

# A Software System for Secure Computer Aided Exams

Prof. Dr. E. Başar  
Computer Engineering Department  
Eastern Mediterranean University  
G.Magusa, Mersin 10 / TURKEY

B. Genç  
Computer Engineering Department  
Eastern Mediterranean University  
G.Magusa, Mersin 10 / TURKEY

*Abstract - In this paper, a program is designed and implemented for exams which are taken in computer laboratories. The aim of the software is to overcome difficulties of such exams. Program mainly solves two important problems, which are preventing file sharing between client computers and collecting answer files from client computers. Program consists of two main parts, server part and client part. The server part is used by the instructor and the client part is used by students. The instructor uses the server part for managing student, course, exam data, and it is used for controlling the clients and activating them during the exam. Activated client blocks the network communication of the computer but it permits file transfer between the client and the server. Client includes a firewall system for controlling network packets and during the exam, the firewall blocks network traffic. This system provides a secure computer lab exam environment since student computer cannot access to local network and Internet. Students use client part's user interface for uploading their files to server. After the exam instructor can easily access and evaluate the students' uploaded files.*

**Keywords: Online Exam, Software, Evaluation, Programming**

## 1.0 Introduction

Computer aided exams are used for many courses. Students take the exam in a computer laboratory environment and submit their results as computer files. These exams are very useful for programming courses hence the student could use the programming environment, debug his/her application, can use help, create a result executable, and instructor could see the student's level better. A work [1] on computer lab exams shows that, this type of exams improves student motivation and making multiple exams in computer lab environment slightly increases the success rates. Computer lab exams are mainly used for programming (VB, C, Delphi...) and design courses (AutoCAD, Photoshop...).

Since the exam is on a computer laboratory, all computers are connected to local network and may be connected to Internet. During the exam, students can share files or communicate (share their information) over the network or Internet. This can not be permitted. Solution of this problem (without a software system) is turning off the network communication device (switch or hub) for that computer laboratory. All computers will work stand alone since no network communication device exists.

Another problem is collecting the exam result files from student computers. Since no network is available, all files must be collected using removable media. Mainly floppy disks are used for this purpose, but capacity, durability and read write speed are main drawbacks of this media. Flash USB disks can be used but they are expensive. One removable disk is required for each computer. Removable disks distributed to computers at the beginning of an exam and collected with student files at the end of the exam.

Some questions may require sample files. For example sample database, text data files or a sample project files may be required for a question. These files should be copied to each computer or removable media before the exam for distributing these files to students. Preparing removable disks for the exam is a time consuming process.

Evaluating exam is a long process since instructor must deal with a lot of disks. Media reading errors, file reading time for floppy disks makes this process harder.

A software system is proposed and developed which overcomes the problems of computer secure computer lab exams using the advantage of local network. Basic aim of the software system is all network communications of the exam computers should be blocked but sample files could be downloaded and result files could be uploaded to a file server over the network.

Developed software consists of two parts. Server part is installed to instructor's computer and Client part is installed to students' computers. Through this report 'server computer' stands for instructor's computer which runs the server part of developed software and 'client computer' stands for students computer which runs the client part of software.

Server part keeps data of courses, students and exams. Server also communicates with client computers, starts and stops an exam and manages files uploaded by clients. Client part is responsible from blocking network traffic of the student's computer. Client also provides a user interface for uploading files to server.

Client works as a windows service and listens command from server. When server starts an exam, client starts blocking all network communications but allows file transfer between server and client. This system provides a secure computer lab exam environment since student computer cannot access to local network and Internet. Result files of an exam are also collected over the network. Each student uploads his/her files after entering his password. Uploaded files are kept in separate student directories. Student can only access his/her files during the exam.

Evaluation of the exam became easier for instructor. Each student's upload directory can be easily accessed using Server part of software.

## **2.0 Problem Definition**

Main aim is to develop a secure software system for computer laboratory exams. Existing exam programs are not suitable for secure programming exams in computer laboratory since these programs are developed for essay type exams. Manually controlling these exams has some difficulties such as collecting answer on removable disks.

Security and collecting exam answers are the main problems that must be solved in the developed software. The system must block the network communication of a student computer to avoid cheating electronically. Also it must allow upload to or download from an exam server for distribution of exam files and collection of student answer files.

