

The Integration of Learning Object Repositories and Learning Management Systems

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Abstract. The systems aimed for manipulating large number of courses and students are called Learning Management Systems (LMS). A LMS can have excellent performance implemented through advanced Web technologies but it is often accompanied by a poor or rarely used repository of institution's educational content. It has still remained. Still remains a problem how to allow users of a LMS to easily modify and integrate the content from federated e-learning repositories into their courses. This article presents an analysis of present repository frameworks and projects. FEDORA (Flexible Extensible Digital Repository Object Architecture) framework is explained as an alternative repository solution. A pilot application has been developed to demonstrate the interaction between a LMS and its repository.

Keywords: learning object repositories, learning management systems, learning objects

1. Introduction

One globally accepted way to implement e-learning is by using a Learning Management System (LMS) as all-in-one system for online education, which covers registration, administering and monitoring of users and content. LMS also provides other tools such as assessment tools, discussion forums, grading tools and so forth. Therefore, it has become an irreplaceable solution for modern universities and other educational institutions. Blackboard is the leading commercial provider of LMS solutions and Moodle is a widely accepted open source solution [1]. Generally, LMSs support exporting of learning content to other systems but collaboration with external e-learning

repositories is not standardized yet. On the other hand, solutions for e-learning repositories are advancing, offering federated sophisticated searches of learning objects through a network of repositories [3]. The term "learning object" (LO) is not intended to be restrictive but refers to any digital asset which can be used to enable teaching or learning [26].

So on the one hand we have intensively used LMSs and on the other hand there are still poorly used e-learning repositories. Many projects tried to define integration between LMSs and federated repositories but none has provided a widely accepted solution.

The main goal of research presented in this paper is to propose an effective integration between LMSs and e-learning repositories. Realization of such a project could allow university staff to easily access e-learning repository, search, create, annotate, share, compose, decompose and modify content without any special knowledge of web technologies. It is also important that the repository should not function only at the institutional level but it should also have the ability to interact with other repositories as a part of federated network of repositories.

Our principle guideline for research and analysis of projects in the field is defined by the following question – are the present solutions capable or useful for the needed complete integration between LMS and LO repository (LOR) or a network of LORs?

Our research of the projects in the field goes in three main directions:

- LORs and their functionalities

Many e-learning repositories have already joined the federated networks of repositories so in this paper we shall present the main LORs and analyze their capability for integration with LMS.

- Projects focused on integration between LMSs and LORs

Projects in this field are mainly focused on creating plug-in applications that would allow interaction between LMSs and LORs.

- Projects focused on decomposition, reuse and exchange of LO

Diverse projects and existent frameworks have tried to find a way to successfully preserve data in the form of digital objects that could be easily imported, decomposed and recreated into a new object. We shall analyze these projects to see how they can be used for achieving successful manipulation over e-learning content. An analysis of all the three categories is presented in Section 2. The last part of the Section 2 also covers a possible integration of main projects in all three fields mentioned in Section 2.

In Section 3 we propose a proprietary solution by introducing FEDORA [2] repository framework based on data-service oriented architecture. We show how FEDORA can serve as a LOR by examining of the core FEDORA platform features. We explain how it is possible for any LMS to communicate with FEDORA. We also show possible manipulations over LO stored in FEDORA.

For demonstration purposes we have built a pilot application for creating lessons out of LOs stored in FEDORA LOR. In Section 4 we describe the functionality of our application. Testing and evaluation of our application is described in Section 5 and conclusion of this paper is given in Section 6.

2. Research of projects in the field

2.1. LO repositories and actual projects in field

MERLOT, PALOMA, EDNA and ARIADNE LOR [3] are some of the prominent LORs. Since many of them are using different metadata schemes to describe the content stored in the repository, research in the field of e-learning repositories is mainly focused on interoperability between LO repositories. An Application Program Interface (API) was established for querying through Simple Query Interface search (SQI) with special focus on issues related to a common metadata schema and to a common query language [5]. SQI Registry tried to establish interoperability among different LO repositories. It is basically an UDDI (Universal Description, Discovery and Integration) [12] registry, which maintains a list of SQI targets (repositories) that can be queried using SQI. PROLEARN Network of Excellence [13] is coordinating some of the practical experimentation with these specifications and many important repositories already became part of SQI Registry. The GLOBE (Global Learning Objects Brokered Exchange) project is an international effort to create federated search engine over distributed LORs for searching e-learning content [24]. Through GLOBE interface, SQI Registry repositories can be searched with standard web search. An attempt to integrate LMSs into federated repositories was made by the ARIADNE group within the GLOBE project through the development of a tool which is a plug-in for Moodle LMS [4]. The tool allows users just to search, retrieve and store a LO as a local object.

The main SCORM (Sharable Content Object Reference Model) [6] attempt aimed at providing such shareable LO environment is called CORDRA (Content Object Repository Discovery and Registration Architecture) [6]. CORDRA is a highly complex system that is still under development and has not yet been adopted by any of the educational institutions. Basic start up goal is to connect US government departments and agencies, and ADL (Advanced Distributed Learning) laboratories in order to create a network of content which would eventually become widely used.

