Development and Performance Analysis of Web Based Virtual Classroom System using OpenMeetings over Red 5 Server

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ABSTRACT : This paper is to describe the result of the study and development of the pure open source web application over OpenMeetings and Red 5 Server as a virtual classroom system running on CentOS server. PHP, HTML and XML programming language is used to develop the web application integrating with MySQL database for system management. Teacher and student right is granted to each authenticated user for entering the system in each virtual classroom. Administration right is granted for user management, course initiation and registration. OpenMeetings is used for in-class operation along with the streaming server using Red 5. The result shows that the system works well for a small class environment with full administration function as it was designed for. Moreover, The performance test results show that the scalability of the system relies more on the network performance than the system hardware.

Keywords : Virtual Classroom, OpenMeetings, Red 5 Server

1. Introduction

Education Technology is becoming real and being a part of everyday life. Not only using for real time information distribution but also integrating with the computer network and internet technology or other telecommunication technology to build up the distance learning system. Especially, operated over the internet, the Electronic Classroom (E-Classroom) or Smart Classroom system is the virtual classroom created for supporting the teaching and learning of the class. Both teacher and students do not have to be in the same room while in class anymore.

1.1 Research Background

There are a lots of research and development of the system to integrate the application and technology in order to virtualize the in-class teaching and learning operation so that the teacher and students becoming full interactive and have the learning capabilities as well as in the normal classroom. However, the system or application using in the market nowadays is either too expensive or not fully functional. This research aims to create the system that is lower in price but comes with needed full-feature. With web-based platform and pure open sources application development results in the cost effectiveness and high scalability of the system.

1.2 Research Objectives

The research objectives are 1) to design and develop the web based electronic classroom system by applying the OpenMeetings open source application over the Red5 streaming server and 2) to evaluate and analyze the result system on performance, capability, and operation.

2. Virtual Classroom, Open Meetings, and Red 5 Streaming Server

2.1 Virtual Classroom

Virtual Classroom is a term to define the virtual learning environment, the platform used to build up the virtual meeting or classroom by the combination of computing and several information and communication technologies. Students and teachers can interactively communicate with each other via webcam, headset, microphone, or chat box. Most systems have the function to show the same material on the screen with the real-time editing or marking [1]. It is used among several learning institutes and universities, spreading from small group to large group, from lecturing to discussion, and from sit and listen to practicing [2].

There are a lot of virtual learning environment platforms developed and researched over the years. Most of them are web-based because it is easier for the students to access, can be run across the platform and highly scalable. There are a number of researches say that the web-based learning environment has some advantages such as stretching the spatial and temporal barriers, flexibility, interactivity and interoperability, especially the distributed interactive learning environment over the distributed passive learning environment [3], [4], [5], [6], and [7].

OpenCourseWare is a project of the Massachusetts Institute of Technology (MIT) to post all of the educational materials from its undergraduate and graduate level courses online free of charge in some parts. MIT OpenCourseWare is basically a web-based publication system of MIT course materials. Many courses even provide homework problems, exams, and lecture notes. Some courses also included interactive web demonstrations in Java, complete textbooks written by MIT professors, and streaming video lectures [8].

Another system that has also been popular for a decade is the blackboard system. It is an artificial intelligence application based on the blackboard architectural model. It works by having a blackboard as a common knowledge base, and is updated by a group of people that can be a specialist in particular knowledge. Starting with a problem each knowledge source keeps updating the blackboard with a partial solution. Finally, the specialists work together to solve the problem [9].

The OpenCourseWare system is basically the streaming video system. There is no interactive communication between teacher and students. In the other hand, the blackboard system is more like a blackboard that people post the solution or message one after another. There is also no interactive communication for this system. Therefore, the OpenMeeting has been chosen in order to develop the full function web based virtual classroom that teacher and student and interactively communicate during the class period.

2.2 OpenMeetings

OpenMeeting is the open source software which provides video conferences through web-browsing application. It is developed in Java and based on a set of open source components including OpenLaszlo for GUI, Apache, Tomcat, and Red 5 for streaming server and web application. With client/server architecture, clients can access the server through web

browser with flash support in personal computer with headset, microphone, and camera. Some key features of OpenMeetings include audio and video support, any participants' desktop view, and multi-language customization [10].

Santos, Castro, Santos, Fernandes, Sousa, and Varandas [10] had tested the OpenMeetings platform as a conference meeting by having all participant transmitted audio and video for all, without meeting recording and screen sharing activated. They collected the data with different number of clients by having participants joining the meeting more one by one. The server and client statistics were collected during the tests including CPU usage, memory usage, and RX/TX bandwidth. The test shown that the system they tested could provide service upto 12 participants simultaneously with some but acceptable difficulties.

