application (P1) from a web server. Figure 2 describes the proposed e-Learning architecture for a virtual laboratory involving three institutions.

The two architectures integrate three components represented as tiers: the client tier, web server tier and database server tier.

On this platform, at anytime and from any location, students and researchers can access the enterprise e-Learning application using four different communication devices.

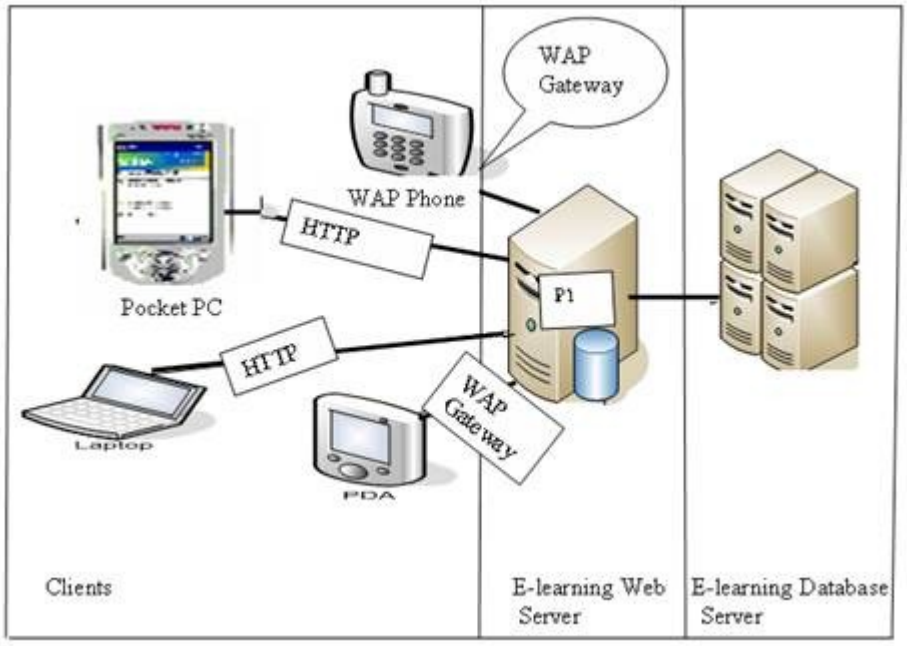

Figure: 1

A Multi-channel e-Learning 3-tier architecture

Sourc
(Azeta et a
2008)

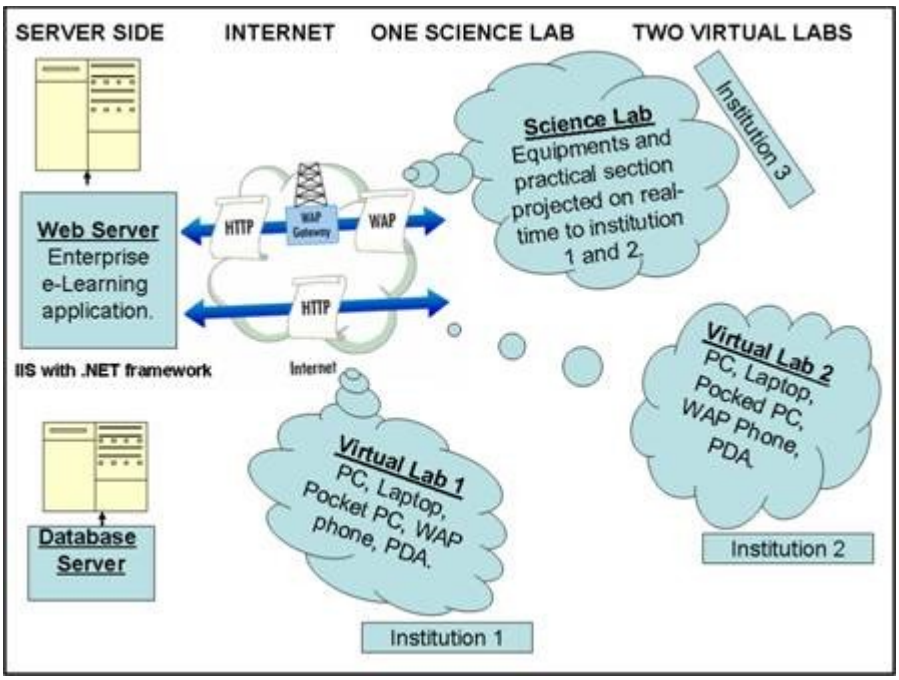

Figure: 2

An e-Learning architecture for virtual laboratory

Ø E-Learning Database Server: The database server stores the learning materials, video/audio data and other learning content data that may be needed by the e-Learning community members.

