IMPLEMENTATION OF SCORM – COMPLIANT DIGITAL LEARNING OBJECT REPOSITORY FOR E-LEARNING PURPOSES

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Digital learning object repositories are the catalogues of the e-learning era. They are the fundamental first step in knowledge discovery and object exchange. They provide the foundation for eLearning, eWork and eCommerce in the knowledge market. This is why nowadays they are of priority interest. In Technical University – Sofia (TUS) arise a need of creation of learning knowledge pool, or digital repositories where digital learning objects may be accumulated and catalogued for broad distribution and use.

This paper presents a project aimed at designing a SCORM (Shareable Content Object Reference Model) Digital Learning Object Repository as a main part of the improved service-oriented learning technology system architecture based on open source solution Atutor.

Keywords: Digital Repository Architecture, SCORM, Learning Design

1. INTRODUCTION AND NEEDS ANALYSIS

Learning objects are simply computer files that store lessons, animations, graphics, and other content, which is used to construct e-learning experiences. This is new way of thinking about learning content. As knowledge assets in an e-learning economy, they represent an ever-increasing store of intellectual property and educational capability. Repositories are built on database technology, but seek to go beyond simple warehousing to provide mechanisms to encourage their discovery, exchange, and reuse of learning objects. Although many learning objects could be reused in different instructional contexts, much of this investment is used for highly specific audiences and remains unknown beyond the immediate creators and consumers. The promise of learning objects lies in reusability. If constructed appropriately, warehoused wisely, and catalogued accurately, a learning object might find usage beyond its original audience and instructional context.

Repositories would aggregate collections of learning objects as a book warehouse might store books, or they could hold collections of information about learning objects as a library catalogue might hold descriptions of books. The catalogue descriptions are referred to as the metadata: data about the data contained in the elements.

While the concept of learning objects is a significant advance in the creation of educational materials, it is not enough. To fully realize the possibility of personalized and reusable educational content requires the establishment of standards for the design and description of learning objects. The substantial potential benefits —

reusability, interoperability, durability, and accessibility — can only be realized if there is widespread adherence to the appropriate standards [3], [4], [5], [7].

Because not all repositories store the actual object files, a key function of repositories is to identify the storage location of the objects and provide an indexing system that enables the efficient search and discovery of the objects. How repositories accomplish the first is a function of their architecture; the latter is a function of their catalogue information or metadata.

Organizations such as the IEEE Learning Technology Standards Committee, the IMS Global Learning Consortium and the US Advanced Distributed Learning Initiative have released a collection of learning technology standards that are being implemented in products and systems.

Content that standards based, content that is used and managed in new ways and within new architectures and frameworks requires whole new authoring process and create a new age of authoring.

The European-based distributed digital library of educational resources delivered reusable components has realized and this knowledge pool distributes learning to hundreds of multicultural/multilingual teachers and learners [1], [2], [6], [9].

The need of creation of the Digital Learning Object Repository, which ensures a basic set of functions in order to provide access to learning objects and assets, grows for the engineering education in Bulgaria and in particular for Technical University – Sofia.

The team of Research & Development Laboratory "E-learning Technology" at the Technical University – Sofia aims to design and implement this Digital Learning Object Repository in order to integrate eLearning resources in a distributed Knowledge Pool. It allows repurposing the learning objects from an existing course for reuse in a different context and producing professional, engaging, and interactive training content.

2. Architecture and Services

Our implementation will contain Digital Learning Object Repository with the following characteristics and requirements for its behavior:

Will identify the storage location of a given learning object and provide unique identifier to enable efficient search and discovery of the learning object.

Has to store one or more classes of registered learning objects (learning content, meta-data, learning objectives, etc).

Has to support at least one standard format for representing each class of content object contained within the repository. The format will be used for data import and export of the object.

Has to provide a standard interface to retrieve an identified content object.

May support any number of additional formats, methods and rules.

While finding content, sharing it, and reusing or repurposing it are key long-term goals, the current approaches and interoperability models focus on content and learning management at the intra-organizational course level. There are formal models to describe the content, to move it between delivery and management systems, and to let it be delivered by any conforming delivery system. Content Delivery Model has to offer the following services:

Content service uses information to determine appropriate resources.

Resolution service determines potential resource content sources for delivery.

Resolution service accesses content repository services.

Repository services provide neutral interface to digital libraries and repositories.