Adeyinka, Adewale, Samuel, and Dike [11] had designed and implemented the Video Conferencing Application based on OpenMeeting over a Virtual Machine to improve the number of participants joining the system simultaneously up to 25 participants. Virtual Machine can effectively reduce the hardware limitation since it can be used to create other machine from one to remote distributed system or cloud [12].

2.3 Red 5 streaming server

Red 5 is an opensource Flash RTMP server written in Java that supports streaming video and audio, recording stream, shared objects, live streaming, and remoting with protocol RTMP, RTMPT, RTMPS, and RTMPE [13]. Red 5 is integrated as a component in OpenMeetings for media streaming. It can be modified and integrated to the other open source platform using Flash and scripting support language such as JavaScript, Groovy, Beanshell, JRuby, and Jython.

2.4 Research Framework

The system is designed to be a web based virtual classroom using Open Meetings as a platform over Red 5 streaming server. The management and administration of the system is designed to have 3 levels of users, Admistrator, Teacher, and Students developed by PHP programming language and Mysql database. Performance testing data of the system is collected at the server and client hardware with different number of user scenarios. CPU usage, memory usage, and upload download speed of each scenario is collected and analyzed for conclusion.

3. Design and Development

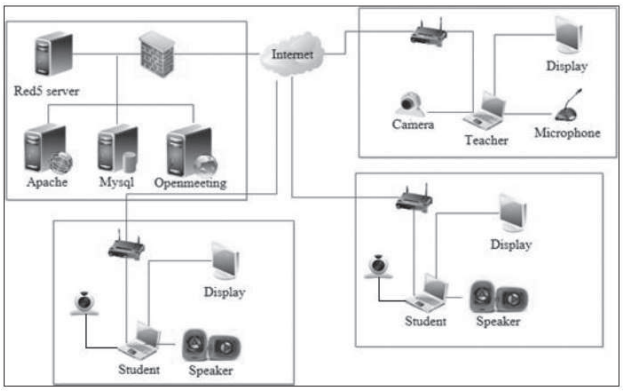

Figure 1 Virtual Classroom System Design Diagram

The design of the Virtual classroom system is as shown in Figure 1 While teacher and students can access into the system over the internet using the personal computer with any web browser application and needed communication devices such as display, microphone, and speaker or headsets, the servers, which are Red 5 as a streaming server, Apache as a web server, Mysql as a database server, and OpenMeetings, are all placed centrally for service control and management system. All of them can be installed either separately or in the same computer depending on the capacity of the system. If the classroom is relatively small, only one high performance server is enough for operation. On the other hand, if the classroom is large, then separation is needed especially for the Red 5 and OpenMeeting. However, in this research, the development mainly targets for cost-effective system for small classroom, the all-in-one server is used in development and testing.

As shown in Figure 2, there are 3 level of user right for the system, Administrator, Teacher, and Student. Administrator is the manager of the system who manages every function and information but not granted the right to join the class. While Techer is basically the in-class operator, Student is only the in-class participant with material download function.

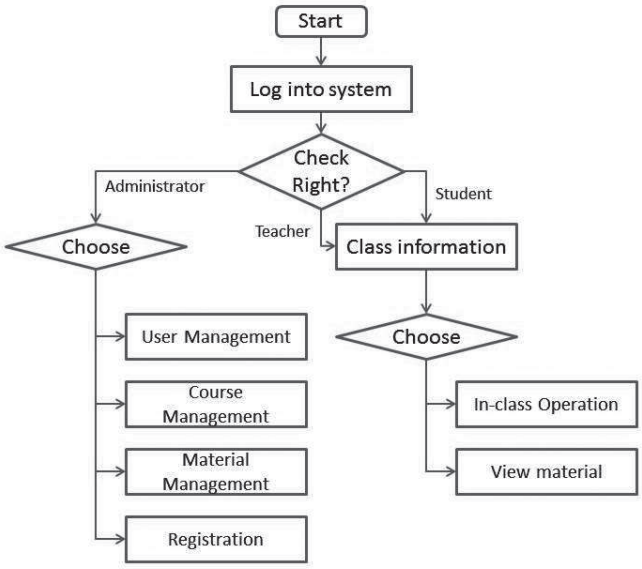

Figure 2 Overview flow chart of the system

As shown in Figure 2, there are 3 level of user right for the system, Administrator, Teacher, and Student. Administrator is the manager of the system who manages every function and information but not granted the right to join the class. While Techer is basically the in-class operator, Student is only the in-class participant with material download function. All of this right granting and process flow is done by the web application developed from the PHP programming language and consolidate with Mysql database with the ER diagram shown in Figure 3.

