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Enabling interoperability for LMS educational services

Pedro J. Muñoz-Merino *, Carlos Delgado Kloos, Jesús Fernández Naranjo

Department of Telematics Engineering, Universidad Carlos III de Madrid, Av. Universidad, 30. E-28911 Leganés, Madrid, Spain

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ABSTRACT

Nowadays, e-learning is undergoing a standardization process. In this paper, an overview of e-learning standardization state of the art is provided and the relationship between Learning Management System (LMS) functionalities and current e-learning standards is presented. Some lacks are found and the importance of defining new standards to cover several LMS aspects is justified. This work describes new e-service specifications for LMS final user application functionalities in order to cover such lacks. In addition, a web-based authoring tool has been implemented according to these new specifications, generating XML files. In this way, interoperability between different new LMS aspects is enabled.

1. Introduction

Nowadays, e-learning is undergoing a standardization process. This is crucial in order to enable interoperability and reusability between different distance educational systems. As e-learning is a relatively new emerging and changing science, at present there are only six defined standards by IEEE LTSC [15] (Learning Technology Standards Committee). On the other hand, there exist multiple specifications (usually also called standards by many authors. In this paper, the criterion is to refer as specification when no standardization organization has approved it at this moment) created by different organizations like the IMS Consortium [12], ADL [1] or the OKI project [21]. There are some e-learning aspects for which different specifications overlap [6], and other important aspects for which there is no specifications or it is not specific to e-learning.

The main computer systems that are used for distance education through Internet are called Learning Management Systems (LMSs). LMSs provide a set of functionalities or educational services. They can be open source, like .LRN (http://www.dotlrn.org/), Moodle (http://moodle.org/) or Dokeos (http://www.dokeos.com/); or commercial like WebCT/BlackBoard (http://www.webct.com/). Ideally, these systems should be according to most e-learning standards and specifications.

LMSs' future tendency is to be service-oriented. In [4], it is called as the next LMS generation. In this scenario, LMSs are based on modular components and they can support different services that do not stick to a specific platform. This is also according to the IMS Abstract Framework [11] philosophy (that lists different Applications, Services, and Components) and the OKI [21] architecture. OKI provides a based-layer architecture that is shown in Fig. 1. The *infrastructure* represents the final resources of an institution, such as file systems or data bases. The *common services* are services that are used by several educational applications, such as authorization or authentication. The *educational services* are specific educational modules like assessment or Course Management. Finally, the *educational applications* are the applications a user directly interacts with and these educational applications can use the implemented educational and common services.

The IMS Abstract Framework architecture is very similar to the defined by OKI, and a perfect relationship among layers of both architectures can be established. Both architectures capture the strong importance of LMS services.

In this context, we envision that the ideal scenario is one in which all the different educational services can be interoperable among different LMSs; and in which the entire design of different LMS courses can be done off-line (outside of LMSs) in an easy way for teachers without high technological knowledge using proper authoring tools; and next these complete courses can be imported within the different LMSs. To achieve this ideal approach, several issues should be addressed that are not solved at this moment. This work contributes in some of them.

1.1. Contribution of our work

In this work, we contribute to the ideal approach regarding the following issues:

1) We provide a new vision of entire reuse within LMSs. We propose a way of using the IMS Content Package (IMS-CP) specification to enable the global organization of all the elements within an LMS course. A new vision of complete reuse within LMSs is provided, in

* Corresponding author. Tel.: +34 91 624 8801; fax: +34 91 624 8749.
E-mail addresses: pedmume@it.uc3m.es (P.J.Muñoz-Merino), cdk@it.uc3m.es (C.D. Kloos), jfernandez@inv.it.uc3m.es (J.F. Naranjo).

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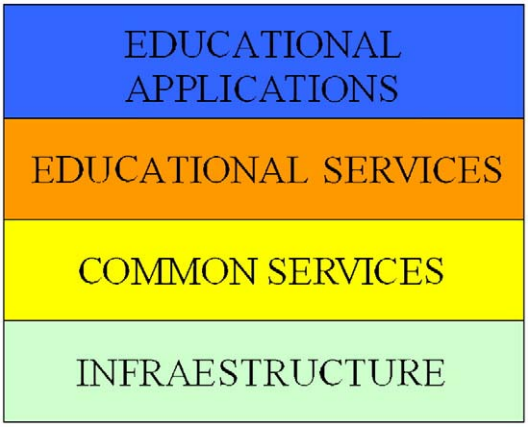

Fig. 1. OKI architecture based on layers.

which everything of an LMS can be reused as a part or as a whole. It allows the design of courses off-line with the help of a proper authoring tool. Several use cases of this new vision are presented in the paper. In this line, we show a new way of using the IMS-CP specification in order to define general configuration information of an LMS course, how to set the layout, or how to describe the structure of the different resources, and services of an LMS course.