### **2.1 Requirements**

Requirements for the initial version of the software are defined at the beginning of the project. Software is developed to meet the following requirements.

- Client computer's network access must be blocked except connection with the server.
- Blocking must be started and finished remotely with a command of server. Client listens network packets coming from server and responds received commands.
- Client computer must keep blocking network access when server or client computer restarts. System must be reliable, restarts because of simple hardware or software (OS) failures cannot affect blocking. Student can restart his/her computer several times during the exam, a restarted computer should understand that there is an exam going on and start blocking.
- Client must have an interface for uploading student's result files and downloading required exam files.

- Student must log on to client software with his/her ID and password before downloading or uploading files. Exam passwords are distributed to students just after the exam starts. Passwords are not known by students before the exam and this prevents a student from identifying himself to the system as another student during the exam.
- Each student can only access his/her private upload area, and upload files only this area. Uploaded files are managed by server and placed in a separate folder for each student.
- Server must have a database and keep track of computer laboratory IP numbers, courses, students of courses and exam folders information.
- Exam passwords must be generated for each student and must be kept in database.
- Student data can be imported from an excel file.
- Server must provide a system for evaluation of the exam. Instructor could easily reach a student's upload folder, view student's picture and enter the marks of student for each question.

### 3.0 Design and Architecture

System consists of two main parts, the Server part and the Client part. Client has three main parts Service, Firewall and User Interface (Figure 1).

Client Service is a windows service, installed to the client computers and runs automatically when the computer starts. This service communicates with the server, starts and stops the Firewall.

The Firewall is an executable. When it is started, it blocks all the communications of computer and only allows communication with server from predefined ports. Firewall communicates with server so server can understand that firewall is running.

Client User interface is a customized FTP client, directly connects to exam server with provided student id and password. It allows downloading of exam files and uploading of exam answer files.

Server is an interface for data entry for the database. It also communicates with Client Service and Firewall. Built in FTP Server allows client to upload and download files.

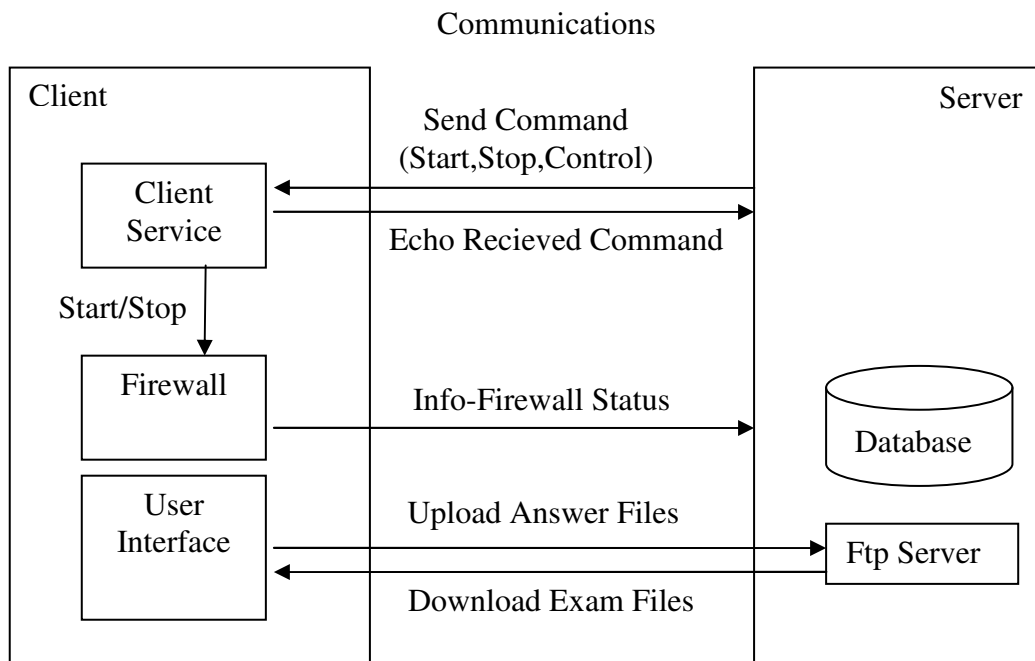


Figure 1. Communications between the Client and Server parts.

