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E-LEARNING SYSTEMS PERFORMANCE BASED ON NEW TECHNOLOGIES

Iustin ANDRONIE
Spiru Haret University, 13 Ion Ghica Street, Bucharest, Romania
E-mail: ia220@spiruharet.ro

Abstract: *The recent developments in modern learning technologies has brought significant changes to domains like education and training programs, changing the way universities and other learning institutions operate. Modern distance learning and distance education programs are cannot exist without the extensive use of e-Learning technologies.*
In today's knowledge based society Information and Communication Technology (ICT) and all the related technologies are the key factors to conceiving, developing and implementing successful e-Learning systems that can satisfy the demands of modern students. In this context, knowing the fact that technological advances are a constant reality in any domain of human activity, implementing e-Learning systems based on the latest technologies available is a good strategy for any university that wants to increase the efficiency of the tuition processes that are carried on, bringing measurable competitive advantages to those who use them.
Using modern e-Learning technologies (based on computers, networking, internet etc.), any person interested can easily access learning resources situated on powerful servers that run dedicated e-Learning software products, without being impeded by the available time and the physical distance to the university that provides the learning resources.
Aided by information and communication technology it is now possible for a mature student that already works and has a family to complete his studies by following tuition programs that help him advance in his career. Having all these facts in consideration, it can be said that today's e-Learning systems are addressed not only to traditional students, but to any person who is interested to learn.

Key words: *e-learning systems, internet, information and communication technology.*

Improving the educational system by adopting the information communication technologies (**I**nformation **C**ommunication **T**echnology - ICT) generally, and the e-Learning system, particularly, providing access to information, to knowledge and their transfer to their beneficiaries leads to the increase of competitiveness in a global economy. Adopting a performing e-Learning system is highly important for the knowledge dissemination process in the educational environment. The increase in competitiveness is conditioned by increasing the investment in performing e-Learning systems, investment which consists in allocating material, human resources and time, especially. The investment in an e-Learning system must lead to providing educational services of improved quality and, consequently, to an improved reputation for the institution.

Adopting an e-Learning platform allows transforming the way knowledge transfer is done to the beneficiaries of learning services, irrespective of age, sex or geographical residence area, the beneficiaries having the possibility to learn how to learn, how to access, how to analyze, how to exploit the available information and knowledge. The knowledge transmitted as such allows the beneficiaries to transform them into new information and knowledge, useful in the activities they carry out.

When choosing a usual e-Learning system one has to choose the system for content development and the knowledge delivery system which best meets the institutional needs.

Before choosing and defining the configuration which will be implemented, it is necessary to perform a work environment analysis, specific to the institution, a volumetric analysis of the requirements and the work model of the user will be identified.

Performance must be treated as a requirement since the design phase and, consequently, needs to be included in the action plan as a series of distinct stages during the development of such a system and continued during its implementation. The evaluation of the performance of an e-Learning system, using various modeling techniques and instruments has to begin since the design planning stage and later on of implementation. Often institutions notice too late that by an incomplete evaluation of an adopted solution they have to supplement the allocated budget for obtaining the required performance. Yet most of the times the institutions which adopt an e-Learning system do not have universal criteria for evaluating the performance of a certain provided system and, consequently, they ignore the evaluation of performance based on criteria which could allow determining the performances of the project proposed to be carried out. The criteria for performance evaluation must be user-friendly and easy to understand and to analyze.

The design and the implementation must be carried out having performance always in mind as objective.

Initially the performance requirements are defined and the performance risk is estimated, the measures for mitigating the performance risk are identified and the set of critical interactions for the system are identified and analyzed.

During the system design stage the hardware architecture model, the software model at module and interconnection level, the interactions model and the pedagogical model are formally defined aiming at performance evaluation. The technical revision of the design documentation is carried out, some models for design are being proposed, the potential errors are highlighted and a prototype model is proposed so that it allows performance evaluation. The definitions are done at description or pattern level on how certain indicators are measured.

During the development and implementation stage tests are carried out on the basic functionalities, the potential bottle necks are identified and the system scaling possibility is analyzed according to potential changes of the activity volume in time.

