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SYSTEM ANALYSIS FOR E-LEARNING GRIDS

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Dezvoltarea sistemelor de e-learning a fost un domeniu ce a evoluat continuu în ultimii ani. Proiectarea acestor sisteme a fost bazată pe arhitecturi client-server, peer-to-peer sau mai recent pe servicii Web, cu unele limitări în scalabilitatea, disponibilitatea sau puterea de procesare şi stocare distribuită. Aceasta lucrare încearcă să îmbunătăţească această situaţie, aducânduşi contribuţia prin propunerea unei analize de sistem în vederea proiectării sistemului ţinând cont de etapele ciclului de viaţă al sistemului şi definirea specificaţiilor precum şi utilizarea reţelelor grid în contextul sistemelor de e-learning. Proiectarea sistemelor de e-learning ţinând cont de specificaţii şi standarde este prezentată în secţiunea 2 a lucrării, în timp ce avantajele utilizării arhitecturilor de tip grid sunt analizate în sectiunea 3.

E-learning systems consist of complex activities and most of them have been designed based on client-server or peer to peer, and recently web services architecture. These systems have major drawback because of their limitations in scalability, availability, distribution of computing power and storage systems, as well as sharing information between users that contribute to these systems. In this context the use of grid technology reveals its utility and availability, as scalable, flexible coordinated and secure resource sharing among geographically distributed individuals or institutions, in the perspective of e-learning. The design of e-learning systems taking into account the specifications and standards is presented in section 2 of the paper. Section 3 reveals the advantages of using grid arhitectures for e-learning systems.

Keywords: education, grid technologies, e-learning, resources, information

1. Introduction

During the last years e-learning systems were increasingly addressing learning resources sharing (text, images, video, on-line data, etc.) and reuse, interoperability and other more different modes of interactions. E-learning

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systems consist of complex activities and most of them have been designed based on client-server peer to peer, and recently web services architecture. These systems have major drawback because of their limitations in scalability, availability, distribution of computing power and storage systems, as well as sharing information between users that contribute in these systems. In this context the use of grid technology reveals its utility and availability, as scalable, flexible coordinated and secure resource sharing among geographically distributed individuals or institutions, in the perspective of e-learning.

This paper presents *a system's approach* aimed at establishing architecture *for e-learning systems based on a grid tec*hnology. Adoption of GRID technology for e-learning is possible only through analysis of the components of the e-learning system and how they fit to common GRID properties.

A simplified and idealized description of an e-learning model of the system will be discussed. From the user point of view it contains some material presentation of components, typically html pages with different contents, followed by the task or activity to be performed by *learner*, *tutor* or *administrator*. That could be, for instance, interactive simulation program, assessment test, or any reality based learning application.

In an application design perspective [1], as it is intended to be used on a grid, both web page and activity software are realized as interconnected *Learning Objects* (LO) supplied with metadata headers according to the standards. LO may reside on different servers, moreover, activity could be executed on the particular server on which the LO is stored or on another server.

In the following sections a system requirement and design analysis will be presented based on e-learning system characteristics and grid technology characteristics. In conclusion the advantages and disadvantages of the proposed architecture will be presented.

An empirical analysis could be done by analysing the features, tools and potentialities provided by different systems in order to make a state-of-art analysis on e-learning systems. Several solutions to support e-learning were analysed. Most of them are content-centred neglecting some important educational issues.

By comparison of commercial to freeware/open-source platforms the conclusion indicates that the commercial ones have more difficulty integrating with other systems and supporting different kinds of pedagogies and of course in terms of costs. Some strong points and weaknesses have been found. The strong points are related to the communication tools, administrative and management tools, compliance with standards implementation level and documentation or possibility of hierarchical organization. On the other hand the weaknesses are linked to resource management and portability, adaptability and personalization, quality of resources, development of new components, diversity of pedagogies and applications and costs, especially for commercial platforms.

