D1.1 Analysis Report on Federated Infrastructure and Application Profile

ECP 2008 EDU 428016

OpenScout

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Deliverable number	*D1.1*
Dissemination level	*Public*
Delivery date	*18.06.2010*
Status	*Final*
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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.

Table of Contents

1 Introduction

The OpenScout project aims to support the distribution and improvement of open educational content in several fields of education managing and training. The goal is to gather together small and medium enterprises (as well as to open web 2.0 communities) that enclose valuable knowledge resources and to provide a skill-based search of content for learning communities.

To reach the project's goals a collective effort of educational content providers, logic and business conceivers and learners is necessary. The process model can be summarized in three steps. First, gather and centralize metadata information in appropriate (L.O.M) format regarding the existing learning resources located at different learning content repositories; also provide core project services, for example user profile management, competencies management, logging services (user activities) and provide tools for document manipulation (authoring, visualization …). Then at a second level, provide a connector model that combines the developed services in order to provide integrated services to user portals, social networks and other e-learning environments. This includes access to the centralized metadata repository for searching and manipulation of the resources, access to user profile and preferences, access to logging facilities etc. The third and last step is the development of a user-interface which will enable users to access the provided services in a user-friendly and convenient way, e.g. searching and retrieving of related learning objects according to user defined criteria (as scientific regions, keywords in titles, competencies etc), suggestions about other related objects, possibility to comment and tag, tools to view and to author these objects.

The present deliverable aims to report on functionalities of the first step of the described process. In other words, the deliverable describes how the consortium will gather the learning objects metadata, centralize the access to existing learning resources and form a suitable application profile which will contribute to a proper and suitable modeling, retrieval and presentation of the required information (regarding the learning objects) to the interested users. The described approach is the foundation for the federated, skill-based search and learning object retrieval. The deliverable focuses on reporting the analysis of the available repositories and the best infrastructure that can support OpenScout's initiative. The deliverable explains the motivations behind the chosen infrastructure based on the study of available information and previous research and literature.

In the rest of the deliverable, we first analyse the state-of-the-art technologies, infrastructures and data modelling options to build OpenScout upon. Our choices are based on the study of general background (Section 2) and the lessons learned from past projects (Section 3).

Later, we describe the actual OpenScout infrastructure (Section 4), the content federation architecture and technological analysis for implementing the prototype. To further clarify the content federation, we describe the module responsible for gathering learning objects-metadata and presenting the repositories together, namely the harvester component, and the processes of content repository integration. In addition, we also describe the services that the content federation provides to both end-users and developers such that they can access the distributed and heterogeneous contents via a unique access point.

In Section 5, we explain the OpenScout application profile. We report the analysis of the chosen integrated application profile for the federated infrastructure including content, usage and social metadata.

Additionally, we describe the underlying content repositories and basic information of the content providers. Each repository has been analysed according to its available content and metadata (Appendix - Section 8). Note that the repositories reported in this deliverable are the ones that have been or will be integrated in the first stage. When the project proceeds, new repositories will access our content federation continuously. Therefore, the current federated application profile may change accordingly and new technologies may be incorporated as well, although the main data model and architecture will remain stable.

To verify the proposed federated infrastructure, we have already implemented a simple running prototype which integrates three content repositories and allows end-users to search the underlying contents through OpenScout Web portal. Since there is a deliverable dedicated to the running federated infrastructure due in M15, we leave the implementation details to that deliverable while focusing on design and analysis issues in this deliverable. Last, we conclude this deliverable and provide a short overview for the next steps and connection between this work in WP1 and the tasks in other WPs.

2 General Background

The following chapter presents relevant information and options for searching repositories and describing metadata. The chapter also provides comparisons of the most suitable solutions. First, repository searching and harvesting is described and compared and finally, the chapter concludes to comparison of learning object data models and selection of the most promising approach.

2.1 Architectural Design for Searching Repositories

In this section we describe the two most prominent design patterns for searching repositories, namely the federated search pattern and the harvest pattern, for further details please see [21].

2.1.1 Federated Search Pattern

A federated search pattern lets search clients avoid maintaining connections with several repositories by giving them access to just one search interface through which they can search an entire network. To enable federated search, a registry maintains a list of repositories with which a federated search engine can interact. The federated search engine federates an incoming query to all repositories contained in this registry. It then waits for the answers, combines them and returns an answer to the originating search client.

2.1.2 Harvest Pattern

The search on harvest pattern uses an intermediate repository to support searching repositories that expose a harvesting interface. A registry maintains a list of repositories that can be harvested. A harvester harvests all metadata contained in the repositories and stores them in a centralized repository that can be searched by search clients.

2.1.3 Federated Search Pattern vs. Harvest Pattern

Although both patterns have advantages and disadvantages, we decided to use the harvest pattern for searching repositories. Searching harvested metadata means, that users aren't always searching the latest version of metadata, there might also be a harvested copy of a metadata instance in the centralized repository which is already removed in the original repository. However, the harvesting approach can give clients search access to OpenScout repositories that only support harvesting and don't offer search interfaces. Furthermore, when searches are federated, the federated search engine's response time relies on those parties' response time. This also impedes the pre-processing of the results, e.g. ranking, as the search engine needs to wait for all results. Another argument for using the harvest pattern is that the system architects are free to decide which query languages the metadata store will provide to the source applications and what technology to use to implement searching.

2.2 Learning Object Data Models

In this section we give a brief introduction to learning objects metadata and domain specific application profiles, before we analyse the two most preeminent options to describe the learning objects metadata profile in OpenScout, namely LOM Standard and Dublin Core Metadata. The results of the analysis and the comparison lead to the selection of LOM Standard as OpenScout's LOM profile.

2.2.1 Introduction to metadata, metadata standards, and application profiles

Metadata play an important role in online repositories with learning resources. Metadata are usually defined as 'data about data'. Metadata are in general used for describing the properties of information resources, in order to facilitate their categorization, storage, search and retrieval in digital collections. Storing the metadata in a structured and standardized manner supports the automation of search and retrieval mechanisms, the comparison between descriptions of different resources, the reusability of descriptions in different applications, as well as the interoperability between different storage systems. [13]

Metadata are associated to resources and consist of various metadata elements. Metadata schemas (or metadata models) are sets of metadata elements designed for a specific purpose, such as describing a particular type of resource [15]. Metadata specifications are well-defined and widely agreed metadata schemas that are expected to be adopted by the majority of implementers in a particular domain or industry. When a specification is widely recognized and adopted by some standardization organization (such as ISO – the International Standardization Organization), it then becomes a metadata standard.

However, there is no single metadata standard that can be used in *all* application domains. Rather, there are various metadata standards or specifications that can be adapted or "profiled" to meet application specific needs. This requirement for specific adaptations has brought up the concept of application profiles. An application profile is a collection of metadata elements selected from one or more metadata schemas, and its purpose is to adapt or combine existing schemas into a package that is tailored to the functional requirements of a particular application, while retaining interoperability with the original base schemas [7].

Metadata are in particular important for the description of Learning Objects stored in learning repositories. (Educational) Metadata associated with learning objects make search, retrieval

and access faster, easier and more effective. For the description of the metadata related to Learning Objects various standards exist. Two of these standards (LOM and DublinCore) are described in the following sub sections. Using a recognized metadata standard is important for a variety of reasons: metadata descriptions (records) of learning resources may be exchanged among different Learning Object Repositories (LORs); search queries may be propagated among different (and interconnected) LORs; and generally the integration of data from different sources is facilitated.

When developing a repository with Learning Objects for a particular application domain, in the case of OpenScout for the management application domain, additional special requirements arise that need to be reflected in the metadata of the learning resources. These additional requirements concern e.g. the particular topics that the learning objects cover, the competences that can be achieved by working with learning objects and other special requirements. Therefore it is necessary to combine standard-based and OpenScout application-specific educational metadata.

2.2.2 LOM

The Learning Object Metadata (IEEE 1484.12.1 – 2002 Standard) refers to systematically created and formatted descriptions of resources, intended for learning, informational, or other purposes. The LOM standard has become the most widely used solution for classifying and describing digital resources intended specifically for learning and education.

