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FreeLOms: supporting the collaborative evolution of "open learning objects"

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Abstract: - In this paper we present FreeLoms a collaborative environment for sharing and creating Learning Objects in an open perspective. FreeLoms combines the functionalities of a Learning Object Repository with those of a collaborative environment. An abstract Learning Object model was implemented in order to facilitate the management of different typologies of learning materials. Our work was conceived within SLOOP (Sharing Learning Object in an Open Perspective), a project co-financed by the European Commission, under the Leonardo Da Vinci programme.

Key-Words: - Learning Object, Learning Object Repository, LOM, SCORM, CSCL

1 Introduction

There is an ever more frequent application of ICT in educational contexts and a corresponding increase in teachers' ability to use these technologies; but the production and sharing of digital contents according to the Learning Object approach in the school and university is still at an embryonic stage and practiced by a limited number of teachers.

At a technical level the diffusion of Learning Objects appears to hampered by a lack of software which facilitates their authoring but still allows the sharing and reusability of the contents produced. Generally, the term *sharing* indicates "providing common access to contents", while we consider a deeper level of sharing which envisages cooperation between teachers in creating the educational objects, or even better in a "collaborative evolution" of these objects.

The objective of creating software for authoring and sharing learning objects at the same time seems to be difficult to achieve. In order to understand the reasons for this, it is worth taking time to consider the basic concept of a learning object: in a very general way, we can see it as any digital object that can be used to support learning, described through metadata; embracing the SCORM terminology, we can restrict this view by adding that the object must be usable by a web browser.

The idea of setting up a platform which allows users to edit any digital form in a simple and economical manner appears to be extremely ambitious.

In particular, by adopting the SCORM[1] standard, in order to facilitate the sharing and reusability of learning objects and their integration in the highest possible number of Learning Management Systems, the editor should first allow the manipulation of all the digital formats imaginable for the assets (defined in the standard as "...electronic representations of media, text, images, sounds, web pages, assessment objects or other pieces of data that can be delivered to a Web Client"); it should also allow the management of its own data format for the SCO (defined as "...a collection of one or more Assets that include a specific launchable asset that uses the SCORM Run-Time Environment to communicate with ...LMSs") as well as the various proprietary formats of firms producing SCORM compliant authoring systems, since no shared format exists.

To reduce the complexity of such a system, choices should be made to limit the options for users regarding:

- the format to use for creating different assets
- the authoring system to use for producing SCO.

This could simplify the development of an on-line editor capable of producing Learning Objects collaboratively, but would also mean moving away not only from the standard adopted but also from the basic concept of a learning object, as described above.

The aspect concerning the management of metadata, the second fundamental component of a learning object, is completely different. In this case, the management of the metadata of any learning object (whatever the digital format of its contents) by means of a single editor appears to be a feasible objective, and it is advisable to work in this direction in developing simple, intuitive and economical

environments for the production and management of Learning Objects.
In this paper, we describe FreeLOms, a platform that allows teachers to develop, modify and reuse LOs in a real and effective collaborative way.
The original aim was to implement a repository to share LOs produced with tools external to the system; later, we enhanced the functionalities of the repository in such a way as to transform it into a LO management system
The work illustrated in this paper is part of an EU funded project named SLOOP: Sharing Learning Objects in an Open Perspective[2], co-financed by the European Commission, under the Leonardo Da Vinci programme (Project N. I/05/B/F/PP-154194)

2 Learning Object Repositories and the Sloop project

The technological evolution has brought about remarkable changes in various fields of education; radical transformations have also taken place in the production and the sharing of educational resources. The last few years have witnessed a transformation from the production of specialized courseware for specific platforms to a modular approach with the aim of producing reusable and interoperable learning resources.
The characteristics of reusability and interoperability are linked to the need to create learning resources to be used in different educational contexts and for different platforms in order to safeguard the financial investments in the production of didactic materials.
The proposal to structure learning contents according to the model of the learning object has evolved out of this context. In the literature [3] learning objects are considered as modular and self-consistent educational elements, and are often compared to LEGO bricks.
According to the conception of the learning object, the modularity and self-consistency of the learning resources allow the authors of the course to produce personalized lessons by selecting and arranging didactic material in order to meet specific educational objectives.
As a consequence, the importance of sharing didactic materials has led to the diffusion of Content Repositories which are specialized in the storage of didactic contents and have become known as Learning Object Repositories (LOR).
As already stated in the introduction to this paper, the Sloop project proposes the implementation of a content environment that extends the storage functionalities of Learning Object Repositories, by adding functionalities to facilitate the sharing of learning materials, creating a collaborative work environment for Learning Objects.