Another attempt in the field is EduSource Communication Layer (ECL) [7]. The ECL Gateway [7] is a middleware framework that enables building bridges to other protocols easily. It is used to develop bridges to several other protocols and networks such as OAI (Open Archive Initiative) [16], SRW/SRU (Search and Retrieve Web services/ Search and Retrieve URL) [17], Resource Discovery Network in UK [18], EdNA (Australia), SMETE (USA) [19], LionShare (Gnutella based P2P network) [20] and also SQI. ECL is one of the first implementations of the IMS Digital Repositories Interoperability (IMS DRI) [7] specification. IMS DRI will allow repositories not only to share, search, and import results but also to gather records, alter each other

according to new materials and submit new materials in other repositories [14].

In comparison with SQL, ECL has further broadened its goal, trying to connect practically every repository that could be found, including those in P2P networks and private users. Large number of universities and other institutions are using ECL framework. All connected networks are registered in the ECL registry and are available to ECL users. ECL registry is implemented in JUDDI (an implementation of standard UDDI) [21]. All previously named implementations are focused on interoperability among LORs but they have poor integration with existing LMS systems. The GLOBE tool for example does not allow LMS users to change a LO, store it as a new LO, subscribe to changes in a LO, nor does it provide easy integration with present content through any form of referencing service. ECL on the other hand has many of these features but each of them is tied to a certain exchange protocol upon which a given repository functions, without tools for integration with LMSs.

There is another institution that is doing a lot of research in the related field of library archives - Open Archives Initiative has started Object Reuse and Exchange (OAI-ORE) [9] which defines standards for the description and exchange of aggregations of web resources. The goal of these standards is to expose aggregations of rich content to applications that support authoring, deposit, exchange, visualization, reuse and preservation [9]. The OAI already produced a protocol very similar to SQL - Protocol for Metadata Harvesting (OAI-PMH) [9], as a mechanism for repository interoperability. It consists of Data Providers, repositories that expose structured metadata via OAI-PMH, and Service Providers that make OAI-PMH service requests to harvest or manipulate that metadata. OAI-PMH is widely used, highly valued and continually developed, which cannot be said for the network of LORs based on SQL and used by the academic community. A large number of frequently used institutional repositories and projects are based on OAI-PMH, while LO reuse through LORs is not currently in mainstream focus even among teachers [10]. While most LORs have been in operation for several years (MERLOT: 7 years, SMETE: 5 years, ARIADNE: 7 years), the amount of learning objects indexed in any one of them is small and it is comparable in number to the amount of learning objects stored in a single medium-sized LMS [10].

2.2. LMS-LOR integration

The best solution for users would be if their needs could be met in their native environment, and that is their own institutional LMS, which should allow them to access the LOR from the LMS with possibility to create, modify and integrate the content.

The main effort in this field is undertaken by the EU-funded LUISA [11] project. The goal of the project was to create a rich flexible infrastructure supporting the development and reuse of learning materials for both learners

and educators, and also the integration of LOR with a Learning Content Management System (LCMS). Therefore, the whole software solution is built on Moodle, and a plug-in for Moodle is available that allows for searching the LUISA LOR, based on the ontology (encoded in RDF), which is the core of the LUISA project. The LUISA solution relies on Semantic Web Services that can apply user profile, topics and competencies to resolve the required set of LOs for the given user. Although the LUISA architecture allows for the integration and interaction with other web applications, these applications are still not developed. A set of tools should be developed to prove that LUISA's services can be integrated into any LMS environment, which has until now been achieved only for Moodle.

Swiss Virtual Campus project team tried to achieve similar integration between three types of LMS (WebCT Vista, Moodle and OLAT (Online Learning and Training LMS)). Main shortcomings of that project were that the LOR used in the project had not been designed to work as a part of federated network of LORs and the created applications did not allow modifications of LO from LMS but only an upload and integration after an object had been created and imported [25].

ARIADNE, as one of the leading institutions in the field states that "a huge number of LMSs exists today and institutions often use different kinds of LMS. Thus, ARIADNE decided to focus on its LOR and to build an API dedicated to the specific LMS." So far integration between ARIADNE Federated network of LORs and LMS is achieved only for Moodle LMS and for the less used LMS INES [27]. ARIADNE solution cannot easily be integrated into any LMS environment, besides; every subsequent version of an LMS might require modifications of application for integration with the LMS as well.

Obviously these projects have not achieved the practical goal of the LMS-LOR integration - to have a set of web service applications accessible from any LMS for authoring lessons (LOs) on the interface of LOR, or a LOR federated network.

2.3. Frameworks for decomposition and reusability of LO

Many repositories store complex and large amounts of data as single LO. Under these circumstances, LOs are losing their original meaning. Therefore, a decomposition of LOs for reusability with a proper meta description is the main goal of projects in this area.

Examples of such projects can be found in [14] where authors propose a repository of SCORM-described content packages, which are actually complete courses. On the other hand in [15] is discussed how repositories can be created by decomposing SCORM content packages in order to create customizable learning content. It is obvious that propositions are not satisfactory for users, mainly because complete courses cannot be accessed and adopted into the new LMS environment easily.

By decomposing SCORM packages, users can get only basic raw resources out of them, which then require a special authoring system for assembling that data into customized courses and another system for the proper meta description.

This problem had been recognized by the academic community and therefore a number of projects have started in order to achieve effective ontology-based decomposition and integration of LO. The main projects in this area will be discussed further in the text.

