ECP 2007 EDU 417008

ASPECT

Infrastructure & Services v3.0

Deliverable number	*D2.7*
Dissemination level	*Public*
Delivery date	*March 2011*
Status	*Final*
Author(s)	*Joris Klerkx (KUL), David Massart (EUN), Tien-Dung Le (EUN), Neil Smith (VMG), Lars Ingesman (UNI-C), Bram Vandeputte (KUL), Gonzalo Parra (KUL), Erik Duval (KUL)*
Internal reviewer(s)	*Elena Shulman (EUN), Jim Ayre (EUN)*

e*Content*plus

This project is funded under the *e*Content*plus* programme[1], a multiannual Community programme to make digital content in Europe more accessible, usable and exploitable.

[1] OJ L 79, 24.3.2005, p. 1.

Summary

Deliverables D2.5, D2.6 and D2.7 should be seen as a combined document that describes the ASPECT infrastructure and services. It is aimed at both ASPECT consortium partners and a wider constituency of software engineers and content providers. Together, the three deliverables present an overview of all the services that are part of the ASPECT Infrastructure for the discovery, exchange and reuse of educational resources through open standards and specifications. Note that the actual deliverables D2.5, D2.6 and D2.7 are the software tools and services that are described herein.

Contents

1 Introduction

As explained in all WP2 deliverables, the aim of the ASPECT Service-Oriented Architecture[2] is to provide a set of standards' implementation support services and a platform in which existing and emerging standards and specifications are applied to enable the discovery, exchange and reuse of educational resources. Through this architecture:

- Content providers can offer their learning resources to teachers;
- Teachers are able to discover and therefore use those resources.

The target group of this deliverable are both ASPECT consortium partners and a wider constituency of software engineers and content providers interested in working together to apply the best practice standards developed in the project.

The actual deliverable D2.7 is not this document, but the third version of the ASPECT infrastructure and its software components (tools and services) that are described hereafter. The purpose of this document is to give an overview of these components. Therefore, the structure of this document is aligned with the structure of the previous deliverable D2.6.

Section 2 starts with an overview diagram of the infrastructure architecture. All the services and tools in this diagram are presented in sections 2.1 and 2.2. Section 3 presents three case studies that have been built on top of the services and tools and that are meant to remove friction for typical end-users in making their learning resources available. Section 4 provides conclusions on the work carried out.

[2] Note that most services used in the ASPECT infrastructure can also be accessed individually from the LRE Service Centre provided by ASPECT at http://aspect-project.org/node/52.

2 The ASPECT Infrastructure & Toolset v3.0

This section presents an overview of the ASPECT Infrastructure that has already been partly presented in

- D2.5 “Infrastructure and services v1.0”, and
- D2.6 “Infrastructure and services v2.0”.

Therefore, we only introduce those v3.0 services that are new, enhanced or adapted since versions 1.0 and 2.0.

The infrastructure includes a number of services, which are added in the overview Figure 1. We distinguish between single services, which are represented in red blocks, and sets of services, which are represented in orange blocks.

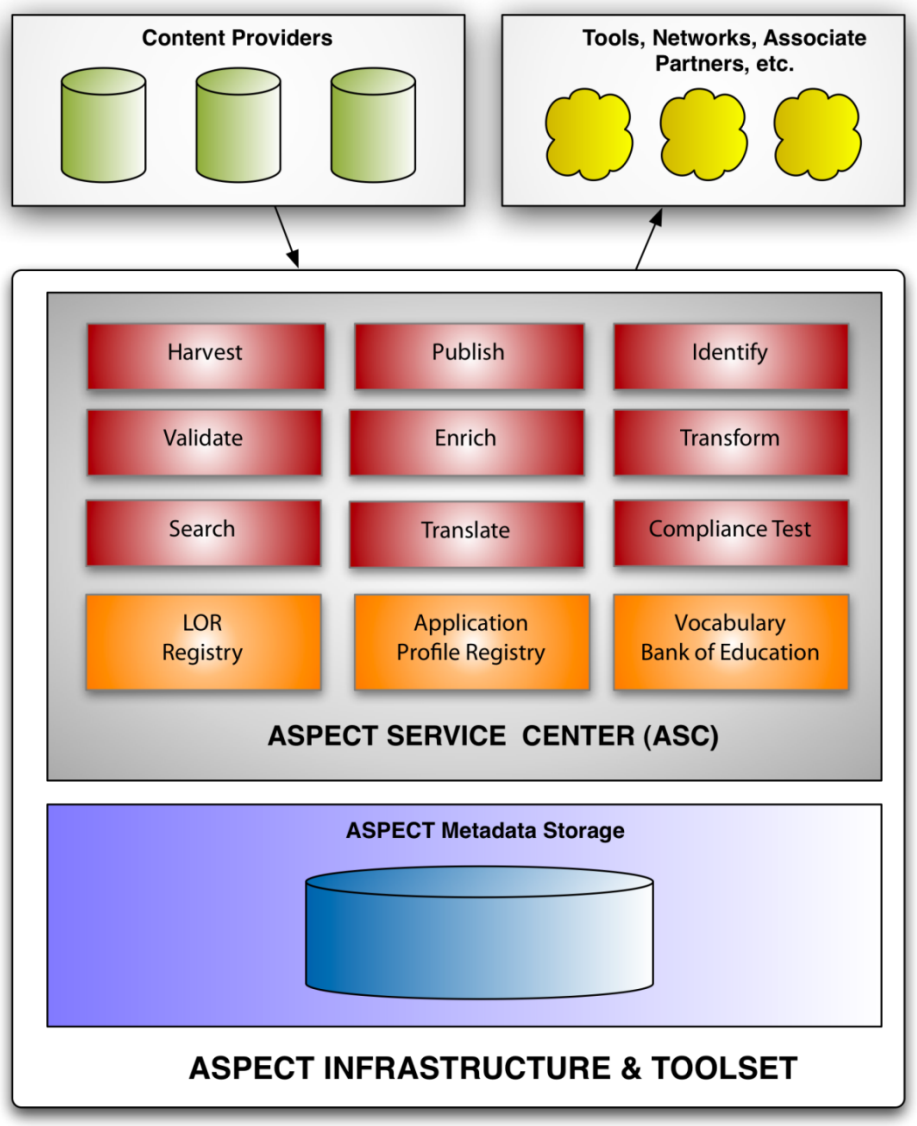


Figure 1: The ASPECT Infrastructure

2.1 Sets of Services

In this section, we describe the sets of services that have been enhanced or modified since the previous versions of the ASPECT infrastructure. First of all, we will describe the Learning Object Repository registries that were developed as a result of cooperation between the ASPECT project, the IMS Learning Object Discovery & Exchange (LODE) working group and the CEN WS-LT project team on the interconnection of registries. Secondly, we present the Application Profile Registry. We conclude this section with an overview of the current contents of the Vocabulary Bank of Education.

2.1.1 Learning Object Repository (LOR) Registries

The LOR registries are catalog services that provide up-to-date information on collections of learning resources. They facilitate interoperability between different content providers by describing:

- Collections of learning content (e.g., languages, formats, topics covered)
- Collections of metadata used to describe this content (e.g., metadata schemas, metadata languages) and
- Protocols used to get access to these collections (e.g., OAI-PMH, SQI, SPI, SRU/SRW)

This information is needed for systems to be able to interconnect all of these resources distributed in various 'silos' of learning material.

