Development of Distributive Architecture for Post-Unified Tertiary Matriculation Examination (UTME) Assessment

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ABSTRACT
Since the inception of Post-Unified Tertiary Matriculation Examination (Post-UTME) in the educational system of Nigeria, all efforts have been harnessed to better the system so that only qualified candidates emerge at the end of the exercise. But every year there have been complaints from students, parents, institutions and government on how badly the exercise was carried out. Sometimes the country is filled with bad news of ugly incidences that happened to their young children as they are exposed to the hazards of traveling down to their chosen institutions to take part in the exercise. However, after the exercise, some students are under-evaluated or over-evaluated while some are denied of their test grades. Though some institutions of higher learning in the country have converted from pencil and paper based examination to computer based, it has not been able to solve the problem as these students still have to travel far to take part in this exercise. The main idea of this study is to develop a distributive system that enables institutions of higher learning in Nigeria to conduct online examination for their candidates irrespective of their location, with stored questions in the examination bank. The system will then assemble the questions to become an examination paper. Candidates can then access the system and take part in the exam from various dispersed locations. Upon completion of the examination, the system will be able to grade and record students’ test scores. This will go a long way to drastically reduce the risk, stress, and fraud frequently experienced in the existing methods of conducting these examinations.

Keywords: Extranet, Intranet, Biometrics, e-exam, distributed firewalls.

1. INTRODUCTION
The World Wide Web is used by millions of people everyday for various purposes including email, reading news, downloading music, online shopping and learning or simply accessing information about anything. Its use in educational system has seen exponential growth for the past decades. It is used in both training (web-based) and assessment (e-exam) of people. Web-based training is a training that is delivered via a browser over the public Internet, an intranet or an extranet. It is often used interchangeably with online learning or online training [1]. Nowadays, Internet-based examination has greatly grown in number as well as quality. We have experienced many kinds of merits of IT-based education and examination. It has helped in enabling students/candidates to get eager to study the subject, to easily share the world-wide instructive resources that have been created by other educational staff in the world, among students from all over the world, to conduct distance learning and online examination anywhere in the world, etc. Online examinations are a cost-effective and popular means of assessing student knowledge. Bicanich et al [2] noted that from a study of 400 vocational learners, 75% preferred online testing to paper-based assessment. Though, it is not so easy to make a fair online evaluation of how well the students have understood the contents. There are several obstacles to realizing fair assessment of candidates such as under-grading, over-grading and impersonation. The proposed Computer-Based Exam presented in the following sections is an example of a solution to these issues. We have developed an online examination system based on a Server framework, which administers the examination, performs auto-grading for objective questions and processes admission of students. This system will run as a fully distributed system to help candidates take exams in centres of their choice.

Few Universities in Nigeria have chosen to convert their post-UTME examinations from paper-and-pencil test platforms to e-based test programs. In paper and pencil test, question booklets and Optical Mark Reader (OMR) based answer sheets are provided to the students for shading of the correct option out of the four choices A, B, C and D. After that the OMR sheets are collated and sent for marking/scanning. In this scenario, distribution, collection and marking large volume of sheets as well as uploading the results take an appreciable amount of time. Sometimes some candidates are under-evaluated due to human error either through improper/inadequate shading or grading. An e-examination is quick and easy with wide range of features. With e-exam, there is no need of the above mentioned processes. It saves time in managing tests and getting result correctly. Therefore, there is need for all universities in Nigeria to adopt the e-based platform for the Post-Unified Tertiary Matriculation Examination (Post-UTME).

The objectives of this paper therefore are to develop a system that serves as question bank for the storage and creation of post-UTME questions and answers dynamically; a system that has distributive features to enable institutions of higher...
learning conduct examination for the incoming students irrespective of their centers of choice, and a secured examination system with improved security features.