RAMLET (Resource Aggregation Model for Learning, Education and Training) [8] is a project that is focused on retrieving, interpreting, disaggregating, (re)aggregating and deploying content in LMSs from different types of structural elements available in specialized repositories. RAMLET is a conceptual model, expressed as a human readable table and a set of ontologies that specifies how this aggregation formats map to each other via a single core model.

Unfortunately, RAMLET's ontology has aggregating purposes and it is not concerned with the relationships between sections and chapters or with the interactive properties of different media types. Also RAMLET is a one way design offering no possibility for changing LO in the original repository. The RAMLET model is complete, but has not been implemented yet.

Another project that tried to cover that field is ALOCOM (Abstract Learning Object Content Model) [8], which provides a generic content model that defines a framework for LOs and their components. The ontology defines concepts representing different LO component types and their structure. This explicit definition of both content and structure enables the disaggregation of LOs into their components. In [23], the authors explain similar project in which "the use of the XML technology allows, on one hand, content structures to be defined at different levels of abstraction, and, on the other hand, content to be separated from presentation."

The authors in [24] propose the use of domain ontologies to annotate LO content as well as content structure ontologies to enable direct access to LOs' components. Basic goal in this case is that "same LO can be used in different ways and by different users, that is, it can be repurposed" [24].

It is obvious that there are many propositions and projects that are being developed by leveraging ontologies as a common knowledge representation format. As much as the development of new abilities through new ontologies is welcomed, the problem of interoperability of repositories and applications grows in case where there is no agreement on the usage of certain ontology.

ALOCOM plug-ins are available for MS Word and MS PowerPoint allowing users to search for text, graphs, pictures and other elements of decomposed MS Word and MS PowerPoint documents stored in the ARIADNE repository. However, ALOCOM ontology is not a part of the ARIADNE core tools and it is not functional on the whole SQI Registry [8]. In fact ARIADNE, so far, offers integration of SQI search with GLOBE tool only for Moodle LMS but including ALOCOM features. Apart from offering search functionality through PowerPoint, this plug-in offers an automatic generation of presentation out of objects stored in ALOCOM-based repositories [8]. It is important to note that

ALOCOM is an abstract data model, not a tool. There are plug-ins developed on top of this data model. A prototype of a standalone tool was available before the plug-ins were developed, but it was just for demonstration and testing purposes.

RAMLET, on the other hand, is focused on allowing users to search through different structural elements, enabling them to create a new content base. It can be implemented in different ways, depending on the used ontology and available metadata. If used with ALOCOM by ARIADNE, it is obvious that it will be tightly connected to the ARIADNE metadata mandatory fields as the probable starting point for developing other semantic ontology-based applications.

So it is likely that the RAMLET project will complement the work being undertaken within and around the OAI-ORE [22]. In our opinion RAMLET can also produce significant results if combined with ALOCOM in ARIADNE repositories but ALOCOM ontology is still not widely accepted nor completely implemented even in SQL federated repositories.

The main goal in our opinion should be to allow a user to retrieve LOs by searching through federated repositories, with the ability to modify those objects and compose lessons out of them. But the problem at hand is obvious - without a common nomenclature and a conceptual model to allow for the interpretation of these formats and specifications, it is difficult to create applications that can interoperate.

2.4. Possible LMS-LOR integration through existing projects

Considering the previously stated, the design of a system will be proposed that can be built upon all the projects mentioned here. LUISA is a good basis for LMS-LOR integration but its ontology should be improved through other projects in this field. For example, the parsing, categorizing and annotation of LOs could be complemented with OAI-ORE decomposition in combination with ALOCOM ontology principles.

The conclusion is that the majority of the quality content resides in LMSs. Simple Automatic Metadata Generation Interface (SAMGI) [10] project shows that many valuable metadata fields can be extracted from this content. So SAMGI can be used for metadata extraction and RAMLET could be used for the composition of LOs from different repositories. SAMGI would be a good tool to refine results of the searches, whereas the ECL protocol could be the best solution to achieve interoperability across different federated networks of repositories. RAMLET complemented with OAI-ORE, with stronger semantic web services integration points, could allow for the development of a number of distributed applications for rich user-content and user-user interaction. The key point at this moment is not the technology but the agreement on usage of a common ontology, metadata schemas and semantics in applications and repository implementations.

3. Architecture of data-service oriented digital repository

The previous chapter described a number of projects that could offer an effective solution for LMS-LOR integration but also pointed out many shortcomings.

The main problems with existing solutions are following:

- Inability to search federated LORs through any LMS.

Present solutions only partially solve this problem: the GLOBE tool enables searching only through SQL federated repositories; ALOCOM-based solution facilitates search of decomposed LOs but only with desktop application not through LMS; ECL connects almost all known types of repositories but without integration with LMS.

- Inability to modify and directly integrate content in any LMS.

Platforms like RAMLET and ALOCOM exist, but they are not properly implemented nor do they allow easy implementation of such features in any LMS.

- Lack of sophisticated authoring tools for creating lessons out of modified or stored content in federated LORs.

LUIA offered a customized LMS with interoperable platform specialized for searching LORs, but it still does not have any similar authoring tool features.

In what follows we explain how FEDORA platform can be used as a web service oriented platform, integrated with existing solutions or used as an LMS internal LOR, connected to a network of LORs. We explain the advantages of architecture like FEDORA over the repositories mentioned in the previous chapters. FEDORA will be described because it represents an ideal platform for the development of a LOR that can be easily integrated into any LMS.

