Digital Rights Management Implemented by RDF Graph Approach

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ABSTRACT

This paper proposes a design framework for constructing Digital Rights Management (DRM) that enables learning objects in legal usage. The central theme of this framework is that any design of a DRM must have theories as foundations to make the maintenance, extension or interoperability easy. While a learning objective consists of learning resources and its metadata, a DRM also needs metadata for describing itself as Rights Expression Language (REL). The proposed Resource Description Framework (RDF) graph design in this study is based on the Boolean operations of graph theory, whereas the RDF graph provides not only more coherent operations, but also opportunities for maintenance and interoperability at different platforms. Two algorithms for encoding and verifying rights in DRM are designed to deal with REL metadata in RDF format. This technological support also reduces the sophistication among role assignments, learning objects and task ontology of DRM. The DRM module is embedded to SCORM-compliant Content Repository Management System (CRMS) for IPR (Intellectual Property Rights) protection. Finally, some implications of this study are also included.

Keywords: digital right management; ontology; RBAC; resource description framework/RDF Schema (RDF/RDFS); right expression language (REL); role-based access control

INTRODUCTION

The digital revolution, powered by the engines of information and communication technologies (ICT), has fundamentally changed the way people think, behave, communicate, work and earn a living. It has restructured the means by which the world conducts economic and business activities and runs governments. Moreover, it has formed new ways to create knowledge, educate people and disseminate information.

Recently, the MIT Open CourseWare (OCW) has offered more than 700 free of charge courses, including lecture notes, course materials, examinations and lecture videos (OCW, 2004). Thus, the OCW can be accessed by anyone eager to learn domain knowledge in the global village, free from any physical

boundary. Although MIT has been a pioneering institution in learning technologies field, the real potential problem is to keep content providers who are willing to provide high quality teaching materials and to protect their contents in legal usage. In this digital era, the Digital Rights Management (DRM) not only refreshes e-learning content, but also leads us towards a new model of education (Rosenblatt, Trippe & Mooney, 2001). However, the enactment of DRM for content providers in education must rely on better algorithms to deal with Digital Rights metadata.

ICT has been adopted for access control in terms of protecting content providers rights. Many approaches have been proposed and applied in the real market such as Microsoft, Adobe or IBM. Although those leading companies have digital rights to make their rewards, the rewards only apply to specified customers, data formats or delivering platforms. Thus, we must develop a new way for learning objects to be protected by access control. Generally speaking, most of the existing access control mechanisms implemented for Web applications can be classified into two major categories: role-based access control (RBAC) models and the hypertext-based authorization models (Lu & Chen, 2003).

One of the core components of RBAC models is a role that represents different organizational responsibilities and functions. The use of this role can simplify the task of authorization administration by organizing related access privileges to a role and assign users to the role (Sandhu, Coynek, Feinsteink & Youmank, 1996). Later, if a user is promoted to a new position in the organization, the user can simply be assigned to a new role and removed from the old one. In addition, RBAC models support various security policies such as role hierarchies and constraint. Traditionally, the objects under control of RBAC models are either programs or documents. In this study, we extend it to Sharable Content Object Reference Model (SCORM), compliant learning objects or content packages (ADL, 2004).

Originally, a role in RBAC can access rights of the whole course package but, not portions of the course package. This feature, however, seriously limits its applicability on the Web. To overcome it, we adopt the Resource Description Framework (RDF) graph with Boolean operations to unite different learning objects as a unit. A RDF graph consists of nodes and arcs (Brickley & Guha, 2000). Nodes are labeled either with an URI (concept Resource) or an atomic value (concept Literal). Thus, a role with access rights, encoded as RDF graph, on a course package in our study can access a content package or a portion of the package.

Content Repository Management System (CRMS), a collection of SCORM-compliant learning objects, has been developed (Yang & Tsai, 2003). It, however, did not consider DRM while it authorizes a system administrator as the gate keeper for assignments of digital rights of learning resource. It violates content providers as primary authorization to confer rights for any potential users. In this study, we assume that only content providers can decide their contents to users with permissions.

Summarily, this study proposes a mechanism to enact the DRM for content providers within legal usage. To describe the authorization language, RDF graph is selected as Rights Expression Language (REL) language instead of traditional XML-based language such as ODRL (Open Digital Rights Language) (ODRL, 2003; XrML, 2002) or XACML (eXtensible Access Control Markup Language) (Guth, Neumann , & Strembeck, 2003). The reason for the RDF graph being chosen is that RDF graph has superiority to deal with the complexity of rights assignment, and Boolean operation for learning objects or content packages. Moreover, REL in RDF file formats can be used to reason by graph matching. In this study, content providers encode the digital rights in RDF file. Then, the system will decode digital rights from RDF file while users access those learning objects or content packages in CRMS. With support of semantic RDF graph, this study proposes a simpler, machine processsble and extensible model for DRM.

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