An Experience on a Distance Education Course over the Access Grid Nodes

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ABSTRACT

Jackson State University (JSU) is one of the PET (User Productivity Enhancement and Technology Transfer) team members and has been involved in the program as a service provider as well as a service beneficiary. In the fall of 2003, the Department of Computer Science at JSU participated in the Advanced Distance Education Courses project, which was supported by the PET program. The project goals were to deliver a series of seminars and courses on the subject of Grid Technologies from Indiana University (IU) to JSU, the US Army Engineer Research and Development Center (ERDC), and other DoD sites using distance education tools, and to test the collaborative education tools at various sites, including Access Grid Nodes at IU, JSU, and ERDC and the Web browser-based shared display technologies. This paper describes the collaborative education tools, format and contents of the course, feedback from the students, and findings from the experience. The collaborative education tools were tested throughout the spring 2004 semester, and the results show that the tools were successfully adapted to the Access Grid Nodes. The student feedback also show that the course was very informative and was a good opportunity for them to learn state-of-the-art Grid technologies.

Keywords: Distance Education Course, Access Grid Nodes, Collaborative Education Tools, Gird Applications and Technologies

1. INTRODUCTION

The Department of Defense (DoD) High Performance Computing Modernization Program (HPCMP), initiated in 1992, provides supercomputer services, high-speed network communications, and computational science expertise that enables the Defense laboratories and test centers to conduct a wide range of focused research, development, and test activities [10]. To accomplish its goals, the program is organized into three components: HPCMP HPC (High Performance Computing) centers, Networking, and Software Applications Support. The PET (User Productivity Enhancement and Technology Transfer) program is a subcomponent of the Software Application Support program, and its goal is to enable the DoD HPC user community to make the best use of the computing capacity and to extend the range of DoD technical problems solved on HPC systems.

Jackson State University (JSU), located in Jackson, MS is one of the PET team members (as a subcontractor to Mississippi State University), and has been involved in the program as a service provider as well as a service beneficiary. In the fall of 2003, the Department of Computer Science at JSU participated in the Advanced Distance Education Courses project, which was supported by the PET program. The project goals were as follows:

- To deliver a series of seminars and courses on the subject of e-Science, e-Business, e-Government and their Technologies from Indiana University (IU) to JSU, the US Army Engineer Research and Development Center (ERDC), located in Vicksburg, MS, and other DoD sites using state-of-the-art distance education tools; and
- To test the collaborative education tools at various sites, including Access Grid Nodes at IU, JSU, and ERDC, and the Web browser-based shared display technologies.

To accomplish these goals, the project offered two seminars via the Access Grid Nodes at IU, JSU, and ERDC during the fall to study the feasibility of providing a course over the communication lines, and to examine the facilities and distance education tools at each site. For the following spring semester, the project provided a graduate course titled "e-Science, e-Business, e-Government and their Technologies" to the JSU Computer Science Department. The IU research team taught the course, and JSU graduate students and researchers at ERDC were recipients of the course. This paper describes the distance education tools and environments, format and contents of the course, and student feedback and findings. The next section explains the collaborative education tools, and Section 3 presents the course environment and topics. Section 4 presents student feedback and findings from the course, and Section 5 gives a conclusion.

2. COLLABORATIVE EDUCATION TOOLS

This was one of several courses taught roughly once per year from 1997 – 2005 using a variety of technologies [3, 4, 5, 9]. The first classes used Internet audio with no video and the curricula materials were shared using a shared web browser that used JavaScript to trap the teacher's URL and transmit it to the Jackson State classroom. The initial classes were successful even though the connection bandwidth was only 100 kilobits/second. The 2004 class supported the same pedagogical model but exploited newer technology and higher performance network connections.

The basic model is the natural distance extension of a conventional classroom. The teacher is at a distant location and the audio/video and curricula are shared with students in one or more classrooms. There is greater rapport between teacher and students due to the video; with just audio, the teacher is always a little worried as there is no visible sign that the class is there! Typically each classroom represents one audio-video site and similarly the curriculum is displayed on a single large classroom display. Actually the shared curricula is not limited to one per site but could be accessed by individual students on their computer if preferred. In fact the latter choice was made in the original 1997 – 2000 classes. The system allows the teacher to deliver classes by speaking while navigating through the curriculum. The students can ask questions as in a conventional class through the audio link. The system is augmented by other standard tools including the ability to annotate (highlighting) the curriculum page, white boards and text chat. However these additional facilities were not extensively used.