3.1. The FEDORA Platform

FEDORA is project based on OAI-PMH, so in its core there is an elementary system of data and service providers. The FEDORA platform enables flexible, application oriented architecture for the management and delivery of digital content. It has a powerful digital model for storing objects, which supports different ways of manipulation, editing and establishing relations over and among objects. FEDORA is actually designed for archiving of bibliography records but our goal is to show how such a powerful platform can be used in an e-learning environment.

The architecture of a FEDORA repository is shown in Fig. 1. Users can access the LO repository via web browser, client application or a third party application which communicates with frontend web services. In this way different functionalities can be achieved like searching, modifying, and adding

digital objects, linking objects, retrieving metadata or whole objects etc. An example of such application is given later in this paper. A LO in FEDORA platform consists of three main groups of data as shown in Fig. 1.

1. Metadata:

- Description metadata: used for correct description of a LO.

Metadata define the purpose, type, and possible educational usage of the respective object. Any metadata scheme can be used in FEDORA [5]. XML is the native FEDORA format for data interchange and services interactions. Any given metadata schemas and ontology references can be added to single or multiple LOs inside the repository.

- Relational metadata: definition of relations among objects, relations between object and external content and definition of parameters needed for application manipulation.

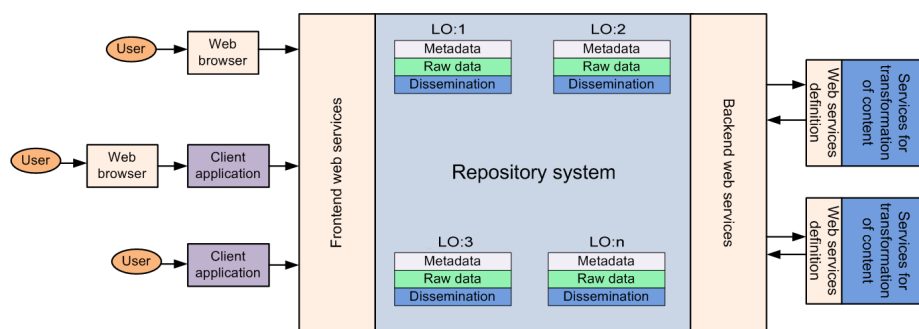


Fig. 1. Architecture of the system for digital objects storage

Relational metadata is actually a great basis for sophisticated ontology implementation. Any relations among objects can be stored even if an object is on another server, so projects like SAMGI can easily complement FEDORA for the purpose of harvesting metadata from a LMS.

2. Raw data: all stored data supported by a LO repository. Raw data is the term used for all Multipurpose Internet Mail Extensions (MIME) [10] types of data or data without metadata attached to it.

3. Dissemination data: used for calling remote or local application for management of objects stored in LO repository. Examples of applications that require dissemination are, for instance, application for picture manipulation and for automatic transformation of certain types of content into the PDF format. Since most of the applications used by repository are web applications, dissemination data has to contain the source and format definitions of the data that needs to be transformed, and also the location and parameters needed for calling the web service over the REST [6] method or SOAP [7] protocol.

Web services on the frontend of the system are used for communication with other services and applications and for calling backend web services for

transformation of content. Backend service also serves for interaction with other repositories, for maintaining and indexing of objects.

An advanced example of content manipulation by third party web service is shown in Fig. 2. [2]. The client requests HTML file of a poem stored in a LO repository. The repository may contain only an XML version of the requested file, but the LO which contains the XML data can also contain dissemination data for calling a web service.

The called web service can be an internal web application, which is usually the case, but in FEDORA it can also be an external web application from different web server like in the Fig. 2. In FEDORA, a LO in the repository does not even have to contain dissemination data but it can refer to another LO that contains the needed dissemination data for the required type of transformation (i.e., XSL file which defines transformation, in this case from XML to HTML). It is obvious that this kind of architecture leaves a lot of space for integration of the repository into any kind of system without the need for a specific platform application or plug-ins like it is the case with GLOBE tool or ALOCOM.

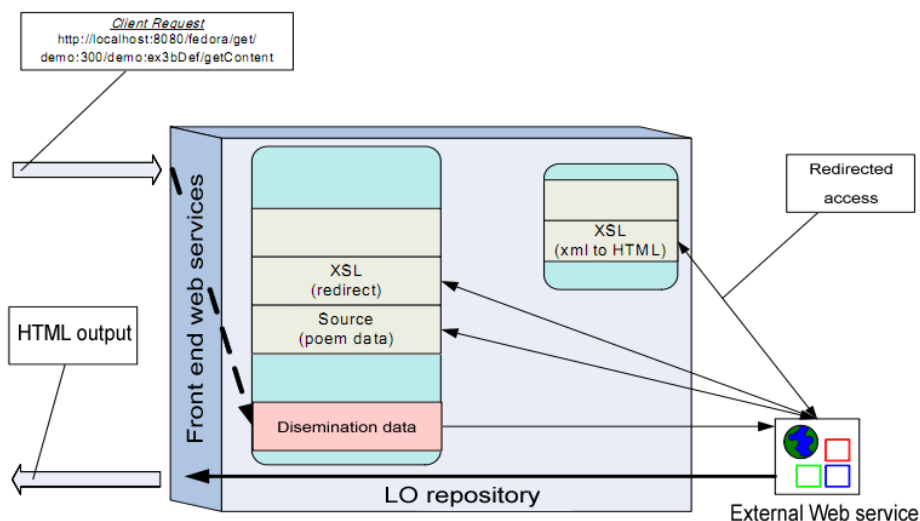


Fig. 2. Calling external Web service for LO transformations

Any given ontology, semantics and application can be applied in FEDORA. Each LO is actually encapsulated inside the object. Semantic value of the LO can grow over time because it can store information from every LMS, repository and system that has accessed or modified it. FEDORA has a versioning system that allows for saving different versions of the same LO.