2.1 Learning Object Repositories

The Learning Object Repositories have been used to improve the management of categorization and retrieval of learning materials. An analysis of the main definitions adopted in literature for the term “Learning Object” reveals that any digital or non digital content used in a learning context may be considered as a Learning Object. Therefore, the typologies of didactic content can be very different and include: textual content, images, videos and materials produced in an open format or with proprietary authoring tools.
The description of the learning object using the meta-data is the essential factor for an efficient categorization of all these possible typologies of didactic resources which are available in different formats. The validity of this approach is demonstrated by its successful application in book categorization.
The metadata description makes it easy to perform searches on multimedia contents, too; these types of contents are typically more difficult to index using traditional search engines based on keywords.
There are generally two approaches used by Learning Object Repositories for finding stored Learning Objects: the organization of the content in categories linked to a taxonomy of the topics; free searching by means of the keywords present in the content (when the format allows this) or in the meta-data associated to the content.
As regards the memorization of Learning Objects, generally Learning Object Repositories can be classified in two categories: repositories that store Learning Objects and their meta-data descriptions, and repositories that store only the archives of meta-data associated to Learning Objects and the references about where to retrieve the Learning Objects [4].
Repositories belonging to the first category are divided into those that follow a centralized model in which Learning Objects are stored in a single location, and those that follow a distributed model in which the information is distributed among different connected locations.

2.2 Sharing Learning Objects in Sloop

To meet the objectives of the Sloop project we have designed a collaborative environment capable of storing both metadata and learning contents, and of

managing collaborative work in a distributed, shared archive.

As already mentioned, one of the main problems linked to the management of learning contents is related to the variety of formats in which the contents can be created.

Therefore, in the framework of the Sloop project an environment has been designed by means of an abstract model of the contents which is able to manage different formats of learning materials, thus simplifying sharing. Consequently, attention is not focused on the implementation of a universal environment for editing every format of contents, but our objective is rather to develop a collaborative environment for the creation of didactic contents.

In the Sloop approach a repository is intended to manage *Free LOs,* i.e. "open" contents; by the term "open" we mean:

- contents developed according to open data formats, which can therefore be edited with a variety of tools (e.g. commercial products as well as open Source editors);
- contents developed by commercial software that also provides the data source, thus enabling other users to change the content.

In this perspective, our system will enable "collaborative evolution" of the educational objects at content level, too.

Therefore, we have planned the main functionalities in order to allow the sharing of didactic material published by different users in different formats.

In the system we have designed, the typical functionalities of a Learning Object Repository have been extended in order to allow:

1) the management of the changes made to the didactic contents and to the describing metadata by means of a versioning system able to recognize the differences and distinguish the contributions supplied by each user.
2) the possibility of managing a branch that can originate from a specific version of a Learning Object.
3) the support in the transformation of contents available in unsuitable formats for learning platforms, to contents compliant with the new standards for e-learning.
4) the definition of specialized and personalized searches on the contents of the repository. These features meet the needs of each author who is often interested in carrying out searches on the same specific topics for his/her educational discipline.

Finally, one of the main objectives of the Sloop project is to create an environment of collaborative management for didactic resources; it has also to supply functionalities typical of Computer Supported Collaborative Work systems, allowing synchronous or asynchronous communication processes, as well as the sharing of resources and the support of group processes.

Naturally, the realization of such an environment requires a considerable effort if the design is not based on standard specifications that improve the quality of the system to be developed. In the following paragraphs we describe the technological solutions on which the design for the creation of the system is based.