ASPECT plays a leading role in the standardization of registries. The project is present in the IMS LODE working group (led by David Massart) that defines a data model for registries and in the CEN WS-LT project team on Interoperability of Registries (lead by Joris Klerkx) that looks at protocols for inter-registry communication.

2.1.1.1 First ASPECT Registry

A first learning object repository registry is available online at http://ariadne.cs.kuleuven.be/ariadne-registry/.

Following deliverable D2.6, two new use cases are supported by this registry:

- Reporting problems with the registry
- Providing an overview of the registry contents.

These are presented in more detail in the following paragraphs. Other key use cases for the LOR registry have been listed in the previous deliverable D2.6.

2.1.1.1.1 Report a problem with the registry

Summary:
A person is using the user interface of the Registry and detects a problem or a bug. The person can report this problem to the support team of the Registry.

Actors:
Any Person

Trigger:
Triggered by the actor.

Description:

- A user browses the registry web application.
- The system displays an error or a problem.
- The user can click on the 'Found a bug' that is available in the user interface.
- The system forwards the page to a "Request For Change" tracking system.
- The system pre-fills information in the form so that there is a low-barrier for the user to report problems.
- The user adds further information about the bug he has found.
- The user submits the problem.
- The system sends out an automated mail to the ASPECT support team.

Result:
The ASPECT support team learns about a problem that is found by a user. They can take action to make sure the problem does not happen again in the future.

Remarks:
A screenshot of the pre-filled form of the "Request for Change" tracking system can be seen in Figure 2.

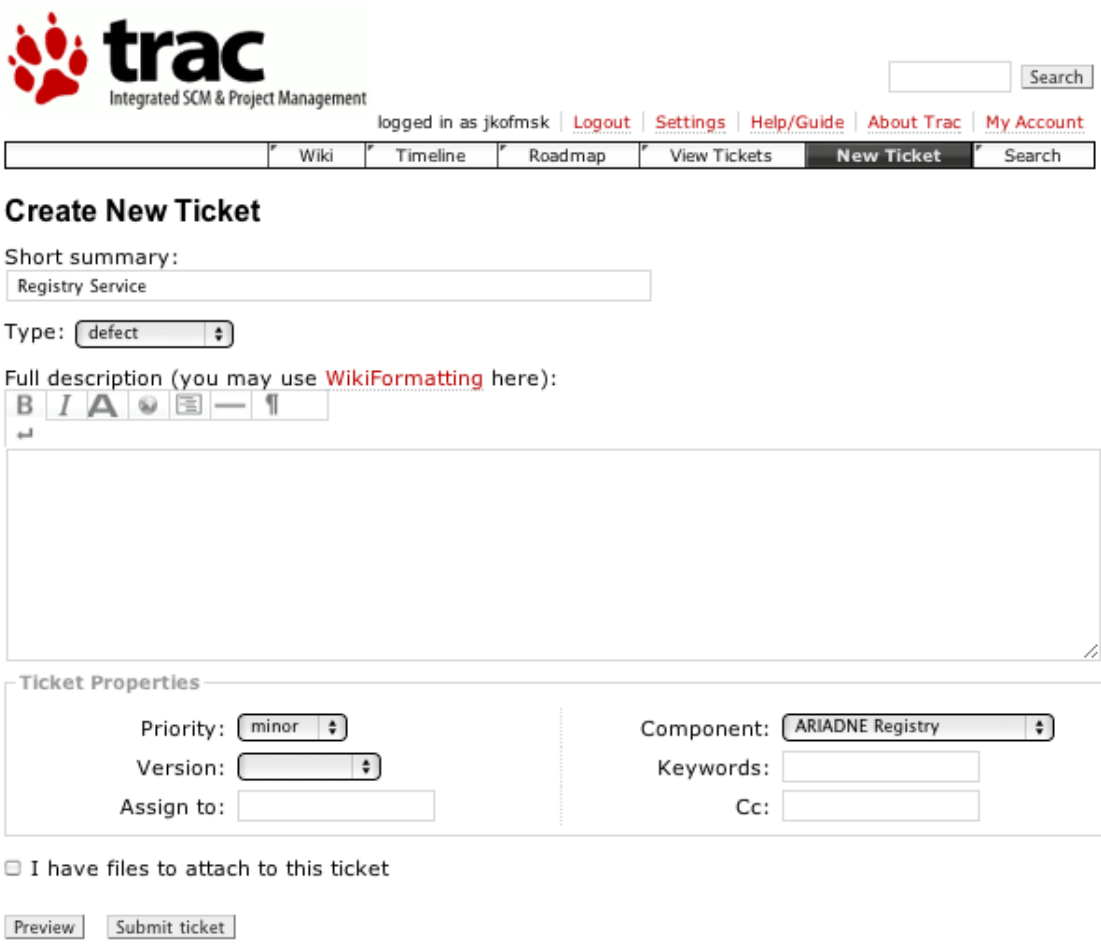


Figure 2: Screenshot of the request for change system

2.1.1.1.2 Provide overview of the registry contents

Summary:
A person wants to get an insight on the contents of the Registry

Actors:
Any Person

Trigger:
Triggered by the actor.

Description:

- The user navigates to the "statistics page" of the registry.
- The system shows a dashboard visualization that presents the contents of the registry.

Result:
The user gets an insight on the current content of the ASPECT registry.

Remarks:
A screenshot of the dashboard can be seen in Figure 3. This graph shows the number of targets per catalog or collection. For instance, there are 13 targets in the ICOPER collection. ICOPER is the sister eContent*plus* project of ASPECT. They have used the ASPECT registry for handling information about the ICOPER content providers. At the time of writing, the Share.TEC project has also decided to also use the ASPECT registry for the same purpose.

