A Low-Cost Remote Lab for Internet Services Distance Education

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ABSTRACT

Academic departments seeking to reach students via distance education course offerings find that some on-line curricula require a traditional hands-on lab model for student evaluation and assessment. The authors solve the problem of providing distance education curriculum and supporting instruction lab components by using a low-cost remote lab. The remote lab is used to evaluate student performance in managing web services and website development, solving security problems, patch management, scripting and web server management. In addition, the authors discuss assessment and evaluation techniques that will be used to determine instructional quality and student performance. Discussed are the remote lab architecture, use of disk images and utilization of Windows 2003 Internet Information Service, and Linux Red Hat 9.0 platforms.

Keywords: Remote lab, assessment, evaluation, Internet services, distance education.

INTRODUCTION

Higher education is undergoing rapid and constant change. One area of tremendous evolution is distance education (Robinson, 2002). According to the Instructional Technology Council, distance education is "the process of extending learning, or delivering instructional resource-sharing opportunities, to locations away from a classroom, building or site, to another classroom, building or site by using video, audio, computer, multimedia communications, or some combination of these with other traditional delivery methods." As the rate of growth increases for distance education programs specific courses that require extensive use of laboratory facilities, traditionally delivered face-to-face, are being delivered via an Internet-based modality (Hamza, 2000).

Distance education and traditional face-to-face classroom course delivery are not mutually exclusive. Each has positive aspects that can be maximized and negative aspects that can be minimized by combining them, an approach known as blended learning (Hentea, 2003). Student learning is enhanced when technology is made available that allows for a live learning environment and remote labs are an ideal delivery method for distance education curriculum. This paper describes the deployment of a low-cost remote lab in support of Internet services education at Southern Illinois University.

The remote lab described in this article is part of an overall approach to deliver Internet service material via an asynchronous distance education tool. The lab represents a dynamic venue for student learning that was relatively cheap to design and implement and is fully capable of re-imaging itself in the event of a hardware or network outage.

Background

The School of Information Systems and Applied Technologies offers an on-line course entitled, Information Systems Technologies IST 405 – *Installation and Configuration of Internet Services.* The course provides technical information and practices in managing web services, including web server protocols, and typical website uses, considerations for evaluating a web server, and hardware and software on a variety of platforms. Students also gain core competencies such as configuration and security. The course includes a discussion of some organizational issues in managing Internet services, surveying a few of the popular web servers, and completing a final project.

Primary course content is provided via Web CT and instructor-supported web pages. The remote lab represents a web-based learning venue for enrichment of student skills and commitments. Specifically, the remote lab enhances the student's skills in website design, website maintenance, and web server configuration.

The remote lab is a complimentary on-line learning tool that will support true interaction between a host server and the student. Historically, on-line offerings provided content, summaries, exams, and quizzes using a static website and/or asynchronous distance learning application (i.e., Web CT, Blackboard). With the successful deployment of this on-line lab the student's learning experience is enhanced to further an Internet services administration and configuration education. The remote lab is deployed with three main goals in mind, 1)

low start-up cost (hardware and software), 2) ease of administration (reload server images from bootable CD), and 3) capable of supporting either Linux or Windows 2003 web server platforms.

LAB CONFIGURATION AND MANAGEMENT

Server Selection and Architecture

The remote lab web server nodes conflict with prevailing wisdom and are made up of PC desktop hardware. This is done for two reasons. The first is the low cost of replacement parts and the second is ease of administration. Each individual server node in the remote lab is an identical out-of-warranty PC workstation available via a campus-wide life-cycle replacement surplus equipment program. PC workstations not configured and running as server nodes are available for spare parts. Using Norton Ghost™, each remote lab web server node software image is identical to ensure consistent course curriculum and hands-on lab exercise delivery. Two web server node images are used, Windows 2003 (Web Version) Internet Information Services and Linux Red Hat™ 9.0 web server configuration.

Table 1 below displays the configuration options in the remote lab. The client machines are Dell Optiplex GX 110 with standard client configurations. The Windows 2003 Server™ software and registry keys were provided as a part of the Microsoft Developer Network Academic Alliance (MSDNAA) that the IST program purchased for $800.

DNS Subdomain

The DNS subdomain records are shown in Figure 1 below.

Figure 2 below displays the network structure of the remote lab web server nodes.