## 3.1 Server

Server's architecture is explained in three main parts. Database part explains the database system used with server software. Exam Control part explains the communication issues between client and server, and explains how server controls the client computers. FTP server part explains the built in ftp server which is used for collecting files from clients.

### 3.1.1 Database

Server is a database application; all forms in the applications read and written to database file. Courses, students, exams, exam room IP numbers and evaluation results of exams are kept in the database.

Exam information is created using course and student data before the exam. Students' upload folder and exam files folder are entered for an exam. System creates separate upload folders for each student.

### 3.1.2 Exam Control

Exam control form is used for starting, inspecting and finishing an exam. Summary of Exam Control algorithm as follows:

- Course, Exam and Exam room must be selected. After that, three buttons, 'List Client Computers', 'Start Exam' and 'Finish Exam' can be selected.
- When 'List Client Computers' is selected
  - List IP numbers of exam room from database
  - Send UDP broadcast message 'Control' on port 5888. Continuously send the message in every 3 seconds.
  - Listen port 5889 for incoming packets. Clients will echo the same message from port 5889.
  - Check incoming messages and mark IP numbers that echo the message as available. Available clients are shown with 'ok' sign on the screen.
- When 'Start Exam' is selected
  - List IP numbers of exam room from database.
  - Start FTP server.
  - Send UDP message 'Start' to listed IP numbers continuously.
  - Listen port 5889 for incoming packets which are echo of the messages
  - Check incoming packets and mark replied clients as available.
  - Listen port 5892 and 3022 for incoming packets from firewall.
  - If a packet received from port 5892, display the current time for the sender as the last response time. Client firewall sends these packets in every 30 seconds.
  - If any packet received from port 3022, then firewall is not functioning properly. A warning message displayed for the packet sender client.
- When 'Finish Exam' is selected.
  - Send UDP message 'Stop' to listed IP numbers.

System uses UDP packets for communications. TCP packets are more reliable than UDP packets because they are connection oriented, but UDP has a broadcasting feature for reaching many computers at once and UDP is faster than TCP since it does not have connection overhead. Rather than trying to connect each client one by one sending UDP packet and waiting for a response, is better for dealing with many computers. Since UDP broadcast repeat with a small amount of time, disconnected or unavailable clients can be detected easily.

### 3.1.3 FTP Server

Exam Control also starts a built in ftp server with exam and closes it while finishing the exam. FTP Server allows client computer upload files to server and download exam files from server. FTP server runs on port 5890 and for data transfer uses port 5891.

Ftp Server accepts anonymous login and returns the directory content of exam files. These common files are viewed by all clients. Anonymous users can browse the directory and download files but cannot change the directory content. This means anonymous users can not upload, delete or rename files and folders.

Ftp server also accepts logins with student ID and password. Server checks username and password from the database and accepts login. If login is accepted student can browse his own upload directory which is located on server. Upload directory is the folder with name 'StudentID' located in the student files folder. User can only see the inside of his/her folder and upload files to this area. Student also can manage files (delete, rename ...) in this folder.

## **3.2 Client**

Client software consists of three separate programs: client service, firewall and user interface. Client service is the main process, which runs all the time and listens for packets from a server. Firewall controls the network traffic and is activated by client service. User interface is used by student for uploading and downloading files.

### **3.2.1 Client Service**

Client service automatically starts at start up and begins listening packets from port 5888. When it receives a packet it echoes the packet on port 5889, and then checks the content of message. If message content (data part) is 'start' then it sets 'Count' value in the registry to 120, sets the 'ServerIP' registry value to peer IP of received packet. Then if not firewall is running, starts the firewall using the path stored in the registry. During the exam Service receives same message several time and does the same things again. While server is sending packets to client, count value is always 120.

Client service also checks the registry on start up. If count is greater than zero then it executes the firewall. If count is bigger than zero on start up this means that an exam was going on before the computer is shut down. So firewall is activated and computer continues on exam mode without affecting any reboot process.

When Client service receives a 'stop' message it sets count value to zero and clears the 'ServerIP' value.

### **3.2.2 Client Firewall**

When firewall is executed, it reads the 'ServerIP' value from registry. Then it sets required filters for packets and activates the firewall engine. While firewall is active, computer cannot access any network resource, and computer also inaccessible for other network computers. Only communication with server on ports 5888-5892 is allowed.