The LOM standard, usually encoded in XML, includes 76 data elements, covering wide-ranging characteristics attributable to LOs, including their size, level and type of interactivity, and the educational context to which they are best suited. The LOM defines all of its data elements in interrelationships that are both hierarchical and iterative. At the top of the hierarchy of LOM elements are nine broad category elements: General, Lifecycle, Meta-metadata, Technical, Educational, Rights, Relation, Annotation and Classification. The category elements each contains sub-elements, which, in turn, often contain further sub-elements. Many of the category elements, sub-elements, and subordinate elements can be repeated. This results in complex hierarchical and iterative structures, allowing for a total of over 16,000 possible, concatenated element repetitions.

Given its relative size and complexity, as well as the fact that it is the first technical e-learning standard to be widely adopted, the implementation of the LOM presents an excellent opportunity for study and research. By looking at how it has been implemented in projects and in specific metadata records, it is possible to learn valuable lessons about e-learning standards implementation, and about how to develop and refine further standards to meet implementers' and educators' needs.

2.2.3 Dublin Core

A related metadata specification to LOM is Dublin Core Metadata [6] Element Set (commonly known as Simple Dublin Core) which provides a simple, loosely-defined set of elements with some overlap with the LOM, and which is useful for sharing metadata across a wide range of disparate services. It is a conceptual schema we can use to describe a metadata model such as LOM.

The Dublin Core metadata standard, defined by ISO in ISO Standard 15836, and NISO Standard Z39.85-2007, is a simple yet effective element set for describing a wide range of

networked resources. The Dublin Core standard includes two levels: Simple and Qualified. Simple Dublin Core comprises fifteen elements; Qualified Dublin Core includes three additional elements (Audience, Provenance and RightsHolder), as well as a group of element refinements (also called qualifiers) that refine the semantics of the elements in ways that may be useful in resource discovery. The semantics of Dublin Core have been established by an international, cross-disciplinary group of professionals from librarianship, computer science, text encoding, the museum community, and other related fields of scholarship and practice [6].

Implementations of Dublin Core typically make use of XML and are Resource Description Framework (RDF) based which allows multiple objects to be described without specifying the detail required.

2.2.4 LOM versus Dublin Core

The simple version of the Dublin Core schema consists of a set of 15 independent elements, including for example: Title, Identifier, Language, Description, etc. Qualified Dublin Core employs additional qualifiers to further refine the description of a resource. The conceptual schema for Dublin Core defines the semantics of the DC elements and their qualifiers, such as: “An element is a property of the resource being described", “An element refinement is a property of a resource that shares the meaning of a particular DCMI element but with narrower semantics", “An encoding scheme provides contextual information or parsing rules that aid in the interpretation of a value string". There is work underway to make the DC conceptual schema explicit [4]. It should be noted that the Dublin Core schema is deliberately designed to be compatible with RDF.

LOM, by contrast, uses a completely different schema. LOM describes resources using a set of more than 70 attributes, divided into these nine categories:

General	Lifecycle	Meta-Metadata
Technical	Educational	Rights
Relation	Annotation	Classification

The descriptors are organized in a tree-like structure under these categories. This tree makes it possible to organize the information in a consistent way, grouping information into related pieces. The LOM schema is thus based on a recursive container model. However, it can be seen that it is not compatible with the DC schema [14]. As a simple example, the 2.3.3 Date element (in Appendix 9) is not a property of the resource being described, but can be seen to be a property of the “Contribution" it belongs to. Similarly, the elements in the “Meta-metadata" categories are not properties of the resource being described, but of the metadata document itself.

The container-based model used by LOM is thus not compatible with the model used by Dublin Core. When does this matter? Binding LOM to RDF is the obvious example in this context, as the schema of RDF is based on a property-value model and not containment. In general, it leads to difficulties when trying to combine terms from two metadata standards into the same system. When the schemas are compatible, such a combination or mapping can be realized by a simple translation. If the schemas are incompatible, the translation must be

done on an idiosyncratic, element-by-element basis. This schema incompatibility is the main source of the challenges in binding LOM to RDF [6].

Furthermore, LOM is gradually becoming the reference standard for educational systems managing learning objects of many kinds, besides that it is one of most important standard for Interoperability [10]. Also, LOM is part of SCORM which is the standard to package learning resources; it is used by most LMS and consequently it is a de facto standard. We therefore have to support LOM. In addition, due to its full coverage of learning objects metadata description, the *IEEE 1484.12.1 – 2002 Standard for Learning Object Metadata* has been chosen as the schema model for the OpenScout centralized repositories. In Section 5, OpenScout application profile based on LOM is described.

3 Examples and Best Practices

This chapter looks in to existing approaches for managing repository infrastructures. The analysis covers related European projects. The selected examples are Ariadne, MACE and ICOPER. Outgoing from these project experiences, we will design and improve the OpenScout federated infrastructure. We will also consider re-using specific parts of the existing solutions.

3.1 Ariadne

The Ariadne[2] foundation is a European association for knowledge sharing and re-use. It was created to exploit and further develop the results of the ARIADNE and ARIADNE II European Projects, which created tools and methodologies for producing, managing and reusing computer-based pedagogical elements and telematics supported training curricula. The core Ariadne infrastructure has several components, namely the repository, the federated search engine, the finder, the harvester and the metadata validation service which will be described in more detail in the following. All described Ariadne components can be downloaded from the Ariadne website to be re-used and further developed, as they are available under LGPL license.

3.1.1 Repository

The Ariadne repository offers a metadata and a content store for persistent management of learning objects and LOM instances. Additionally, it provides an Simple Query Interface (SQI) for searching, an Simple Publishing Interface (SPI) for publishing and an OAI-PMH interface for harvesting metadata. As SQI, SPI and OAI-PMH hide the structure of the metadata storage paradigm, the repository component enables loosely coupled integrations with external applications.

3.1.2 Federated Search Engine and Registry

The Ariadne federated search engine relies on SQI, it therefore federates incoming queries to SQI-enabled repositories that it dynamically loads from a registry. The federated search

[2] http://www.ariadne-eu.org/

engine awaits results from repositories, aggregates them, and sends them to the originating query tool.

3.1.3 Finder

The Ariadne finder allows end users to search educational contents and browse their results. It also lets them authenticate with OpenID and publish LOs.

3.1.4 Harvester

The Ariadne harvester builds on OAI-PMH. It manages an internal registry of OAI-PMH targets containing basic parameters for each target, such as the base URI and the content provider. After harvesting, this component publishes the metadata through SPI in one or more repositories. The harvester employs incremental harvesting, which uses the date-range queries offered in OAI-PMH and a scheduling mechanism, so that incremental harvesting occurs regularly.

3.1.5 Metadata Validation Service

The Ariadne medadata validation service is used by the harvester to validate each individual target's metadata against a specific validation scheme.

3.2 MACE

MACE [19] (Metadata for Architectural Contents in Europe) is a pan-european initiative to interconnect and disseminate digital information about architecture. The MACE project connects various repositories of architectural knowledge and enriches their contents with metadata. In order to ease the access to relevant contents the learning objects can be connected across repository boundaries. Further, the MACE project enables the users to annotate learning resources with tags, comments and ratings, build up personal portfolios and contributing new learning resources to enable improved access and experience multiplication for students, teachers and professionals.

The intention of the MACE infrastructure is to open up existing Learning Object Repositories (LORs) to make the containing contents accessible to the users. Therefore the MACE system makes use of ARIADNE services, mainly the repository, the harvester and the metadata validation service as described in the previous section, which provide the possibility to harvest the metadata of the included LORs and republish the enriched metadata. The available content metadata inside of the LORs are harvested through the OAI-PMH protocol to store them into a central MACE metadata store. Since the metadata contains references to their original location the MACE metadata store can be used to search for specific contents across LOR boundaries and link to the original learning object. In order to unify the harvested Learning Object descriptions of the separate repositories the Learning Objects are described using the MACE application profile based on an extension of the Learning Object Metadata (LOM) standard. The basic LOMv1.0 schema has been extended by the following elements to integrate the different types of metadata considered in MACE: data elements, vocabulary values, a faceted classification of architectural terms, a taxonomy of learning competences.

Extended data elements which have been added to the LOM schema are Geo-location which link the location of a built architectural project and Min/Max EQF to describe the proficiency level of the respective competence expected to be achieved by the consumer of the LO.

