AN IMPLEMENTABLE ARCHITECTURE OF AN E-LEARNING SYSTEM

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Abstract

This paper analyses current standards and proposals for e-learning system architecture. Its main objective is to contribute an original proposal for a functional architecture and service architecture for building standard-driven distributed and interoperable learning systems. The functional architecture defines components that make up an e-learning system and the objects that must be moved among these components.

We implement the service model with Web Services technology to provide a standard means of communication among different Learning management systems and different content authoring tools. This paper focuses on how to integrate Web Services on the e-learning application domain. We use J2EE as our technical infrastructure to build our components and integrate with Web service.

Keywords: *e-learning system architecture; Web Services; J2EE*

1. INTRODUCTION

E-Learning has grown organically without a clear picture of the components of a typical e-learning system or how they interrelate. The need for such architecture is critical for defining competitive arenas and for standards development.

Up to this date, proposals are available for the standardization of information models, such as learning object metadata, learner profile and content packaging. Those standards provide the needed data structure for improving interoperability and reusability among e-learning content and system components. There are also standards about a conceptual component model of e-learning architecture like LSTC of IEEE [7]. But there is a lack of an implementable architecture to define how to combine the information model with the component model and how to define an appropriate interface between each component and subsystem to achieve interoperability.

The main objective of this paper is to contribute to this standardization process with an original proposal for a functional architecture to build standard-driven distributed and interoperable learning systems. The functional architecture defines components that make up an e-learning system and the objects that must be moved among these components. There are some proposals about functional model, such as SCORM [9], which define a general functional model of a learning management system, and Sun Microsystems also present a functional model [6]. Compared with those functional models, our proposal divides the learning system into a content management system and a learning management to make the functional responsibility more clear and try to cover all the e-learning function components. We also define the learning objects exchanged between each component, which is related to current existed learning standards.

Nowadays there are many e-learning products existing in the market which are implemented using different platforms that are not compatible with each others. For example, distributed object systems such as Microsoft's COM family and the OMG CORBA standard did not interoperate. Each presented numerous security and administration challenges when deployed over the internet, and neither quite met the scalability expectations created by the Web. Web Services provide a standard means of communication among different software applications, running on a variety of platforms and/or frameworks. The excitement over Web Services is based largely on the potential for a combination of XML, the Web, the SOAP and WSDL specifications, and to-be-defined protocol stacks to address many of the problems these technologies have encountered. Web Services are designed as a standard reference architecture in order to promote interoperability and extensibility among these applications, as well as to allow them to be combined in order to perform more complex operations [10]. This paper focuses on how to integrate Web service on the e-learning application domain.

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At the end we use J2EE as our technical infrastructure to build our components and integrate with Web Services.

There are some researches that focus on e-learning architecture. [4] proposes a framework for designing and developing agent-based online learning systems, which integrates software agents and learning objects technologies. [3] addresses the interoperability problem consequence of the proliferation of online learning systems and selects CORBA as the technological supporting infrastructure. [2] presents an open functional architecture based on an analysis of the processes involved in managing and delivering educational content and shows how agent technology can be used to solve the problem of planning collaborative learning and presenting didactically optimal content. [1] presents a layered component model to support Web-based collaborative applications. The contribution of this paper is defining a clear functional model of an e-learning system which has a close relationship with current exist standards and uses the newly emerging technology of Web Services to solve the problem of interoperability between different learning systems.

The organization of this paper is as follows. In chapter 2, we introduce the current e-learning interoperability standards and specifications. We propose a functional architecture of a standard-driven distributed and interoperable learning system in chapter 3. In chapter 4, we describe how Web Services are used in a learning environment according to the functional model we proposed and how to integrate Web Services into a J2EE platform.

2. STANDARDS IN E-LEARNING

In general, the purpose of e-learning interoperability standards is to provide standardized data structures and communications protocols for e-learning objects and cross-system workflows. When these standards are incorporated into vendor products, users of e-learning can purchase content and system components from multiple vendors, based on their quality and appropriateness, with confidence that they will work together effectively [5]. Learning standards and specifications can be organized into five categories as follows:

Metadata: Learning content and catalogs must be labeled in a consistent way to support the indexing, storage, discovery (search), and retrieval of learning objects by multiple tools across multiple repositories. Data used for this purpose are referred to as learning object metadata. Several initiatives are creating metadata standards: The Learning Object Metadata, or LOM of IEEE Learning Technology Standards [7], and the Dublin Core Metadata. Many other organizations have adopted and adapted LOM.

