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A HIGH PERFORMANCE AND PLATFORM INDEPENDENT WEB-BASED DISTANCE LEARNING ENVIRONMENT

YEM POH CHEANG

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By

YEM POH CHEANG

Thesis Submitted in Fulfilment of the Requirement for the Degree of
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Abstract of the thesis submitted to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

A HIGH PERFORMANCE AND PLATFORM INDEPENDENT WEB-BASED DISTANCE LEARNING ENVIRONMENT

By

YEM POH CHEANG

July 2001

Chairman : Associate Professor Borhanuddin Mohd. Ali, Ph.D.

Faculty : Engineering

The growth of the Internet and the World Wide Web (WWW) has significantly increased the amount of online information and services available to the general population of society. The fast development of high-powered communication technology, together with an increasingly computer-wise society have created new opportunities for the delivery of educational material and distance education on the Web. Among the popular Web-based distance learning systems are WebCT, Blackboard, Lotus LearningSpace and Virtual-U. However, these systems have limitations such as platform dependent, slow performance and expensive cost.

In this thesis, a Web-based distance learning environment (WebEd 2000) has been developed using Java servlets and random access file to address these problems. It is essentially an extension of WebEd, a first working prototype of Web-based distance learning system developed at the Broadband and ATM Research Group, Universiti Putra Malaysia (UPM). This new version provides significant improvement over its

predecessor in various aspects, such as system performance, usability, scalability, security, reliability and stability. WebEd 2000 enables delivering conventional lecture notes over the Web and providing various tools to help in managing and maintaining course materials in a server. It also enables traditional face-to-face interaction to be carried out asynchronously via email and announcement services. Moreover, the system also supports monitoring and tracking of students activities as well as managing of students within a course.

WebEd 2000 is mainly developed using the combination of Java servlets and JavaScript technologies. The server-side servlets, together with the binary format random access file, are used to process various client requests and store data, while the client-side JavaScript is used to enable DHTML features and perform less security concern processes such as generating an input dialogue box, hence lessening the workload of the server in relative.

Finally, WebEd 2000 can easily be set up and deployed in any platforms with minimal modifications. Flexibility is achieved by utilizing Java technology for the system applications and random access file for the system data repository. It is this platform neutrality of Java bytecodes and binary file format that makes WebEd 2000 a completely platform independent Web-based distance learning environment.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PERSEKITARAN PEMBELAJARAN JARAK JAUH YANG PANTAS DAN BEBAS-PELANTARAN BERASASKAN INTERNET

Oleh

YEM POH CHEANG

Julai 2001

Pengerusi : Profesor Madya Borhanuddin Mohd. Ali, Ph.D.

Fakulti : Kejuruteraan

Pertumbuhan pesat Internet dan *World Wide Web* (WWW) telah meningkatkan jumlah maklumat dan perkhidmatan yang dapat dicapai oleh masyarakat sejagat. Perkembangan pesat dalam teknologi komunikasi yang berkuasa tinggi dan juga bertambahnya masyarakat yang celik komputer, telah menghasilkan peluang baru bagi penghantaran bahan pendidikan dan perlaksanaan pendidikan jarak jauh di dalam Web. Antara sistem pembelajaran jarak jauh berasaskan Internet yang popular ialah WebCT, Blackboard, Lotus LearningSpace dan Virtual-U. Namun demikian, sistem seumpama ini mempunyai kelemahan seperti tertakluk kepada pelantaran, lambat dan kos yang tinggi.

Dalam tesis ini, satu persekitaran pembelajaran jarak jauh yang berasaskan Internet (WebEd 2000) telah dibangunkan dengan menggunakan Java servlets dan fail capaian rawak untuk mengatasi masalah ini. Ia sebenarnya adalah kesinambungan dari WebEd, iaitu satu contoh sistem penbelajaran jarak jauh yang dibangunkan oleh Kumpulan Penyelidikan *Broadband* dan *ATM*, Universiti Putra Malaysia (UPM).