From the given information, it is obvious that LOs inside FEDORA are totally platform independent units. Any information needed for a LO to be manipulated and retrieved is stored in the LO itself. LO stores in itself ontology and metadata information but also data needed by the web services

for exchange, metadata harvesting or manipulation of data stored in the LO. Therefore looking from technical perspective, the LO is an independent unit which contains all the data needed for communication with other systems and programs.

3.2. Communication of an LMS and a LOR

FEDORA can interact with any LMS. Fig. 3. shows how two widely used LMSs, Moodle and WebCT, can interact with the same FEDORA LOR. Moodle and WebCT are taken just as an example. A number of other LMSs can be connected in this way to the same digital repository. The exact number depends on the characteristics of the network, server, repository and workload, which is beyond the scope of this paper.

In Fig. 3, FEDORA LOR can be replaced by a FEDORA network of repositories which can exchange metadata.

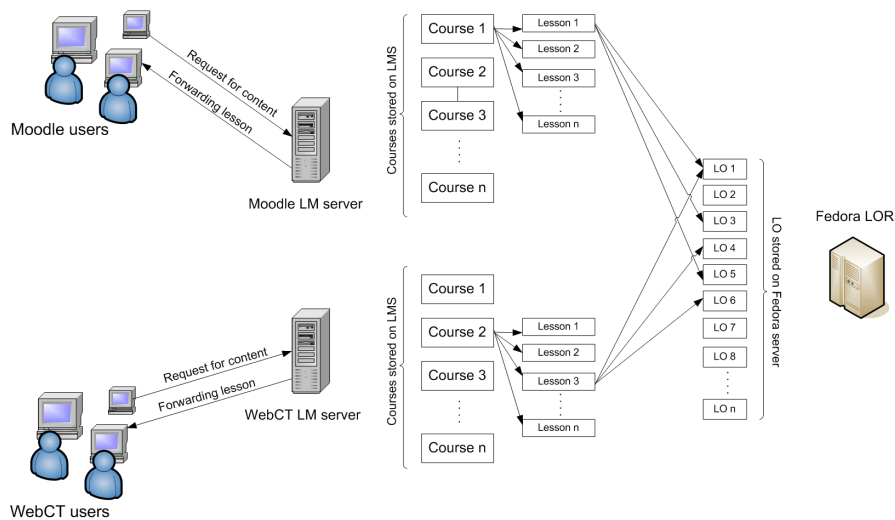


Fig. 3. Example of communication between LMSs and a digital repository

SQL federated repositories can also exchange data with FEDORA over FEDORA backend services and ECL supports the integration of OAI-PMH based frameworks so that interoperability with other repositories is achieved.

In the rest of the paper it will be shown how FEDORA LO can be referred to, modified and combined with another LO without being saved in the local repository of an LMS. Simple embedding application will be called from WebCT wrapper in the form of an external URL. Our application will manipulate LOs from FEDORA through FEDORA web service. The final product will be a URL with location of the lesson which in our case is a combination of LOs stored in FEDORA.

3.3. Manipulation of LO compositions in FEDORA

Because of the way in which FEDORA LO is defined, LMS objects can be stored inside LMS repository and can be manipulated through FEDORA. Fig. 4. shows the user interface of the administrator's backend and one LO stored with its Learning Object Metadata (LOM) [6] and its content items.

Fig. 4 shows all content items of the PrimjerExample:1 LO. The left hand side of the figure shows the list of content items and "001slika" (001picture) JPEG picture is presently the displayed item. Item details are shown for "001slika": MIME Type (image/jpeg) and the Fedora URL. Metadata (in this case LOM-based metadata) can also be stored for a content item and it is shown just above "001slika" content item. Metadata in this case are added manually but as described before, there are several ways for automating metadata descriptions. Each content item can be modified and each modification can be stored as a new content item accessible (by its own URL) and available for manipulation by third party web application over Internet. This also enables for easy storing of metadata from an LMS and harvesting of the same metadata by other systems