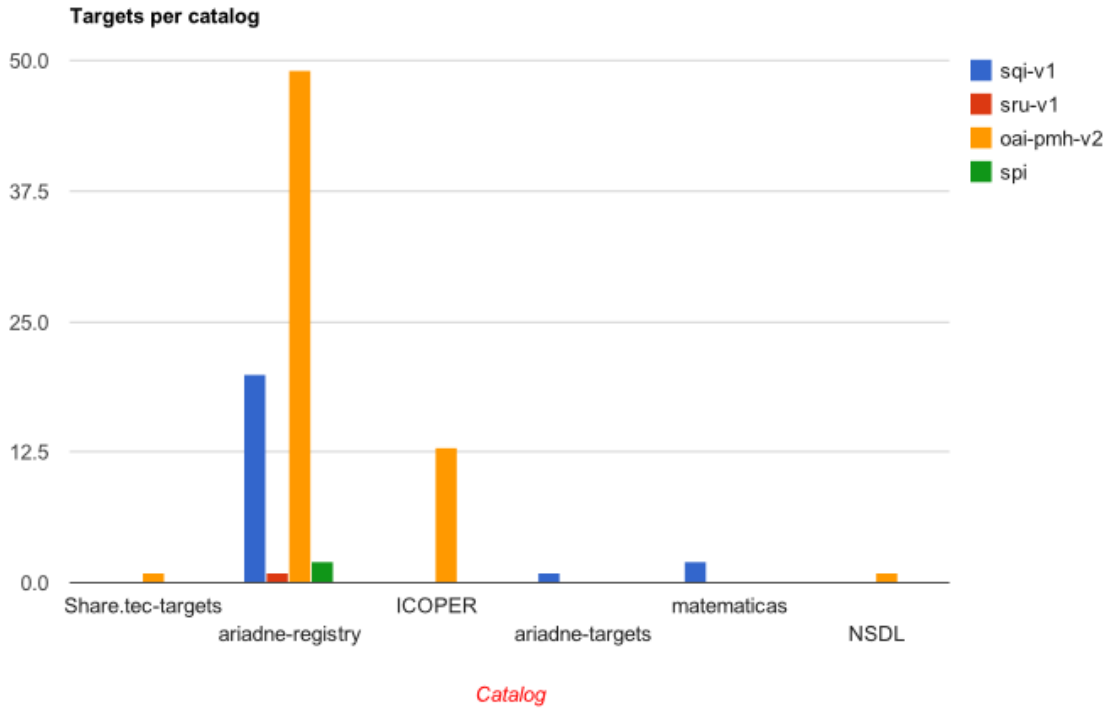


Figure 3: Statistics Dashboard

2.1.1.2 Second ASPECT Registry

A second learning object repository registry[3] is available online at http://lreregistry.eun.org:5984/registry/_design/registry/index.html.

The LRE Learning Object Repository Registry (LORRy) is used to manage information about the LRE content providers and the learning object collections they wish to share using the LRE. The registry is used to manage the entire lifecycle of the relationship between a content provider and the LRE. When applying to join the LRE, content providers are invited to fill in a registration form to describe the collections they offer (see Figure 4)

[3] The development of this second registry was mainly motivated by the necessity to validate the ASPECT approach to the interoperability of registries.

2. Metadata Collection

Describe the metadata collection in 2-3 sentences	Whole LRE Collection
Describe the rights that apply to the metadata collection	Creative Commons licenses
Quality Procedure: The quality procedure(s) applied to the metadata in the collection.	
Language: The language(s) of the metadata in the collection.	Language-free English Abkhazian Afrikaans Albanian
Application Profile: Please provide the URL where the profile is available	/docs/LREMAPv4p5p2w.pdf
Name of the individual responsible for the collection and/or target (in vCard).	BEGIN:VCARD FN:EUN N:EUN ORG:EUN
The role of the person named above	technical contact
Describe your metadata access policies, if any.	

3. Protocols

Describe all the protocols (name, and access point) used to give access to your metadata. E.g., SQI, SRU, OpenSearch, RSS, OAI-PMH.

Figure 4 - Application form for candidate LRE content providers.

Once this information is reviewed and the providers' applications are accepted, they are invited to complete it with more technical information, i.e., the details of the protocols supported by their repositories such as OAI-PMH (see Figure 5).

OAI-PMH Protocol Implementation Form

Protocol version	2.0	
OAI-PMH base URL	http://lrecoreprod.eun.org:6080/oaitarget/OAIHandler	
Sets (separated by comma)		
Granularity	YYYY-MM-DDThh:mm:ssZ	
Earliest Datestamp	2000-01-01T00:00:00Z	
Deleted Record	no	
Compressions (separated by comma)		
Descriptions (each line: namespace = schemaLocation)	http://www.imsglobal.org/services/lode/imslooaipmh-2p0_v1p0 = http://www.imsglobal.org/xsd/imslooaipmh-2p0_v1p0.xsd http://www.imsglobal.org/services/lode/imslooaipmh_v1p0 = http://fire.eun.org/xsd/registry/imslooaipmh_v1p0.xsd	
Metadata Format Remove	Metadata Prefix	oai_lre4
	Schema	http://fire.eun.org/lode/imslorsltitm_v1p0.xsd
	Metadata Namespace	http://www.imsglobal.org/xsd/imslorsltitm_v1p0
	Application Profile Identifier	http://lre.eun.org/sites/default/files/docs/LREMAPv4p5p1.pdf

Update Cancel

Figure 5 - Registry form for the OAI-PMH protocol.

Once this technical information is available in the registry, it can be used by registry client applications to get access to repository collections in an automated way. Examples of such client applications include registry-driven

OAI-PMH harvesters and registry-driven federated search (see Figure 6 for the latter).

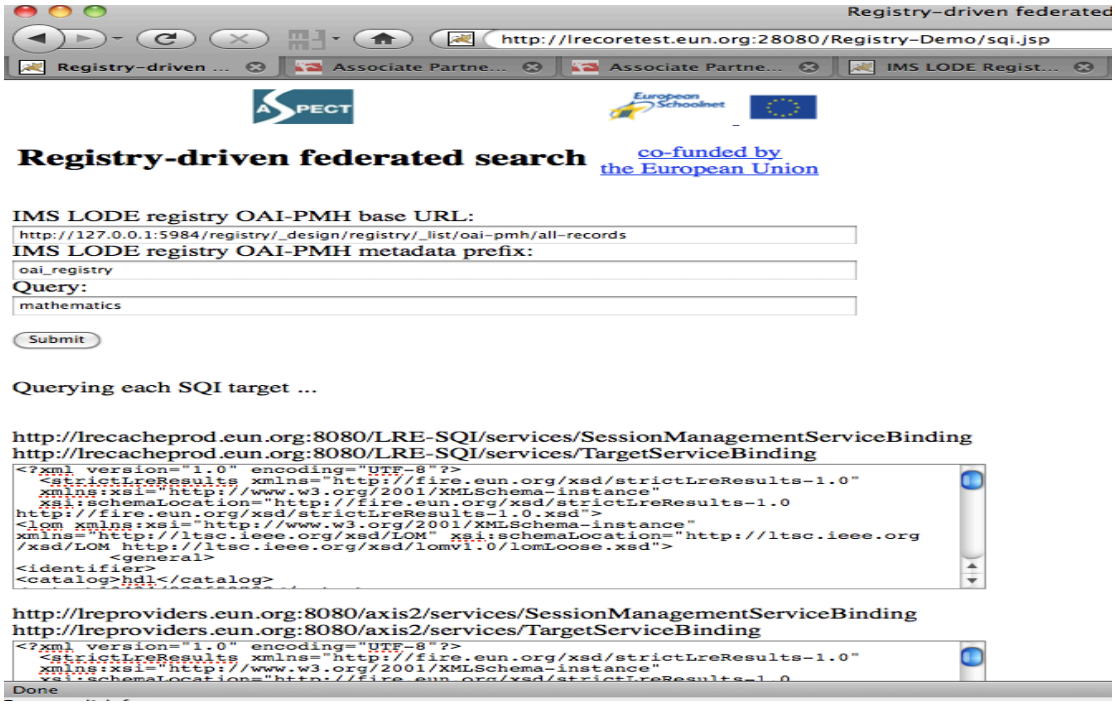


Figure 6 - Registry-driven federated search.

