E-learning Grid - An Online Learning Network

FH CHOO, KL GAY, H MIR MOHAMMAD HOSSEINI, CB TEO
School of Electrical and Electronic Engineering
Nanyang Technological University
Singapore 639798

Abstract: - Online learning or e-learning is not only an important cost saving measure for corporations to train their staff and customers but it provides the flexibility and opportunities to reach out to a much larger audience. Schools and institutions have been using it to complement their existing classroom lectures. Unlike corporations where contents and materials are driven by business and profits, schools may not have the resources to design and develop these materials. Furthermore, setting up and maintaining an e-learning system may not be an option for many because of the lack of IT resources or the lack of funds. As a result e-learning adoption, although well publicized, has not been widespread and in most cases, the true benefits of e-learning have not been realized. This paper proposes an e-learning grid (EGRID) to address some of the shortcomings of the existing e-learning systems. EGRID is a novel implementation of global networked computers to form a learning community. It allows all schools and users to focus on teaching and learning without having to manage their own hardware and software. The system allows information and learning contents to be shared or retained as proprietary materials for the individual school. It allows all users to interact and grow with the learning community, sharing ideas and ways to manage learning and project work. The paper highlights the grid architecture used and the key features of the grid

Key-Words: - e-learning, community network, learning, sharing, administration, management

1 Introduction

E-learning started with computer-based teaching (CBT) where computer tapes and later CDs were used to store teaching contents for playback. The arrival of the world-wide web has changed the way people communicate and interact. Businesses were quick to adopt the new technology. The success of Amazon.com in the early years of the internet age had caused a prolific explosion of the dot com business. The dot com bubble expanded too quickly and eventually burst leading to its premature demise. The dot com business, however, has recovered strongly due to the healthy growth in the global economy. The successful public listing of Google, the undisputed preferred search engine of many internet users, has renewed the interest in internet business.

Social websites with millions of users have mushroomed across the globe. Email and online chat are no longer the only ways that people use the internet. Blogging and Wikipedia have recently emerged as popular uses of the internet for people to express themselves; learning, sharing and interacting with people from all walks of life across the world. It has certainly changed the way we acquire knowledge. Learning is no longer the same as before. It is no longer limited to lessons in the classroom. The traditional e-learning system, where a learning management system is used to deliver and manage contents and learning, is no longer sufficient. A learning community is necessary to satisfy the ever increasing sophistication of the new generation of students where computers and the internet are closely knit with the classrooms. Knowledge is no longer limited to textbooks and learning is no longer limited to classroom interaction. Learning and knowledge building has become a highly integrated and interactive global process. It has grown beyond that of the interaction between the students and teachers in the classroom to that of global classrooms and communities. The traditional e-learning platform can no longer provide the processes required to sustain the interest of a student as he learns. New interactive features have to be included, and new learning paradigms implemented, (e.g. personalized learning and knowledge mapping [1, 2]). Without these, e-learning platforms will be reduced to mere content and knowledge repositories.

In this paper, we present an e-learning grid called EGRID which strives to create a learning community through an online network of servers and computers. The paper presents the motivation for its creation and addresses some of the technical issues involved in creating a massively integrated computer network grid for e-learning.

This paper is organized as follows: following this introduction, the motivation behind the creation of the EGRID system is first described. The features necessary to address the shortcomings of current e-learning platforms are highlighted. Basic grid computing is introduced and the architecture needed to implement the EGRID is then presented. Some details of the middleware of the architecture are described. Lastly, this paper concludes and presents areas for future work and improvement.

2 Grid Computing

Grid computing [5,6,7,8] is essentially leverages on existing hardware and software for sharing heterogeneous resources (based on different platforms, hardware/software architectures, and computer languages), located in different places, and belonging to different administrative domains, over a network, using open standards. In short, it involves the virtualization of computing resources.

A computing grid unifies different resources such CPUs and storage devices remotely. It manages the distribution of computations and the storage and movement of data across computers in a grid. This is done in a transparent way so that users of the grid are not aware of it. Through this, available resources can be used more efficiently and the aggregation of idle CPU cycles can match supercomputing capabilities.

Modern grids also focus on scalability and adaptability and therefore adopt Web technologies and standards such as the Extensible Markup Language (XML) and Web services. In the evolution of grid computing, two basic types of grids have emerged: Computational grids and data grids.

In the E-learning platform, the grid is typically implemented as a form of middleware which provides all grid-related services and can also use the Internet as a communication infrastructure. A generalized, layered, protocol architecture for grids can be represented as shown in Figure 1.

