COMPUTER SUPPORTED COLLABORATIVE LEARNING IN A GRID COMPUTING ENVIRONMENT FOR INTEGRATED CIRCUIT AND MICROELECTROMECHANICAL SYSTEM DESIGN ACTIVITIES

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ABSTRACT

e-Learning grid is an emerging branch of education that offers innovative learning experiences coupled with collaborative technologies. The advantages of e-learning grid are improved scalability, interoperability, availability, and creation of new possibilities for future e-learning development. e-Learning grid also provides educational opportunities at different levels by enabling access to a large amount of software and hardware resources. This paper presents the development of e-learning based on a computer-supported collaborative learning approach in a grid computing environment for integrated circuit and microelectromechanical system design activities. The design challenge is to develop new platform and architectures for e-learning in grid computing environments among consortium members in the community of a university.

KEYWORDS

e-Learning; Computer Supported Collaborative Learning; Learning Management System; Single sign on; Search engine adapter; Grid Architecture

1. INTRODUCTION

e-Learning is a term that encompasses all forms of technology-enhanced learning, such as online or web-based learning. Grid computing is the combination of computer resources from multiple administrative domains applied to a common task. Grid architecture design is an important criterion for successful wide resource sharing in open grid services, and collaborative learning environments are some of the most promising approaches for e-learning. Previous research on the development of e-learning grid focused on designing new platforms and architectures to address learning resources/services in sharing, reuse, and interoperability that support both distance and traditional learning processes [1].

Computer-supported collaborative learning (CSCL) is a method of supporting collaborative learning using computers and the Internet. This technology allows individuals who are physically distant from one another to collaborate online. The overall goal of CSCL research is to design software tools and collaborative environments that facilitate knowledge construction. The application of CSCL in educational and workplace environments is well known [2], [3], [4]. However, the application of CSCL at the university level, particularly in micro-design activities integrated circuit (IC) and microelectromechanical system (MEMS), are not well discussed. Therefore, a new platform of CSCL for micro-design activities should be developed to assist and support collaborative learning at the university level toward its emergence in grid environments.

Research efforts have been exerted to develop e-learning grid architecture over the last decade. Wen-Chung Shih et al. (2008) used a rapid
approach based on automatic draft generation and wiki-based revision as an e-learning architecture. The course martial was developed using wiki-based authoring by rapid prototyping method. The advantages of this approach are rapid construction, access, and modification. However, the content was not reviewed by anyone before its publication. Thus, in our proposed architecture, the tutorial and publication need to be approved first by experts before publication. Kong, Feng, and Yang Xudong (2009) used multi-video-on-demand (VOD) architecture in grid technology for learning and teaching materials. The multimedia files of the learning materials are stored separately to solve the storage capacity bottleneck. The VOD distribution algorithm requests multimedia files dynamically, increasing processor performance. The advantage of this approach is that it increases storage capacity and processor performance during a bottleneck. However, there is no interactive learning between students and lecturers/teachers.

Currently, the development of e-learning in grid computing environments has yet to be exploited, particularly in IC and MEMS design activities. The current paper introduces a new, distributed, large-scale, and cross-organizational collaboration by creating a group-centered next-generation collaboration environment, wherein both intra-group and inter-group collaborations are supported. This system consists of electronic design automation (EDA) tools and their online tutorial (material provided by experts), an online publication (materials provided by previous graduate students and lecturers), and an online discussion forum (facilitated by experts).

2. RESEARCH METHOD

Figure 1 shows a new learning management system (LMS) platform developed with infrastructure that connects user tools to help students, lecturers, and researchers using single sign-on through a web portal. The difficulties faced during the design stage can be reduced to provide more comprehensive reference materials and discussions directly by experts in the field, and to facilitate the sharing of research materials among researchers and students.

![Figure 1. CSCL grid architecture for a new learning management system platform](image)

2.1. Service-oriented Grid Architecture

Figure 2 shows that the two services provided by combining the use of CSCL tools and platforms facilitate the understanding of students and researchers in the field of IC and MEMS. Students and researchers can simultaneously access both of these services.

![Figure 2. Students access e-learning and tools simultaneously through the MicroEDIS portal](image)
2.2. Learning Resource Architecture

Figure 3. Architecture for support members to contribute their learning resource materials

Figure 3 shows that the learning resource materials are developed based on contributions of university consortium members, including lecturers, researchers, and experts from the industry. Students also contribute their design projects to committee members for future reference.

The development of this e-learning system uses the rapid approach by constructing and customizing few open source software and combining it with the new LMS platform.

3. RESULTS AND DISCUSSION

The development of various learning libraries can help students and researchers easily and quickly improve their mastery of IC and MEMS designs. The figure 4 shows the learning library developed in a high-performance server.

All libraries learning systems are deployed using a high-performance server to facilitate large-scale knowledge sharing. Each library learning system runs on VMWare ESX image with the specifications given in the table 1 below.