The LRE Registry is implemented on top of Apache CouchDB (http://couchdb.apache.org/), a document-oriented database that offers incremental replication with bi-directional conflict detection and resolution. The registry is a key element of a federation such as the LRE. Inter-registry replication makes it possible to easily maintain and update a back-up registry that is, therefore, always ready to replace the primary registry in case of a problem. Moreover, this replication feature also permits the sharing and exchange of collection descriptions between different federations.

From a specification standpoint, the LRE Registry makes collection descriptions available in the IMS LODE Registry format using the OAI-PMH protocol. Sharing of collection descriptions via OAI-PMH was successfully demonstrated between the two ASPECT registries.

2.1.2 Application Profile Registry

The Application Profile Registry (APR) describes the metadata application profiles used to describe learning resources managed in different learning object repositories. The APR allows 'core standards' such as IEEE LOM to be defined in terms of the elements within the standard's published data model. It also provides links to externally-held and authoritative documents such as schemas

for technology bindings, specifications and guidance. The APR is available at the following URL: http://apr.vocman.org

When a profile of a core standard is created, the APR automatically populates the profile with details about the core standard, allowing the author to modify these details rather than having to populate the entire profile from scratch. Elements in the APR are defined in terms of their obligation, size, order, vocabulary and data type. Elements can be used in multiple profiles and can be modified for a particular profile (e.g., to use a different controlled vocabulary). References to controlled vocabularies are made by linking to the URIs that are provided for that vocabulary by the VBE. The APR provides mappings between profiles, highlighting differences. The APR provides this information via a human readable interface and via a RESTful machine API.

The APR was designed to support the following functional requirements:

- Storage of descriptive information about application profiles conforming to a specified schema (including their location)
- Authentication of users
- Role assignment for users
- Storage of application profile bindings. This is available in case the profiles have no public location.
- Web-based browsing
- Client based browsing
- Web based data management (add, delete, update, register for changes)
- Web based administrative functions (change permissions, add, user, delete user)
- Client-based searching
- Web-based searching
- Change Notification
-

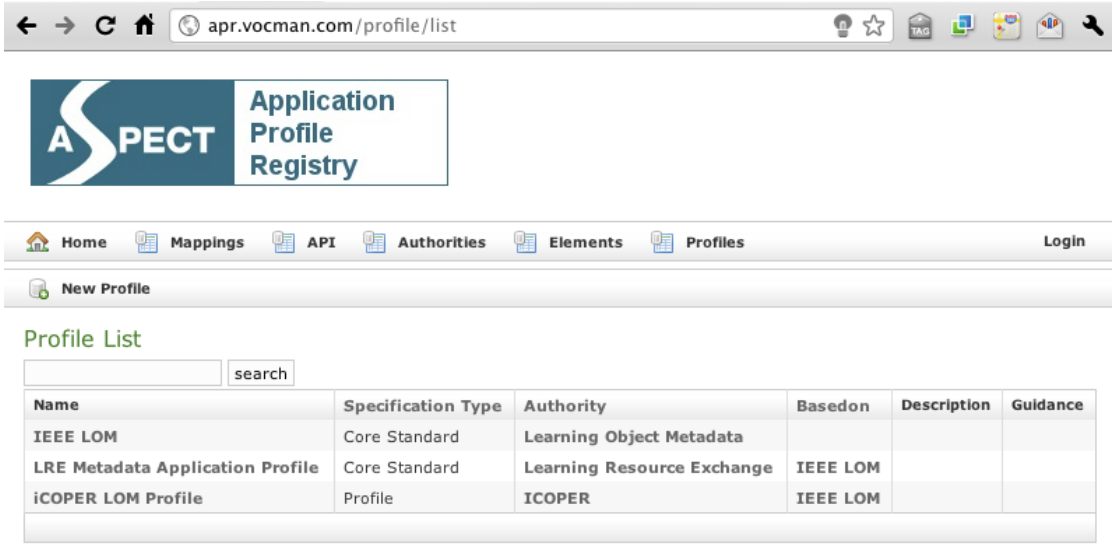


Figure 7: The Application Profile Registry

Figure 7 shows a screenshot of the APR with the application profiles that are currently stored:

- The IEEE LOM standard
- The LREv4.X application profile
- The ICOPER application profile

The section below lists the key use case of the Application Profile Registry.

2.1.2.1 Mappings between Application Profiles

Summary:
A person wants to see the mapping between two application profiles that are registered in the APR.

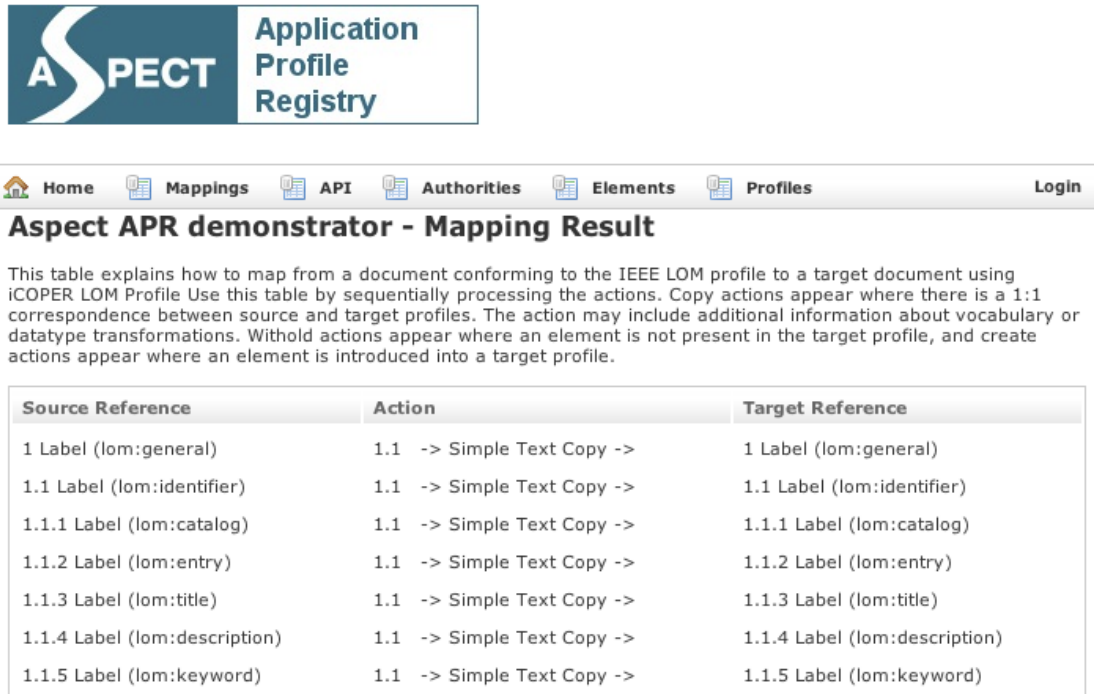
Actors:
Any Person

Trigger:
Triggered by the actor

Description:

- The users navigate to the "mappings" page of the APR web application.
- The system asks the source and the target application profiles.
- The user selects the source and the target application profiles.
- The system returns the mapping between the requested profiles.

Result:
An overview is presented to the user that maps each metadata element of the source application profile to the metadata element of the target application profile. This overview is shown in Figure 8.