Versi baru ini memperlihatkan kemajuan yang ketara dalam pelbagai aspek, seperti prestasi sistem, kebolehgunaan, kebolehlanjutan, keselamatan, kebolehgantungan dan kestabilan. WebEd 2000 membolehkan penghantaran nota kuliah melalui Web dan membekalkan pelbagai peralatan untuk membantu dalam mengurus dan memelihara kandungan kursus dalam sebuah pelayan. Ia juga membolehkan tradisi interaksi secara muka ke muka dijalankan secara asinkronus melalui perkhidmatan email dan pengumuman. Tambahan pula, sistem ini juga menyokong pengawasan dan pengesanan aktiviti-aktiviti pelajar dan juga pengurusan pelajar di dalam sesebuah kursus.

WebEd 2000 dibina menggunakan gabungan teknologi Java Servlets dan JavaScript. Aturcara servlets dan fail capaian rawak melaksanakan pelbagai proses dan penyimpanan data di peringkat pelayan. Sementara itu, JavaScript digunakan untuk menghasilkan kesan DHTML dan melaksanakan proses seperti mempamerkan antaramuka untuk input, dengan itu mengurangkan beban pelayan secara keseluruhannya.

Akhir kata, WebEd 2000 boleh dijalankan di atas semua pelantaran terkenal dengan sedikit modifikasi. Ini adalah disebabkan oleh penggunaan teknologi Java untuk aplikasi sistem dan fail capaian rawak untuk sistem penyimpanan data. Kelebihan Java *bytecodes* dan fail binari inilah yang menjadikan WebEd 2000 bebas-pelantaran.

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I certify that an Examination Committee met on 5th July 2001 to conduct the final examination of Yem Poh Cheang, on his Master of Science thesis entitled "A High Performance and Platform Independent Web-based Distance Learning Environment" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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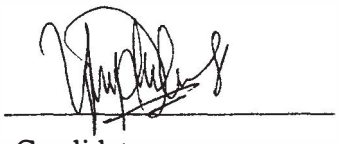
DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.



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LIST OF ABBREVIATIONS

API	-	Application Programming Interface
ASP	-	Active Server Pages
CAI	-	Computer-Assisted Instruction
CBT	-	Computer-Based Training
CGI	-	Common Gateway Interface
CME	-	Computer-Mediated Education
CMI	-	Computer-Managed Instruction
DFD	-	Data Flow Diagram
DHTML	-	Dynamic Hypertext Markup Language
GUI	-	Graphical User Interface
HTML	-	Hyper Text Markup Language
HTTP	-	Hyper Text Transfer Protocol
IP	-	Internet Protocol
JDBC	-	Java Database Connectivity
JDK	-	Java Development Kit
JVM	-	Java Virtual Machine
LAN	-	Local Area Network
ODBC	-	Open Database Connectivity
PERL	-	Practical Extract Report Language
RDBMS	-	Relational Database Management System
SQL	-	Structured Query Language
WWW	-	World Wide Web

CHAPTER I

INTRODUCTION

Distance Learning

In its broader context, distance learning is a term used to describe instruction where teachers are physically or geographically separated from their students. In general, distance learning is any instructor and student interaction where the participants are separated by distance, time, or both. Distance learning is not simply group video-conferencing, but involves instructor control, student participation, and introduction of class materials. It occurs when technology (i.e., audio, video, data, and print) is used to bridge the instructional gap between a teacher and students separated by distance (Willis, 1994). Several key features define distance learning. They are:

- the separation of teacher and learner during at least a majority of each instructional process;
- the use of educational media to unite teacher and learner and carry course content;
- the provision of two-way communication between teacher, tutor, or educational agency and learner;
- separation of teacher and learner in space and/or time;
- volitional control of learning by student rather than distance instructor.