2. REVIEW OF RELATED WORKS
A literature review carried out revealed that research and studies based on implementation of variety technologies in college courses have conducted. “The internet has opened many possibilities for the classroom instruction but it can also be a barrier to teaching as well” [3]. The recent innovative technologies provide opportunities to improve learning and create a more exciting and motivating environment [4]. Ralph, Buskirk, and Schmidt [5] discussed a case study regarding the use of online projects, students in favor of online projects indicated that the accessibility to the professor for fast and easy feedback was a great asset. Furthermore, the study revealed that when implementing technology students were concerned with the expense of the technology, the necessity for internet access, and the reliability of the technology. Research on student perceptions and satisfaction with online courses provide insights to student reactions and satisfaction with implementation of an online exam. Hale [14] found that student satisfaction surveys reveal that the most important reason for taking a distance education course is its convenience. In addition, Steinman [6] indicated that “students’ perceptions of online courses can be negative if they experience large transactional distance with the instructor and with other students and can influence whether a student will stay in or drop out of a class”. A similar study, [6] also found that “many students choose to enroll in online courses and the demand for online courses is high. Taking an online course can provide educational experiences that would otherwise be unavailable, especially for students who live in rural areas and do not have convenient access to schools.” Rowh [7] also found that “online courses offer convenient learning and that students who take online classes are working hard. They're just doing it at their own pace, on a schedule and in a setting that works for them”. Walker [8] indicates that the “widespread availability of computers and the Internet provide considerable enrichment in terms of variety of material and formats for presentation over what was possible with the old correspondence courses”. Meanwhile, [3] reported that a university stated that they “use electronic education to add on to their curriculum, not as the main basis.” This lends to the implementation of an online exam into a traditional classroom where students still get the face-to-face interaction with the instructor and classmates but the control of time and location to take their exams. Patterson [9] conducted a post-examination survey of students completing an online exam. The study “found a large majority of students were able to easily access the online exam, found the testing tool easy to use, and were able to complete the comprehensive exam with little difficulty. The future use of online assessment for the comprehensive exam was supported by 87% of respondents”. Furthermore, Patterson found that the “Web-based comprehensive exam procedures employed made it possible for students to take the exam at the time and place of their choice”. The exam was able to reduce stress for students by giving them the ability to choose time and location of taking the exam. Patterson also acknowledged that the “challenges to test items security and the creation of procedures to minimize the possibility of collaboration and cheating on this type of "high-stakes" examination remains to be fully met.

3. PROPOSED NEW SOLUTION
Considering the need for exam takers to sit for their examination at a location convenient to them, we have proposed a distributive system that would enable institutions of higher learning in Nigeria conduct e-exam for their incoming students at different locations. We also considered the main problems of distributed system which is security. The security features of the system are described in section VI.

4. SYSTEM ARCHITECTURE
In this research, the system that we established basically has four main functional modules: administrator, staff, student, and examination modules. Each of these modules is described below.

A. Administrator Module
This module enables the system administrators to configure and maintain various variables in the system such as Faculty Maintenance, Department Maintenance, Candidate Maintenance, Staff Maintenance, Examination Maintenance, etc. System user with administrator role is the user with super user role to the system. This category of user will have the full administrative access rights to each module in the system. The administrator is the "gatekeeper" of the system and has right to assign user to different role of the system. With the use of admin panel as presented in figure 1, the administrator can add questions, edit questions, set time for the test, delete questions, etc.

Figure 1: Admin Panel of New System
B. Staff Module
System users with staff role are those users with staff role as assigned by the system administrator. As the name implies, this group of users will act as staff in the system. Staff can: Compile exams from existing database of questions, add new questions, add images to the database, administer exams (create, update or delete an exam which he/she has been given the access right), view and compare students’ exam scores using student exam summary reports and measure student performance in various subjects, departments, faculties, etc.

C. Student Module
System users with student role are those users with student role as assigned by the system administrator. This group of users will act as student in the system. Student can: take exam to test his/her own capabilities, request for change of password, and view and print own score after examination.