2. System Requirements and Design Analysis

A properly functioning and competitive system could not be reached without application of systems life cycle engineering and analysis (Fig. 1a). The life cycle starts with the identification of a need and extends through conceptual and preliminary design, detailed design and development, production and/or construction, product utilisation, phase-out and disposal [7].

System design within the system life cycle is different from design in the ordinary sense. Life-cycle focused design is simultaneously responsive to customer needs and to life-cycle outcomes. Design should not only transform a need into a product/system configuration but should ensure the design's compatibility with related physical and functional requirements.

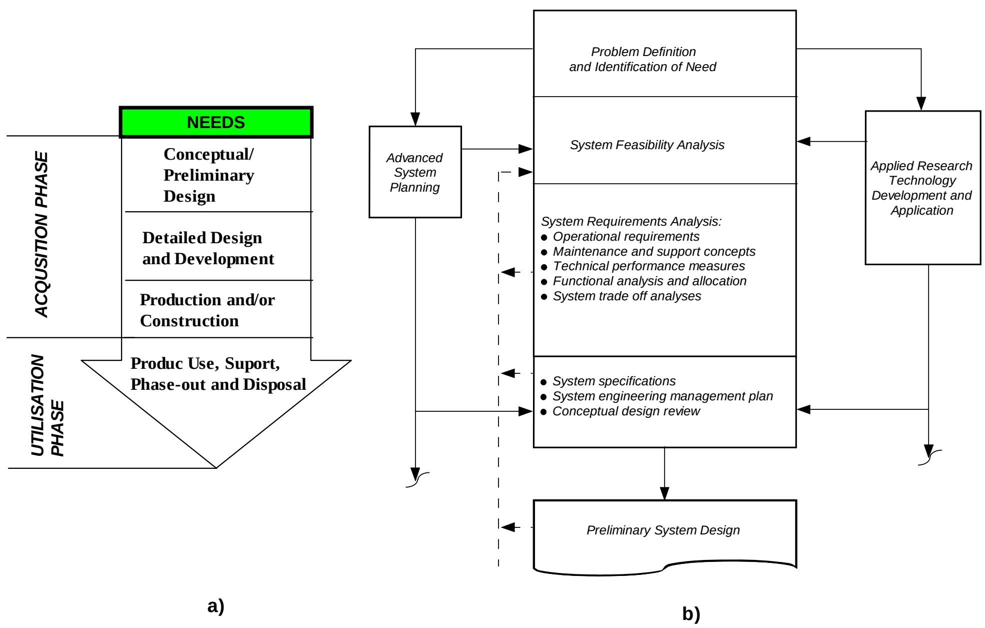

Fig. 1. The product/system life cycle (a) and the major steps in the system requirements definition process (b)

The preliminary design is the first and the most important phase of the system design and development process. The major objective in preliminary design of the system is the system requirements definition (Fig. 1b) of the process and it suppose the next sub-processes: problem definition and identification of need; requirements analysis; operational requirements; maintenance and support concepts; evaluation of feasible technology applications; selection of technical approach; functional definition of the system.

The phase of system requirements and design analysis could be based on the already existing international standards and specifications that have been developed in order to structure content and information on e-learning systems in order to promote interoperability between systems and to obtain a greater quality of teaching.

The most technological educational standards and specifications are more focused on the course design and structuring all the processes of teaching/learning. IMS Specifications [11], AICC [12], SCORM [10] and DublinCore [13] were analysed [9]. Standards like Sharable Content Object Reference Model (SCORM) [10], a project from Advanced Distributed Learning (ADL), that becomes more of a standard integrator than a standard by itself, what makes it dependent of the other standards it integrates, and it doesn't consider the evaluation and characterization of students. Another specification, the IMS, is used as a guide for structuring contents, developed by the IMS consortium that began its activity with the definition of specifications for instructional structure, to become the standard it is today. It based its metadata specification on the IEEE LOM [14] standard and includes specifications to structure the learning process, the learning objects and their metadata, to design units of learning and courses, to evaluate and characterize the users, among others, storing them in XML files [5].