Table 1: Remote Lab Software, Hardware and Network Options with Cost

Web Server Node Selected Options	
Selected Option Software: • Microsoft Windows 2003 Server™ (Web Edition) Remote Desktop • Linux Red Hat™ 9.0 (configured as a server) • Norton Ghost™ • Client test machines	**Cost** ➢ $800* (Cost of MSDNAA) for Microsoft server software ➢ No cost (open source) ➢ Less than $20 for 10-24 licenses (academic pricing) ➢ No cost for out-of-warranty PCs
Selected Option Hardware: • Dell Pentium III Optiplex GX110, 733 MHz, 256 RAM, 40G HD, with on-board video.	➢ No cost out-of-warranty PCs
Selected Option Network Configuration: • Dedicated sub-domain managed by academic unit.	➢ No incurred labor cost
Total Cost (10-24 node remote lab) = $820	
*Actual cost may vary depending on size of campus and quote	

Figure 1: DNS Subdomain

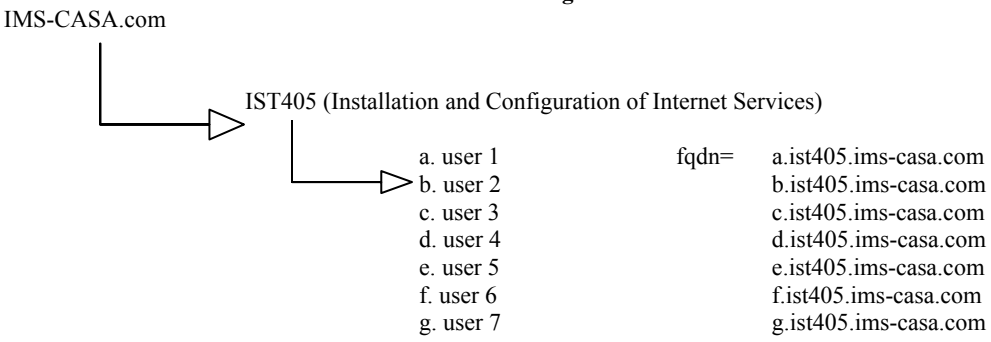
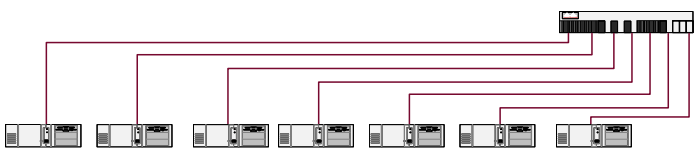


Figure 2: Remote Lab Logical Network Configuration



CURRICULUM

Students are expected to perform tasks remotely to the web server nodes as if they were sitting down next to the server in a face-to-face lab. Root access to the remote lab client enables web server administration and completion of security routines. Table 2 provides some example remote lab learning concepts. Each task and assignment is iterative and structured so initial tasks lay the foundation for future tasks and assignments that result in a secure web platform. From the web platform students can run services, security testing, and administrative services that provide a non-volatile network environment for learning.

Evaluation and Assessment

Evaluations and assessments will be used to affect the instructional quality and performance of the students. Assessment is defined as data-gathering strategies, analyses, and reporting processes that provide information that can be used to determine whether or not student learning outcomes intended are being achieved (Gagne, 1998). Evaluation will be conducted using assessment information to support decisions on maintaining, changing, or discarding instructional practices (Hanson, 1992). Faculty will make use of quantitative data collection methods that yield numerical data for analysis of program impact. Data collection will involve pretests and posttests on course material, student surveys, instructor observation of results, and an analysis of institutional data such as grades, enrollment trends, retention, course success rates, course completion rates and graduation rates. Table 3 contains a summary of proposed methods for disclosing patterns and relationships of evaluation and assessment data**.**

CONCLUSION

The inclusion of a remote lab into the distance education curriculum represents a first step in bringing into alignment the traditional face-to-face instruction and the on-line courses. Lab activities in the face-to-face classes are used to enrich the education experience for students on campus. A place-bound student enrolled in an on-line version of the campus-based lab intensive course will benefit from an equivalent live learning environment.

The authors plan an investigation that will compare student assessment and evaluation data for campus based lab intensive courses and the on-line counterpart that has an integrated remote lab component. The goal will be to compare remote lab on-line delivery methods to traditional campus delivery by using pre and posttests, surveys, instructor observation, and course evaluations.

Table 2: Example Remote Lab Learning Concepts

- Managing and setting up user accounts
- Different ways to add web content
- Preparing the server for publishing
- FTP (File Transfer Protocol)
- Testing and updating website content
- Understanding logs
- Backing up the web server
- Securing the web server

Table 3: Candidate Student Evaluation and Assessment Tools with Anticipated Results and Data Descriptions

Candidate Tool	Anticipated Result	Data Description
Pretest	Student knowledge and ability prior to coursework	Number of correct pretest responses
Posttest	Student knowledge and ability after completing coursework	Number of correct posttest responses
Student Survey	Opinion, feedback, scalar data on specific questions	Summary descriptive responses, quality of course delivery, remote lab performance information
Instructor Observation	Gain insight to the nature and extent of learning	Compare course objectives with observable student performance
Course Survey	Quality of instruction and course material	Summary of descriptive responses

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