5 Label (lom:educational)	1.1 -> Simple Text Copy ->	5 Label (lom:educational)
5.1 Label (lom:interactivityType)	1.4 -> Copy Controlled (LOM:interactivityTypeValues) to Controlled (LOM:interactivityTypeValues) (Same Vocab) ->	5.1 Label (lom:interactivityType)
5.10 Label (lom:descriptionUnbounded)	1.1 -> Simple Text Copy ->	5.10 Label (lom:descriptionUnbounded)
5.11 Label (lom:language)	1.1 -> Simple Text Copy ->	5.11 Label (lom:language)
5.2 Label (lom:learningResourceType)	1.4 -> Copy Controlled (LOM:learningResourceTypeValues) to Controlled (LOM:learningResourceTypeValues) (Same Vocab) ->	5.2 Label (lom:learningResourceType)
5.3 Label (lom:interactivityLevel)	1.4 -> Copy Controlled (LOM:interactivityLevelValues) to Controlled (LOM:interactivityLevelValues) (Same Vocab) ->	5.3 Label (lom:interactivityLevel)
5.4 Label (lom:semanticDensity)	1.4 -> Copy Controlled (LOM:semanticDensityValues) to Controlled (LOM:semanticDensityValues) (Same Vocab) ->	5.4 Label (lom:semanticDensity)
5.5 Label (lom:intendedEndUserRole)	1.4 -> Copy Controlled (LOM:intendedEndUserRoleValues) to Controlled (LOM:intendedEndUserRoleValues) (Same Vocab) ->	5.5 Label (lom:intendedEndUserRole)

Figure 8: Mapping one application profile to another

2.1.3 The Vocabulary Bank for Education

The VBE is a repository in which controlled vocabularies can be published and disseminated. The VBE allows vocabularies to be uploaded and downloaded in a range of standard interchange formats. Information about terms within vocabularies and their relationships with other terms is held internally in a manner that allows these relationships to be represented in standard ways. It also allows custom relationships to be defined if required. Terms from a vocabulary may be re-used in other vocabularies, with all links being tracked. All aspects of the VBE are multi-lingual, including labels and descriptions for terms and the user interface itself. The VBE user interface allows for vocabularies and terms to be discovered via search-and-browse mechanisms. As well as an RSS feed providing details of newly published and changed vocabularies, the VBE now has a comprehensive RESTful machine API which allows a wide range of queries to be executed. A major feature is the ability to retrieve details about the 'delta' or differences between two versions (revisions) of a vocabulary.

The VBE was already present in the first version of the ASPECT Infrastructure. The VBE v3.0 now supports the following key use cases:

- Upload of existing vocabularies in a defined range of formats
- Download of vocabularies in a defined range of formats
- Ability to represent defined relationships between terms
- Implementation of an agreed workflow for publishing vocabularies

- Providing multilingual vocabularies and facilities for vocabularies and terms to be translated
- Search and browse of vocabularies and terms by humans
- Search and retrieval of vocabularies and terms via a machine API
- Tracking of revisions, including the ability to provide a 'delta' between two vocabulary revisions.

The following table presents an overview of the contents of the VBE at the end of November 2010. As can be seen in this table, the ICOPER project also decided to make use of the ASPECT VBE for the storage of their controlled vocabularies.

Vocabulary Names	Terms per Vocabulary Count	Number of separate vocabularies in available languages
Actions (Bloom)	83	1
DCCAP Accrual Periodicity	17	1
ESA Lifecycle Contributor Role Values	16	1
EUN Age Range Values	25	1
EUN Area Values	9	1
EUN General Age Range Values	32	1
EUN General Yes-No Values	11	1
EUN Geography Values	655	1
EUN Hardware Type Values	23	1
EUN Language List Values	173	1
EUN LRE Thesaurus Subject Sublist Values	2	1
EUN Organization ICT Access Values	14	1
EUN Organization Specialization Values	28	1
EUN Organization Type Values	24	1
EUN Personal Title Values	6	1
EUN Person Role in Organization Values	30	1
EUN Software Type Values	37	1
EC Key Competencies for Lifelong Learning	9	1
Eurovoc Geography Values	655	1
ICOPER Annotations	4	1
ICOPER Learning Outcome Levels	4	1
ICOPER Learning Resource Types	21	1

ICOPER Purposes	11	1
ICOPER Relationship Kinds	17	1
ILOX Manifestation Name Landing Page Parameter Values	2	1
ILOX Manifestation Name Values	8	1
ILOX Manifestation Web Feed Parameter Values	2	1
ISO Country Code List Values	223	1
ISO Language Code List Values	172	1
LOM Aggregation Level	4	1
LOM Classification Purpose	9	24
LOM Copyright and other restrictions	2	24
LOM Educational Contexts	4	1
LOM Educational Difficulty	5	24
LOM General Structure	5	24
LOM Intended End User Roles	4	1
LOM Interactivity Levels	5	24
LOM Interactivity Types	3	24
LOM Learning Resource Types	15	1
LOM Lifecycle Contributor Roles	15	11
LOM Metadata Contributor Roles	2	1
LOM Relationship Kinds	17	12
LOM Rights Cost	2	24
LOM Semantic Density	5	24
LOM Status	4	24
LOM Technical Requirement Names	12	1
LOM Technical Requirement Types	2	1
LRE Credit-Based Access Currency Values	1	24
LRE Educational Learning Context	12	24
LRE ESA Lifecycle Contributor Role Values Mapping	17	1
LRE ILOX Description Facet Values	9	24
LRE ILOX Expression Description Facets	7	24
LRE ILOX Expression Dimension Names	4	24
LRE ILOX Item Description Facets	5	24
LRE ILOX Manifestation Description Facets	6	24

LRE ILOX Manifestation Name Parameter Landing Page Values	2	24
LRE ILOX Manifestation Name Parameter Package In Values	19	24
LRE ILOX Manifestation Names	8	24
LRE ILOX Manifestation Name Web Feed Parameter Values	2	24
LRE ILOX Work Description Facets	7	24
LRE Image MIME Types	6	1
LRE Intended End User Roles	7	24
LRE Learning Principles	10	1
LRE Learning Resource Types	34	24
LRE License-Based Access License	2	24
LRE Lifecycle Contributor Roles	16	24
LRE LOM Resource Type Mapping	47	1
LRE Metadata Contributor Roles	4	24
LRE MIME Types	42	1
LRE Relationship Kinds	17	1
LRE Thesaurus	1449	13
NSDL Resource Type Values	88	1
RESL Technology Keyword Values	10	1
TOTAL	4259	692

The VBE is available at the following URL: http://aspect.vocman.com/vbe/

2.2 Single Services

In this section, we only describe new services and tools or services and tools that have been enhanced or modified since the previous versions of the ASPECT infrastructure. More information about the other services of Figure 1 can be found in previous deliverables:

- The harvest service – D2.4 and D2.6
- The publishing service – D2.4
- The transformation service – D2.6
- The compliance testing tools – D3.2.1 and D3.2.2
- The learning object identity service – D2.5

2.2.1 The Validation Service

The validation service is available for testing the conformance of metadata instances against multiple application profiles that exist in various networks of learning resources. Since the previous version 2.0, the validation service now allows for testing the conformance of 19 different application profiles. These application profiles come from several networks and projects such as the EUN Learning Resource Exchange (LRE), ARIADNE, ASPECT, ICOPER, Share.TEC, MACE, ORGANIC-EDUNET, MELT, and others. The complete list can be found in Figure 9.