Content Packaging: Content packaging specifications and standards allow courses to be transported from one learning system to another. The initiatives dealing with content packaging include: The IMS Content Packaging specification [8], the IMS Simple Sequencing specification [8], the ADL Sharable Content Object Reference Model (SCORM) [9].

Learner Profile: Learner profile information can include personal data, learning plans, learning history, accessibility requirements, certifications and degrees, assessments of knowledge and the status of participation in current learning. The most important effort to standardize learner profile information is the IMS Learner Information Package (LIP) specification [8].

Learner Registration: Learner registration information allows learning delivery and administration components to know what offerings should be made available to a learner, and provides information about learning participants to the delivery environment. There are two initiatives currently dealing with these requirements in e-learning: The IMS Enterprise Specification [8], and the Schools Interoperability Framework which supports the exchange of this type of data in the K-9 environment.

Content Communication: When content is launched, there is the need to communicate learner data and previous activity information to the content. Work going on is the ADL's Sharable Content Object Reference Model (SCORM) project based on the CMI specification of the Aviation Industry CBT Committee. [9]

3. THE FUNCTIONAL MODEL

To understand how different systems might work together, it is useful to have a simple functional model of an e-learning application environment. The functional model can provide a visual representation of the components that make up an e-learning environment and the objects that must be moved among these components. SCORM defines a highly generalized model of a "Learning Management System" (LMS) as a suite of Services that manage the delivery and tracking of learning content to a learner. But it does not specify functionality within the LMS. The functional model we propose is strongly influenced by the SCORM functional model. We supplement some functions to make it cover most of the functions an e-learning environment should have, for the reason that SCORM only focuses on the function of delivery and tracking of learning content in LMS. We also divide the LMS which SCORM defined into LCMS (Learning content management system) and LMS (Learning management system) to make each system's functionality more focused and clear. In the functional model, we also define which standards information should be interchanged among each component. The standards information focuses on the SCORM content model but is not limited to it. Figure 1 below shows the functional model.

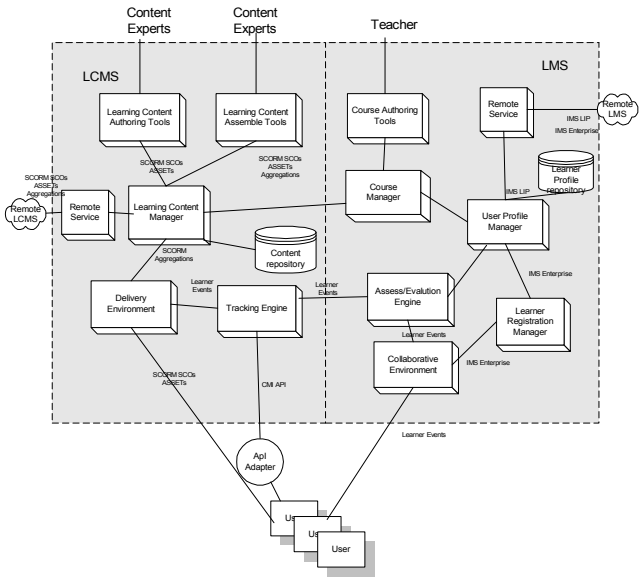

Fig. 1. Functional model of e-learning system

An LCMS is a multi-user environment where learning developers can create, store, reuse, manage, and deliver digital learning content from a central object repository. Whereas an LMS manages the processes surrounding learning, an LCMS manages the process of creating and delivering learning content, just as the names indicate.

LCMS allow users to create and reuse small units of digital instructional content. The use of standardized learning metadata structures plus standardized learning object import and export formats also allows learning objects to be created and shared by multiple tools and learning repositories. To support this interoperability across systems, LCMS is designed to conform to standard specifications for content metadata, content packaging, and content communication. Figure 1 shows the components in LCMS and the standard objects interchange between those components.

LMS needs the interchange of user profile and user registration information with other systems, the location of the course from LCMS and gets the learner action from LCMS. The components and standard information needed are shown in figure 1.

The key to integrate successfully between LMS and LCMS is an open, interoperable approach. In this paper, we introduce an architecture that uses Web Services technology to implement the interoperability between the LMS and LCMS and also between different learning systems.

4. The service architecture

From the features of Web Services, we know that Web Services are perfectly feasible for implementing the interoperability of e-learning systems for three main reasons:

- The information exchanged between e-learning systems like LOM, IMS content packaging, all have standard XML binding.
- Web Services architecture is platform and language independent. It can promote interoperability and extensibility among these various applications, platforms and frameworks that have existed in the real e-learning market.
- Web Services provide a unified programming model for the development and usage of private Intranet as well as public Internet Services. As a result, the choice of network technology can be made entirely transparent to the developer and consumer of the service.