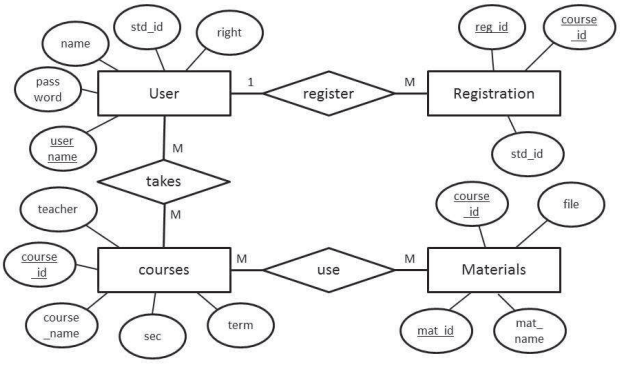

Figure 3 Entity Relation diagram

The in-class operation of the system is basically the function took out from OpenMeetings such as Chat box, Whiteboard, User list, Activity notification, and Camera view as shown in Figure 4.

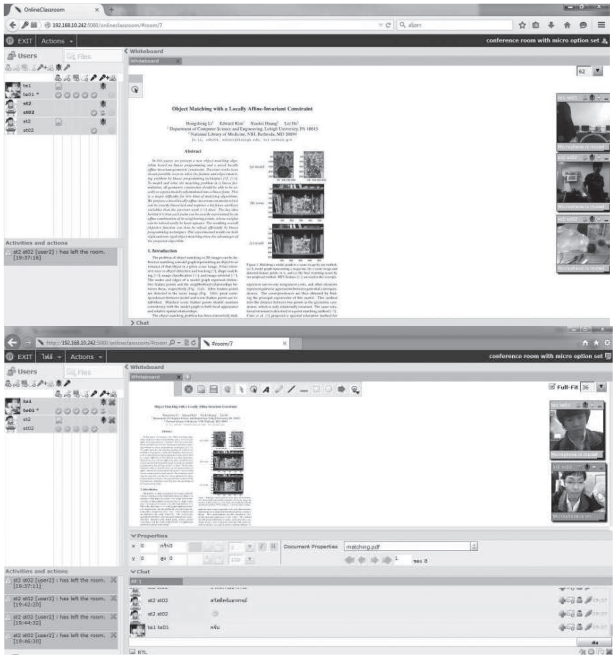

Figure 4 OpenMeetings In-class view

4. Performance Analysis

The performance evaluation has been tested over a few different scenarios in order to find the scalability of the system. By collecting basic system performance data, the experiment is created starting from one teacher one student situation in the same network following by additional of student one by one in order to see the tends of increasing of system resource usage. Table 1, Table 2, and Table 3 present the comparison of the collected result from the experiment.

Table 1 One teacher, one student system load

	Server	Teacher	Student
Upload (kbps)	204	98	96
Download (kbps)	236	121	104
CPU usage (%)	23-25	18-20	14-16
Memory usage (%)	48-50	42-45	40-45

Table 2 One teacher, two student system load

	Server	Teacher	Student
Upload (kbps)	406	99	94-97
Download (kbps)	447	122	113-121
CPU usage (%)	23-25	18-20	12-18
Memory usage (%)	48-50	42-45	40-47

Table 3 One teacher, three students system load

	Server	Teacher	Student
Upload (kbps)	612	99	95-98
Download (kbps)	670	123	115-122
CPU usage (%)	24-27	18-21	14-18
Memory usage (%)	47-51	42-47	41-47

5. Discussion and Conclusion

In terms of functional capability, the system development accomplished what it objected to. The system is absolutely workable in the small classroom environment with full administration function. While the load result shows that the system needs no high performance computer unit, the scalability of the system is majorly related to the network performance. As the number of student joining the class grows, the better upload and download speed is required. From the result, the approximate upload and download speed for each person, either teacher or student, joining the classroom is just above 200 kbps.

Although the system does not require high performance computer hardware, the user should not have other application open or run at the same time attending the class. Since the system took about 40-50 % memory usage at all time in class, using some other application simultaneously would affect the picture and sound of the system directly.

In the upcoming work, the comparison of the system performance in term of utilization and function will be researched and analysed.

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