The validation service is available at the following URL: http://ariadne.cs.kuleuven.be/validationService/

```
<?xml version="1.0" encoding="UTF-8"?>
<validationSchemes>
  <scheme>http://aspect-project.org/validation/ASPECTv1.0/core/deprecated</scheme>
  <scheme>http://www.icoper.org/validation/ICOPERv1.0/core</scheme>
  <scheme>http://www.organic-edunet.eu/validation/ORG-EDUv1.0/Recommended</scheme>
  <scheme>http://aspect-project.org/validation/ASPECTv1.0/recommended</scheme>
  <scheme>http://info.mace-project.eu/validation/MACEv4.4</scheme>
  <scheme>http://www.organic-edunet.eu/validation/ORG-EDUv1.0/Core</scheme>
  <scheme>http://www.share-tec.eu/validation/ShareTEC/minimal</scheme>
  <scheme>http://www.imsglobal.org/services/lode/validation/Registry</scheme>
  <scheme>http://info.mace-project.eu/validation/MACEv1.0/full</scheme>
  <scheme>http://www.openarchives.org/OAI/2.0/</scheme>
  <scheme>http://lre.eun.org/validation/LREv3.0</scheme>
  <scheme>http://info.mace-project.eu/validation/MACEv1.0/minimal</scheme>
  <scheme>http://www.icoper.org/validation/ICOPERv1.0/recommended</scheme>
  <scheme>http://info.melt-project.eu/validation/MELTv1.0/full</scheme>
  <scheme>http://aspect-project.org/validation/ASPECTv1.0/core</scheme>
  <scheme>http://ltsc.ieee.org/xsd/LOM/loose</scheme>
  <scheme>http://ltsc.ieee.org/xsd/LOM/strict</scheme>
  <scheme>http://www.stellarnet.eu/validation/BuRSTv1.0</scheme>
  <scheme>http://info.melt-project.eu/validation/MELTv1.0/NoThesaurus</scheme>
</validationSchemes>
```

Figure 9: List of Application Profiles supported by the validation service

2.2.2 Metadata Enrichment Services

The metadata enrichment services aim at improving the discoverability of the LRE learning resources by enriching the metadata used to describe these resources.

2.2.2.1 Optimization of Services

Although no new functionalities were provided, WP2 has worked at improving the performance of some of its enrichment tools and services.

- Metadata Identity Service: The Handle Server was, and still remains, the potential Achilles' heel of the Metadata Identity Service. It was very slow (providing identifiers for more than 200,000 learning objects referenced by the LRE took up to 5 days). After optimization, it was possible to reduce this time to 2.5 days.
- Thesaurus descriptor enrichment tool: This tool takes an LRE descriptor as an input and returns the corresponding broader terms. It is used to enrich metadata with new LRE descriptors. The first version of this tool was based

on an XML version of the LRE Thesaurus provided by the VBE and implemented with standard Java XML libraries. As a result, performance was poor and conflict with incompatible Java XML libraries occurred when deploying the tool on some middleware platforms. In order to solve these problems, the tool was entirely rewritten using ad-hoc parsers and in-memory data structures. As a result, the new version of the tool has no dependencies with external libraries and runs 60 times faster than the initial one, reducing the time necessary for enriching the entire LRE metadata collection from 30 hours to 30 minutes.

2.2.2.2 The LRE Social Data Manager

A person's reputation can easily be known by listening to what other people say about this person. Similarly, a learning object's reputation can be appraised by looking at the opinions people expressed about it when, for example, they rated it, added tags or comments, or added it to their lists of favorite resources. When looking for learning objects, reputation usefully complements descriptive metadata (such as the one provided by IEEE LOM or Dublin Core) by providing a criterion to compare and rank the learning objects (e.g., most reputed first) in a results' set. Obviously, the more opinions about an object one can collect, the more accurate the appraisal of the reputation of this object.

In a federation such as the LRE, opinions about a given learning object are expressed in the different portals and learning systems connected to the LRE. As a consequence, the information necessary to establish the reputation of this learning object is scattered among these systems. The LRE Social Data Manager (SDM) was proposed as a way to overcome this limitation. It consists of a central database for storing reputation data (e.g., ratings, comments, tags and bookmarks). As shown on Figure 10, instead of managing its own reputation data database, each LRE portal can delegate this task to the SDM[4]. The latter aggregates all the reputation data by object and exposes it to the LRE using OAI-PMH. After harvesting by the LRE, the reputation data of an object is added to the other metadata of this object using the "reputation" facet of the LRE Metadata Application Profile (http://lre.eun.org/node/6).

[4] LRE portals can access the Social Data Manager using a REST API.

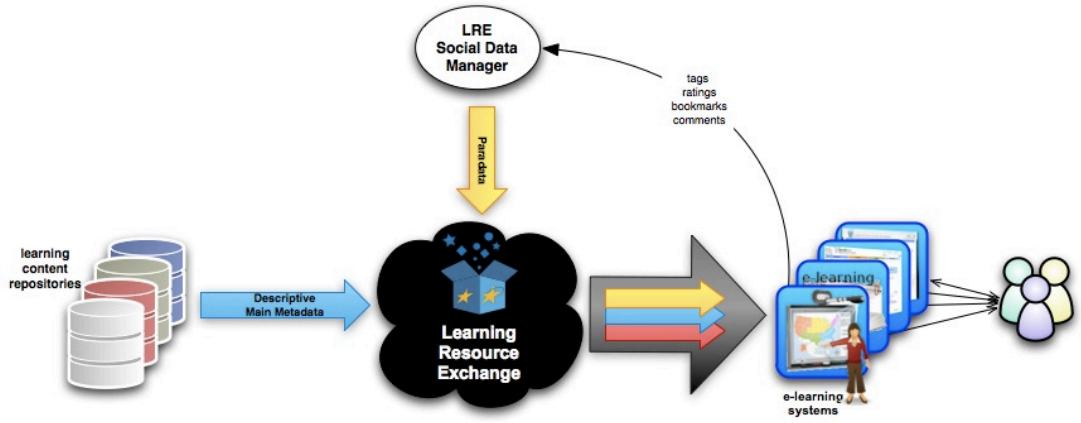


Figure 10 – The LRE Social Data Manager developed by ASPECT.

The aggregated reputation data that is exchanged between the SDM and the LRE is encoded using the NSDL "paradata" XML binding (see http://nsdlnetwork.org/stemexchange/paradata/). As an early adopter of this schema, ASPECT is contributing to its development in the framework of its collaboration with the Learning Registry project (http://groups.google.com/group/learningregistry/).

The final objective of this collaboration consists of enabling the exchange of learning objects between the LRE and NSDL by exchanging both metadata and paradata.