Within the MACE project, a service oriented architecture was used to connect the presentation layer with the data sources. Besides metadata and content retrieval services to provide search functionality MACE made use of services which allow users to annotate contents with own metadata, track activities and generate metadata from user actions. The filtered search provides a keyword search which lists LOs containing the respective keywords. The resulting list can be refined by selecting different facets that describe the context of the LO, i.e. the repository the resource belongs to, the language of the resource, the media type, its classification, and the associated competency. In the resulting list the user can choose whether to access the content directly or to access the metadata view of the LO. Since the MACE project is also interested on the users that are interested in the provided contents, users were encouraged to contribute information in form of tags, comments, ratings, formal classifications or even new contents. Having this information, MACE provides a social search which provides a keyword search through user generated content as well as presenting the most popular tags as a tag cloud and clicking on a tag results in a list of respective LOs. Further the system provides the possibility to browse the contents by MACE classifications i.e. classifications of architectural concepts or the competence catalogue which help the learner to achieve the respective competence. If the learner needs to find contents based on a specific location, she can browse a world map which indicates the geographical position of a respective content.

To track the user activities within the MACE system, user interactions such as access of learning objects and communication activities are automatically captured. The observed user actions are stored as Contextualized Attention Metadata (CAM). The Usage Metadata is used to provide self reflection features so that the learner is able to analyze which learning resources she accessed when, how she found them and which topics have been relevant to her and when.

3.3 ICOPER

ICOPER is an *e*Content*plus* Best Practice Network involving experts in digital educational development and technology enhanced learning (TEL). The project aims at analysing the specifications and standards available and in use, addressing issues such as exchange of competency models and learning outcomes, collaboration around learning designs, integration of content via federated search and harvesting, reuse of instructional models and content in learning delivery environments and interoperability of item banks for assessment and evaluation.

In the context of the ICOPER project, the Open ICOPER content space (OICS) has been defined as the umbrella combining a portfolio of interoperable repositories, content and tools, as a test bed for the specifications and standards that become part of the ICOPER reference model.

Technologically, the OICS is based on metadata harvesting and provides a simple search interface for querying this metadata. Three types of components are connected in the architecture chosen for this prototype [22], [23]:

1. Repositories, exposing metadata via their respective interfaces, i.e. OAI-PMH (Open archives initiative – Protocol for metadata harvesting), RSS (Rich site summary) feeds, etc...

2. An OAI-PMH harvesting framework that pulls metadata from the OAI-PMH targets, and publishes it via an SPI (Simple publishing interface) service into the metadata store

3. A metadata store based on the OpenACS framework. Besides accepting input through SPI, an import script reads the OpenLearn RSS feed, retrieves the metadata files, converts metadata to LOM and ingests it into the database. A simple user interface (UI) is provided for searching the metadata store.

This work is under finalization (the ICOPER project is still running) and is leading to a set of recommendations that will be carefully evaluated by OpenScout as soon as available (estimated time around end of 2010).

4 OpenScout infrastructure and services

According to the previously acquired knowledge from other projects and existing literature, in this chapter we will describe the architecture of the OpenScout federated infrastructure. Subchapter 4.1 describes the overview of the infrastructure, inspired to the architecture exposed for the MACE project, while the following subchapter describes specific components of this architecture. Finally, subchapter 4.5 describes the process, how heterogeneous repositories can be integrated to the federated infrastructure.

4.1 Content Federation Architecture and Processes

The different layers of the architecture in the OpenScout approach are exposed in **Figure 1**. Based on a shared technical infrastructure for federated access to the repositories, metadata harvesting and content enrichment, web services for metadata manipulation and retrieval and metadata-based content access will be provided. The approach aims to make the learning objects in all repositories jointly searchable and retrievable.

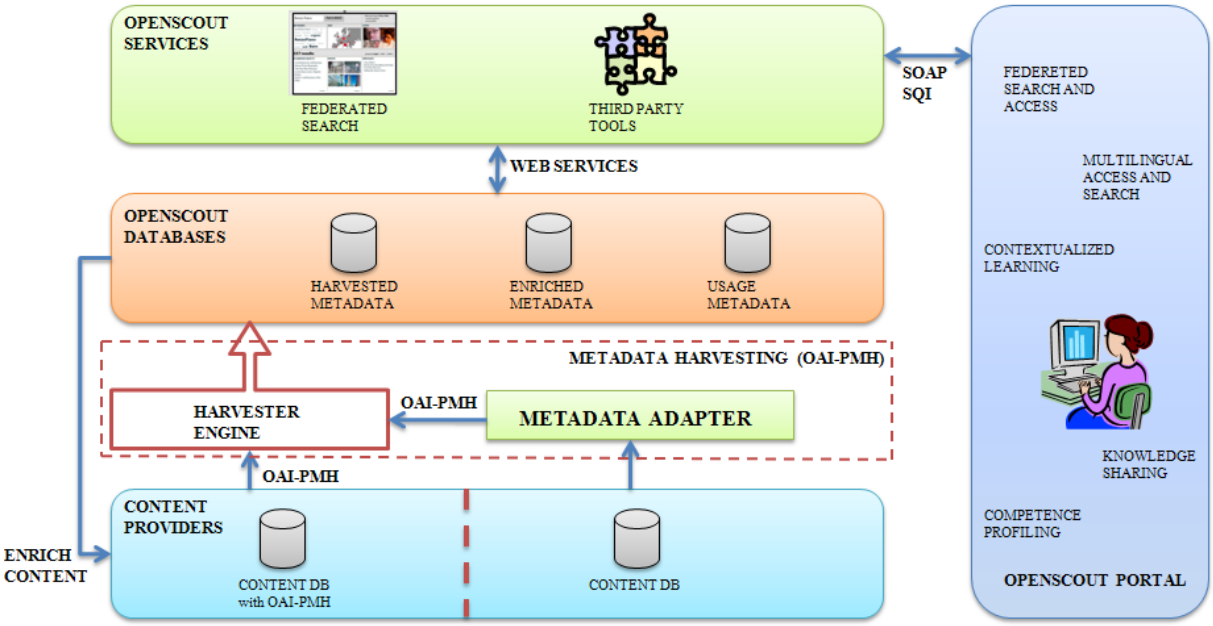

Figure 1: OpenScout infrastructure overview

Services in OpenScout connect the presentation layer with data sources. They process user queries and return results, handle user management and provide means for gathering and manipulating metadata. Some services provide simple functions while others are more complex and can even aggregate functionality. Besides metadata and content retrieval, OpenScout services will allow users to annotate contents with own metadata, track activities and generate metadata from user actions. Examples for basic services are: “FederatedSearch” which enables to search across all repositories/content sources connected to the federated infrastructure; “Subscribe” which allows users to become notified as soon as relevant content is added or changed; “CompetencySearch” which makes competencies searchable by connecting competencies, contents and context; and so on. Based on these basic services, more complex services can be realized in order to aggregate and combine various functionalities, e.g. services to enable adaptation and localization of content to the culture and language of the European countries.

To ensure full interoperability, all services will be based on open standards, such as the Open Archives Initiative Protocol for Metadata Harvesting (referred to as the OAI-PMH in the remainder of this document) for metadata harvesting and SOAP for remote web service connectivity. More details about OAI-PMH will be presented in section 4.1.1. The search service is enabled through the Simple Query Interface (SQI) [18] in order to be able for OpenScout to join Learning Object Repositories (LOR) federations like Globe [9] and Ariadne [1]. SQI can be combined with any query language [17].

The open content repositories federation is based on the exchange and combination of metadata. The real learning objects are not exchanged between the different components in the architecture, only the metadata description is processed during the progression of the federation. The metadata availability flow in OpenScout is illustrated in **Figure 2** and it describes the basic information access sequence. Firstly the content repositories provide accessible metadata describing the learning objects. The harvester component accesses this information and stores it in the centralized repository. Next, a SQI service grants the

connector component access to the centralized metadata. Finally, the connector component processes the metadata and provides high level services to the interfaces (Webportal, widgets, etc) accessed by the users.