3 FreeLOms

FreeLOms is a platform that provides teachers with a repository to facilitate the sharing and reuse of LOs (both assets and SCOs) produced with systems external to the platform.

In particular it includes features for:

- LO Metadata Editing (IEEE Standard for Learning Object Metadata 1484.12.1)[5] that can be used to add and edit metadata to any LO uploaded into the repository;
- Versioning and differencing (both at metadata and content levels): these terms refer to the management of multiple versions of a set of information; they are used in processes (normally collaborative) which involve the management of digital documents constantly evolving. More precisely, these features will make it possible to handle the changes performed by different users to the same LO, at metadata level, thus guaranteeing the "collaborative evolution" of LOs
- Managing LOs in SCORM vision (Sharable Content Object Reference Model) by allowing users to edit Assets, SCOs and Content Aggregations.

To provide this kind of platform we have enhanced and customized the Alfresco content management system [6] that includes a repository system. According to the vision of the Sloop project, Alfresco is an open source platform based on open standards. In fact, the Alfresco repository is compliant with the Content Repository API for Java™ Technology Specification (JSR 170) [7] while the Alfresco Web Client is compliant with JSR-168 portal, such as the JBoss 2.0 Portal. The Alfresco portlet framework is reusable, extensible and has been developed using the JSR-127 Java

Server Faces.
Moreover, Alfresco has some other interesting features that make it an effective solution for the creation of a modern LOR. Below, we provide a brief description of these Alfresco features.

3.1 Content Repository API for Java and Alfresco

As a repository, Alfresco is JSR-170 Level 2 compliant, therefore it allows users to manage a repository model structured as shown in Fig. 1.

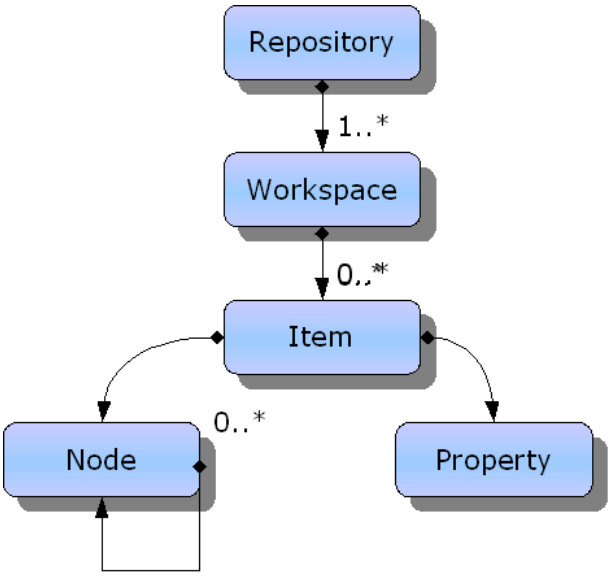

Figure 1: Repository model in JSR-170 Level 2

The repository consists of an unbounded set of named workspaces; each workspace contains a hierarchy of items in the form of a tree (nodes and properties). Nodes provide names and structure to the contents while properties (by key/value mechanism) contain the content.
Each workspace has its own name and root node and is independent of the others; i.e. the node hierarchy and content within that workspace are not directly affected by changes in other workspaces; however, there is a corresponding relationship between nodes in different workspaces. This is a useful feature in collaborative applications for tracking changes within other workspaces and performing comparisons.
A node is typed using an extensible mechanism based on a namespace which allows users to structure the content through the definition of specific constraints. As an example, some node types may be closer to a directory consisting of a set of child nodes, while other node types may be similar to a file and consist of a collection of child properties such as the author, the creation date, the content itself, and so on. Each node may be versioned through an associated graph of past version nodes.
The JCR specification defines different levels of compliancy; in particular JSR-170 specifies a Level 1, a Level 2 and a set of optional repository features. Alfresco is fully JSR-170 compliant and therefore supports Level 1, Level 2 and some of the advanced features.
Besides Alfresco, there are several implementations of JSR-170 such as Jackrabbit or Magnolia Open CMS. However, starting from the new aspect-oriented programming approach, Alfresco creates a highly customizable system both at architectural and content model levels.
Firstly, Alfresco provides the *Aspect* concept that allows the user to define cross-cutting properties for the content as an Aspect and to link Aspects with specific behaviors (examples of Aspects are Versionable, Translatable, etc.).
The system also provides full text indexing and retrieval mechanisms, using the Lucene search engine; there are multiple query models that support different types of searching and information access such as the JCR/Xpath query specification (as required by the JSR-170) and an extended version of the Lucene query language that facilitates mixed metadata and classification searches with full-text searching.
Besides, the end user can manage rule-driven processing of content (e.g. add, modify, classify, convert or move data); for example, after a document is uploaded, the system can automatically extract metadata or convert them into another content type by using the OpenOffice server engine.
One of the many features that makes Alfresco particularly suitable for the SLOOP project, is the option to create collaborative spaces and control the content creation process. Other important features provided by Alfresco include:

- enterprise authentication systems (such as LDAP and Microsoft Active Directory),
- the definition of policy at role/group level,
- the definition of workflows (in the future Alfresco will be able to manage BPEL processes),
- locking, to prevent more than one person from updating the same LO at the same time,
- the versioning system.

Furthermore, Alfresco has a standard interface that allows its integration into a more complex system; moreover, it provides several kinds of interfaces such as Java-Remote Method Interface (Java-RMI),

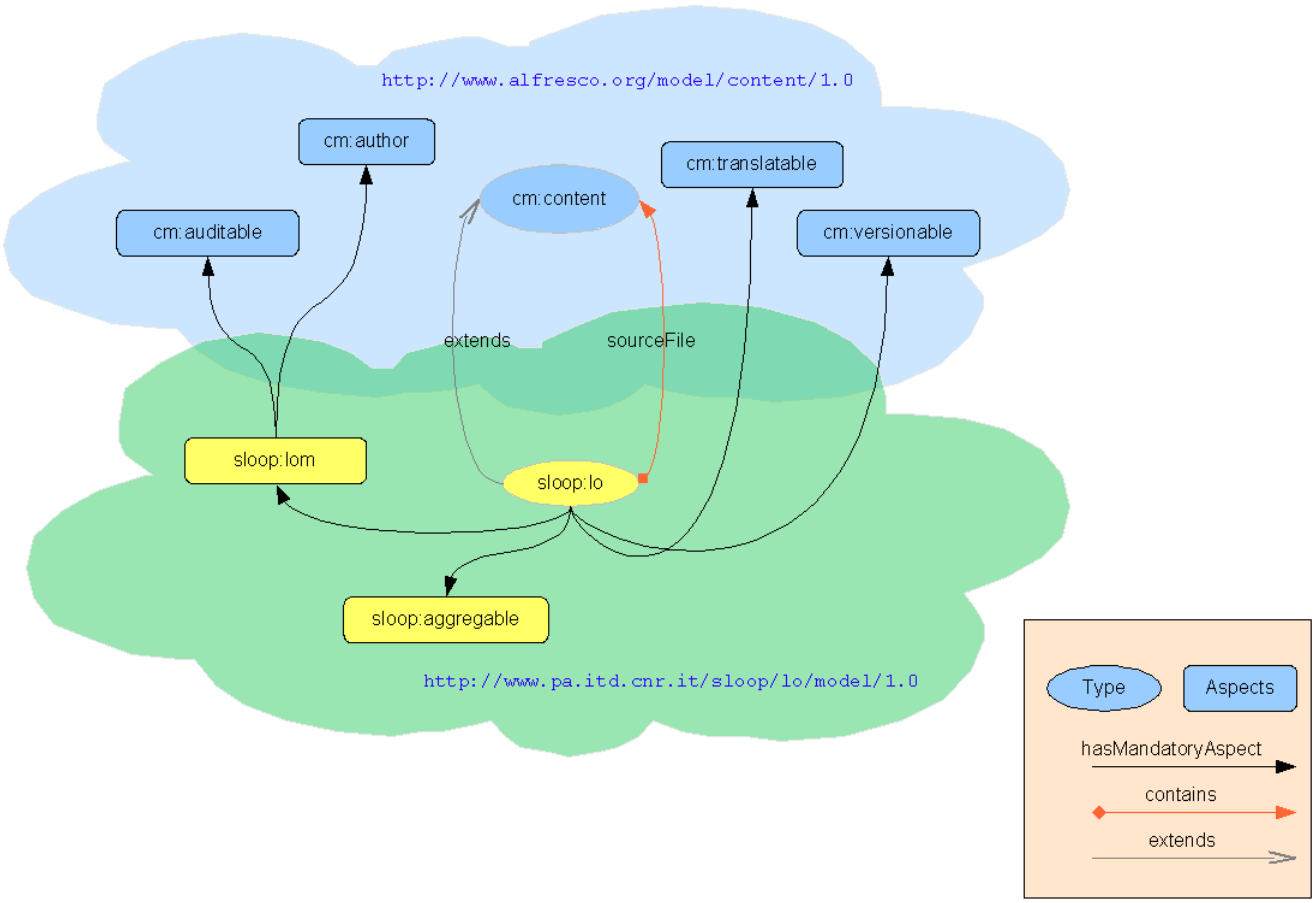

Figure 2: FreeLO content model

Web Service and WebDAV and the API support for languages other than Java, such as Perl, PHP and .NET.

In addition, Alfresco provides easy access to the repository by the emulation of the Common Internet File System standard (CIFS) that allows end users to access the repository as though they were accessing a shared drive, and so to access it from any application, permitting off-line synchronization, drive mounting and so on.

Finally, Alfresco has a Web Client that allows users to access all the features described above.

3.2 Making Alfresco FreeLOms

Alfresco provides end users with an XML language to extend the repository content model through the definition of new types and aspects. The definition of new content types is based on typical object oriented constructs such as extension, aggregation and association. Moreover, as described above, it is possible to define new aspects to model the cross-cutting properties of the contents.

Taking this structure as a base and following the general guidelines of the Sloop project, we have defined a specific model to develop "real" re-usable Learning Objects. In particular, we have defined:

- a specific Learning Object Metadata profile
- a new content model for LOs and a new LOM aspect according to the Alfresco system
- a new content model for assets and SCOs
- a new content model for Content Aggregations