2.2.3 Other tools

2.2.3.1 Broken URL Handling System

In a large federation of learning object repositories such as the LRE, learning object locations or learning object URLs in metadata can become out of date when learning objects are moved or deleted. Regular checking of learning object URLs is essential. However, fully checking across a large federation imposes an unsustainable burden on time and resources while negatively impacting networks and repositories. In order to address this issue, ASPECT has developed a broken URL handling system with a heuristic model that can provide a sustainable solution for federation service managers while enhancing communication and collaboration among federation stakeholders. This system is now integrated[5] in the LRE where it is used for systematically checking metadata for broken URLs and reporting problems to content providers. Further details about the Broken URL Handling System can be found at http://sunsite.informatik.rwth-aachen.de/Publications/CEUR-WS/Vol-681/paper05.pdf.

2.2.3.2 Generic OAI-PMH target

ASPECT has confirmed the usefulness of the OAI-PMH protocol for exposing and exchanging metadata in different formats. Within the project, OAI-PMH is used,

[5] Currently, the Broken URL Handling System is not available as a standalone tool.

for example, to expose learning object descriptions in IEEE LOM and IMS ILOX formats, collection and repository descriptions in IMS LODE Registry format, or social data in NSDL Paradata format. In order to facilitate the deployment of such OAI-PMH targets whatever the format of the metadata to be exposed, ASPECT has developed an open source, generic OAI-PMH target based on the OAI-CAT (http://www.oclc.org/research/activities/oaicat/) and Lucene (http://lucene.apache.org/) libraries.

Once deployed on Tomcat, the Generic OAI-PMH Target can be used to expose any XML metadata stored on a file system where:

- Each metadata instance is stored in a single file,
- Each file name is used as metadata record identifier,
- The file last modification date is used as metadata record last modification date,
- The names of the directories in which the metadata files are stored correspond to the OAI-PMH sets
- The names of the directories in which the set directories are stored correspond to the OAI-PMH metadata formats.

The source code of the generic OAI-PMH target is available at http://oaipmh-target.svn.sourceforge.net/viewvc/oaipmh-target/ under the GNU Library or Lesser General Public License (LGPL).

3 Case Studies

3.1 Semi-Automatic Metadata Generation (SamgI)

Without appropriate metadata, no learning content will be really reusable because it will be difficult or impossible to identify and retrieve it. The SamgI framework tries to enrich a limited set of metadata associated to learning resources. The SamgI framework has been created in the context of the previous eContent*plus* project MELT. For ASPECT, we have performed a small case study to semi-automatically generate metadata from Common Cartridge packages.

Figure 11 shows an example cartridge about "Medicine and Society in Europe" that originates from the OpenLearn repository (OU-UK) that is available in the ASPECT network. The rectangle in the right upper part shows all contained files that are used in the cartridge. For each of them, metadata is automatically generated. This has two advantages:

- In this example, "keywords" and "reading age" are taken from the separate files in the cartridge. Those are combined and added to the general LOM metadata instance that describes the complete CC package. Therefore, the package may have a higher discovery rate as more search keywords can be matched with the new keywords in the metadata.
- Because we open up the cartridge, we can add LOM metadata to each individual content object in the package and make those individually available in ASPECT as well by publishing them with auto-generated metadata in the LRE.

This case study shows that we can enrich the metadata that describes packaged content and that we can also expose the learning objects inside the package itself.

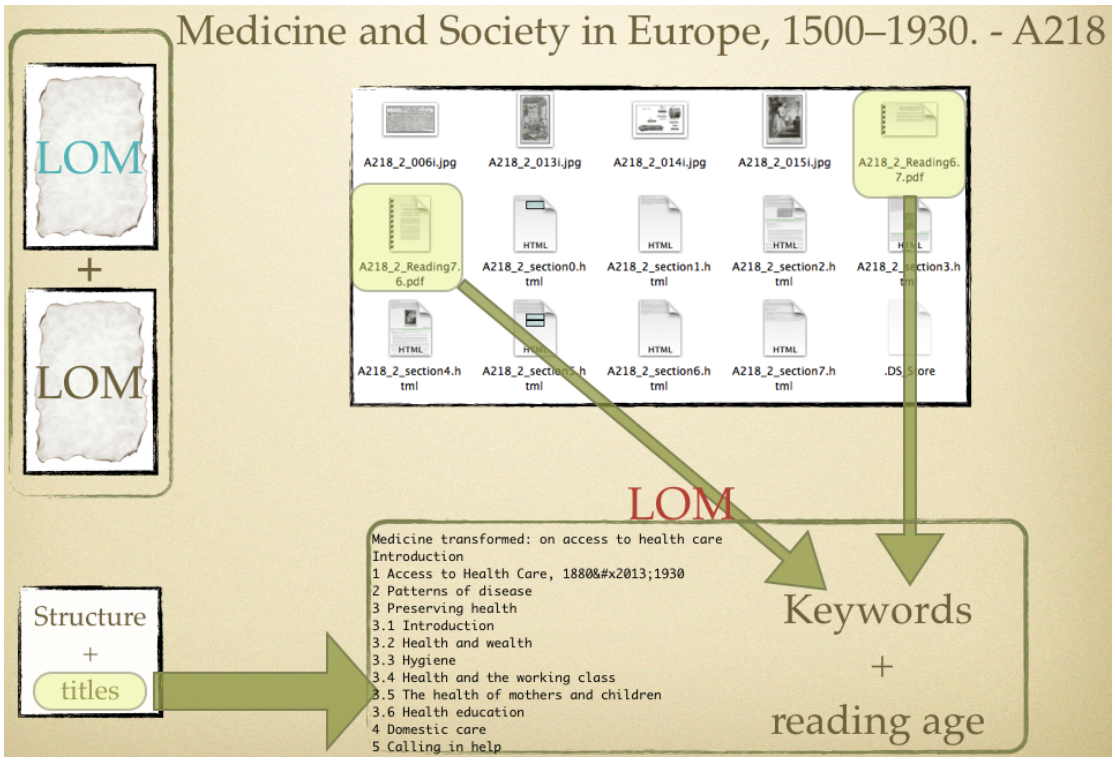


Figure 11: Using SamgI to generate metadata from CC-package

3.2 Content Package Publication Made Easy

ASPECT has used its transformation service as the basis for a tool that allows content publishers to make IMS Common Cartridge packages discoverable by uploading them into a repository. Once a cartridge is uploaded via a web page (see
Figure 12), the tool is used to automatically:

- Generate metadata for these packages (see Figure 14)
- Expose the package and its metadata through an OAI-PMH target. Once exposed, the generated metadata instance can be harvested by the Learning Resource Exchange and the package can be discovered from the ASPECT portal where the package can be rendered in a browser (see Figure 15).

Figure 12: Content Publishers Interface for uploading Packaged Content

The purpose of this tool is to demonstrate that making content packages discoverable can be simplified. Content providers can focus on producing valid common cartridges. Once the cartridge is ready, the rest of the publication process can be entirely automated.

Figure 14: The generated metadata from the CC package is shown to the user.

