Chapter 2
Enhancement of e-Learning Systems and Methodologies through Advancements in Distributed Computing Technologies

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ABSTRACT
The evolution of the Internet, distributed architectures, and Grid-oriented frameworks can change the way people acquire and disseminate both knowledge and experience, thus the way they learn. Therefore, one can envisage new e-learning models, based on a more efficient users’ interaction, that also empowers the hands-on experience. This will improve learning outcomes, while reducing the need of physical devices and removing the inherent boundaries. Moreover, this reduces costs by promoting the sharing of resources and learning assets. From this perspective, the chapter discusses the integration of classical e-learning paradigms with new advancements of distributed computing, such as: 1) the usage of Peer-to-Peer (P2P) to produce network-independent overlays, also by enabling direct student-to-student exchanges; 2) the integration, through grid-based middleware, of real or virtual devices, plants and Sensors Network (SN) within the e-learning environment; and 3) the adoption of a distributed e-learning system to spread culture through mobile devices, with an emphasis on satellite communications.

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INTRODUCTION

The continuous advancements in the field of Information and Communication Technology (ICT) lead to fast changes in the scenario of content management and sharing. New systems influence the way people acquire knowledge and disseminate their experience. Nevertheless, such evolution enhances how individuals achieve results by means of e-learning systems and services, in education and at work (Rosenberg, 2001). As a consequence, also e-learning environments are experiencing a paradigm shift. This can happen owing to many important technological enablers. We mention, among the others: the mobile and broadband Internet, distributed computing architectures, Grid-oriented frameworks, and the Peer-to-Peer (P2P) communication paradigm. Therefore, it is possible to envisage new models for sharing both knowledge and information. As an example, an intrinsic added value concerns the efficient circulation and delivery of ideas, which can be produced or consumed by different bodies, e.g., Universities, Companies, and “common” people. Additionally, the sharing can be not limited only to knowledge, but it can be also extended to “machineries,” in order to perform hands-on experiences to grant a more successful learning process.

To give a better understanding, we perform a short introduction of architectural blueprints and components commonly adopted for e-learning purposes. In standard set-ups a well-defined centralized entity, usually defined as the Learning Management System (LMS), is responsible of: 1) providing basic functionalities for the e-learning services, such as authentication, accounting and monitoring; 2) allowing data delivery, for instance the digital contents for educational purposes. Such learning assets are made available in the form of Learning Objects (LOs) (Ip, Morrison, & Currie, 2001), and they can be locally archived into a Learning Content Management System (LCMS), or distributed among different Learning Object Repositories (LORs). The most adopted solution relies upon a unique LCMS. Notwithstanding, if multiple LORs are employed, each LOR must have at least indexing and archiving functionalities, to handle specific policies, ranging from requirements of data protection, to the widest possible diffusion of the knowledge. To this aims, people as well as software applications, can access LORs, simply with a Web browser (thus requiring a proper server-side Web-oriented logic), or through duly developed access interfaces.

In this perspective, the engineering of the LMS can be a complex task, since it could embrace different constraints. In fact, it should be properly tweaked for specific user needs (e.g., the desired level of interaction among students and accessibility issues), the chosen learning strategies (i.e., associative, cognitive, or situative), and the specific pedagogical model (i.e., constructivism, constructionism, or reflection). Depending on the chosen approach, different applications are feasible and must be made available. To handle such a variety of choices, the LMS platform is designed to deliver a set of standard services, which can be further composed to provide more sophisticated functionalities. However, they could not be sufficient, and then an Application Programming Interface (API) is often supplied, to inter-connect with external tools and third-party products, and to allow access to internal data and services. This concept can be further pushed owing to Web 2.0 technology, used to merge the LMS with other “full-featured” services or with remote devices/laboratories, exported through standard interfaces, such as Web-Services (Okon, et al., 2006). As an example, the integration of a LMS can range from a static link to a forum or a blog, to the transparent internetwork with complex social network platforms. At the same time, the functionalities provided by the mashup concept, allow the retrieval and the aggregation of heterogeneous contents published outside the LMS.

Additionally, the LMS must guarantee a proper degree of scalability. In fact, the required software