<table>
<thead>
<tr>
<th>Library Learning Module</th>
<th>Platform</th>
<th>Platform Specification</th>
<th>VM Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture notes Library System</td>
<td>Moodle</td>
<td>Moodle 2.0.8+ Apache 2.2 PHP 5.2.8 MySQL 5.0.25</td>
<td>RAM 4GB Processor 2 cores Storage 500 GB</td>
</tr>
<tr>
<td>e-Books Library System</td>
<td>Calibre</td>
<td>Calibre 0.8.50</td>
<td>RAM 8GB Processor 4 cores Storage 1 TB</td>
</tr>
<tr>
<td>Media Library System</td>
<td>KalturaCE</td>
<td>Kaltura CE 5.0 Apache 2.2 PHP 5.2.x/5.3.x MySQL 5.1.37</td>
<td>RAM 16GB Processor 8 cores Storage 5 TB</td>
</tr>
<tr>
<td>Technical Report Library System</td>
<td>ePrints</td>
<td>ePrints 3.0 Apache 2.2 Perl Module MySQL 4.0</td>
<td>RAM 4GB Processor 1 core Storage 500 GB</td>
</tr>
<tr>
<td>Publication Library System</td>
<td>ePrints</td>
<td>ePrints 3.0 Apache 2.2 Perl Module MySQL 4.0</td>
<td>RAM 4GB Processor 1 core Storage 500 GB</td>
</tr>
<tr>
<td>Community Forum</td>
<td>phpBB</td>
<td>phpBB3.0 MySQL 3.23 PHP4.3.3</td>
<td>RAM 4 GB Processor 1 core Storage 500 GB</td>
</tr>
<tr>
<td>Wiki</td>
<td>Wikimedia</td>
<td>Version 1.18.3 Apache 2.2 PHP 5.35 MySQL 4.0</td>
<td>RAM 4 GB Processor 1 core Storage 500 GB</td>
</tr>
<tr>
<td>Design Library System</td>
<td>ePrints</td>
<td>ePrints 3.0 Apache 2.2 Perl Module MySQL 4.0</td>
<td>RAM 4 GB Processor 1 core Storage 500 GB</td>
</tr>
</tbody>
</table>

Table 1. List of system and server requirements for each learning library system


### 3.1. Single Sign-On

The challenging part in integrating all open-access learning systems is the creation of a single sign-on. This method allows students and researchers to gain access to the learning library via the MicroEDIS web portal using a single registered ID. First, a table is created to handle login sessions.

```
CREATE TABLE IF NOT EXISTS `login` (`id` int(11) NOT NULL)
```

The PHP style pseudo code used to describe the flow of single sign-on. The user sign on the MicroEDIS web portal.

```
GET username
GET password
IF (username == registereduser &
password ==
registeredpassword) THEN
  IF (usercategory == student) THEN
    UPDATE session_status = 1, timer = 3600
    TARGET display main page Student
  ELSEIF (usercategory == instructor) THEN
    UPDATE session_status = 1, timer = 3600
    TARGET display main page Instructor
  ELSEIF
    UPDATE session_status = 1, timer = 3600
    TARGET display main page Administrator
  ENDIF
ELSEIF
  PRINT login failed
ENDIF
```

When the user signs out of the system, the delete function removes the ID from the login table.

```
// delete username record from single sign on table
GET username
GET password
DELETE username FROM login table
UPDATE session_status = 0
```

The cURL updates session status when the user opens another learning library.

```
// opens another learning library
GET username
GET password

IF (username == registerduser &
password ==
registeredpassword &
session_status == 1 ) THEN
  TARGET display main page library
ELSEIF
  PRINT session end
ENDIF
```

### 3.2. Search Engine Adapter

A development search engine can help students and researchers easily and quickly search for reference materials. The figure below shows how the search engine is used to find reference materials.

![Search Engine Adapter](image)

Figure 5. Search engine using the jQuery function from each learning library database

Figure 5 shows the jQuery function requires Javascript and AJAX to run a query from a search engine adapter and then display list of result on PHP.

The following is a PHP style pseudo code to run the function.

```
// get parameter from Javascript form and AJAX function
GET parameter

// check and display result from lecturenotes library
CONNECT lecturenotes database
SELECT parameter FROM lecturenotes table
PRINT Title, Authors, Source
CLOSE database

// check and display result from e-Book library
CONNECT e-Book database
SELECT parameter FROM e-Book table
PRINT Title, Authors, Source
CLOSE database

// check and display result from Media library
CONNECT Media database
SELECT parameter FROM Media table
PRINT Title, Authors, Source
CLOSE database

// check and display result from Technical Report library
CONNECT Technical Report database
SELECT parameter FROM Technical Report table
PRINT Title, Authors, Source
CLOSE database

// check and display result from Publication library
CONNECT Publication database
SELECT parameter FROM Publication table
PRINT Title, Authors, Source
CLOSE database
```
3.3. Access Performance of EDA Tools in the Grid Infrastructure

To test the smoothness of remote access using RealVNC Java Applet, figure 6 shows the same schematic circuit is designed on a different resolution in Redhat Linux ES4 64-bit platform. The 24-bit color depth is chosen for these testing based on the minimum requirement for EDA tools.

Figure 6. Schematic circuit design activity on resolution 1024 × 768

Figure 7. Graph of bandwidth readings based on schematic design shows in figure 6 (design on Xterm display mode and resolution 1024 × 768)

Table 2 Summary of the results of testing

<table>
<thead>
<tr>
<th>Display Mode</th>
<th>Best Bandwidth Requirement (Resolution size; in kbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1024 × 768 (13”-15” LCD size)</td>
</tr>
<tr>
<td>Xterm</td>
<td>100</td>
</tr>
<tr>
<td>Gnome</td>
<td>250</td>
</tr>
</tbody>
</table>

Therefore, students need to ensure that the resolution and best mode for project design are performed in remote and functioning.

4. CONCLUSION

The concept of knowledge sharing by combining variety of libraries and learning systems is reinforced using tools to enhance the understanding of students and researchers in the field of IC and MEMS. The effectiveness of the e-learning grid learning process will in turn produce highly skilled human capitals with knowledge sharing practice among students and researchers.

5. ACKNOWLEDGMENT

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6. REFERENCE