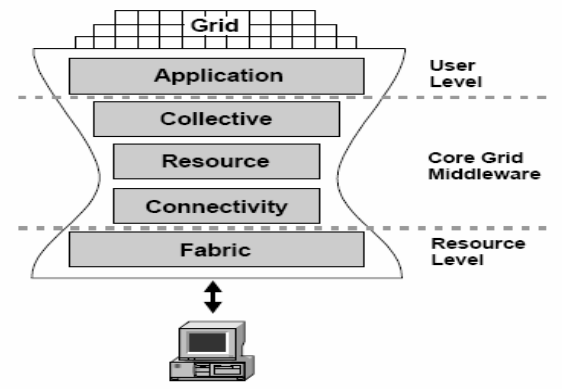

Figure 1. The five layers in a Grid Middleware

3 E-learning Grid – EGRID

EGRID is the acronym for e-learning grid, an e-learning network for the learning community adapted from, the middleware of the grid computing architecture as shown in Figure 1. EGRID is a proposed network that makes use of existing computers and network hardware connected in the world-wide web by exploiting its resources which would be otherwise left idle. EGRID uses the scalability of the learning management system, ecLEMS [3,9], as the learning platform. ecLEMS has all the necessary features including that of the social networking functions that are missing in many of today's e-learning platforms. Figure 2 shows the infrastructure of the EGRID system. Only eight of the n-number of nodes in the grid is shown as satellite servers in this example. In practice n, the total number of computers joined in the grid as nodes, can run into thousands and even millions.

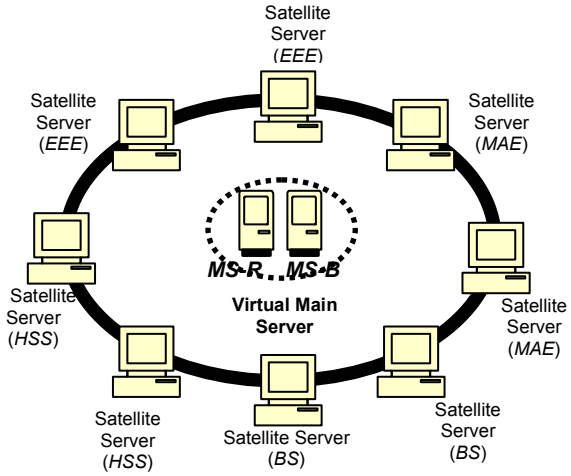

Figure 2 EGRID virtual servers

3.1 E-learning Issues and Motivation

E-learning typically includes predetermined content – such as streaming audio and video, hyperlinked Web pages, live Web broadcasts, and portals of information – and/or interactive methods – such as bulletin boards, chat rooms, instant messaging, video conferencing and discussion threads. Technological advances such as rich streaming media and advanced Web designing languages have revolutionized e-learning solutions. Synchronous learning over the Web improves the learner experience and provides on-demand learning that transcends geographical and time boundaries.

There is currently no shortage of e-learning platforms available. Many of these platforms are proprietary such as Blackboard and others. Open source e-learning platforms can be readily downloaded from

the internet. Good examples of these are Moodle and Sakai. Both of these open source platforms have features matching that of the well established commercial platforms. They are quite popular but their use have been limited by whatever support there is available at the schools and organizations who installed them. For an e-learning system to facilitate online learning effectively, it requires more than just a platform [10, 11]. The technical support and the participants, namely the content and service providers and the students, must be motivated to sustain the learning interest in using this alternative media. With the current popularity of blogging and many readily available social websites, retaining students' interest in an e-learning site is a challenge due to the many distracting factors. Moreover not many teachers are trained and competent enough to design interesting and interactive learning contents to capture the attention of the students. As a result many e-learning facilities ended up as merely file servers. Besides the need for teachers and content providers to be properly trained, these rich contents often strain the network bandwidth resulting in undesirable speed performances. One solution is to upgrade the servers and network hardware. The alternative is EGRID. It makes use of the pool of existing computer resources to resolve this bottleneck and bandwidth issues. It solves bandwidth constraints by matching the users to the nearest node and distributing the load to the satellite servers from the active dynamic main server.