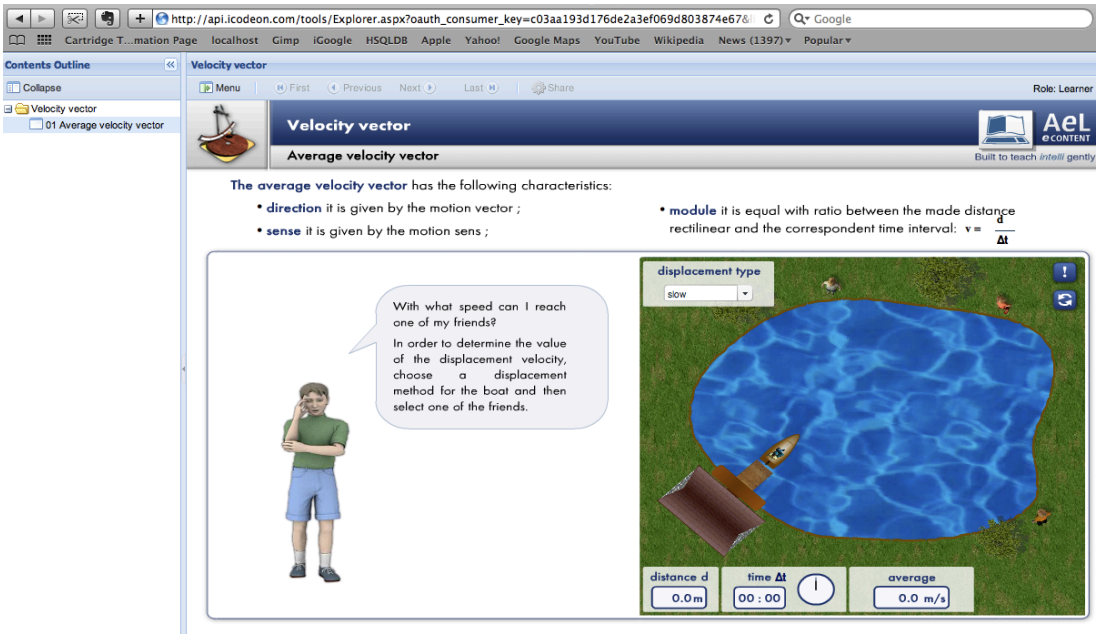


Figure 15: The rendered, uploaded package

3.3 Access through Moodle

Many teachers and learners will want the flexibility of being able to access learning resources from within a learning platform rather than by having to visit a dedicated resource portal. With this in mind, we have provided a Moodle Bridge in ASPECT via a component that is integrated into the Moodle Learning Management System (LMS). As illustrated by Figure 16, when users want to upload a document to their course, the bridge enables them to search in Learning Resource Exchange (LRE) from within Moodle. Along with this search capability, they can directly import and deploy the packages that they have discovered in the LRE.

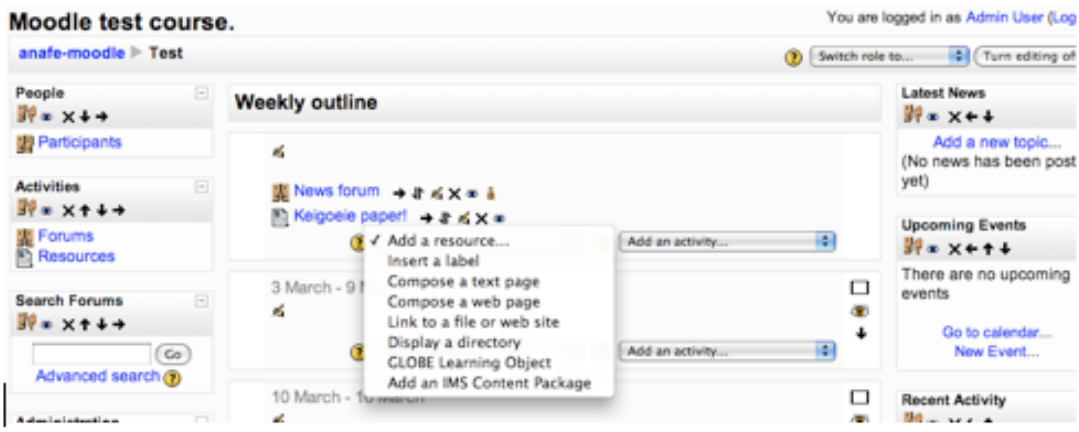


Figure 16: Searching the LRE from within Moodle through the ARIADNE Moodle Bridge

4 Conclusions

This document has described the different tools and services that were added to the third version of the ASPECT Infrastructure. The latter is the actual deliverable D2.7.

ASPECT WP2 is continuously working together with standardization groups to ensure interoperability. For the moment, we are contributing to the following groups:

- IMS Learning Object Discovery & Exchange (LODE – http://imsglobal.org/lode/)
- *The IMS LODE Information for Learning Object eXchange (ILOX):* This data model serves as a basis for the LRE Metadata Application Profile version 4.X (latest version available at http://lre.eun.org/node/6/). The latter was created in ASPECT and content providers use it to describe learning resources. Most of the tools developed by ASPECT have been designed to take into account the characteristics of the ILOX data model that allows, among other things, for managing multiple versions and/or formats of a learning object and handling metadata of different origins and formats. Examples of such tools include the ASPECT portal, the harvester, the validation service, the transformer service, the VBE, the application profile registry. By doing so, ASPECT was able to provide important feedback that has proved key in finalizing the ILOX data model.
- *The IMS LODE Registry Data Model:* This data model and its XML binding is the central element of the ASPECT Learning Object Repository Registries that have played a central role in testing the candidate specification and informing its development.
- CEN Workshop on Learning Technologies:
  - *Interoperability of registries:* In this working item, we are working on a standardized way for federations, such as the EUN Learning Resource Exchange (LRE) [http://lre.eun.org/], Ariadne [http://www.ariadne-eu.org/] and GLOBE [http://www.globe-info.org], to exchange information about potentially relevant repositories. This information includes the locations of the participating repositories, the description of their collections and the descriptions of the protocols supported by these repositories for exposing learning resources. ASPECT has gathered a lot of useful experience in building learning object repository registries (see section 2.1.1) and interconnecting them that is directly useful to this working group.
  - *Capturing & Sharing Social Data:* ASPECT is playing a leading role in this work item. Working together with other projects (including Organic.Edunet and ROLE), ASPECT is looking at the best way to define, share and reuse social data around learning resources. Here also, ASPECT has gathered a lot of useful experience in building its social data manager (see section 2.2.2.2) that is directly contributing to this working group. The group focuses on two aspects:

- Describing and capturing "activities" that take place around learning resources. Examples of such activities are: downloads, ratings, recommendations, etc. These activities start from a user's perspective and store the data in the user's profile.
- Describing and capturing tags, comments, ratings, etc. that are linked to a learning resource itself. This information can be stored in the metadata that described the learning resource itself.

Note that, at the exception of the Vocabulary Bank for Education (VBE), which is a commercial product licensed by VMG[6], all the other services and tools described in this document are distributed as open source software.

[6] As part of the ASPECT consortium agreement, VMG is committed to make the VBE software instance available to all ASPECT partners under the continued payment of the existing third party hosting fee. Any ASPECT partner wishing to purchase a traditional license to implement Lexaurus Bank, incorporating the features implemented during the ASPECT project, will be offered discounted terms.