Content is typically stored in file systems or content management systems that are coupled with learning delivery (e.g., a learning content management system) operated for a single (typically closed) enterprise. Content interoperability focuses on models to describe content and move collections between delivery systems, local repositories and delivery environments. One such approach will be cost effective; will reduce the time and the learning content can be effectively uncoupled from a particular delivery technology.

The IMS Digital Repository Interoperability (IMS DRI) model is the product of the IMS Digital Repository Working Group and it is the model that we will follow for designing of the Digital Learning Object Repository. The goal of the IMS DRI is to provide repository technology to support the presentation, configuration and delivery of learning objects.

Repository systems provide key infrastructure for the development, storage, management, discovery and delivery of all types of electronic content. SCORM content packaging, with its inclusion of mandatory self-descriptive meta-data, plays an important role enabling advanced functionality for repository systems.

Repositories must provide a basic set of services in order to provide access to learning objects and other assets in a secure environment. The following list of operations presents a sampling of common core functionality:

Search/Expose service defines the searching of meta-data for assets "exposed" by repositories. A repository can be searched directly or using an intermediate search engine. Xquery is used when searching meta-data in the IMS XML format, while Z39.50 is used for searching library information. Cross-domain queries search repositories containing different types of meta-data. One possible method for implementing cross-domain searches would rely on an intermediary that would translate a query, based on a subset of the XQuery grammar, into the appropriate syntax for one or more target repositories.

Gather/Expose service allows the aggregation of meta-data from repositories for use in subsequent searches. The Gather function may actively request meta-data from a repository ("pull") or it can subscribe to a service that notifies the Gather component when meta-data in the repository has been added, deleted or changed ("push"). A Gather Engine periodically searches a set of target repositories and retrieves meta-data based on a range of dates. Using date as the primary criterion for retrieval is effective in harvesting all the meta-data that has been added or modified. Another option for Pull Gather is to periodically harvest all the meta-data from all the target repositories. Push Gather relies on repositories notifying specific aggregators each time meta-data is added or updated. The notice could be a message indicating that the meta-data had changed or it could be the actual meta-data record. An adapter that is external to the repository could also provide this functionality. The adapter could forward the meta-data to the aggregators as content is added to the repository. It could also handle any required message translations between the repository and the network.

Submit/Store refers to the way an object is moved to a repository and made accessible. Submit places an object into a repository. Store allows a repository to store the object so that it may be retrieved later. Existing repository systems may already have a submission mechanism such as File Transfer Protocol (FTP) in place. For newer repositories the Submit function could be performed using Simple Object Access Protocol (SOAP) messages with attachments, where the attachments are IMS compliant Content Packages. For repositories that deal specifically with learning objects, the DRI refers to the IMS Content Packaging Specification. This specification defines a compressed file package that contains learning object(s), meta-data and a manifest listing the contents in the package.

Request/Deliver services allow a system user to request learning objects or other resources located with the Search function. The Search function returns repository object identifiers as a list of locations or as a method, such as a Digital Object Identifier (DOI), that resolves to one or more locations. The location returned by Search resolves to a URL that can then be used to Request the object. The protocol used to deliver a requested learning object depends on the object type. For example, online materials and streaming media would be delivered using HTTP, while documents and executable files would be delivered using FTP. Request functional component allows a resource utilizes that has located a meta-data record via the Search (and possibly via the Alert) function to request access to the learning object or other resource described by the meta-data. Deliver refers to the response from the repository, which provides access to the resource.

Alert/Expose services provide a method for notifying interested parties of any changes made to content stored in a repository or repository system. They are not considered in Phase 1 of the DRI specification. It is envisioned that the Alert function could be provided using a mechanism such as SMTP (Simple Mail Transfer Protocol) email.

3. USE CASE ANALYSIS AND FUNCTIONAL ARCHITECTURE

The use case analysis visualizes all above mentioned services of SCORM-complaint Digital Repository. It defines Repository's functionality and the participation of different actors. Actors are people or systems that participate in the process of performing a use case. The actors in the use cases perform roles of Producer, Learner, Performer, or Coordinator.

Producer is an actor that participates in the process of developing resources for or modifying resources in the repository system. Learner is an actor that needs to acquire knowledge through education or training using the repository resources, and is not expected to have knowledge in the learning materials. It is most likely that the Learner access the training via LMS. In contrast Performer has some mastery of the learning materials and has some idea of what to seek, where the information is to fulfill an immediate performance need through focused training. Coordinator is an actor that accesses and aggregates resources from the repository system for use by other actors.

