A Sharable e-Learning Platform Based on Cloud Computing

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***Abstract*--Over the Internet, e-Learning has speeded up the knowledge transfer without restrictions on time and space in recent years. In order to achieve the goal of knowledge sharing and reusing interactively, lots of available e-Learning standards have been adapted to complete this purpose. Normally, learning objects meeting these standards are sharable with other e-Learning platforms. Most e-Learning platforms, however, are unable to share learning objects directly on the Internet. The characteristics of Cloud computing provide a promising infrastructure to compute and store resources as services. Hence, this paper introduces Cloud computing into an e-Learning platform to allow the integration of different e-Learning standards to enhance interoperability of learning objects. By combining the characteristics of e-Learning and approach of Cloud computing, educators have not to re-construct learning objects to satisfy e-Learning environments developed from different e-Learning standards.**

Keywords-e-Learning, Cloud Computing, Learning Objects, Learning Standards

I. INTRODUCTION

E-Learning plays an important role in creating a good learning environment with the rapid development in internet technology. Over the past decade, an increasing number of schools and businesses have set up e-Learning platforms for their students and employees for the purpose of efficiency. Generally speaking, a good learning environment involves an authoring system, and LMS (Learning Management System), and learning object repository to create, execute, and store the teaching content [9]. Especially, the LMS plays to deliver the desired learning objects when and as needed and to track the learner's reactions and responses. There are lots of famous e-Learning standards launched to support e-Learning environment, such as SCORM (Sharable Content Object Reference Model) [1], IEEE LTSC LOM (Learning Object Metadata) [2], and IMS Common Cartridge [3]. Basically, learning objects meeting e-Learning standards are sharable with another LMS. However, every LMS platform runs its own learning objects and cannot be exchanged with another LMS. The main problem is that every individual LMS does not have the capability to share learning objects directly with another LMS. This is due to the lack of a reliable sharing mechanism among these acknowledged standards such that results in an isolated e-Learning platform. In this paper, we make use of Cloud computing platform to provide a necessary foundation for a sharing e-learning platform, where learning objects can be shared and reused significantly between e-Learning standards.

II. BACKGROUND

A. e-Learning and Metadata

With the rapid development of e-Learning and the XML (Extensible Markup Language) technology, metadata for e-Learning becomes an important item. Many e-Learning standards use metadata to pack learning objects, sharable content objects, and learning resources, such as SCORM, IEEE LTSC LOM, and IMS Learning Resource Metadata XML Binding Specification. The SCORM standard consists of two main components: CAM (Content Aggregation Model) and RTE (Run-time Environment). The CAM comes with three main elements: content model, metadata, and content packaging. The content model arranges a course for reuse, known as SCO (Sharable Content Object). Metadata files are used to describe information for a learning object through XML. Content packaging uses imsmanifest.xml (Manifest XML files) to pack SCO as the structure of the course. IEEE LOM provides a unified description for a learning object and is comprised of 9 categories: General, Life Cycle, Meta-Metadata, Technical, Education, Rights, Relation, Annotation, and Classification, to annotate learning contents in a comprehensive perspective. IMS Global Learning Consortium released a new e-Learning standard named Common Cartridge in the beginning of 2007. It mainly integrates SCORM and QTI (Question and Test Interoperability) standards [4]. The viewpoint of Common Cartridge is that SCORM-compliant courses are reused like learning resources in Common Cartridge. The metadata of Common Cartridge follows the IEEE LOM specification to develop learning contents.

While a number of e-Learning standards for learning object interoperability have been addressed, learning object meeting an e-learning standard is unable to be sharable with

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other standards. The main problem that arises is that every individual LMS does not have a capability to share learning object directly with other LMS. Therefore, there is a need to propose an interoperable way to improve learning object interoperability among these e-Learning standards such that educators and learners are greatly benefited in the content generation and content aggregation phases.

B. *Cloud Computing*

Cloud computing has become one of the hottest buzzwords in the IT area over the past years. Many companies, institutes, and researchers are trying to define clouds and provide solutions on clouds to enlist their help in computer work.

