System Requirements Analysis for e-learning systems using grid

OLUMUYIWA B. ALABA, IOANA FAGARASAN, RADU DOBRESCU
Faculty of Control and Computers, “Politehnica” University of Bucharest,
313 Splaiul Independentei, Bucharest
ROMANIA
pnob12@yahoo.com, ioana@shiva.pub.ro, radud@isis.pub.ro

Abstract: Until recent years network-based education and grid technologies were two distinct areas. But e-learning systems have been increasingly addressing learning resources sharing (text, images, video, on-line data, etc.) and reuse, interoperability and other more different modes of interactions. 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.

Key-words: networked-based, education, grid technologies, e-learning systems,resouce sharing, interoperability, standardisation.

1. Introduction

This paper presents a system’s approach aimed at establishing an arhitecture for e-learning systems based on a grid technology. 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.

Initially 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.

From application design perspective, as it is intended to be used on a grid, we assumed that 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 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 argued.

2. Current Approaches

In order to make a state-of-art analysis on e-learning systems, an empirical analysis could be done by analysing the features, tools and potentialities provided by differnt systems.

Several solutions to support e-learning was analysed. Most of them are content-centered neglecting some important educational issues.

From the comparison of commercial and 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 & portability, adaptability and personalization, quality of resources, development

of new components, diversity of pedagogies and applications and costs, especially for comercial plataforms.
These weaknesses are mainly traced to problems regarding interoperability, reusability and quality of resources, learning domain independence, extensibility of the platforms, and meeting some of our goals already presented. In order to solve these problems a proper system requirements analysis will be proposed.

3. System Requirements Analysis

Experience in recent decades indicades that a properly functioning and competitive systems could not be reached without application of systems life cycle engineering and analysis (Figure 1). The life cycle begins 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.
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.

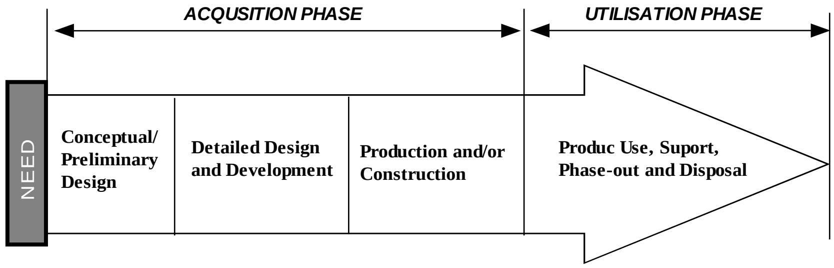

Figure 1. The product/system life cycle

The conceptual is the first and the most important phase of the system design and development process. The major objective in conceptual design of the system is the system requirements definition (Figure 2) of the process and it suppose the next subprocesses: problem definition and identification of need; requirements analysis; operational requirements; maintenenace and support concepts; evaluation of feasible technology applications; selection of technical approach; functional definition of the system.

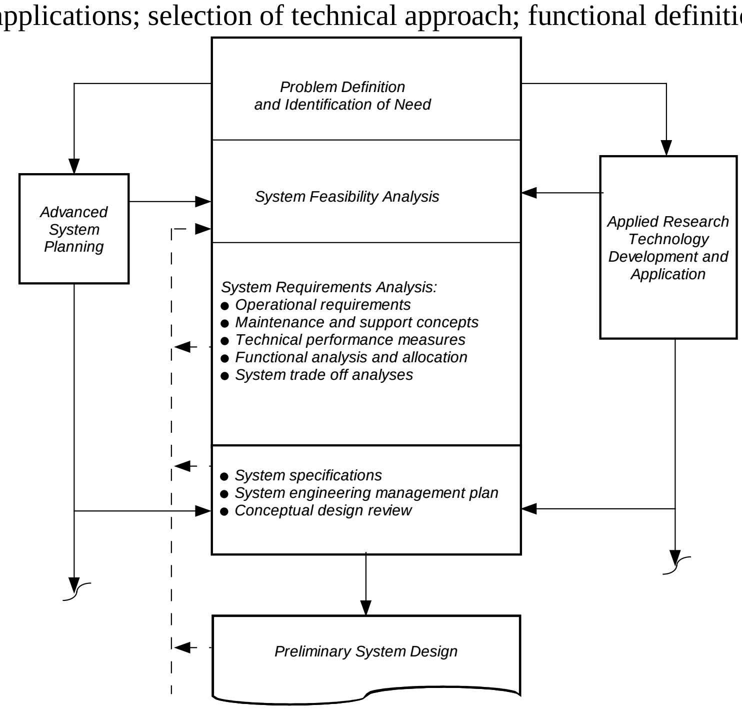

Figure 2. Major steps in the system requirements definition process

The phase of system requirments 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 [2], AICC [3], SCORM [1] and DublinCore [5] was analysed [13]

Standards like Sharable Content Object Reference Model (SCORM) [1], 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 bases its metadata specification on the IEEE LOM [8] 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 [4].