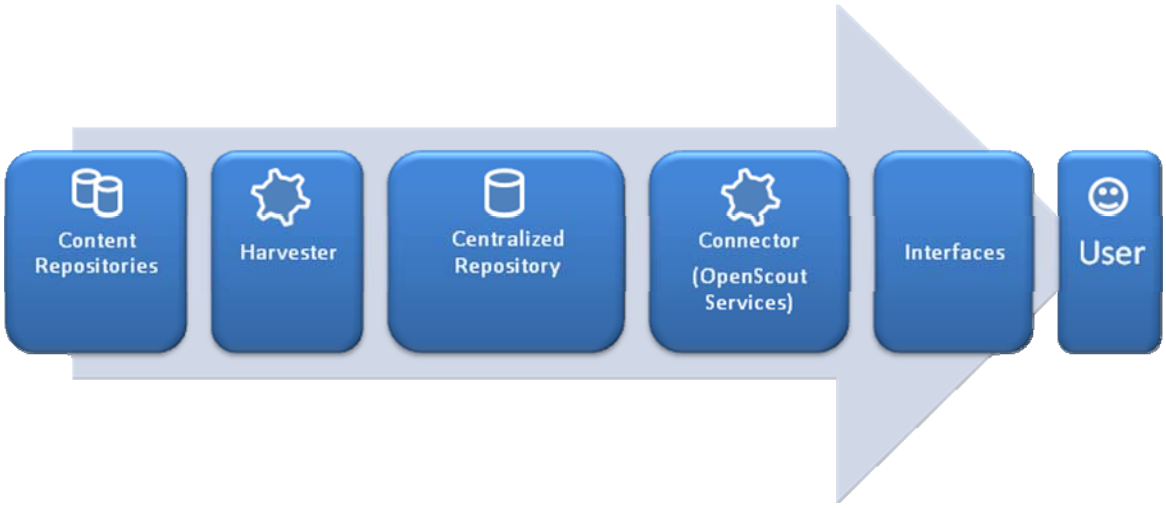

Figure 2: Metadata flow in OpenScout

4.1.1 Open Archive Initiative Protocol for Managing Harvesting

OAI-PMH (Open Archives Initiative Protocol for Metadata Harvesting) [16] is a protocol developed by the Open Archives Initiative. It is used to harvest (or collect) the metadata descriptions of the records in an archive so that services can be built using metadata from many archives. An implementation of OAI-PMH must support representing metadata in Dublin Core, but may also support additional representations.

OAI-PMH is based on a client–server architecture, in which a harvester requests information on updated records from the repositories. Requests for data can be based on a datestamp range, and can be restricted to named sets defined by the provider.

Within the database layer, OAI-PMH is used for harvesting content and domain metadata. Data describing the usage (usage metadata) is collected using the RSS (Rich site summary) protocol. While OAI-PMH is suited to collect changing metadata, RSS is used only when new metadata instances (like in log files) are added.

Both RSS and OAI-PMH build on the same common technologies although their intents are rather different. Both use XML documents that are transported over HTTP, and both can support multiple vocabularies, although RSS is predominantly used for syndicating content (usually via references to that content), while OAI-PMH is primarily focused on the job of harvesting metadata. RSS defines a simple encapsulation methodology that can be used by several classes of applications - typically (though not limited to) RSS readers, while OAI-PMH defines both a schema and an application-level protocol. RSS is particularly suited to lightweight data transfers to the user desktop or handheld, while OAI-PMH was developed to manage system-to-system processes (typically institutional repository-to-repository synchronizations).

4.2 Content Metadata Harvester

The harvesting component is the foundation of the OpenScout effort. Harvesting means to crawl and to analyze content metadata of Learning Objects (LO) from different Learning Object Repositories (LOR) and store it in a centralized repository (based on the Open Archive Initiative Protocol for Managing Harvesting OAI-PMH). This is not a one-time import action, it is an event repeated in a regular basis or triggered by updates. Once harvested, the LO is described through an application profile described by LOM standard [8]. The result of the harvesting processes provides a centralized repository where metadata of learning objects of all repositories are federated thus providing means to uniformly query and retrieve the learning objects. It is important to remark that the learning objects remain on the content provider's repositories; only the metadata is transferred and indexed.

As we have seen, the infrastructure provides means to enrich the LO metadata so the users are able to acquire knowledge and contribute sharing additional inputs. As retribution, the central repository offers an OAI-PMH interface so that the enriched metadata can be retrieved by the content providers, thus augmenting their content. Supporting this integration facilitates the quest of finding LOs and enables a full extension of operational possibilities over the LOs, albeit each LO belongs to a different repository that possess different metadata schema [17].

The OpenScout's harvesting extends the reach of knowledge gathering by providing flexible means to collect valuable LOs. The harvesting model gathers content metadata by collecting information from repositories that offer an OAI-PMH. After the data is harvested, it is validated using the OpenScout Application Profile and then stored in the centralized repository.

4.3 Centralized repository

An important OpenScout component is the centralized metadata repository, which was developed for Ariadne and re-used for our project. It offers persistent management of LOM instances. Such instances are stored by the harvester component, as explained in the metadata flow. Additionally, it provides a Simple Query Interface (SQI) [18] for searching, an interface for publishing based on the Simple Publishing Interface (SPI), and an OAI-PMH interface for harvesting metadata. In details, SQI allows the repository to operate with several query languages (at the moment, we use PLQL [20] to query the repository) and metadata standards (in our case LOM). One of the key features of SQI is the simplicity of the specification and implementation. As of April 2010, a simple testing prototype has been implemented, and 3 content repositories can be accessed using the SQI services through the content federation.

As SQI, SPI and OAI-PMH hide the structure of the metadata storage paradigm, the repository component enables loosely coupled integrations with external applications.

The advantages of only aggregating the metadata rather than raw contents include ease of creating a large federation, low overhead for the centralized repository and high efficiency. One of the main disadvantages is the inconvenience of access for end-users. Currently, we are exploring techniques to overcome the problem. For example, OpenScout Web Portal may use iFrame to show the content within the OpenScout website rather redirecting end-users to other LCMSs.

4.4 Federated Infrastructure Services

The content federation aggregates metadata of distributed content repositories. To make use of this information, OpenScout Federated Infrastructure provides services to both end-users and other components (developers) to access the federation such that upper layers need not know the technical details of underlying contents. With a unique interface, the heterogynous and distributed contents can be accessed easily. Note that part of this section has been reported briefly in deliverable D5.1 since one type of the services is to be used by the connector. Although basic services for testing have been realized already, we only describe high-level concepts here and more technical details will be reported in the next deliverable of WP1 due in M15.

- **Content Access Services for End-users**

Through the Web Portal component in WP1, OpenScout provides content access services for end-users, for example basic key-word search, to access the contents. The search operation is conducted on top of the centralized metadata repositories.

The simplest search is to compare the search keyword with all the metadata fields in the database fields assuming all fields are equally important. The ranking of the search result can be determined based on the matching score of the database. An advanced search can let users to specify a number of search fields, within which the search keywords will be compared. More complicated search field combination can be specified by the users. For instance, a user can specify search “marketing tips” within content titles where the publication dates are later than 2008, the content types are video and the accessibility is for public.

In addition to keyword-based search, end-users may also able to access the contents via navigation. For example, contents are classified based on categories, media types, publishers, accessibility and so on. Users can zoom in a category and narrow down the content into a particular sub-category.

Note that the search and navigation services are based on metadata. That is, to view learning content, the users may or may not need to access other LCMSs depending on whether the contents are publicly available. If not, the users will have to go through the authentication process of the corresponding LCMS.

Next, we describe the content access for developers within or outside OpenScout such that other LCMS or OpenScout components can also access the underlying contents easily without knowing much technical details of the content repositories.

- **Content Access for Developers**

In addition to providing services to end-users, OpenScout also enables developers inside (e.g. the connector component described in D5.1) or outside the OpenScout consortium to access the federated infrastructure. This is necessary for different reasons. For example, this service helps existing LCMSs access the federated contents, enlarge their repositories and thus benefit their users. Also, this service increases the impact of OpenScout and makes OpenScout open contents visible to boarder audiences.

From WP1 OpenScout provides content federation access services in the format of web services. Specifically, the web services allow clients to access a centralized metadata repository and returns links of the contents which are physically stored in distributed content repositories.

To implement the content access services, we use an existing technique, Simple Query Interface (SQI).

One note is that the content federation only provides centralized access to metadata rather than to the raw contents. To view or download the original learning objects, users need to follow the links provided by the content access services and possibly login into a learning content management system (LCMS) to obtain the contents.

Based on current communication with WP2, the skill-based metadata can be also accessed as other regular metadata fields. That is, we assume the federated content repositories contain skilled based metadata. This information can be either obtained from human experts who annotates the learning objects or from automatic annotators which identifies the skill level of learning objects.