In particular whereas the 1997 – 2000 classes saw most student-teacher interaction via the text chat, the audio system was preferred in the 2004 class. This probably just reflects the more powerful technology used with the Access Grid in 2004 supporting echo cancellation allowing students to talk conveniently through a single audio system. Another technology difference between this and the early classes was the use of shared display rather than either shared URL (1997 choice) or shared PowerPoint (Access Grid default) for the collaborative curriculum.

Shared display has the important advantage that it can share dynamically any material on the teacher's desktop and so can be used for both PowerPoint, Web pages and the Desktop GUI's or command windows of any tools. The latter are clearly needed in teaching of practical software. The disadvantage of shared display is the needed high network bandwidth needed to share the megapixels of a new curriculum window. This contrasts with the few bytes needed to share a URL or slide number used in the other approaches. However the modern internet has high bandwidth and shared display, and it is probably the best choice for this type of distance education. There are many choices for shared display and Figure 1 shows a montage from four systems we evaluated earlier for the PET Program [7]. It is remarkable that current systems are very similar in capabilities and interfaces. We used the approach from Anabas – a small business for which Fox is Chief Technology officer – for which we had a free license.

It is interesting that the dominant problem in collaborative environments remains unchanged from 1997 to today – namely it is that network glitches cause problems with synchronous collaboration. The shared display system works with a powerful messaging system NaradaBrokering [11] which provides efficient software multicast. However the Anabas application does not yet take advantage of error recovery capabilities of this software. The Access Grid uses hardware multicast as its basic collaborative mechanism but this probably makes reliability worse not better; further the software multicast is not only more fault tolerant but also has excellent performance with a single Linux server handling several hundred collaborative clients [12]. Synchronous collaboration will certainly improve as we see with the audio from Ebay's Skype system. Further we expect that community tools [6] such as Blogs, Wikis, shared annotation systems like del.icio.us [2] will become valuable. We were unsuccessful in using wiki's in the 2005 class [9] but believe there is now better Wiki technology.

3. COURSE ENVIRONMENT AND TOPICS

3.1 JSU Access Grid Node

The course was scheduled as a regular graduate course at JSU, and delivered to the JSU Access Grid Node located in JSU's E-center. The Access Grid was initiated by Argonne National Laboratories as an open global project to develop a large-scale collaborative environment.

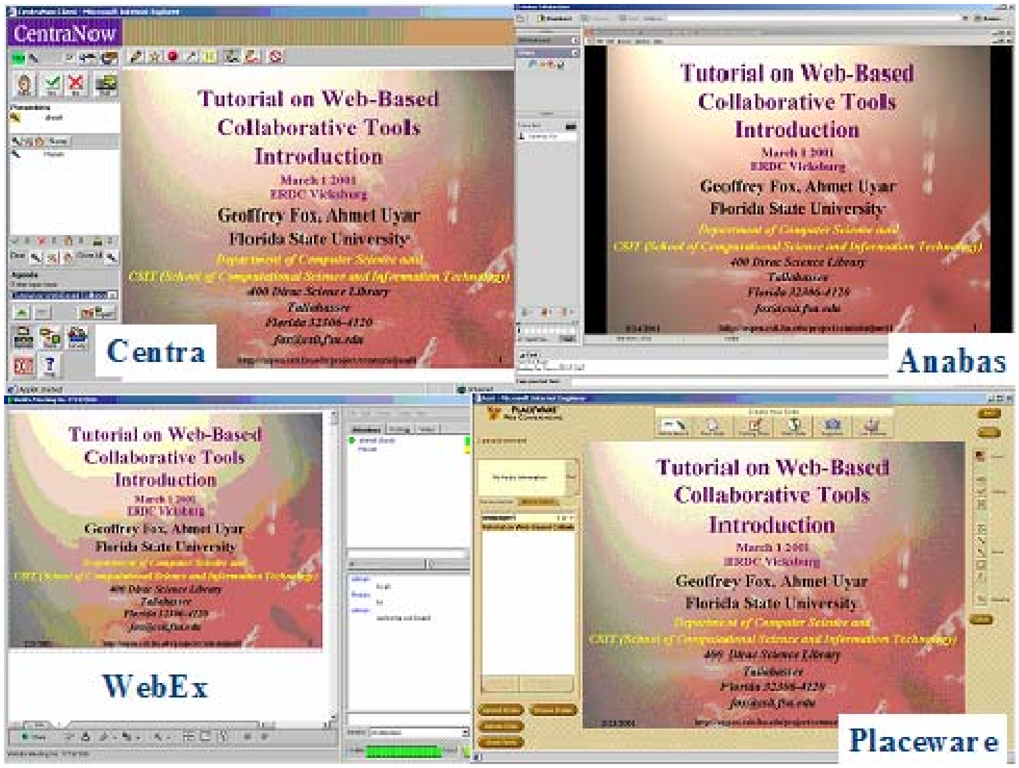

Figure 1 Evaluated Shared Display Systems

An Access Grid Node consists of multimedia large-scale displays, presentation and interactive tools, and interfaces to Grid middleware and to visualization environments. These Grid Node resources support group-to-group interactions across the Grid.