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][13].

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 developed good e-learning systems.

The use of online learning content must allow three identities to interact with one another and with the learning content (Figure 3). **Authors** 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).

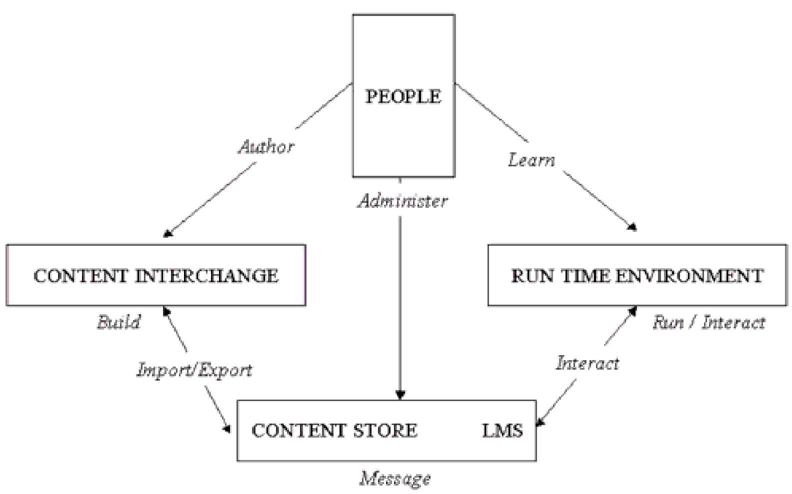

Figure 3. Content framework goals

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 the following figure 4.

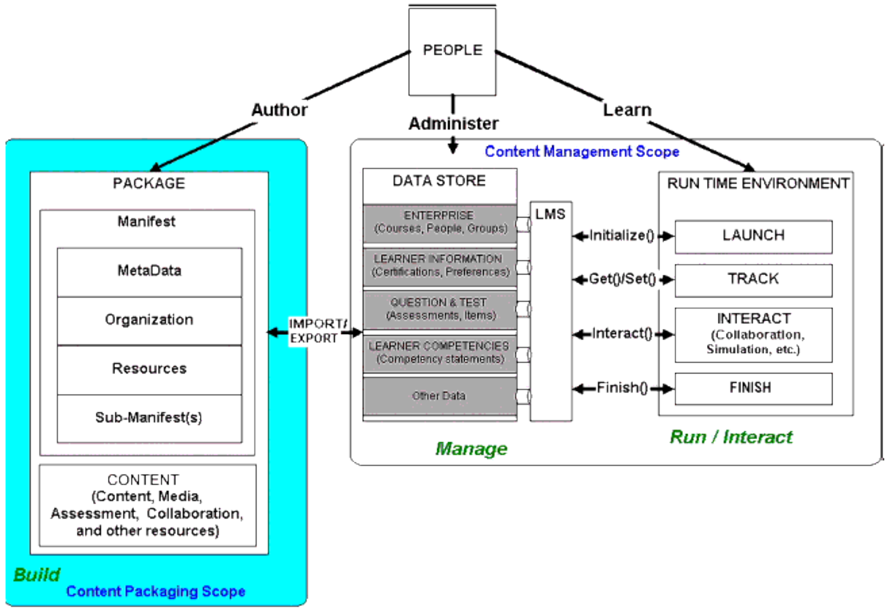

Figure 4. Content framework

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.

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.

4. Grid infrastructure

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 [6]. 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 computing is a service-oriented architectural approach that uses open standards to enable distributed computing over the Internet, a private network or both, providing high performance computing and large storage capacity. This approach can help academic organizations and universities aggregate disparate IT elements such as computational resources, data storage, devices, instrumentations and sensors, and filing systems to create a single, unified system and address fluctuating workload requirements.

5. Conclusion

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.

Actually, these implementations provide grid services delivered according to rather strict QoS requirements [14]. More challenges arise, such as resource management among different Grids, varying resource usage across Grids, different security policies, resource reservation and co-allocation by research communities in peered Grids, and, formation and management of virtual organisation (VO) in the InterGrid.

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