"Cloud computing" is used to describe both a system platform and a type of application in IBM's technical white paper [6]. A cloud is a type of distributed data center which delivers infrastructures as services. That is to say, it consists of massive resources and offers mechanisms to provide, re-image, workload rebalance, de-provide, and monitor those resources. In other words, it represents as one or more unified resource entities, and renders users/applications with services to access those resources without knowing the detailed information [10]. Therefore, in the Cloud computing platform, the servers can be physical or virtual servers. One of the most important characteristics behind Cloud computing is scalability, and the key technology which makes it possible is virtualization [5]. Virtualization automates the management of those resources as a single entity through hypervisor technologies such as VMs [7].

The features and advantages of Cloud computing are as follows [12]:

1. Cloud provides powerful computing and storage capacity. It makes the support of varies of applications convenient and rapid to retrieve the powerful computing and storage resources.
2. Cloud provides high resources availability. It provides real-time configuration and utilization information, allocates resources on-demand, and improves the usage rate of available resources.
3. Cloud provides high security. It guarantees the users' data security to the greatest possible degree by relying on one or more data center.
4. Cloud provides virtualization. Each application deployment environment and physical platform is managed, expensed, migrated, and backup through virtualization platform.

III. A Sharable e-Learning Architecture Based on Cloud Computing Infrastructure

A. *System Architecture*

A sharable e-Learning architecture based on Cloud computing infrastructure is composed of three layers: Infrastructure layer, Middleware layer, and Application layer as shown in Figure 1.

Infrastructure layer is used as the e-Learning resource pool that includes hardware and software virtualization technologies to ensure the stability and reliability of the infrastructure. At the same time, this layer supplies the computing and storage capacity for the higher level.

Middleware layer mainly supplies a sharable platform. The sharable platform consists of two modules: CNRI's (Corporation for National Research Initiatives) Handler System Module [8] and Metadata Transformation System Module [11]. The former is utilized to record the metadata description and physical resources in teaching resources. The latter illustrates a flow chart of metadata transformation for a variety of e-Learning standards.

Application Layer is the last application platform to supply services for learners. At this layer, Cloud computing provides convenient access to the e-Learning resources, such as authoring tool and content repository.

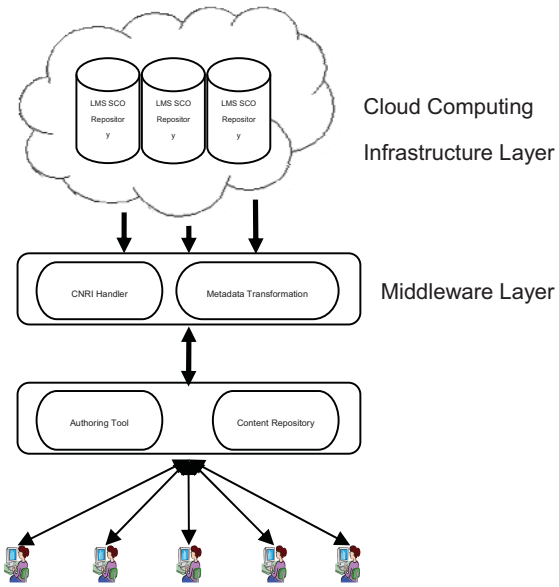

Figure 1. Architecture of a Sharable e-Learning Based on Cloud Computing.

B. *CNRI's Handler System Module*

An identification mechanism called Handler System is proposed by Corporation for National Research Initiatives. Handler system can be considered as an indexing method for general purposes which provide efficient, extendable, and secure Name Service. The Handler System in our work aims to provide a resolution service in the back-end learning content repository. Figure 2 shows the registration process and the returned parameters.