The unique features of distance learning allow students to work independently and still have personal contact with their instructors and classmates. In fact, the use of email and course discussion forums can facilitate discussions that are deeper and more thorough than typical classroom discussions, where interactions are often limited by time and space. Being connected to a peer group or cohort and to an instructor, and perhaps a tutor, the remote learners or students can also have the benefits of the important people-to-people communications that campus learners or students have always enjoyed, and which self-learning alone does not provide. Distance learning makes learning more accessible by bringing the many benefits of cohort-style learning to remote learners without regard to distance or time-synchronization constraints. It may bring to reality the vision that anyone should be able to access education at anytime or anyplace.

There are a wide range of technological options available to the distance educator. They fall into four major categories:

- **Audio.** Instructional audio tools include the interactive technologies of telephone, audio-conferencing and short-wave radio. Passive audio tools include tapes and radio.
- **Video.** Instructional video tools include still images such as slides, pre-produced moving images (e.g., film, videotape) and real-time moving images combined with audio-conferencing (one-way or two-way video with two-way audio).
- **Data.** Computers send and receive information electronically. Computer applications for distance education are varied and include computer-assisted instruction (CAI), computer-managed instruction (CMI) and computer-

mediated education (CME). CAI uses the computer as a self-contained teaching machine to present individual lessons. CMI uses the computer to organize instruction and track student records and progress. The instruction itself need not be delivered via a computer, although CAI is often combined with CMI. CME describes computer applications that facilitate the delivery of instruction. Examples include electronic mail, fax, real-time computer conferencing and World Wide Web applications.

- **Print.** Print is a foundational element of distance education programs and the basis from which all other delivery systems have evolved. Various print formats are available including textbooks, study guides, workbooks, course syllabi and case studies.

Among these technologies, CME is the most preferable in the 21st century as it enables more seamless delivery of instruction via WWW and allows anyone to access instruction anytime and anyplace. With the current advancement in Internet and Web technology, we proposed to use the WWW as the primary medium in delivery of education materials with a Web-based distance learning environment project.

Web-based Distance Learning

Joseph No. Pelton from International Space University said "The idea of schools without walls, universities webbed together by electronics, and learning systems based upon new academic paradigms will not be easily denied in the 21st century." The Internet is increasingly being used for the delivery of educational material and distance education. Information is available at any time from any place to any

Internet user. This is creating tremendous opportunities for universities to provide a learning environment that is accessible to all. The "same time, same place, only some people" traditional educational environment is giving way to "anytime, anyplace and anybody" instructional models. Internet-based learning allows students to learn at their own pace, access the information at a time that is convenient for them, and provides education to remote students that otherwise would not be able to travel to a classroom. A variety of technologies are currently being used to deliver education on the Internet. These technologies include the use of the World Wide Web (WWW) for online lecture notes, newsgroups for collaborative discussions and class announcements, email correspondence between students and instructors, interactive video over the Internet for remote participation in classes and discussions, and virtual reality for exploring three dimensional scenes. Multimedia is increasingly being used in online education to enhance the learning process.

Web-based distance learning refers to the use of WWW as the primary medium in delivering educational materials. Advances in information technology and telecommunications are allowing Web-based courses to replicate more seamlessly the features of face-to-face instruction through the use of audio, video and high-speed Internet connections that facilitate synchronous and asynchronous communication in chat groups, Web discussion boards and virtual forums. In fact, traditional face-to-face instructional activities can be easily translated to the Web environment with the use of existing Internet technologies:

- **Content:** Lectures and homework can be developed for the Web by using any word-processing package with html capabilities, or the html editor

available with many browsers. Example includes Microsoft Word, Netscape Composer and Microsoft FrontPage.

- **Delivery:** Instead of being delivered in-class, lectures can be placed on a server.
- **Interaction:** One of the biggest advantages of the traditional learning environment is face-to-face interaction. Due to bandwidth restrictions, this is not yet easily translated into the Web-based environment, in spite of the many video conferencing packages currently available, such as PictureTel (PictureTel, 2001), NetMeeting (NetMeeting, 2001), and CUSeeMe (CUSeeMe, 2001). However a highly interactive learning environment can be created using Web tools such as threaded discussion boards, forums, bulletin board, email and others for asynchronous communication and online chat rooms for synchronous interaction.
- **Assessment/Feedback:** Traditional form of student assessment and feedback can be adapted to Web-based environments. For example, students can take online exams that may be automatically graded online, in real time or may be electronically sent to the instructor for grading, which in many cases reduces feedback time.