2) It sets the relationship between main LMS services and present e-learning specifications, determining some lacks. For each LMS service, its relationship to present standards is provided. In addition, some lacks of educational standards for some LMS services are determined, explaining and illustrating the advantages of such standardization based on the presented case studies.
3) We present new e-learning specifications for several educational services. We propose new data models and XML bindings [3] that describe the different features of the selected educational services for which there are lacks of specifications. These new specifications are based on our analysis over different LMSs (mainly Moodle, .LRN, and BlackBoard/WebCT), other different tools, and our own ideas. For each educational service, the common features that are present among most of the different LMSs should be determined. These are candidates to be mandatory fields in the specification. In a similar way, important features that are present in some LMSs but not in others are candidate to be optional fields in the specification. Finally, some marginal features of some LMSs are candidates not to be part of the new specifications.
4) We present a new authoring tool for the new LMS service specifications. The authoring tool that we have created integrates all our new defined specifications for LMS educational services and can generate XML files according to such new specifications. As far as we know, it is the first authoring tool for a wide spectrum of LMS services according to defined XML specifications. In addition, it shows that these LMS services can be put in terms easy to use by teachers without high technical knowledge.

1.2. Structure of the paper

The remainder of this paper is organized as follows. Section 2 describes the main present e-learning standards and specifications. Section 3 explains the motivation of this work based on some case studies. In Section 4, we analyze the relationship between different LMS services and present e-learning specifications. Section 5 shows how to use IMS-CP for describing the overall organization of a complete LMS course; while Section 6 explains the semantics of the new different specification models and provides some details of the XML binding. In Section 7, the implemented authoring tool is presented. In Section 8, there is a discussion about related work in relationship to our work. Finally, Section 9 is devoted to our conclusions.

2. State of the art of e-learning standards and specifications

Different studies show the importance of interoperability and standards in e-learning, such as in [25]. There are multiple consortiums and organizations that create e-learning standards and specifications. Some of the most important are: IMS Global Learning Consortium [12], ADL (Advanced Distributed Learning Initiative) [1], AICC (Aviation Industry CBT Committee) [2], OKI project [21], IEEE LTSC (Learning Technology Standards Committee) [15], and ISO/IEC Joint Technology Committee Subcommittee on Standards for Learning, Education and Technology [13].

There are different classifications of standards depending on the categorization criterion. We have divided the existing standards in the following groups:

- *Architectural standards*. They try to define architectures involving learning components. The IEEE Standard for Learning Technology Systems Architecture (LTSA) is one example.
- *Data standards*. They try to define data models for enabling the interchange of information between different learning systems. They have a data model and an XML binding. Most of IMS specifications are of this type.
- *Behavioural standards*. They try to define programming interfaces for building educational modules in order to enable communication calls between different learning systems. The OSIDs of OKI are examples of this type. Note that each educational service can have a data standard and also a behavioural one. For example, there is an OKI OSID for assessment modules and there is also the IMS-QTI specification for describing the assessment data.

In the following subsections, there is an overview of current e-learning standards and specifications. Several works explain most important ones in a deeper way such as [8] or [9].

2.1. IMS global learning consortium

IMS is a non profit organization that integrates different actors. IMS has defined a wide set of specifications related to different aspects of e-learning. Table 1 shows all the IMS specifications, with a brief description about the topic that covers. All the commented specifications are accessible through the IMS Global Consortium web page [12].

2.2. ADL: Advanced Distributed Learning initiative

ADL is a part of the Defense Department of the United States of America. The function of ADL is to document, validate and promote the use of specifications and standards developed by other sources. Their more successful e-learning specification is SCORM [1] (Shareable Content Object Reference Model). SCORM can be seen as a combination of three specifications: IMS-MD, IMS-CP and IMS-SS. It also includes a Run Time Environment in order to launch contents and track the use in LMSs.

2.3. AICC: Aviation Industry CBT Committee

Aviation Industry CBT Committee [2] was funded in 1988 for the standardization of the aviation industry products. One of their defined specifications is AICC/CMI (Computer Managed Instruction) that can be applied to e-learning. The aspect covered by AICC/CMI is very close to SCORM. At present, SCORM is more used than AICC/CMI, but some of the concepts defined in AICC were used by SCORM.