3.2 Features for Learning Community

The advantages of EGRID and its features can resolve many issues and problems related to the use of current e-learning systems. These problems are: the challenges faced by teachers and students in managing and using the system as an alternative learning media, optimizing and sharing the use of resources, the increasing demand for video streaming and the management of synchronous learning. To cater to these needs, a learning community needs to be created. EGRID is an e-learning computer grid network linking all schools and institutions. The grid network allows schools to join the grid as satellite servers to serve the local needs. EGRID administrators will manage these satellite servers remotely, releasing schools from the burden of setting up and administering their own e-learning system. The learning management system, ecLEMS, in EGRID also provides the features for schools to share teaching content resources such as the use of the ecLEMS's usable test objects (RTO), reusable assignment objects (RAO) and learning contents. The built-in social networking system allows students to seek out friends to discuss focus topics from other schools in the learning community. Unlike the conventional social networking portals, EGRID provides a more conducive environment for intellectual discussion on projects and academic matters. ecLEMS groups users into centers, schools, courses and classes. This grouping facilitates users in easily seeking out other users doing similar courses from other schools and centers. Centers are clusters of school groupings formed to share common goals and resources.

4 EGRID Architecture

The EGRID system is made up of a network of servers and clients connected on the world-wide web. The primary communication protocol is the universal internet protocol, TCP/IP. The design makes use of standard existing hardware and software so that new computing resources can join the grid easily to reduce cost and complexity. Maintenance of the grid should be simplified through remote procedural calls and other standard browser-based client software.

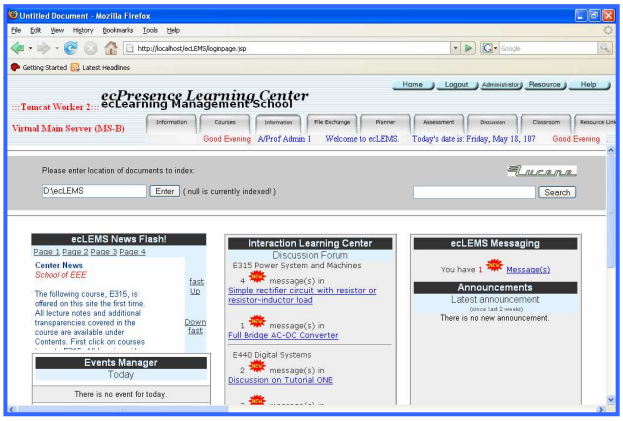

Figure 3. ecLEMS information page

The grid, with its connection of satellite servers and client access, is shown in Figure 2. Figure 3 shows one of the pages of ecLEMS running within the grid. The search engine and the server re-direction are displayed showing the operation of some of the middleware features.

The e-learning grid architecture is made of four layers as shown in Figure 4. The top layer is the content repository layer and is served by the ecLEMS e-learning management system. ecLEMS has many of the features necessary to create a learning community.

4.1 Infrastructure Layer

The is the bottom layer of the grid which is made up of all the basic network support environment devices

and systems such as computing devices (servers and clients) and network protocols (TCP/IP). The use of the TCP/IP simplifies devices that can join the grid to allow expansion and unlimited growth of the grid network.

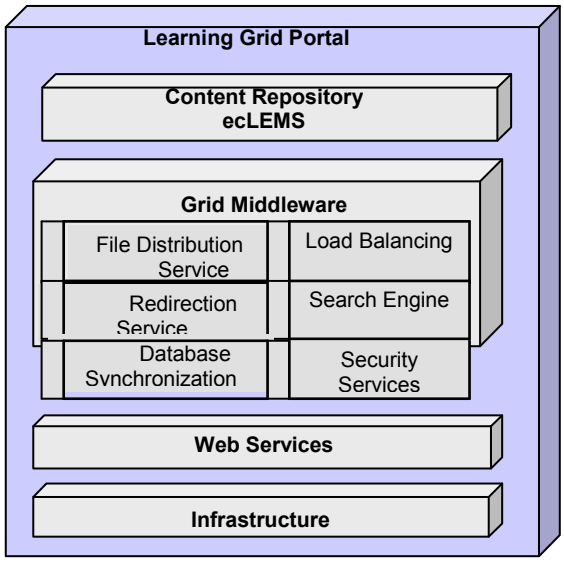

Figure 4. EGRID Architecture

4.2 Web Services Layer

The web services layer is for implementing the basic web services related protocols such as XML, UDDI/SOAP/WSDL etc. This layer provides the elementary connectivity, interoperation, reliability and flexibility for the layers on top of it. SOAP was chosen in this project mainly due to its use of XML syntax, providing advantages in terms of internationalized information (via Unicode), existing and upcoming tool support (both open source and proprietary).