Characteristics of Web-based Distance Learning

Early on, the Web offered static content as the main vehicle for interaction. The first, and still most popular format for interaction in Web-based distance learning is asynchronous conferencing. With this technology, learners were able to constantly collaborate with others. This idea grew into document sharing, and learners were enabled to work together, regardless of the time and location.

Recently, Web content has become more dynamic. Streaming video and audio is becoming more available, and more distance learning sites are taking advantage of it. New collaboration tools are also emerging to allow merging of the static content, discussion forums, and multimedia. In the future, with broadband access, video will become an integral component of Web-based distance learning.

Numerous studies have shown that Web-based distance learning are not only possible, but have many advantages over traditional education (Hiltz, 1997; Kearsley, 1998). These include the convenience of asynchronous participation, a permanent record of the class, and analysis tools. As bandwidth become less of a concern, it will be possible to economically simulate on the Web many of the audiovisual aspects of face-to-face environments. The ultimate goal in this area is to provide a seamless learning environment, independent of platforms and tools (Aggarwal, 2000).

Benefits of Web-based Distance Learning

The benefits of Web-based distance learning share most of the advantages of other distance learning systems, such as:

- **Cost-effectiveness.** Distance learning cuts the expensive costs of transporting the students and instructors to a centralized location. Duplication costs of materials are also dramatically reduced.
- **Increased emphasis on collaboration.** With the new distance learning systems, it is less likely that student will be a passive learner than in the traditional broadcast format. The tools involved (teleconferencing, 2-way

video, asynchronous forums) encourage active participation and collaboration (Chute, 1999).

- **Transcend time barriers.** Streaming 2-way video has not yet become an integral part of Web-based distance learning. As a result, most of the exchanges of information have become asynchronous. Although this may seem to be a limitation, it gives the learners the flexibility to learn at their own convenience. This aspect of Web-based distance learning also gives students time to reflect on ideas and concepts before participating in a class discussion via an asynchronous forum.
- **Direct access to the experts.** The Web gives each learner direct access to the instructor of an online class. Discussion forum and email empower the students to reach the instructor when questions arise without taking up classroom time, or taking the risk of speaking to the entire classroom.
- **Low equipment costs.** The Web can be a low cost solution to distance learning, especially on the client end. The client requires an Internet connection, a Web browser and a computer capable of running it.

The Challenges in Developing High Performance Web-based Applications

Web-based Distance Learning, while providing significant benefits, introduces new technical challenges with respect to scalability, and management of session, state, transaction, security as well as server loads. Web-based distance learning applications can face unpredictable and potentially peak loads at any given minutes. In order to solve this problem, a high performance architecture that is extremely scalable is needed. The Web is a stateless environment, in which the client and server are loosely coupled. Applications must keep state information from one page to

another if they are to avoid requiring users to re-enter information such as user name and password from page to page. Furthermore, the Web also presents new security issues such as accessing to an internal database, Web services, etc because of the sharable nature of WWW. User authorization and authentication are more challenging in the Web environment because of the large number of potential users. In short, in order to preserve the usability of Web-based applications and WWW, Web applications must provide reliable, secure and stable processing under heavy demands.

Consequently, several existing server-side technologies such as Common Gateway Interface (CGI), Microsoft Active Server Pages (ASP), etc have been introduced to cater these challenges in the past few years. Although these technologies had been use extensively in the past few years in developing Web-based applications, none of them, however, address all the Web challenges mentioned at the same time.

In this thesis, we develop a Web-based distance learning system called WebEd 2000 based upon WebEd (Low, 1999), a first prototype of Web-based distance learning system developed in the Department of Computer and Communication Systems Engineering, Faculty of Engineering, Universiti Putra Malaysia (UPM). It is essentially a continuous work of WebEd with new approach to solve all the problems suffered in the first version such as memory management, security threat and platform dependence.