The following Use Cases describe scenarios where certain actors (considering that the actor is logged and authenticated in the system) assume specific roles within a learning repository.

Create Resources – Producer authors a course and submit it to the repository.

Modify Resources – Producer requests a course, modifies it, and submit it to the repository.

Discover Resources – Anyone of the actors searches the meta-data in the repository and requests the discovered resource.

Notification of Modification of Resources – Anyone of the actors subscribes to be alerted when a specified change occurs to the meta-data in the repository.

The diagram in Figure 1 depicts the Digital Repository functional architecture. The red lines show the interactions. The diagram maps out three entity types that define the space where eLearning, digital repositories, and Information Services interact, and which provide a context for exploration of the problem space.

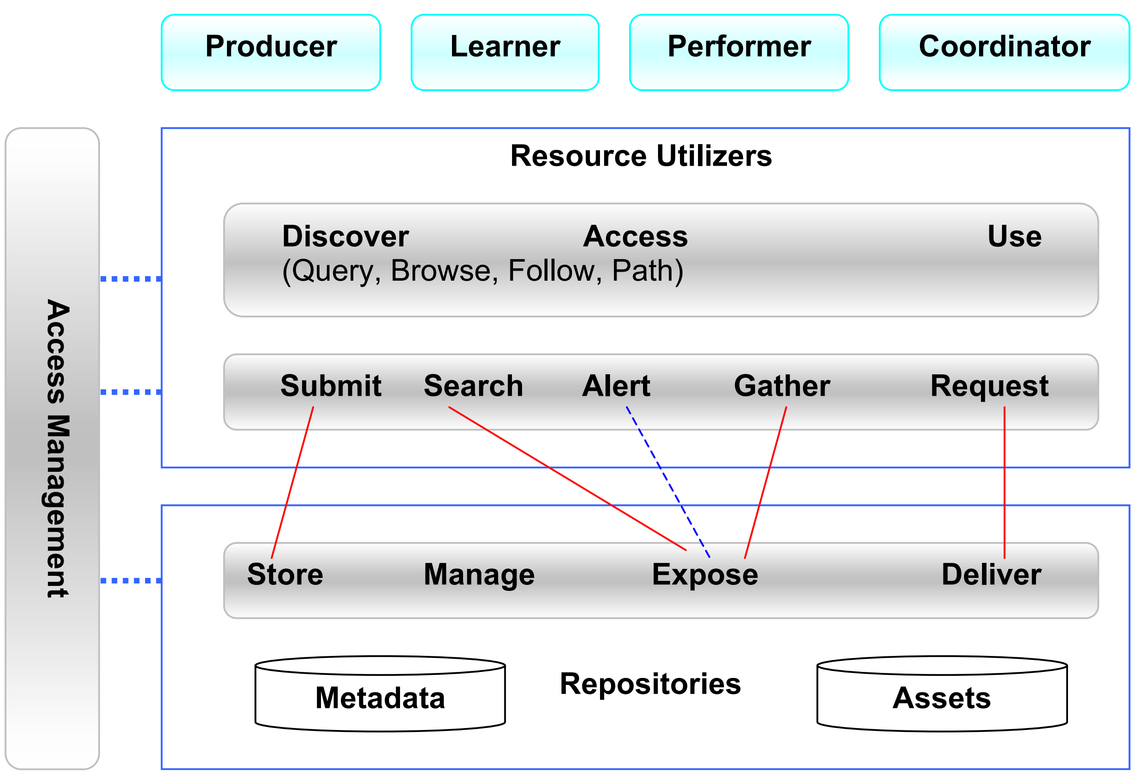

Fig. 1

4. Results and Conclusions

This investigation paper shows one way for Digital Learning Object Repository designing and implementation of a number of major services - Search/Expose, Gather/Expose, Submit/Store, Request/Deliver, Alert/Expose. The analysis will affect on future repository architecture implementation in TUS and be useful for managing SCORM-compliant content.

The creating of Digital Learning Object Repository is the main part of the improved service-oriented learning technology system architecture based on open source solution ATutor. The future objectives are to:

Develop the Technical Architecture.

Implement the Digital learning Object Repository.

Develop meta-data descriptive tagging schema.

Extend the schema to identify objects that can and cannot be combined with each other.

Ensure access and compatibility with ATutor.

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