The definition of performance is the result of a fine-tuning process of the requirements and of the architecture of the developed system. Practically, during the development and also the implementation stage it is possible to estimate the system performance and some project correction measures can be proposed.

The full performance evaluation of the system requires carrying out sets of distinct evaluations by applying tests on the system and monitoring its behavior various working conditions. The so-called "black box testing" or functional testing is carried out, consisting in verifying the compliance of the specifications of the software component of the system at system interaction level in terms of inputs-outputs such as testing the user interface, the functions expected to be carried out by the system when related to set of rules and declared algorithms, verifying the results expected for a certain set of specific inputs, testing the error processing, the compliance with the sector standards etc. Also, other issues are verified: the system compatibility with the calculation equipments, the peripheral and network devices, the system compatibility with the operating system, the database system and compatibility with the browsers used.

During the functional testing some mismatching can be detected and which are repaired by adjusting the configuration parameters of the hardware or software subsystems or of the application itself by means of the set of options of the advanced configuration menu. The functional testing will be restarted completely after adjusting the parameters. Most of the times the users consider wrongly that once performed the functional testing is enough.

The performance evaluation of an implemented e-Learning system is carried out on the whole system in the context of complete functional specifications, aiming at keeping its behavior in the performance limits expected by the users. This activity is a complex operation which has to be done in a structured manner, based on a clear plan, using dedicated instruments specific to the type of platform adopted. The performance evaluation activity is specific to each installation, the architecture and the requirements of each institution being unique.

An analysis is carried out during an interview with the users. Following the interview, the proposed objectives are identified, the work methodology is presented and evaluations processes are set up. The work model and date model are identified for determining the profile of the future system. Following the volumetric analysis there will result the total number of active users by roles (student, trainer, tutor, course editor, guests, web administrators, system administrators etc.), the total number of enrolled users, the number of courses, the number of items in a course by types. The minimum, maximum number and the standard deviation are identified for each category. A behavior and system interaction analysis is carried out and a model is being created depending on the prediction on the work volume increase in time. (*Fig.1.and Fig.2.*)