4.5 Integration of heterogeneous systems

This subchapter describes how heterogeneous repositories can be integrated into the OpenScout federated infrastructure. The aim of this process description is to structure the repository integration. The integration process is described on a high level and will be refined in the course of the project. The process describes all phases from repository identification, negotiation of the content provider and OpenScout, the actual content preparation and integration to dissemination and deployment of the content. The structured process will be used as a handbook and a guideline for the content providers. This will help the content providers to integrate their repositories to the OpenScout federated infrastructure.

The following Figure describes this high level process in an UML diagram.

Activity Diagram

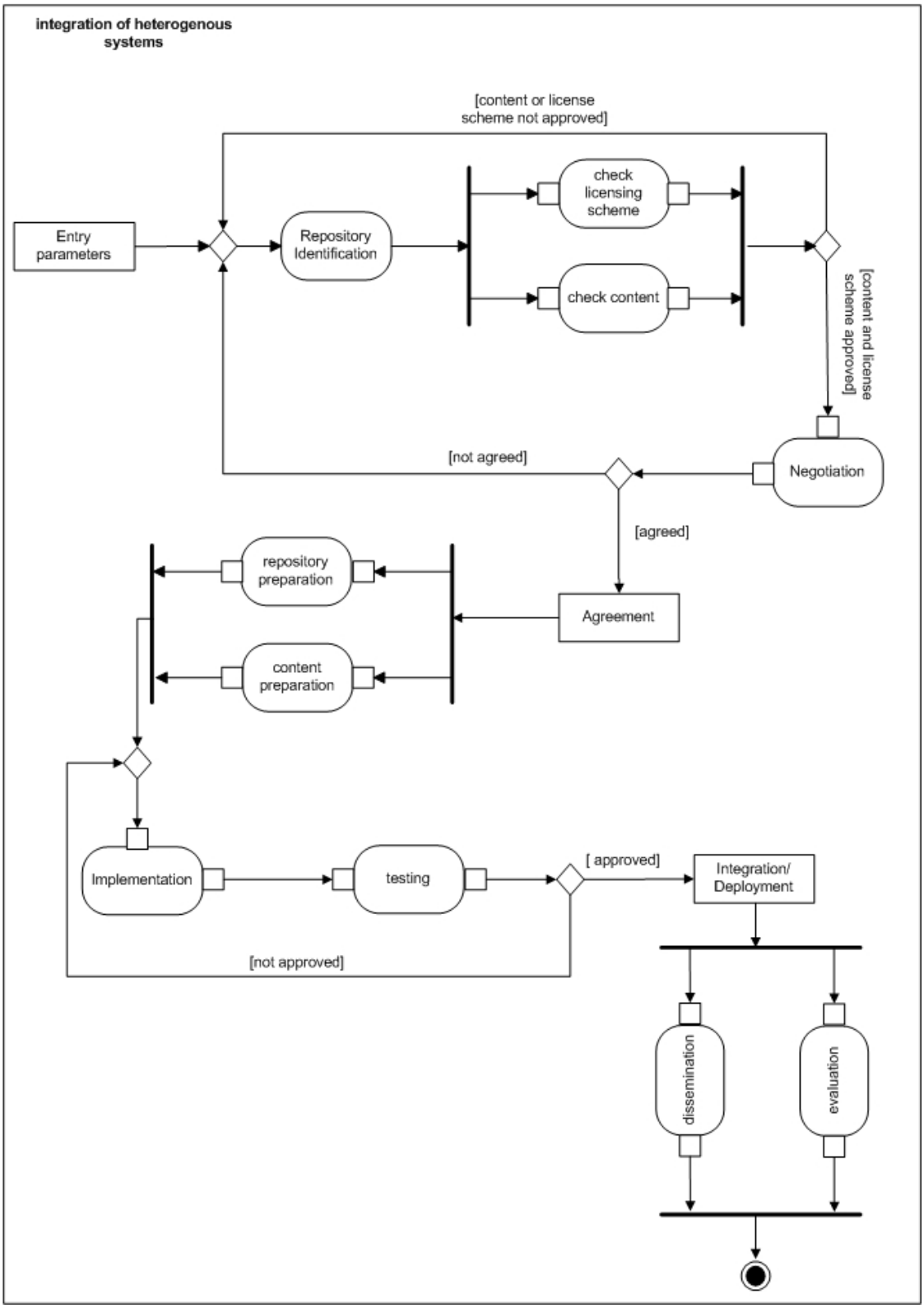

Figure 3: Repository integration process

Each function of the process can be understood as a sub process and will be described briefly in the following table. Therefore, we also indicate the involved stakeholders and components per function.

Process to integrate heterogeneous systems	
1. Repository identification	**Description:** Identifying possible repositories for the federated infrastructure. This focuses is on the licensing scheme as well as on the content of the repositories. **Stakeholders:** • Content provider • Repository provider Developer **Components:** • Content • Repository Federated Infrastructure
2. Negotiation / Agreement	**Description:** Negotiation between the repository and content providers and the OpenScout Project management board. This leads to an agreement which includes the provided services, exchanged data and a development plan (further steps including e.g. testing plan, evaluation plan) **Stakeholders:** • Repository provider • Content provider • OpenScout Management board • Developer • Administration **Components:** • Content • Services • Repository • Federated Infrastructure

	• Testing plan • Evaluation plan • Agreement • Development plan
3. Repository preparation	**Description:** Preparing the repository for the integration into the federated infrastructure. This includes the preparation of the metadata scheme and the installation of the OAI-PMH target. **Stakeholders:** • Repository provider • Content provider • Developer **Components:** • Repository • Content • Metadata schema • OAI-PMH
4. Content preparation	**Description:** In this phase the existing metadata offered by the repository is analyzed and mapped to the OpenScout metadata scheme. **Stakeholders:** • Content provider • Developer **Components:** • Metadata • Repository • Content
5. Implementation	**Description:** In this phase, the connection and interfaces between the systems are implemented. **Stakeholders:**

	• Repository provider • Developer **Components:** • Tools • Services • Web Portal • Connector
6. Testing	**Description:** In this phase the integration will be tested. This will be done from the developers' point of view regarding technical correctness as well as from the users perspective regarding usability. **Stakeholders:** • Repository provider • User • Developer • Content Provider **Components:** • Content • Web Portal • Services • Tools • Federated Infrastructure
7. Roll-out / Deployment	**Description:** Roll-out the integration and make it available for the end-user **Stakeholders:** • Developer • Content provider • Users **Components:** • Content

	• Web Portal • Services • Tools • Federated Infrastructure
8. Mutual dissemination	**Description:** Joined dissemination of the new integration to relevant stakeholders including HEI, SMEs etc. **Stakeholders:** • OpenScout • Content provider **Components:** • Web Portal • Dissemination Material • WWW
9. Evaluation	**Description:** Evaluate the integration. Questions to be answered: • Did the integration follow the development plan? • Was the intended outcome reached? • How to strengthen the partnership? • How to develop the solution further? **Stakeholders:** • Users • OpenScout • Developer • Content provider **Components:** • Content • Federated Infrastructure • Services • Tools • Metadata • Web Portal

The processes briefly illustrated above will be refined in the repository implementation stage. In the refinement phase we will describe the sub processes in detail and define use cases for each to explain the activities of each stakeholder. As an example, in the refinement of the negotiation phase we will provide an agreement template for the stakeholders that indicate in detail which shared services we offer (e.g. search, publishing, recommendation, collaboration, internationalization). The agreement also describes which data can be exchanged (e.g. user profiles).

5 OpenScout Application Profile

This chapter describes the initial OpenScout application profile and required data elements. The application profile will be extended and developed further during the course of the project.

5.1 Introduction

Duval et al. define an application profile as "an assemblage of metadata elements selected from one or more metadata schemas and combined in a compound schema. The purpose of an application profile is to adapt or combine existing schemas into a package that is tailored to the functional requirements of a particular application, while retaining interoperability with the original base schemas" [6].

Interoperability in the context of metadata refers to the ability of a system to process metadata instances produced by a third party system [2]. Thus, an application profile enables the corporation within a consortium but also with outside partners like the Ariadne foundation.

Application profiles take one or more base standards or specifications – as discussed in chapter 2.2.1 - as their starting point. The application profile then imposes additional restrictions on this baseline, e.g. by restricting the value space of an element to a subset of the original value space or by excluding data elements, if they are not needed for the specific purpose. While all base standards allow further restrictions, there are also standards, like the LOM standard, that allow extensions. Therefore, it is possible to extend a LOM based application profile with further data elements and additional data values.