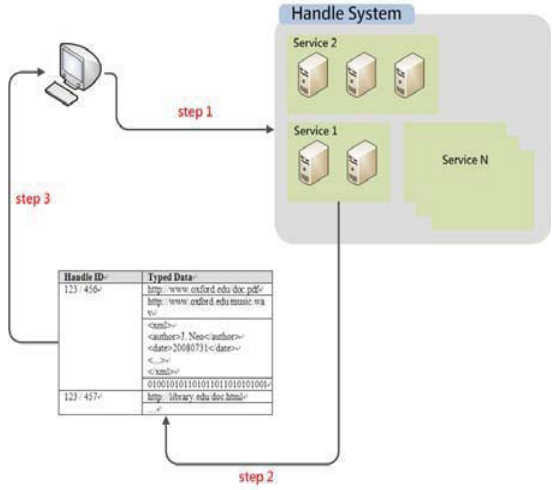

Figure 2. The Registration Process and The Returned Parameters of Handler System.

An example in figure 2 could be illustrated as below:
<HandleID>=<NamingAuthority>"/" LocalName>
A Handler is comprised of 2 main parts: Handle Naming Authority and Handle Local Name. If a handler is formed as 123/456, the Naming Authority would be 123, and the Local Name of the handler would be 456. The Local Name in the belonging Naming Authority is unique and represents a specific URL for allocating the learning resources. In this paper, we utilize the "HandleID" returned by CNRI service server to be the basis of identification of the learning resources and metadata description while re-aggregating them into the new learning content structure. Through this mechanism, the edited learning materials would be given a unique ID such that we could do the modification without lost of relevant information.

C. Metadata Transformation System Module

The flow chart of metadata transformation system module for different e-learning standards is well-defined and we also make it in an order. The detail information of the flow steps is shown in Figure 3.

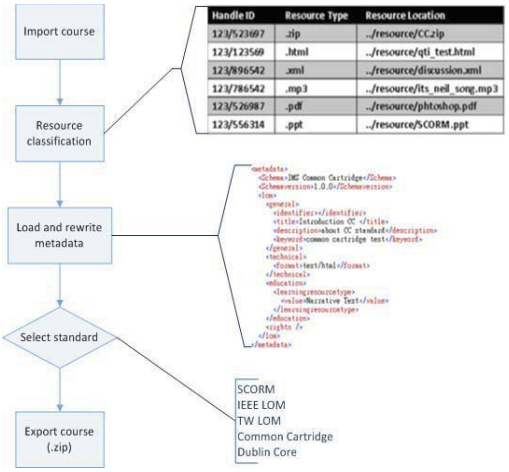

Figure 3. Process Flow of the Metadata Transformation Mechanism.

The first step is to check which platform users log in by authoring tool or LMS since both of them have different transformation process. The process in authoring tool is triggered when the learning content has been modified and is triggered when the learning content has been loaded into it in LMS. No matter which platform the users choose, learning content will be extracted to separate resources and each one of them will be marked with a HandleID. The users cannot observe the results of this step. The metadata description will be extracted form the original learning content after assigning the HandleID to each learning resource. The original metadata description is written to the temporary space by a metadata reader as shown in Figure 4 and is categorized into nine classifications based on IEEE LOM specification in order to re-build the metadata description and content aggregation of the other e-learning standards. The storage format of our proposed architecture is based on the XMLpath (the path of eXtensible Markup Language) to record the whole information and value of the original metadata description.

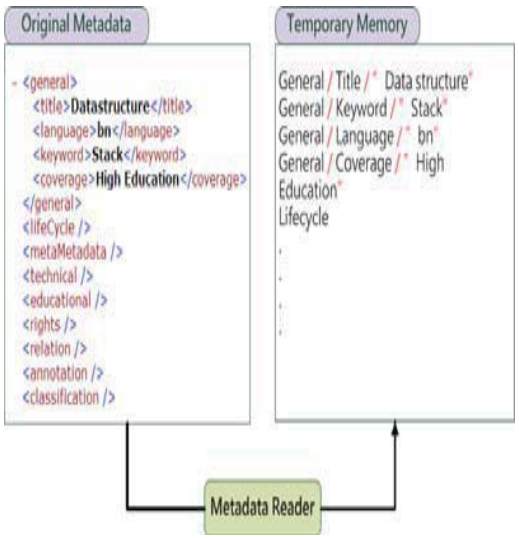

Figure 4. Temporary Memory for Storing the Original Metadata Description.