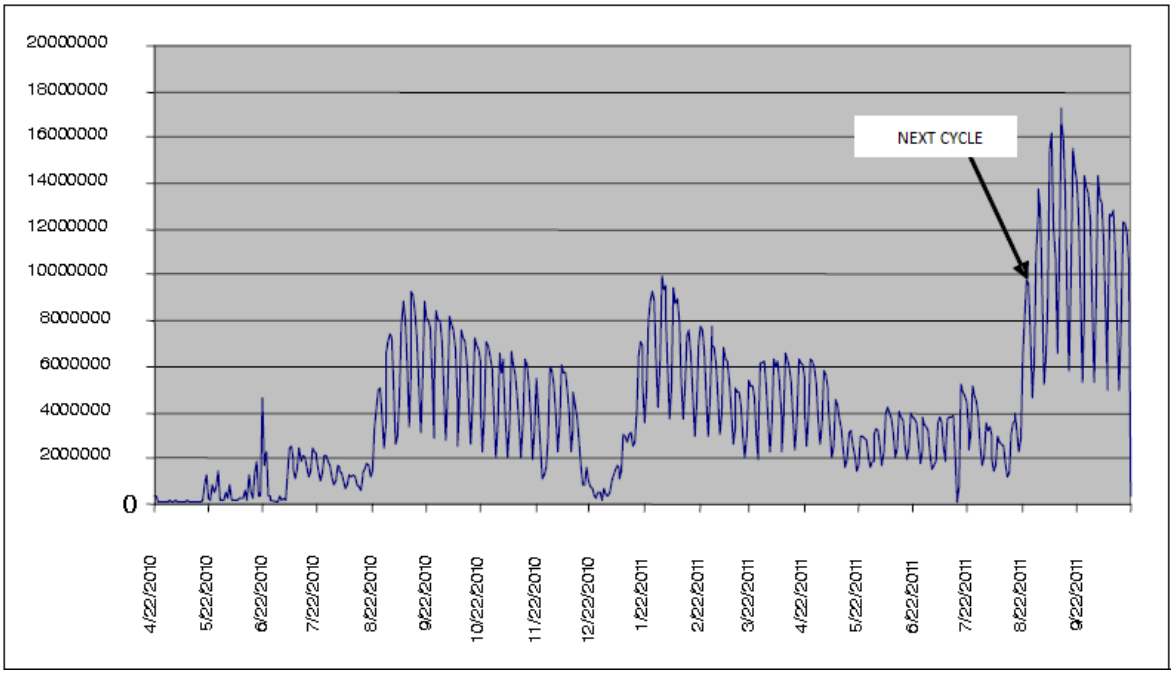

Figure 1. Estimated growth model for a higher education institution

An analysis of the newtork traffic and a behaviour model are conceived. (Fig. 2.)

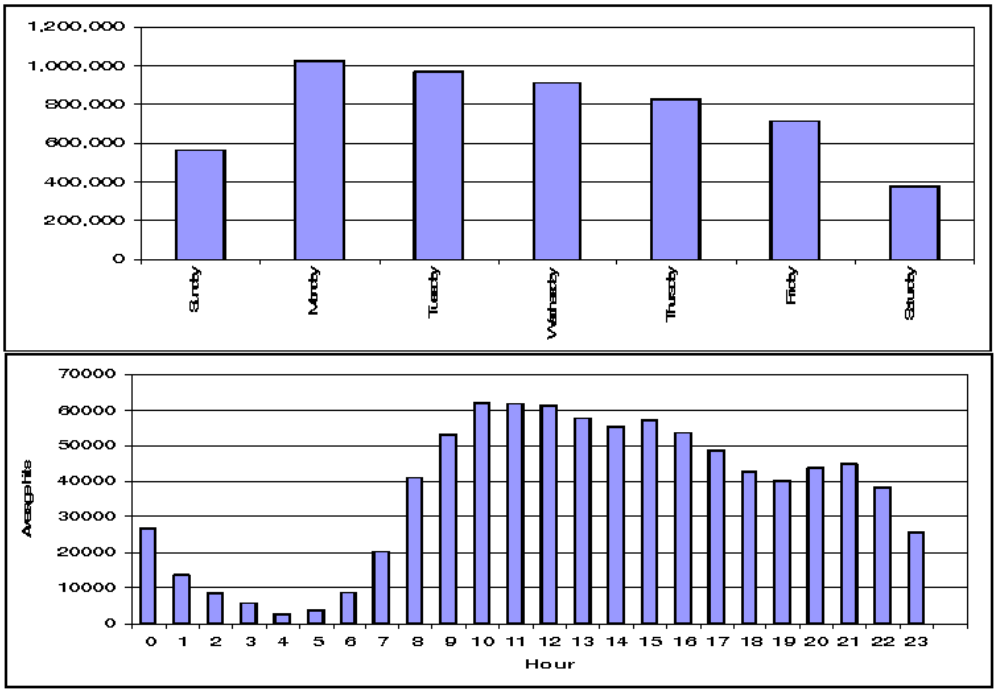

Figure 2. Example of the distribution of the access by days and hours

Analyzing the data collected during past activity the traffic problems of the systems are identified as due to equipment failure. A series of measures are proposed, drawing upon mitigating the impact of these equipment failures. (Fig. 3.)

The result of the analysis consists in a behavior model based on a set of data reflecting the interactions of each type of user by roles with the various types of activities and data included in the system (students, trainers, tutors, classes, tests, e-mail, calendar, passwords, gradebook, groups, announcements, assignments, searches, login etc.).

Before drawing up the test scenarios, an audit of the implemented e-Learning platform is carried out, consisting in verifying the architecture, the network configuration and the configuration parameters.

Following the system audit, we can notice a saturation of the Internet connection during the testing period and having a negative impact on the users outside the campus. (Fig. 3.)