There are a lot of LOM based application profiles developed in the area of technology enhanced learning addressing different purposes which can be application oriented, subject-specific or national [2]. Appendix 10 contains a comprehensive comparison of the application profiles for MACE, Eleonet, UK LOM CORE, SCORM, Moodle Core, Celebrate and RDN/LTSN. The OpenScout Full Element Set can be found in Appendix 9.

In addition to harvesting content metadata, the OpenScout system will enrich the Learning Objects with further metadata. This additional, user-driven metadata will be stored separately as it is conceptually different to the LOM application profile.. The additional metadata support the user in selecting appropriate Learning Objects from the search results or even allow for a personalized search. It captures social and usage metadata. Social (or user-generated) metadata are metadata added by the users of the OpenScout system or by users in external systems (e.g. comments, ratings, tags, votes etc.). Usage metadata on the other hand

are automatically generated and stored when a user works with the OpenScout system. Usage metadata are e.g. number of views of a Learning Object, number of downloads or ratings, searched keywords etc. OpenScout Deliverable D5.1 “Connector Model” describes use-cases for the utilization of social metadata to support a user when working with OpenScout. Furthermore Deliverable D5.1 gives a first introduction of how the usage metadata (also called attention metadata) will be stored using the CAM (Contextualized attention metadata) schema. OpenScout is currently in the process of defining the metadata schema for storing these additional social and usage metadata in external databases. These additional metadata are not part of the current deliverable where we focus on the OpenScout application profile for storing content and competence metadata.

5.2 Obligation of Data Elements

The OpenScout Application Profile identifies elements as being mandatory, optional, recommended or conditional. In order for a metadata instance to be valid, it must contain values for all mandatory elements. A value for an optional data element may not be present in a metadata instance, whereas values for recommended data elements should be present. A value for a conditional data element shall be present in a metadata instance, if a certain condition is satisfied, e.g. when a contributor of metadata is present there must be a value for the role of this contributor, e.g. “author”. As soon as a data element is present in a metadata instance, its parent element is required, too.

It is eligible to have as exhaustive metadata instances as possible to offer the user more support possibilities. Though, not all repositories offer the same amount of metadata. Appendix 11 exposes the investigation of the repositories Avicenna, INSEAD, OpenER, OpenLearn and SlideStar which have been or will be integrated by aligning their metadata attributes to the metadata attributes of the standard LOM schema used in OpenScout. Therefore, the OpenScout application profile considers only those data elements as mandatory that are needed to deal with the learning objects and allow their retrieval by the user.

5.3 Value spaces

The value space of a data element defines the set of values that the elements shall derive its value from. Typically, a value space in LOM is defined through a vocabulary, i.e. an enumerated set of values or a reference to another standard, e.g. ISO/IEC10646-1:2000 or specification, e.g. vCard [2]. To be as open as possible, the current OpenScout AP doesn’t restrict any of the original LOM data spaces. Though, it allows the classification of learning objects according to the domain of management education.

The classification is helpful for content retrieval and browsing. For example, with the classification one can easily obtain all content within a sub-category and conduct search within the sub-set of all contents; this is sometime known as faceted search.

Since different repositories may have different classification schemes, OpenScout needs to either manually have the classifications of repositories mapped to a unified scheme or use some existing tools, depending on the number of different classification schemes. OpenScout will encounter with the progress of integrating more content repositories. Another possibility is to have the classification from advanced users using the Web portal.

To illustrate the concept, we have some classification examples in the following sub sections.

5.3.1 INSEAD Classification[3]

Note that this is not the final classification; with more content integrated, this classification will be refined accordingly.

Inside INSEAD, contents are classified into 9 categories:

- Accounting and Control
- Decision Sciences
- Economics and Political Science
- Entrepreneurship and Family Enterprise
- Finance
- Marketing
- Organisational Behaviour
- Strategy
- Technology and Operations Management.

For each of these disciplines, contents can be further classified into sub-categories. For example, under Marketing, there are branding, B2B marketing, consumer behaviour, customer relationship management, and so on.

5.3.2 Library of Congress Classification[4]

In Library of Congress (LOC), social science is classified into different categories, and we only list those related to management education below.

- Industrial management

This includes capital investments, competition, Technological innovations, Crisis management, Public relations, Management of special enterprises and so on.

- Commerce

This includes Boards of trade, Balance of trade, Commercial geography, Business ethics, Black market, Office management, Accounting and so on.

- Finance

This includes liquidity, personal finance, banking, credit, debt, loans, Foreign exchange, International finance, Finance management, Business finance, Investment, capital formation and so on.

- Public finance

This includes Income and expenditure, Budget Revenue, Taxation, Internal revenue, Customs administration, Public debts and so on.

We used two examples to illustrate content classification in the discipline of management education. Based on the experience and knowledge from content partners, there is no common

[3] http://www.insead.edu/facultyresearch/faculty/academic_areas.cfm

[4] http://www.loc.gov/catdir/cpso/lcco/

classification in the consortium, and different partners either use their own classifications or do not classify their contents at all. Thus, we may have to use classification mapping techniques to convert different classification scheme into a centralized one. Depending on the quality of the mapping tested on more repositories to be integrated, we will refine OpenScout content classification with the progress of the project.

5.4 Data Elements

Similar to the data spaces, the current OpenScout AP doesn't reject one of the data elements of the LOM standard. Though, as OpenScout will also offer the opportunity to find content related to competences in the field, the OpenScout AP extends the LOM standard to enable the storage of competence metadata. The rationale behind competence related metadata, an overview about existing competence services, and specific implementation details can be found in Deliverable D2.1.

The competence metadata for each learning object is stored in the classification section of the OpenScout Application Profile, whereas each competence is stored within a taxonPath that contains a pair of taxons describing the related domain and the competence with the assigned EQF (European Qualification Framework) range.

6 Conclusions and Next Steps

This deliverable reports the OpenScout content repositories that have been and will be integrated into the content federation. To better design our system, we study a few related systems, and technical options. Based on the repository analysis, conceptual and technical study, we use the IEEE LOM standard to describe the integrated application profile. Comparing two content federation mechanisms: Federated Search Pattern and Harvest Pattern, we choose the latter and give the arguments of this selction. Also, we use OAI-PMH to gather distributed content metadata and build our content federation. After demonstrating the OpenScout federated infrastructure and metadata harvesting process, we describe centralized content access services to both end-users and developers.

Although we have implemented a simple running prototype integrating 3 repositories and provided certain basic key-word based search functionalities, we only report the conceptual model and architecture in this deliverable because the prototype is premature, only for testing purpose and the URL of the prototype has been changing. Further technical details are left to next deliverable D1.2.1. Initial Federated Infrastructure V1.0 due in M15 and an online prototype will be available then.

During this period, we plan to extend our content repositories and may have to adapt new technologies for integrating new repositories. Meanwhile, we will refine the content access services: both for the end-users and for developers. For end-users, we may add advanced search functionality depending on the feedback from our user groups; for developers, we will connect our content federation with other components such as the connector model in WP5 and other existing LCMSs. Further, we will connect our component with the competency component so as to provide better skill-based search.

In addition, we will provide multilingual services for contents from different cultural backgrounds. Currently, some of the existing contents will be integrated once the multilingual services are ready.

Finally the possibilities for login services to integrated LCMSs will be explored provided that they are supported by the corresponding e-learning platforms. For this reason, currently two solutions are investigated, the first is an OpenID implementation and an alternative solution is the central storage of users' credentials in their OpenScout user profile. Along with the progress of other modules, new issues on how to better integrate different components into the unique OpenScout access point, the Web Portal, need to be addressed.

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8 Appendix - OpenScout Content Repositories

OpenScout's open content repositories federation is supported by many content partners that are willing to share their learning material with the community. However, each single repository holds a unique description of their learning objects that must be aligned to a standard profile to fulfil the requirements of the federated repository. This section holds an analysis of the repositories, summarizing each one's characteristics, content features, available metadata and access issues. So far, three repositories have been already integrated in the federated infrastructure – OpenER, OpenLearn and SlideStar - and for those, a more specific mapping of the metadata profile is described.