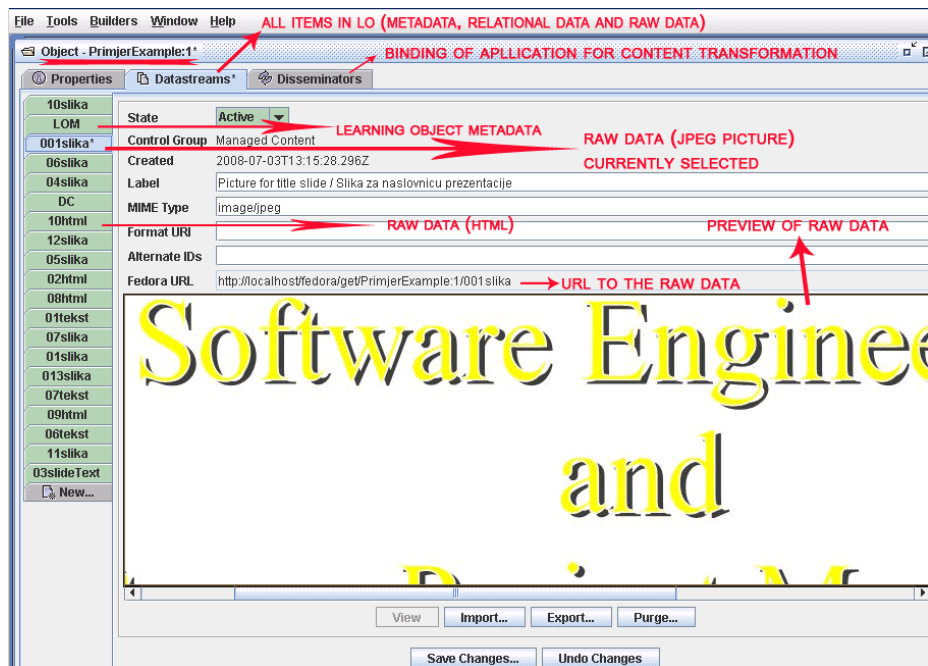


Fig. 4. A screenshot of the administrator's backend with an example LO

Fig. 5. shows the definition of the dissemination part of a LO. This is not an end-user application but an administration backend for the definition of web service handlers for manipulation with a LO. Method definitions are automatically available according to the type of the content item, in this case

a JPEG picture. According to the definitions of the chosen method (web service arguments), different mechanisms (web services) can be used for different manipulations. The respective URL is then available for calling the defined web service. For example, URL of web service for picture manipulation will be available when user is storing a picture.

So in our case Fig. 5 shows a web service connected with picture content item shown on Fig. 4. This web service (disseminator) is used for seven possible picture manipulations which are shown in the figure (resizeImage, zoomImage, brightImage, watermarkImage, grayscaleImage, cropImage and convertImage). It is important to emphasize that dissemination data (data needed for calling web services) is an elementary part of a LO just as any other content item or raw data. Dissemination applications (web applications), as described before, can be called from other remote server applications. This kind of architecture provides maximum interoperability for content and functionalities. Every part of a LO can be changed and stored as a new version. Users can keep or change old versions. They can also subscribe to a desired version of a LO, so any change of the LO in repository will also reflect on all the systems that integrate that LO.

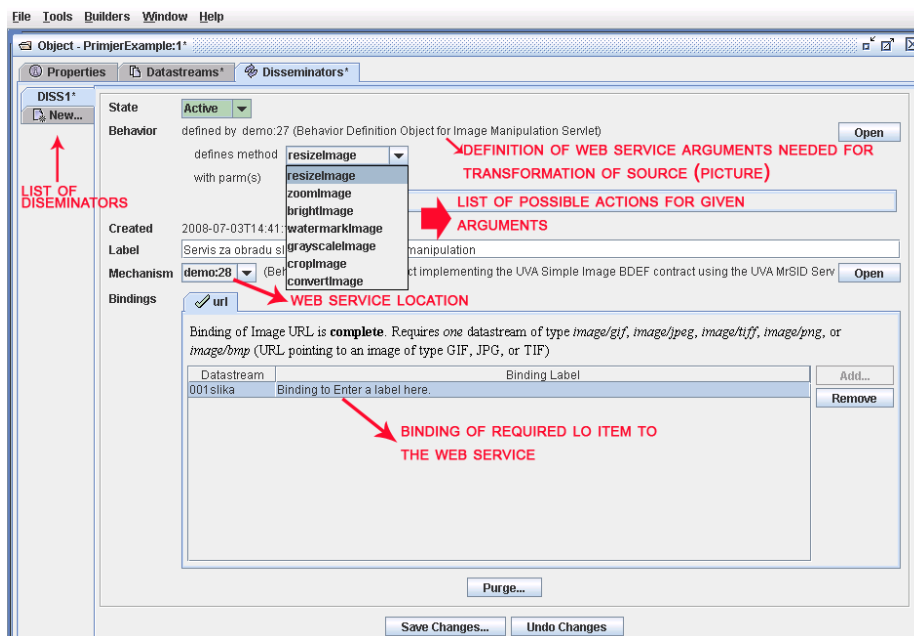


Fig. 5. Definition of web service (dissemination data) for picture manipulation

4. Application for creating lessons from LO

Screenshot of our pilot application for creating lessons is shown in Fig. 6. The figure shows application integrated as a tool inside WebCT LMS. The application is installed on one web server, WebCT functions on another web server and FEDORA LOR functions on a third web server, so three independent web servers are present in this scenario.

Any designer in any WebCT course can start the application via URL from WebCT. User can define title of the lesson and URL of content item from FEDORA LOR. A simple lesson was built out of the stored content items of the PrimjerExample:1 LO. Our application lacks a search engine for searching and retrieving content item URL from FEDORA LOR or the network of LORs. That will be implemented in future versions.