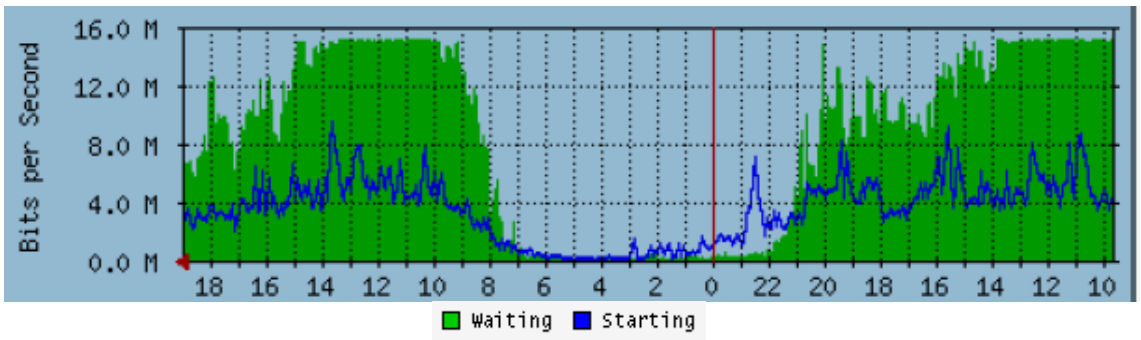

Figure 3. Internet traffic monitoring graph

The test scenarios for the e-Learning platform are drafted based on the volumetric analysis, the determined behavior model and on the audit results. The execution of the performance tests requires the existence of additional equipments for generating the necessary traffic. The traffic is generated by multitask systems, every process imitating the actions of a certain type of user, carrying out activities allowed to each of them according to the determined and proposed behavior model. A certain script matches each user and access to the tested system is granted when running it.

The simulation of the Internet traffic is done as follows: the virtual users launch to the system a mix of requests according to the behavior model identified following the analysis. The bottle necks are identified such as the Internet network and, as the case, the injection of the requests of the virtual users directly in the network of the tested system. The following tests are carried out: a test on the system response capacity to the maximum designed loading and beyond it within the time limits imposed by the main functions and a test of the recovery capacity without intervention after a simulated failure. (Fig. 4.)

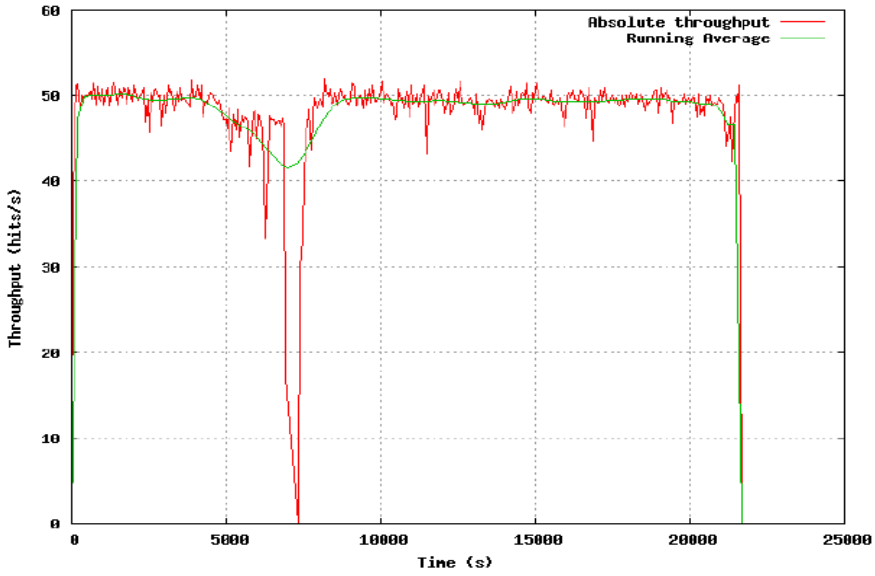

Figure 4. The graph resulting from the test on stability when loading over the designed limit and recovery without intervention after a simulated failure.