8.1 OUUK - OpenLearn

8.1.1 About OpenLearn (OUUK 2009)

Website development began in May 2006 and the site was launched in October 2006, with an aim to regularly add new content and features. It provides free access to Open University educational materials throughout the world. The publication of such structured learning materials, designed for distance learning, is unique in the field of open educational resources. It is the learning space, where learners can find hundreds of free study units, each with a discussion forum.

Open Education materials make three contributions. They make new knowledge available to all (not just the few who can pay for it). They allow users to download, modify, translate and adapt to their culture to the material to enhance its usefulness. They provide the opportunity for people to work together to co-modify, co-produce, test and co-produce, generating a cycle of rapid continuous improvement. Using technology Open Educational Resources aim to remove access barriers to knowledge and educational opportunities around the world.

OpenLearn now offers a full range of Open University subject areas from access to postgraduate level and has seen over 3 million visitors since launch. Until Aug. 2009, there are overall 6,000 study hours of 'designed for open learner' courses in the LearningSpace and an additional 8350 hours in the LabSpace (the experimental zone) taken mainly from archived courses.

8.1.2 Content

8.1.2.1 Content Features

The OpenLearn's educational materials vary in many media types, including text, images graphics, video, flash animation, interactive quizzes and self assessed questions. The material is available in several languages including English, Portuguese, Catalan, German, Spanish, French, Welsh and Mandarin following shortly.

8.1.2.2 Content Metadata

Openlearn follows the Open Archives Initiative Protocol for Metadata Harvesting (referred to as the OAI-PMH); it provides an application-independent interoperability framework based on *metadata harvesting*. Openlearn supports the OAI-PMH as a means of exposing metadata.

Section 5.1 reports the metadata offered by OpenLearn.

8.1.2.3 Content Access

OpenLearn does not require the user to register in the site. In total there are over 3,111 registered users and 5,900,744 unique visitors to the site (August 09).

Access to the content is also available in different formats via: Moodle Package, OUXML, RSS, IMS CC, IMS CP and OAI-PMH target. The usage of the content and access rights (IPR) follows Creative Commons [3] ShareAlike v2.0 license.

8.2 INSEAD

8.2.1 About INSEAD

INSEAD[11] (originally Institut Européen d'Administration des Affaires - European Institute of Business Administration) is a multi-campus international graduate business school and research institution. INSEAD is a non-profit making organisation founded in 1957 in Fontainebleau, France, 3 months after the Treaty of Rome. It operates at an international level: it is one of the world's largest top-tier graduate business schools, with two comprehensive and fully connected campuses in Europe (France) and since 2000 in Asia (Singapore). INSEAD's unique global perspective and multicultural diversity are reflected in all aspects of its research and teaching. Its objective is to become the best management research and management education institution in the world. There are currently several Research Centres or Initiatives at INSEAD and the majority of these are closely linked to either a Faculty Area or to one or more professors who work in a similar research domain.

8.2.2 Content

8.2.2.1 Content Features

Case Study Abstracts – 1560 items

http://www.insead.edu/facultyresearch/research/search_cases.cfm

Working Paper Abstracts – 1564 items

http://www.insead.edu/facultyresearch/research/search_papers.cfm

Videos – 101 items

http://www.youtube.com/user/INSEADofficial

8.2.2.2 Content Metadata

The LOM in INSEAD follows Doblin Core format (see section 2.2.3). It has its own metadata schema for describing the learning objects. A simple component will provide an interface for the relevant LOM required for OpenScout harvesting.

Section 5.1 reports the metadata offered by INSEAD.

8.2.2.3 Content Access

Case Study Abstracts & Working Paper Abstracts: INSEAD will provide a WebService via a URL so the metadata of the learning objects can be easily harvested.

Videos: Can be accessed on official INSEAD YouTube Channel [12].

IPR Issues: Permission is granted to republish abstracts of case studies and abstracts of working papers. If possible, INSEAD would like links back to INSEAD pages. INSEAD should be mentioned as well as all the authors for accurate sourcing.
Videos on YouTube are already freely available.

8.3 IMC -SlideStar

8.3.1 About SlideStar

SLIDESTAR is a service provided by IMC Information Multimedia Communication AG. It is a hosted service, community and library for free and open learning resources for academics and students. The purpose is to provide an open platform to exchange any kind of valuable learning material and content. Users can use and build up on this content for their own studies and researches, depending on the publisher's license agreement. As a publisher the user can define this agreement themselves.

SLIDESTAR is committed to simplify the educational life. Whether users need for helpful material for their studies or they want to find out more about the lectures of a professor or organization, the service will aim to be the platform to make teachings at universities and schools more transparent and comparable.

As an author/active member – or SLIDESTAR as they like to call it – the user can provide the community with learning material ranging from any imaginable department, from A like architecture to Z like zoology. The community can further evaluate and rate his/her content allowing the user to rise as a SLIDESTAR and show off his/her expertise. Furthermore, the authors can stand for themselves as individuals or for a whole educational organization – or a SLIDESPOT as they like to call it. Their interactive world map easily allows users to browse and examine every registered SLIDESPOT and helps them to have a convenient view of the work of other universities and community members.

8.3.2 Content

8.3.2.1 Content Features

SLIDESTAR website contains up to 1000 lecture hours, which 250 are on management topics. In more details, the service hosts high quality materials generated by users for businesses such as power-point lectures and video lectures, but also data files, written text, computer software, music, audio files or other sounds, photographs or other images. The material is available in English and German.

8.3.2.2 Content Metadata

SLIDESTAR follows the Open Archives Initiative Protocol for Metadata Harvesting (referred to as the OAI-PMH); it provides an application-independent interoperability framework based

on *metadata harvesting*. SLIDESTAR supports the OAI-PMH as a means of exposing metadata.

Section 5.1 reports the metadata offered by SLIDESTAR.

8.3.2.3 Content Access

All learning contents are located in the SLIDESTAR Knowledge website. Videos and Knowledge articles can be accessed directly through the Knowledge website. In total there are over 1,000 registered community members with an average of 20-30 new daily lecture contributions.

SLIDESTAR offers a number of services that do not require users to register for an account or provide any personal information, as it is the case regarding the search of contents.

For the usage of the content is necessary to sign a copyright agreement to access the content. The usage of the content and access rights (IPR) follows Creative Commons ShareAlike v2.0 license.

8.4 OUNL - OpenER

8.4.1 About OpenER

In 2006 the Open Universiteit Nederland (OUNL) decided to run an experiment named Open Educational Resources (OpenERs), to find out what effects it would have on the number of people starting a learning path at the higher education level. The experiment was also to give insights in the consequences for the organisation (e.g. effects on each of the schools of the university).

Over the period 2006-2010, OpenERs were offered in an effort to bridge the gap between informal and formal learning and to establish a new style of entry portal to higher education with no barriers at all. OpenER received considerable attention both in terms of visitors and in the media. About 10% of the visitors reported that OpenERs influenced their decision to start some formal learning track at academic level. Lessons learned were both from users and from inside the Open Universities. The experiment changed the attitude towards OpenER within the university itself and led to a growing awareness in the Netherlands of the value of OpenERs in general, in other educational levels as well as among policy-makers and politicians.

Characteristics of OpenER are as follows:

- OpenER is flexible, open, time independent and easily accessible. This is important because in the Netherlands the high workload makes it hard to find a place for learning activity in daily life.
- OpenER gives the individual (e.g. an intermediate vocational student) the opportunity to become familiar with studying at higher educational level without having to make an immediate financial investment. Additionally, there is no 'stress' because it involves online self-paced learning in the learner's own environment. The learner can then decide whether he or she is ready to take the step to formal recognition of a performance by means of the additional services we provide for assessment and certification.

- OpenER is compatible with the goal of using e-learning to achieve the strategic objective of promoting maximum participation in education. Educational institutions are expected to use e-learning to make their education available to people outside traditional target groups. With OpenER, individuals can be given easily accessible experiences with online learning, even those who do not belong to the generation that has grown up from the outset with computers and the Internet. OpenER both complements and facilitates access to e-learning.

8.4.2 Content

8.4.2.1 Content Features

The OpenER repository of the Open University of the Netherlands (http://www.opener.ou.nl/) has around 750 hours (25 ECTS) of learning material in units of max. 25 hours. The material is mainly self-learning material for High School and Higher Education. Around 20% of the material comes from the management faculty of the OUNL and is about management or management-related topics like accounting, group dynamics and scientific methods for management science; some other content is related to the topics of the domain. The material is available in Dutch and English.