4.3 Middleware Layer

This layer is a crucial layer to build the grid environment. The main functions implemented in EGRID are:

- File Distribution
- Redirection
- Database Synchronization
- Load Balancing
- Searching Engine
- Security Services

The middleware provides the dynamic load balancing service, redirection service, file distribution service, database synchronization and security services.

Dynamic load balancing (DLL) is implemented through the Apache-Tomcat active service page application server. DLL provides redundancies in the network to ensure a hundred percent availability. It also provides the persistency and server monitoring service. The re-direction service helps to reduce the main servers load by re-directing services to the nearest active server in the grid or the school server of the user. This increases the EGRID performance by distributing the bandwidth across the active nodes in the grid.

EGRID takes advantage of the node servers in the grid to increase its performance by distributing the learning content files across well defined node servers. This allows the system to render the information to the user through the nearest node. This is possible because all users are registered with the system through the center, school, course and class chain. Files uploaded by the administrator are distributed to all satellite servers while files uploaded by instructors are distributed to the respective cluster servers. As a result the load of the main servers will be reduced and the utilization rates of the other machines are increased

Besides the ecLEMS search facilities, the file content search engine enables users to search for information in the grid network.

4.4 Content Repository – ecLEMS

This layer sits on top of the grid middleware layer and it stores all the contents. This normally resides in an e-learning system or a Learning Management System (LMS) and can be used to store and manage its content. Although LMS built on e-learning standards conforming to the Advanced Distributed Learning Initiative (ADL) such as the Sharable Content Object Reference Model (SCORM) [4] are preferred, EGRID uses features of the ecLEMS learning management system to create the online learning community.

5. Conclusion

Setting up an e-learning system can be easily achieved by either subscribing to a paid system or using one of the open source platforms. Having the platform does not guarantee success in achieving online learning as an alternative, or complement the traditional classroom. Administrators often underestimate the skills needed to maintain the platform as well as the resources needed to feed the system with contents and information to sustain student interest.

In this paper, we have presented a learning community network, EGRID showing the grid

architecture. It not only resolves these problems but creates a global network for the e-learning community to interact and to participate in the educational process. We believe that such a learning community is the answer to the many challenges faced by today's e-learning administrators and implementers. Research efforts to improve the features in the middleware of the grid will be continued. This will also include the use of e-learning standards for content sharing and a more comprehensive search engine to retrieve information and contents that are expected to increase in the growing network.

References:

[1] Teo C.B., Gay K.L., (2006), "Provision of Self-Directed Learning Using Concept Mapping". *WSEAS Transactions on Advances in Engineering Education*, Vol. 3, Issue 6, ISSN 1790-1979, pp. 491 – 498, June 2006.

[2] Teo C.B., Gay K.L., (2006), "Knowledge-Driven Model to Personalize E-learning" *ACM Journal on Educational Resources in Computing (JERIC)*, Volume 6, Issue 1 (March 2006), ISSN:1531-4278.

[3] ecLEMS, a elearning management system; http://www.ecpresence.com

[4] DigitalThink, SCORM: The E-Learning Standard URL: http://c-beta.digitalthink.com/dtfs/downloads/products_services/_wp_stand ards.pdf

[5] Grid Computing URL: http://www.ibmpressbooks.com/content/images/0131456601/samplechapter/0131456601_ch01.pdf

[6] IEEE Xplore, Service-oriented grid architecture and middleware technologies for collaborative e-learning URL: http://ieeexplore.ieee.org/Xplore/login.jsp?url=/iel5/10249/32587/01 524425.pdf?arnumber=1524425

[7] Domenico Laforenza ,The Grid: The Computing Infrastructure URL: http://www.w3c.rl.ac.uk/Euroweb/invited_talks.html

[8] J.Joseph, Evolution of grid computing architecture and grid adoption models URL: http://researchweb.watson.ibm.com/journal/sj/434/joseph.html

[9] F.H. Choo, H.C Chua, S H Heng, "Engineering an e-Learning Platform," ICEE2001 Conference, 29th-30th October 2001, Malaysia.

[10] F.H. Choo, R. K. L. Gay, C. B. Teo, "Instructor-student centric Elearning Management Sytem," digital Learning Asia 2006, Thailand, 26-28 April 2006, Bangkok, Thailand.

[11] F.H. Choo, R.K.L. Gay, "Managing e-Content: Instructor-Student Centric e-Learning Management System," digital Learning, Vol. II, Issue 7 July 2006, pp 18-20.