The main objective of these specifications is to be as general as possible, so they can be applied to any process of teaching/ learning [9][15]. The use of a standard, helps to achieve more stable systems, reduces the development and maintenance time, allows backward compatibility and validation, increases search engine success, among many other advantages.

From this analysis it could be verified that the IMS specifications covers the most of the technical aspects needed to develop good e-learning systems.

The use of online learning content must allow three identities to interact with one another and with the learning content (Fig. 2). **Tutors** must be able to *build* online learning content. **Administrators** *manage* and distribute content and **Learners** *interact* with and learn from the content inside the LMS (Learning Management System).

The complete, identified scope of the content framework is large and complex. To reduce the complexity and decrease the amount of time needed to complete a first specification, the scope was broken down into three, main parts: *Content Packaging*, *Data Model*, and *Run Time Environment*. Each of these topics requires additional explanation and each is described in more detail in Fig. 3.

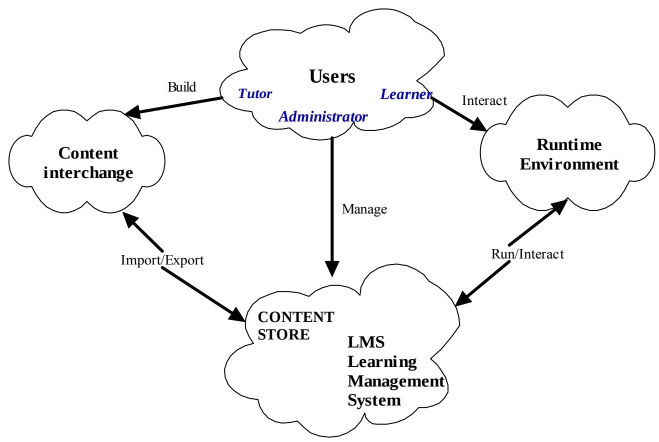

Fig. 2**.** Content framework goals

The *Content Packaging* represents the section that deals with the issues of content resource aggregation, course organization, and meta-data. The *Data Model* represents that portion of the Content framework where content is imported, stored, managed, and manipulated for instructional purposes. The definition of specification of data models first depends on LMS vendors and computer platform vendors.

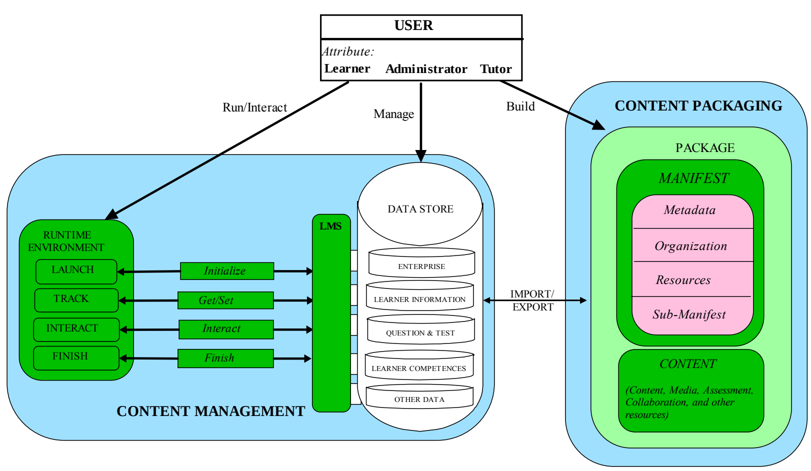

Fig. 3. Content framework

The *Run Time Environment* portion of the Content framework represents the point where learners will interact with the content presented to them. One of the key requirements for this portion of the specification is the identification of standard mechanisms to enable communication between a run time environment and an LMS.

3. Basics of Grid Computing

A Grid is a collection of distributed computing resources available over a local or wide area network that appears to an end user or application as one large virtual computing system. Grid infrastructures support the sharing and coordinated use of resources in dynamic global heterogeneous distributed environments. These include resources that can manage computers, data, telecommunication, network facilities, and software applications provided by different organizations [3].