The evaluation of an e-Learning system is carried out based on the results obtained following the test on the response capacity to a large number of users simultaneously, following the test on data security and the test on the system scalability.
In the same time, we can estimate the system availability, the average time between two consecutive failures, the average time for restarting to function.
The confirmation of the compliance with the initial requirements allows certifying the system as compared to them. Usually the test is carried out on the complete system in order to verify the compliance with the initial requirements of the fact that there are no interferences or mismatching between the hardware / software components of the system. Special attention is drawn upon detecting the system behavior errors, analyzing the system response mode up to the limit of the technical specifications and even over those limits and also the level of compliance with the expectations of the key users. The evaluation of the performance of an e-Learning system is carried out upon installation, periodically based on a graph for preventive verifications of the behavior in time and each and every time that the performance parameters change negatively.

We must avoid the tendency to pay most of the attention to the technical issues and less to the exploitation, maintenance and monitoring of such a system on long term and which are usually considered as minor. This matter of facts leads undoubtedly to taking some critical and compulsory decisions late and without having a clear vision form the very beginning.

An e-Learning system is a complex of hardware and software elements, of knowledge, information and learning strategies, dedicated staff for administration and monitoring etc. which altogether integrate e-Learning technologies which facilitate the interaction and communication between teachers and students in achieving the objectives of the lifelong learning with a major role in the ongoing education of the labor force according to the needs of the labor market which keeps changing.

When evaluating an e-Learning system, apart the evaluation of the system itself, one must take into account also the very important issues related to ensuring the qualified staff, dedicated to administrating and/or monitoring the system, the need for training of the staff, the future users (teachers, specialists, tutors and even students).

During process of performance analysis for an e-Learning project one should not neglect some risk management concepts and thus prepare a business continuity plan (BCP) and also a disaster recovery plan (DRP) after a natural or a human induced disaster. (Fig. 5.)

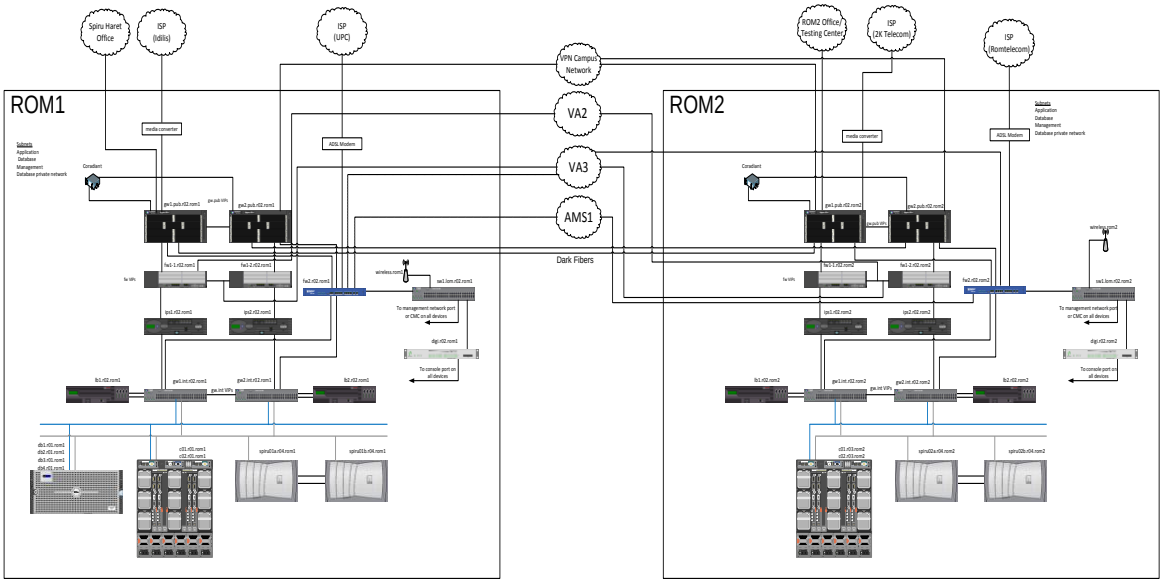

Figure 5. Hardware architecture of an e-Learning system and a disaster recovery plan (DRP) implemented

It is difficult to approach the evaluation of the performance, the efficiency and the capacity of an e-Learning project especially given the wide diversity of solutions existing on the market and the fast changes in the sector.

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