The next step is to load one of the formats of e-Learning standards after loading and writing the metadata description into the temporary memory. In Figure 5, the program loads the metadata format of TW LOM specification firstly and then the metadata writer fill out the corresponding field with the appropriate value.

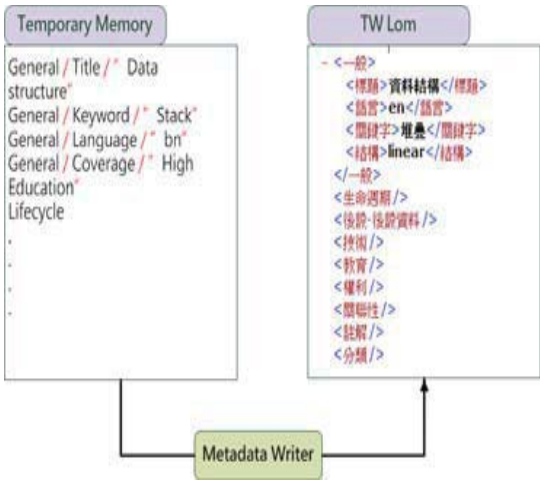

Figure 5. The re-Writing Process of TW LOM.

A program re-aggregates the learning resources in the original learning content after the modification of metadata description, and then follows a new e-Learning standard's specification to generate the content organization. For example, the SCORM-based learning content and metadata description is represented at the top of Figure 6. The metadata transformation result of our proposed flow is based on IMS Common Cartridge shown at the bottom of Figure 6.

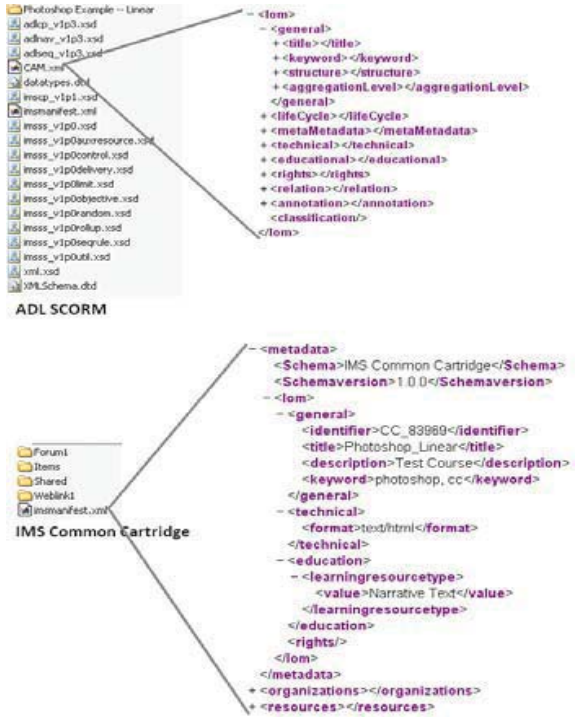

Figure 6. Learning Content Organization and Metadata Description.

IV. CONCLUSION

In the Cloud computing infrastructure, the sharable e-Learning platform was proposed to provide a good learning environment for learners. We proposed a 3-layer architecture of the e-Learning platform to facilitate the sharing, reusing learning objects and interoperability among various learning content efficiently. The middleware layer imports an indexing module and a metadata transformation module to complete metadata exchange among acknowledged e-Learning standards. Therefore, learners can make use of available learning objects without having to be affiliated with other LMS. In other words, the proposed e-Learning platform based on Cloud computing infrastructure would allow the independent LMS embedded in different e-Learning standards to share the learning objects. Finally, in this paper, a huge amount of learning objects can be accessed reliably, flexibly, and availably over the Internet by means of Cloud computing technology.

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