Grid computing has its conception in wide area distributed computing, most especially in meta-computing, where geographically distributed computers are unified such that they can be perceived as one big powerful machine. Modern grids focus on scalability and adaptability and therefore adopt Web technologies and standards such as the Extensible Mark-up Language (XML) or Web services. Grids are typically implemented as a form of middleware which provides all grid related services and can also use the Internet as a communication infrastructure [8]. During the evolution of grid computing, three basic types of grids have emerged; these are *compute grids*, *data grids* and *network grids* [2]. A compute grid has the processing power as the main computing resource shared among its nodes while data grid has data storage capacity as its main shared resource. Such a grid can be regarded as a massive data storage built up from portions of a large number of storage devices. The network grid otherwise known as the delivery grid has its main focus, fault-tolerant and high-performance communication services. In this regard, each grid node works as a data router between two communication points, providing data-caching and other facilities to speed up the communications between such points [6].

A simple system architecture for grids is proposed as shown in Fig. 4. As indicated the middleware contains five levels. The first upper level, which is the *application layer*, contains grid applications built upon the underlying layers of the core grid middleware. This layer can change depending on user programs, while the underlying layers always provide the same functionality. Next is the *supervising layer*, which coordinates global interactions among collections of resources. In this layer brokers and schedulers distribute computations or data on the grid. Following this is the *resource layer* which implements access to single resources and monitors their status. The next layer defines *communication and security* protocols for the grid. The security protocols cooperate with the local security protocols of each resource and do not replace them. The lowest level, *basic interface layer*, implements uniform interfaces for access to resources, such as computers, storage media, or instruments in a grid and ensures interoperability.

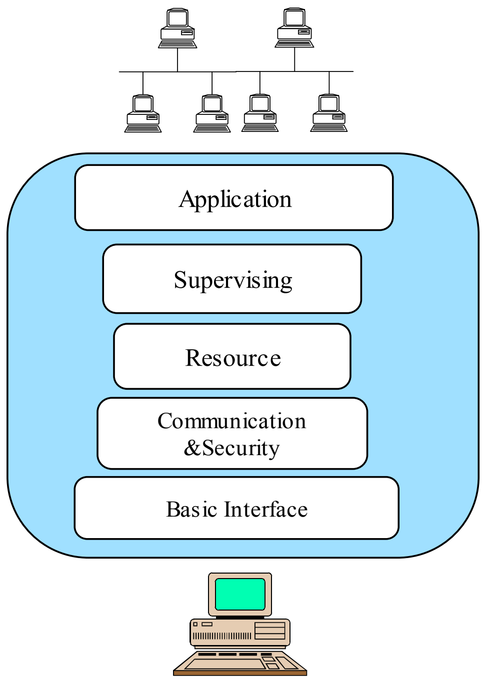

Fig. 4. Grid Middleware

4. Conclusion

In this paper a system's approach aimed to establish architecture *for e-learning systems based on a grid tec*hnology was presented. It was used as a description for an e-learning model of the system taking into accounts the standards and specifications. To reduce the complexity and decrease the amount of time needed to conclude a preliminary specification, a content framework was presented, based on Content, Data Model and Run Time Environement. To compute and facilitates the use of grid computing for e-lerning systems a simple 5 level system arhitecture was proposed in the paper.

At its core, grid computing enables devices—regardless of their operating characteristics—to be virtually shared, managed and accessed across an enterprise, consortium or workgroup. Although the physical resources that compose a grid may reside in multiple locations, users have seamless and uninterrupted access to these resources. This resource virtualization provides the necessary access, data and processing power to rapidly solve complex business problems on demand for research. Grid computing helps to promote the efficient utilization of technology resources and foster the creation of cost-effective, resilient IT infrastructures that are adaptable to change.

Setting up a computational environment that is physically distributed across a potentially wide area that integrates heterogeneous computing resources for e-learning systems might not only be very difficult due to technical reasons but also due to many human related issues such as personal preferences and political interests.

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