JSU introduced the Access Grid Node in 2001 with support from the PET program. The Node operates on the Internet 2 network that is connected to the Abilene Backbone Network, thus allowing multicast connectivity with other Access Grid Nodes. The Node is equipped with four computers, three projectors, three cameras, four microphones, two speakers, and an echo cancellation system. Detailed specifications of the equipments are as follows:

- Computing equipment
  - Four Dell Precision 420 computers
  - Two Dell Trinitron UltraScan P991 CRT monitors
  - Two DELL QuietKey keyboards
  - Two Microsoft Intellimouse PS/2 mice
  - Belkin OmniView Matrix 2x8 KVM switch
- Media equipment
  - Three EVI-D30 Sony color video cameras
  - AKG UHF wireless system: three handheld microphones, one pocket transmitter with lapel microphone, and four stationary receivers
  - Genelec 1029A bi-amplified monitoring system
  - Gentner AP800/AP10 audio conferencing system
  - MM100 level and impedance match maker
  - Furman PL-8 power conditioner and light
  - Two Genelec 1029A bi-amplified speakers
- Projection equipment
  - Two Infocus LP350 projectors
  - One Infocus LP530 projector
  - Wall screen display
- Applications used for the course
  - Access Grid Node Toolkit v2.4
  - Anabas
  - Virtual Rooms Videoconferencing System
  - ParaView 2.4.1

Figure 2 shows the Node, and Figure 3 shows an image from the actual class.

Figure 2 JSU Access Grid Node

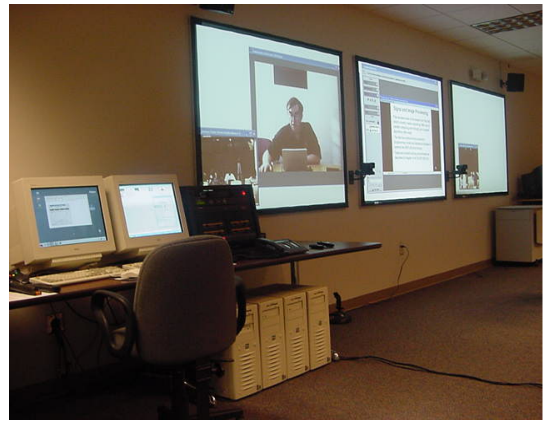

Figure 3 Course Materials on the Screens

3.2 Course Format and Topics

During the spring 2004 semester, the course was offered to graduate students majoring in Computer Science at JSU and researchers at ERDC. The IU research team delivered the lectures twice a week and covered topics on Grid Applications and Technologies. The course topics included:

- Concepts, architectures, and applications of the Grid
- Advanced Java
- Web applications with Java
- Core XML and XML schema
- Web Service Definition Language (WSDL)
- Simple Object Access Protocol (SOAP)
- Message structures and data encoding
- Semantic Web
- Installing Tomcat and Apache Axis

During the lectures, distributed slides via Anabas were utilized to present the lecture content and to show executions of the sample programs, which also helped the students understand the course materials. Each student was given programming and homework assignments throughout the semester and a final project, which requested students to design and develop a web service application that uses the web service toolkits provided by either Amazon or Google.

The grade was based on seven assignments (70%), which consist of a literature survey, writing reports, installing software, and implementing services, and a final project (30%). All students achieved at least a B grade for their final evaluation from the course. More details on the assignments are as follows:

- Write a short report on a Grid application.
- Concurrent programming
  - Modify the implementation of the `SimpleQueue` class, given in the lectures. Replace the `rem()` method with a `get()` method that blocks (waits) if the queue is currently empty.
  - Write a Java program with two threads and one channel. A "producer" thread sends a series of messages to a "consumer" thread through the channel. The consumer thread should print the messages it receives.
  - Write another Java program with two threads and two channels: a "client" thread sends a series of messages to a "server" thread using the first channel. All threads should run in the same virtual machine.
- Servlet programming
  - Download and install the Tomcat Web server on a computer.
  - Write and deploy a simple Web application consisting of an HTML page with a form, and a Java Servlet that processes data input through the form.
- Basic XML
  - Invent an XML format to describe the educational resume of an individual.
  - For a fictional individual write a document of around 50 lines in the invented format.
  - Install Java Xerces on a computer, and check the XML syntax of the document using the dom.Writer application.
  - Write an internal or external DTD for the document, and validate it against the DTD using dom.Writer.
- XML and Java
  - Write a Java program that uses Xerces to read and validate an XML document, and to construct a DOM for the document.