Figure 2 shows how Web Services can be used in an e-learning environment.

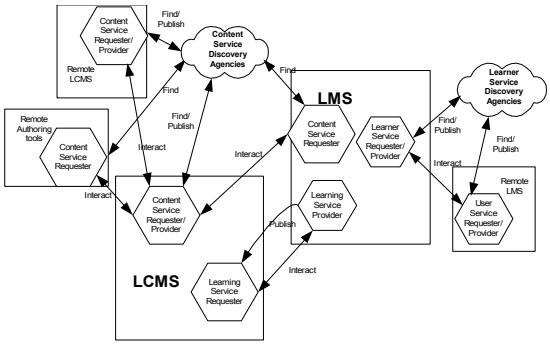

Fig. 2. Service architecture of e-learning system

This architecture defines how different e-learning systems exchange messages through the interaction of Web service agents in each system. Service Provider is the platform that hosts access to the service. It has also been referred to as a service execution environment or a service container. Its role in the client-server message exchange patterns is that of a server. Service Requestor is the application that is looking for and invoking or initiating an interaction with a service. Discovery Agency is a searchable set of service descriptions where service providers publish their service descriptions. The service discovery agency can be centralized or distributed. Standard compliant learning information presented by XML that is wrapped with the SOAP specification is exchanged between the requester and provider. The provider publishes a WSDL file that contains a description of the message and endpoint information to allow the requester to generate the SOAP message and send it to the correct destination.

5. IMPLEMENTATION

Nowadays both the J2EE and .Net platform support the implementation of Web Services. One advantage of using J2EE as a base for our system is that we have a much wider choice of vendors for our pre-built software (application servers mostly), including numerous open source projects. J2EE is an industry standard. The most important reason for us selecting J2EE is that our other systems are all java based. No architectural change is needed when we implement Web Services on J2EE and existing J2EE components can be easily exposed as Web Services. Many benefits of J2EE are preserved for Web Services such as Portability, Scalability, and Reliability.

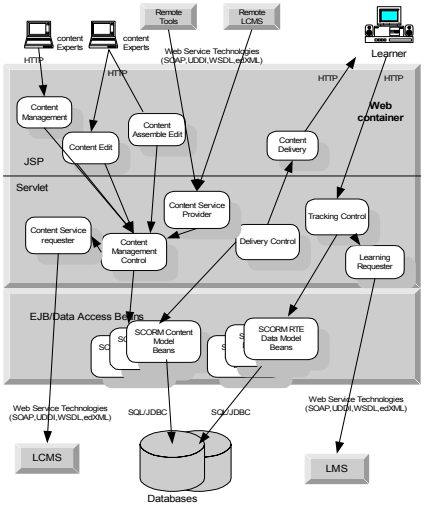

Fig. 3. System architectures of LCMS Using J2EE platform and Web Services

Briefly, Figure 3 is a system architecture view of LCMS. It shows how to use Web Services in J2EE architecture. The component in the functional model is decomposed into several components distributed into different layer. The components with similar function in the same layers are combined into one to provide service to upper layer. The J2EE programming model promotes a model that anticipates growth, encourages component-oriented code reusability, and leverages the strengths of inter-tier communication. It is the tier integration that lies at the heart of the J2EE programming model.

6. CONCLUSION AND FUTURE WORK

In this paper, we analyzed the current state of the e-learning standards. Then we proposed a functional model of an e-learning environment. We also defined the different learning objects exchanged between each components and cross-system workflows which are compatible with current existing standards.

E-learning standards provide the interoperability between learning systems and tools from different vendors from an information viewpoint. But to provide interoperability between systems on different platforms implemented by different technologies, there must have architecture support. Web Services provide a standard means of communication among different software applications, running on a variety of platforms and/or frameworks. In the second part of this paper we defined how to use Web Services technology to implement the interoperability between LCMSs and LMSs. At the end, we gave multi-tiered component-oriented system architecture of LCMS to illustrate how to integrate Web Services into a J2EE platform. We also defined the business tier of the LCMS system, which is compatible with SCORM standards.

There are many challenges for implementing such an e-learning system because Web Services and e-learning standards are all new emerged technology and are undergoing changes and developments. The security of Services, the encryption of messages, and the common taxonomies to describe Services and service access points in e-learning systems environments are all in need of consideration.

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