- **E-Learning Web Server: The web server stores the actual e-Learning application and other value-added information and content that subscribers wish to access.**
- **Clients: The client uses different types of communication devices running various browsers such as WAP Phones PC/Laptop, Pocket PC and PDA.**
- **WAP Gateway: The gateway is the interface between WAP clients (mobile devices), and web server. The functions of the WAP gateway includes: (i) processing of encoded requests for Internet-based information from the mobile devices, (ii) decoding/encoding of task, (iii) conversion of Wireless Session Protocol (WSP) to HyperText Transfer Protocol (HTTP), and (iv) transformation of HyperText Markup Language (HTML) to Wireless Markup Language (WML) content.**

SYSTEMS IMPLEMENTATION

In this section, e-Learning components are described and a prototype implementation of file transfer module, one of the modules of the e-Learning application, is presented.

The components of the e-Learning system includes: Video on Demand (VoD), Video Conference, File Transfer, Virtual Laboratory, White Board and Chat. The second column (see table 1) is the actual requirements of a real life classroom, while the first column represents the equivalent application component offered by the proposed system to service these requirements. The function of the Videoconference application module is to enable the teacher and the student to see and listen to each other. However, the teacher's privilege and that of a student are not the same, since the teacher should have administrative rights over a conferencing session, e.g. in a typical class room environment, the teacher is authorized to disconnect a student when the student misbehaves.

Table: 1

Requirements of a typical e-Learning system

Application Modules	Requirements
Video on Demand	Media(Audio/Video) Presentation
Video Conference	Actual Class Presence
File Transfer	Student Assignment Exchange
Virtual Laboratory	School Lab
White Board	Black Board
Chat	Student Collaboration

The Whiteboard application is the component that represents the traditional class' room blackboard. Since the teacher is responsible for controlling the student, the

teacher's application offers the required functionality for administering the students' sessions. In some cases, students need to handle instruments, do some tests and make measurements in a laboratory environment. This functionality is provided by the Virtual Laboratory application module. As obtained in real laboratory, it is the responsibility of the teacher to give superior powers to a student in order to handle an instrument. Therefore, the teacher's application should have extra management features.

Lastly, the need to exchange large amounts of information such as student assignments is provided by a *file transfer* application available for handling download/upload of files such as documents, software etc. In order to provide these assignments, the collaboration between team of students is necessary in most cases. The Chat application module makes possible this collaboration, by way of the teacher assigning students to different work teams that can communicate and exchange information affecting the assignments. The following pseudocode is an extract for the main menu and *file transfer* module:

Pseudocode for the main menu

```
If menu_selection = 1 then do video_on_demand else
If menu_selection = 2 then do video_conference else
If menu_selection = 3 then do file_transfer else
If menu_selection = 4 then do virtual_lab else
If menu_selection = 5 then do whiteboard else
If menu_selection = 6 then do chat
Endif
```

Pseudocode for the File Transfer module

```
/* Get file extension and exit if not doc for word or xls for Excel or ppt for
powerpoint or pdf  */
$F_ext = GetFileExtension($imagefile_name);
If (($F_ext != "doc") && ($F_ext != "xls") && ($F_ext != "ppt") && ($F_ext !=
"pdf"));
{
        Print "file extension unknown.";
        Print "please upload only file type: doc or xls or ppt or pdf.";
        Exit();
}
Else
{
/* store file in proper directory */
/* click on submit to send the file to the receiver */
}
```

The prototype application

The following steps would allow access to the system:

- **Open mobile device emulator in visual studio**
- **Load the index file**
- **Type user name and then type password, this gives you access to the welcome page/home page**
- **Select option from 1 to 6 from the main menu and follow the instructions on the screen.**

The prototype for the main menu page and file transfer application module is

presented in this session. Figure 3.0 contains some screenshots of four communication devices- WAP Phone, Laptop, Pocket PC and PDA showing the interface of a virtual classroom main menu and file transfer application module from a single application in a web server. This application was put together using Visual Studio.NET platform and tested locally with Microsoft mobile device emulator.

WAP Phone **Laptop** **Pocket PC** **PDA**

Figure: 3

Screenshots of some communication devices

CONCLUSION

This study has been able to create an architectural framework and a prototype software system on a three-tier architecture that will improve learning processes using multi-channel web-based technology to connect students, faculty and the research community, irrespective of the communication device (WAP phones, PC/Laptop, Pocket PC and PDAs) owned by a subscriber.

The prototype application has been tested locally (on a localhost computer) using a mobile device emulator. It can be concluded that with the multi-channel approach, feedback between the students and lecturers is faster since scope of communication device used by clients are more, and interaction is flexible and community based.

One of the contributions of this work is a referenced architectural framework for the research community that will go a long way to assist developers during the development process of e-Learning web application to accomplish multi-channel support. The e-Learning application when fully implemented will fulfill the requirements of the end user and system owner.

The developed application will pave the way for a worldwide deployment of virtual collaborative services. In research and university context, this work, in addition to providing a basic platform for learning, will enable researchers from institutions

with insufficient laboratory equipment to take advantage of this platform by connecting online, real time to the practical section that is taking place in another institution with sufficient laboratory equipment. Students in remote locations will therefore have access to costly and scarce scientific equipment for carrying out experiments in the laboratory. The usage of the application will provide cost-effective, flexible and efficient support services in qualitative education to e-learners and virtual teams, within and outside a university community.

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