- Web services with Java
  - Install and test Tomcat and Apache Axis on a new Web server on a computer.
  - Convert a simple Java program into a Web service using Apache's JWS capability.
  - Using Apache Axis client tools, generate and compile client stubs for the service. Write a simple JSP client program that uses the stubs to invoke the remote service.
- SOAP messages
  - Provide an example of a SOAP message for the service developed in the previous assignment.

4. STUDENT FEEDBACK AND FINDINGS

According to the course evaluation conducted at the end of the semester, the students' experiences with this particular course were very positive. Table 1 shows the results of the evaluation. The scales are averaged: scale 5 indicates "strongly agree", and 1 indicates "strongly disagree".

Comments from the students show that the course was very informative, and the skills and knowledge from the course would be very useful in their future studies and careers. Despite the geographical distance between the IU and JSU, the results show that the collaborative education tools and Access Grid Nodes did not make the distance a problem.

Specifically, one of the interesting findings from the student feedback was that the learning environment expedited the students' understanding on the course topics: the Access Grid Node and the applications on the node are parts of the Grid Network, and the students were beneficiaries of the technologies that they learned. In other words, they were able to see and feel how the technologies are applied and work in real world.

As indicated in the research in [8], a web-based distance education course may have three sources of students' frustrations with it: lack of prompt feedback, ambiguous instructions on the Web, and technical problems. In our case, thanks to the advanced technologies and tools, prompt feedback and direct interactions during the lectures were provided to the students.

Evaluation Items	Scales
The course objectives were clearly stated.	4.50
The objectives were achieved.	4.25
The course was structured in a logical way.	4.50
The course materials were informative, and I will be able to use them as a reference.	4.50
The concepts and techniques were explained clearly.	3.75
The course was interesting and enjoyable.	3.75
Prior to this course, my understanding of the e-Science and their technologies was excellent.	1.75
After completion of this course, my understanding of the e-Science and their technologies was excellent.	3.70
I feel I have gained new skills and knowledge.	4.50
The skills and knowledge that I learned from the course will be useful in my career.	4.50
The instructors were always reachable via email or phone.	4.75
The Anabas slides and program executions were helpful to understand the course topics.	4.00
The homework assignments were useful in understanding the course content.	4.00
My questions or problems were discussed to my satisfaction with the instructors.	3.75
It was easy to interact with the instructor during lecture.	3.75
The audio quality was satisfying.	3.75
The video quality was satisfying.	3.75
The synchronization of the audio and video was satisfying.	3.50
The interface of the Access Grid node presentation was good.	3.75
The Access Grid classroom was comfortable.	4.25
My experience with the distance learning course was positive.	4.25

Table 1 Course Evaluation Results

The distributed slides and the Access Grid Nodes were also successfully adapted to the course so that the students were able to understand the course topics and instructions without major problems. However, as in other distance learning environments, some technical problems were reported: the Grid Node was temporarily disconnected from the network; the synchronization of audio and video sometimes was not satisfying. It was mentioned in the feedback that improving audio, video, and synchronization of the audio and video would result in a more positive experience in the course.

Yet, compared to the benefits that the students received from the course, these problems were considered to be minor, and the course was evaluated as a successful adoption of the collaborative education tools over the Access Grid Nodes.

5. CONCLUSION

This paper describes an experience on a distance course over the Access Grid Nodes at JSU, IU, and ERDC for the spring 2004 semester. The graduate course was delivered from IU to JSU and ERDC as a PET project to test the collaborative education tools including Access Grid Nodes and the Web browser-based shared display tool. The course covered topics on Grid Applications and Technologies, and it utilized Grid applications for lecturing. As indicated in the student feedback, this combination of the content and the educational environment of the course created a synergy effect so as to accelerate the students' understanding on the course topics. The collaborative education tools were tested throughout the semester, and it was reported that the shared display tool was successfully adapted to the Access Grid Nodes. Minor technical problems, such as temporary disconnecting from the network, or synchronization problems between audio and video were identified from the experience as well. These technical problems are expected to be reduced with more advanced technologies in the future.

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