D. Examination Module
Examination module is the module which interfaces with examination form and question bank by picking up questions and subsequently form a set of examination questions to test a student. These questions are then displayed on the screen for the candidates to answer as shown in figure 2.

5. DISTRIBUTIVE IMPLEMENTATION OF THE SYSTEM
Our study came up with a distributive system that will be used for online assessment of students/candidates seeking for admission into institutions of higher learning. We looked at present/related system currently used in the country and observed that the system should be best implemented as a distributive one. Figure 3 shows the distributive architecture of our system.

In this scenario, the system developed is uploaded in examination server (eExam Server) located in different examination centers chosen by the institution and all locations are connected to each other to form a complete distributed system. A back-up system is installed in all locations to encourage system processing continuity in case of failure or attack though a distributed system is able to shift operations when one of the computers (servers) fails. Exam takers are then expected to go to any test centre of their choice. The test administrator checks candidates’ fingerprints for identification with the use of biometric feature (see section VI). If identity screening is successful, the candidate is given a username and password for authentication. During the examination, the manager controls and monitors the candidates through the use of distributed firewall system.
6. SECURITY FEATURES

Security has been the major challenge facing a distributed system and as online education has seen exponential growth over the past decade, questions have been raised over how best to identify, authenticate and monitor test takers at a distance [10]. Bearing this in mind, we provided the system with the following features to enhance security: biometrics, distributed firewall and middleware system.

A. Use of Biometric

Biometric is the application of computational methods to biological features, especially with regard to the study of unique biological characteristics of humans. Such unique biological characteristics rely on individual human identities such as DNA, voice, retinal and iris, fingerprints, facial images, hand prints, or other unique biological characteristics [19]. It is a method of identification that has been growing in popularity. These characteristics are identified using biometric devices. A biometric device is technological device that utilizes an individual’s unique physical or behavioral characteristic to identify and authenticate the individual precisely [20]. Essentially, biometric technologies operate by scanning a biological characteristic and matching it with the stored data. This feature is used during enrollment where students’ fingerprints (templates) who are supposed to appear for the e-exam will have to be captured and stored in the relevant e-learning server database and biometric server database. All the fingerprint scans will be saved in an encrypted form to avoid any modifications. During entrance into the examination hall, this feature is equally used to identify students by checking their fingerprints match with the ones (templates) earlier captured during enrollment.

B. Use of Distributed Firewall System

Distributed firewalls are host-resident security software applications that protect the enterprise network’s servers and end-user machines against unwanted intrusion. Distributed firewalls that are managed from a central server can help to map corporate security policies to the configuration of workstation firewall systems [13]. They offer the advantage of filtering traffic from both the Internet and the internal network. This enables them to prevent hacking attacks that originate from both the Internet and the internal network. This is important because the most costly and destructive attacks still originate from within the organization. They are like personal firewalls except they offer several important advantages like central management, logging, and in some cases, access-control granularity. These features are necessary to implement corporate security policies in larger enterprises. Distributed firewall system helps to monitor candidates and control network packets of all machines during examination and used to ascertain who is exactly ‘pushing the buttons’ and to ensure that candidates do not receive outside assistance to improve their exam score [10].

C. Use of Middleware

Middleware is a layer of software between a network and the applications that use it. Middleware manages security, access, and information exchange on behalf of applications to make it easier and more secure for people to communicate and collaborate. It is layer of software above the operating system but below the application program that provides a common programming abstraction across a distributed system [10]. We urge users of this system to apply the use of middleware during implementation.

7. CONCLUSION

In this study, we have developed and described e-examination system implemented as a distributed system. We also described some security features and how the system could be best implemented. We encourage the use of biometric system for identification of exam takers coupled with traditional username and password system for authentication and distributed firewall system to monitor the network packets and actions of students during examination. Meanwhile, use of middleware is also encouraged during the implementation of this system.

REFERENCES