After firewall started it send packets to server from ports 5892 and 3022. Firewall sends these packets for every 30 seconds. Packet send through port 5892 is for informing server that firewall is running on client and the other one is testing the functionality of firewall since packet cannot reach to server if firewall is functional.

Every minute, firewall reads count value from register and decreases it by one if it's greater than zero. If count value is zero firewall closes itself and stops blocking packets. This used when finishing the exam. Client Service is set count to zero while finishing the exam.

Firewall decreases the count value every minute. If server is exists then service will restore the count value back to 120. So firewalls this behaviour does not affect anything if exam server is alive. If no packets received from server, which means server is failed. Firewall decrease count value and when count value reached to zero it stops blocking and exit. This mechanism prevents firewall from blocking forever and gives two hours time to instructor collect files manually if a problem occurs on server.

### **3.2.3 Client User Interface**

Client reads the Server IP from the registry. If there is no server IP program exits with an error.

Client User interface is a customized ftp client. Two ftp client screens are available and the first one is connect to server anonymously. This part shows the exam files folder and student can download files.

Second ftp client is connected with Student ID and password entered on the login page of client application. This second part shows the students upload folder and student can upload the result files for the questions. The ftp client can download or upload directory contents recursively.

### **3.3 Error Handling**

Client computers or even server computer can be rebooted during the exam. This situation can be faced almost in every exam; most of the client computers may be rebooted because of a crash or may be completely rebooted because of an electricity problem.

If a client computer is rebooted, client service checks registry for exam info and if count is greater than zero it starts the firewall. So client computer does not affected from reboot.

If a new computer in the exam room is start-ups during the exam, client service will receive a UDP packet, which contains start info, in a few seconds, and client computers enters exam mode.

## **4.0 Conclusion**

A software solution is developed for computer aided exams. Requirements that are defined at the beginning of the project are fulfilled. A completely usable software system is developed. Computer laboratory exams can be made easily using this software.

With this program, the Instructor gains time, since preparing exam and evaluation of the exam becomes easier. Instructor is not dealing with several removable disks; he/she can reach student's exam files just by clicking the student's name. Also, distributing a file of an exam to students is a time consuming problem, because files must be copied to each student's removable disk. Student now can access exam files through the client user interface and the Instructor can save time.

This software system is inexpensive because no removable disks required. In most of the exams, flash disks or floppy disks are used. Using this exam software there is no need to such media since the files are uploaded using the network.

Several companies provide exam software (e.g. ExamSoft, Extegrity, SecureExam) [2,3,4,5]. The main idea of these software is to use computers in exams instead of paper. Students write the exam answer to a customized editor and submit the result file. For a secure exam, the software locks the computer and students can only use the editor of exam software. Software locks the computer during the exam and students cannot access to local network or Internet. Students cannot reach to local files and cannot run any other program. At the end of exam, software encrypts the result file, so students cannot alter it after the exam. In our case, the student can use local programs and can manage local files. Instead of locking the computer, our software blocks the student computer's network communication for security. For programming exams, operating system features cannot be disabled because students must use development software and also students must manage files while preparing his/her answers. Blocking network communications of the client computers allow students to use all features of their computers for the exam and prevent electronically exchange of any information

Developed software can be used for any computer based exam, where the result work is expected as a computer file. Programming, design, office program courses are mostly using exams on computers and results are collected as files. This software is used for Visual Programming course exams in Computer Engineering Department of Eastern Mediterranean University in 2005-06 academic year.

## 5.0 References

- [1] J. P. Barros, L. Estevens, R. Dias, R. Pais, and E. Soeiro, "Using Lab Exams to Ensure Programming Practice in an Introductory Programming Course", Innovation and Technology in Computer Science Education (ITiCSE 03), Thessaloniki, Greece, June 30 – July 2, 2003
- [2] Secureexam web page, <http://www.softwaresecure.com/>
- [3] Examsoft web page, <http://www.examsoft.com/>
- [4] Extegrity Exam4 web page, <http://www.extegrity.com/>
- [5] "Security Software Enables Some Universities to Administer Exams With Laptops", <http://chronicle.com/free/v47/i21/21a03002.htm>, February 2, 2001