As Fig. 2 shows, a learning object is an extension of the node type *cm:content* defined in the Alfresco content model and containing, as a child association, another *cm:content* node; with this mechanism users can upload both the source file and the LO (according to the definition of Free LO described above). The LO types have some mandatory aspects such as *versionable* and *translatable* and the *LO Metadata* aspect that we have defined; the LOM aspect allows the user to store the metadata of the LO as defined in the IEEE LOM specification.

In order to provide the management of LOs in the SCORM vision we have extended the content model by defining asset, SCO and Content Aggregation

(the latter is based on the *cm:folder* type), and we have linked these node types to the new *sloop:aggregable* aspect; this aspect allows users to adopt the *aggregable* resource in order to create the Content Aggregation of a SCORM package.

As indicated above, the Alfresco Web Client defines a framework of reusable, extensible portlets developed using the JSR-127 Java Server Faces.

Using this framework we have enhanced and customized the client to allow:

- the insertion and modification of LO metadata
- the editing of assets, SCOs (only some kinds of mime-type can be edited by the system as HTML pages)
- the editing of Content Aggregation
- the export of SCORM packages by means of the automatic generation of imsmanifest.xml files.

Finally, we have enhanced the Alfresco Versioning System to provide a differencing mechanism both at metadata and data level.

4 Conclusions

In this paper we have described FreeLOms. According to the vision of the SLOOP project, FreeLOms provides a repository to facilitate sharing, developing and reusing of open LOs in a real and effective collaborative way.

To achieve this aim we have enhanced and customized the Alfresco content management system through the definition of an innovative LO content model.

The core concept of FreeLOms is the collaborative management of didactic resources through the typical functionalities of Computer Supported Collaborative Work systems.

Future work will focus on the integration of FreeLOms with an open source Learning Management System in order to provide a complete learning environment.

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