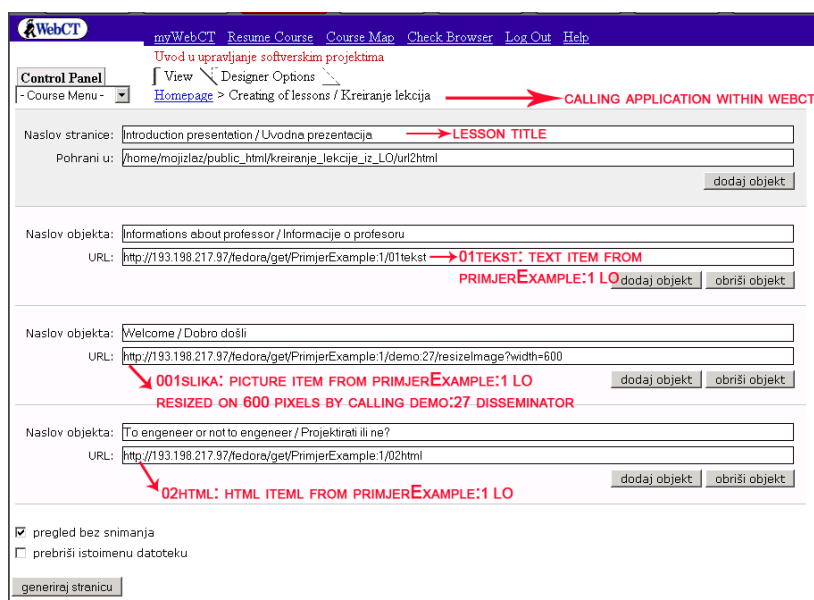


Fig. 6. Screenshot of pilot application for creating lessons

At this point, possibilities for the integration mentioned in the previous chapters will be demonstrated. The URL shown here can be easily obtained because FEDORA has a built-in search engine for searching of local storage.

The process of creating lessons is simple: a user searches FEDORA for LO. After finding the desired LO, the user can open that object inside FEDORA and just copy its corresponding FEDORA URL (see Fig. 4.). In our application, shown in Fig. 6, the user enters LO's title in the field "Naslov objekta" (Object Title) and pastes the corresponding FEDORA URL in the "URL" field. There is no limitation to the number of LOs that can be added in described way.

In our example, the generated lesson takes the form of a HTML page consisting of three content items from the PrimjerExample:1 LO: "01tekst" and "02html" content items (shown on the left hand side of Fig. 4) and "001slika" picture item (shown on the right hand side of Fig. 4).

After defining the URLs of content items, our application provides the designer with the URL of the whole created lesson. Final HTML simple lesson is shown in Fig. 7.

LO "001slika" shown in Fig.7 is a picture resized to 600 pixels, retrieved from a web service. Parameters and information about that web service are shown in Fig. 5. So when the user opens LO s/he can click on the disseminator tab (see Fig. 5.) and see what web services are available for that LO. After that, the user can define a desired manipulation over the object through web service interface, see Fig. 8. In our case, the specific disseminator that is being called is resizelImage with the parameter value set to 600. When the user sets desired parameters for the picture, and clicks "Run" next to it, an URL is automatically generated. After that, the user can just copy that URL, past it into our application and give it a name, just like for any other LO.


Introduction presentation / Uvodna prezentacija

Informations about professor / Informacije o profesoru

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➔ "01TEKST" TEXT ITEM FROM
PRIMJEREXAMPLE:1 LO

Welcome / Dobro došli



➔ "001SLIKA" PICTURE ITEM FROM
PRIMJEREXAMPLE:1 LO
RESIZED ON 600 PIXELS

To engineer or not to engineer / Projektirati ili ne?

Do we need engineering?

- q **Building a dog-house**
 - l we can manage it with some ad-hoc preparation (no big deal)
- q **Building a house - we need to do much more**
 - l Which kind of house we want - *specifying requirements*
 - l *When , how, who will do it , how much it will cost - planning - financial constraints, time, resources ...*
 - l construction plan
 - l building the house
 - l We can change the plans
 - l etc.

➔ "02HTML" HTML ITEM FROM
PRIMJEREXAMPLE:1 LO

Fig.7. Lesson consisting of three content items reused from an existing LO

The web service used for generating the content for "001slika" is shown in Fig. 8, where all of its functionalities for picture manipulation are listed. User interface shown in Fig. 8. gives users the resulting URL with a modified picture after all the parameters have been defined. Specifically, in the given example the web service would fetch the original picture, change its maximum width to 600 pixels, zoom it to 120, change brightness to level 5,

put watermark in the corner “Software projects lecture 2008”, crop image on 500 x 200 dimension and convert it to the GIF format.


Other similar features are available, for example if the user wishes to publish the PDF version of a document he or she can store the whole lesson as another LO and just put a link to the PDF disseminator anywhere in the LMS. The user can still modify a LO in the database and make new versions of the LO automatically available.

So when someone calls the PDF version of the LO, the disseminator application automatically collects the newest LO and makes an updated PDF document. Functionalities of the PDF disseminator are shown in Fig. 9.

Any other web service can be called and manipulated by user in the same way.

| BDEF | Method Name | | Parm Name | Parm Values (Enter A value for each parm) |
|---------|----------------|-----|---------------|--|
| demo:27 | resizeImage | Run | width | 600 |
| demo:27 | zoomImage | Run | zoom | 120 |
| demo:27 | brightImage | Run | bright | 5 |
| demo:27 | watermarkImage | Run | watermark | Software projects lectures 2008 |
| demo:27 | grayscaleImage | Run | No Parameters | |
| demo:27 | cropImage | Run | x | 500 |
| | | | y | 200 |
| | | | width | |
| | | | height | |
| demo:27 | convertImage | Run | convertTo | gif <input type="radio"/> jpg <input type="radio"/> tiff <input type="radio"/> png |

Fig. 8. Functionalities of the picture disseminator



Fedora Digital Object

Method Index (Disseminations)

Object Identifier (PID): demo:26

Version Date: current

| BDEF | Method Name | | Parm Name | Parm Values (Enter A value |
|-----------------|-------------------|-----|---------------|-------------------------------|
| demo:22 | getFO | Run | No Parameters | |
| demo:19 | getPDF | Run | No Parameters | |
| fedora-system:3 | viewObjectProfile | Run | No Parameters | |
| fedora-system:3 | viewMethodIndex | Run | No Parameters | |
| fedora-system:3 | viewItemIndex | Run | No Parameters | |
| fedora-system:3 | viewDublinCore | Run | No Parameters | |

Fig. 9. Functionalities of the PDF disseminator

5. Evaluation and plan for improvements

The presented application is still under development at the Zagreb School of Economics and Management (ZSEM). Through this project, a part of an E-business elective course has already been developed. The application was installed on the School's web server and creating of lessons was tested on WebCT which is the School's mainly used LMS. An associate IT professor and several assistants at ZSEM have evaluated the application. Their feedback was collected through interviews after tool demonstration.

We have conducted qualitative research with a goal to test the usability of application in LMS in which users work, to realize advantages and shortcomings of the application and also to define the main fields for future development.

Evaluation participants have noted as main advantages of our application the ease of installation and almost unneeded maintenance because application doesn't need database support, ease of embedding in any LMS, possibility for integration on different portals and sites and not only to different LMSs.

They also noted that number of users is limited only by memory and processor power of web server and that application can be used from any Internet Browser without need for installation of additional plug-ins and also that data import and export, login and permissions can be implemented through LMS, LOR or even institutional Student Information System (SIS).

Disadvantages so far that participants have noticed is fact that users have to seek LO URLs in LOR and than copy-past each LO into application. Participants proposed an interface to support the following sequence of steps for creation of lessons:

- User seeks LO from LOR (or network of LORs) through application interface
- User uses check box option to check LOs that user would like to use for creating his own lesson.
- After picking desired set of LOs from repository, user will have ability to: edit, define desired sequence, assemble, and store new composition of LOs in database as new LO.
- User is offered new LO as complete lesson which can then be embedded.

Those comments were very useful and they will most probably be main guideline while developing future version of application.

We are planning to further develop application after the content from the faculty LMS - WebCT is disaggregated, described and transferred into FEDORA LOR. Development of the project for transfer of the course content is in preparation.

The proposed application is not yet suitable for end users. Further plans for development include:

- Interface for searching and retrieving content items

- A control panel for deployment of internal and external web services for multiple LOs in the repository
- User friendly interface for manipulating, modifying, composing and annotating of LOs through internal and external web services
- Integration of present solutions like SAMGL which will cover collecting of metadata from the LMS
- Integration of present solutions like ALOCOM or RAMLET which will cover decomposing and storing of LO into repository
- Definition of user roles and permissions
- Integration of web applications for user collaboration.

Possible problems may arise in case that a lesson consists of several LOs and the LMS designer (professor) wants to accept all possible changes of constituent LO from the repository. In case that LOs really change in time, a request for its constituent content items is sent every time a user opens the lesson (i.e. LO) in LMS. That can cause large workload on LO repository and increase network traffic between LMS and LO repository. Instead of that, the LMS can make a local copy of every lesson, cache it and periodically check for updates. In this way the overall network traffic and the LO repository workload can be more acceptable.

Another problem at the global level is that LMSs today don't apply the same rules for defining different user roles within an LMS. Security procedures should be standardized in the future. Permissions of LMS user over LO in repository should include strict rules considering authentication, accessing and modifying LOs from the repository. Otherwise it would become impossible to define standard communication for different types of users.

6. Conclusion

This paper presents an attempt to integrate federated LORs into LMSs as more and more popular e-learning environments of academic community. Many currently active projects that are covering related research fields are presented. Our conclusion is that the majority of these projects are not capable of delivering basic features to end users in any given LMS environment. We can illustrate this conclusion on a simple example. If a professor using any LMS environment wants to search for LOs through networked LORs and easily modify, integrate, annotate, combine and store them as new learning objects or new lessons, he or she would realize that there is no available system to allow this kind of interaction.

Another problem is that many federated LO repositories are hardly used, while at the same time LMSs are storing the majority of relevant LOs. Many projects in e-learning community are focused on achieving interoperability among different LORs, on ontology-based search over these repositories and on decomposition and reuse of LOs stored in such repositories. Therefore, this paper attempts to demonstrate how the architecture of data-service

oriented digital repository can allow users to effectively interact through any LMS with a network of LORs.

We have explained how a LO stored in a digital repository of such architecture can be modified, combined and stored as a new lesson, independently of the user's LMS platform for accessing the repository.

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