8.4.2.2 Content Metadata

OpenER follows the Open Archives Initiative Protocol for Metadata Harvesting (referred to as the OAI-PMH); it provides an application-independent interoperability framework based on metadata harvesting. OpenER supports the OAI-PMH as a means of exposing metadata.

Section 5.1 reports the metadata offered by OpenER.

8.4.2.3 Content Access

The content is managed and offered on a website that is based on the educommons (http://educommons.com/) system, a system for managing open courseware. In total there are over 5,700 users registered with a number of unique visitors since 5 December 2006 of ca. 750,000, of which 90,000 are returning (12%). All courses have been published under a Creative Commons license (Attribution, Non-commercial, Share Alike; see http://creativecommons.org/licences/by-nc-sa/2.5/). In some cases, parts of the course have been published under a more restrictive license because of copyright issues (e.g. the owner of the intellectual property rights on a picture did not give permission for reuse of his picture by other parties than the OUNL). For some parts (photographs or short texts), an symbolic amount had to be paid to the owner before publishing under the Creative Commons license was granted.

8.5 UNED - Avicenna

8.5.1 About Avicenna

The Avicenna project had the objective to create a new eLearning knowledge network in the Mediterranean area to become a model for quality online teacher training and education for students. Avicenna Virtual Campus had successfully set up eLearning centers in Algeria, Morocco, Tunisia, Egypt, Jordan, Lebanon, Palestine, Syria, Turkey, Cyprus, Italy, France, Spain and Malta along four years (2002 to 2006).

AVICENNA holds a virtual library as well as an online control system. The virtual library provides both a web catalogue of hundreds of online courses and it has established a network of scholars and e-learning experts.

8.5.2 Content

8.5.2.1 Content Features

As a backbone of the project, the UNED (Spain) was in charge of creating a knowledge data base - Avicenna Virtual Library (AVL) - which provides a web catalogue of online courses developed in the project along with a LOM based repository for shared educational resources.

At the end of the Avicenna project 206 online modules (20 hours each) had been produced, part of them designed for teacher training in the engineering of eLearning course production, to tutoring methodologies involving online learning for students in the science and technology fields offered by the partner universities. AVL contains academic information on 206 developed online courses (metadata schema based on ECTS Checklist – **Figure 4**)

Format of online courses were very simple, designed mainly as static html navigation pages (easily exportable) in many languages (English, French, Arabic, Spanish, Italian, Turkish …) including also audio and video recordings.

The difference between the Avicenna model and other virtual campuses lied in the fact that Avicenna rendered the participating institutions autonomous by assisting them in creating their own online courses and by offering an open virtual library to be shared by each participating partner After the conclusion of the project several countries have replicated the Avicenna model (network and virtual library) inside their national territories. Therefore LOM repository contains only 17 items provided by UNED.

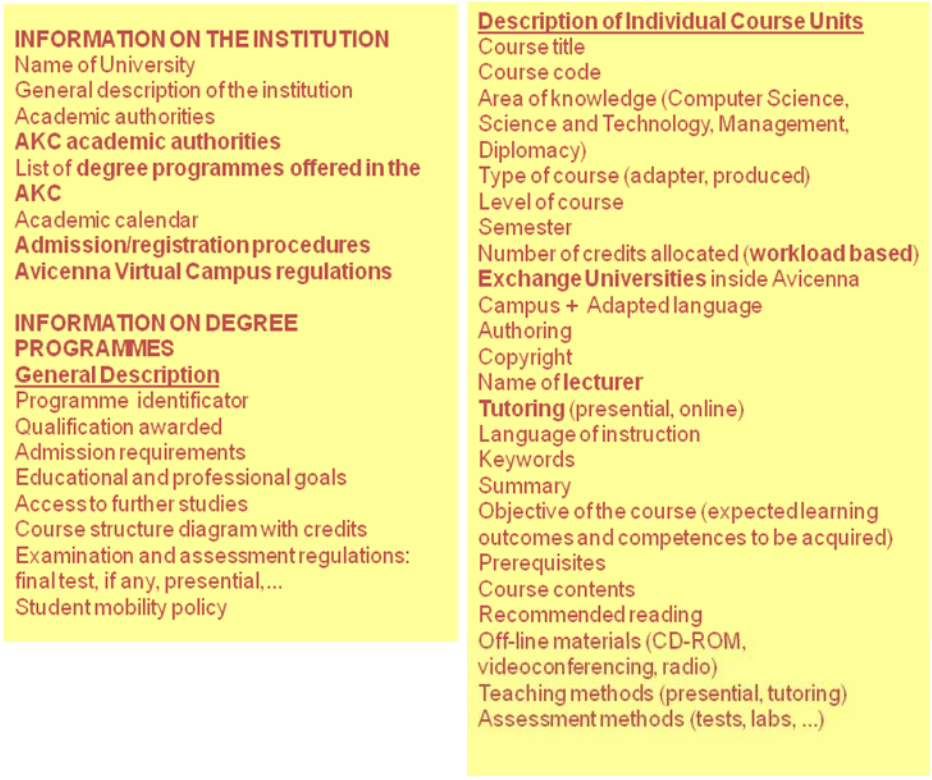

Figure 4: ECTS Checklist

8.5.2.2 Content Metadata

The LOM in Avicenna follows DC format. It has its own metadata schema for describing the learning objects. The data is stored in a MYSQL database that a simple component will provide an interface for the relevant LOM to be translated to OAI-PMH target required for OpenScout harvesting.

Metadata schema developed for online courses institutional and academic information was based on ECTS Checklist (see **Figure 4**).

Section 5.1 reports the metadata offered by Avicenna.

8.5.2.3 Content Access

Developed courses are still indexed through http://avicenna.uned.es/avl/. Developed courses are only accessible through restricted access by institution's portals or by UNESCO directly.

8.6 SPK - Platokempen

8.6.1 About Platokempen

Platokempen is a service provided by SPK PLATO™ vzw, a Belgian "not for profit" organisation founded in 1988 to create projects focusing on the development of SME's in the area of Kempen in Belgium. SPK-PLATO™ is led by a manager from a large private company under supervision of a board consisting of 1/3 of the entire employer's organisations; 1/3 of all the trade unions and 1/3 of the public authorities. In that respect, SPK-PLATO™ vzw is positioned as a neutral partner within Belgium. It is an experienced

project organization focussing on the development of its networking partners and members within each of the activity domains i.e. development & networking programs for SME's but also programs for the "not for profit" social sector and the cultural sector.

The SME activity domain is the inventor of PLATO™ and covers several programs and projects with the PLATO™ learning and development programs for SME owner/managers as its most important ones. Every year, around 250 SME's are following one of these learning programs.

8.6.2 Content

8.6.2.1 Content Features

Platokempen contains powerpoint lectures and simple templates for SME usage in the day-to-day business. About 90 % of the material is about SME management or management-related topics like accounting, management control, marketing, finance, information systems, procurement, personnel leadership-organisations, economics, entrepreneurship, human resource management, etc.

8.6.2.2 Content Metadata

The materials have no metadata currently and the powerpoint documents can only be identified via the filename.

8.6.2.3 Content Access

The relevant (Dutch) learning content will have to be transferred (if approved) to a central OpenScout database. The resources are not centralized and are in static folders on the SPK server.

8.7 JYU - OILI

8.7.1 About OILI

OILI was an EU-funded project run by the Information Technology Research Institute in University of Jyväskylä in cooperation with west Finland state provincial office. The objective for the project was to improve the use of IT in small businesses by using a close supervision method to improve the efficiency of the learning process. To support the teaching method, a portal was created for the instructors and learners including the courses and additional forms and guidelines to support the learning. The project ended in 2006 and the learning materials were applied in various domains including construction, health care, plastic industry, farming etc.

8.7.2 Content

8.7.2.1 Content Features

The OILI contents offer materials mainly targeted for SME workers. The materials focus on teaching basic IT skills, IT security issues and IT in business. Materials include study courses for each of the subject and instructional guidelines for the instructors. The materials are

designed to be taught in a close supervision of the instructor, but can also be applied by the learners' as seen sufficient.

- Materials are currently available only in Finnish language
- HTML-files including specific materials in PDF, DOC and VMW

8.7.2.2 Content Metadata

The materials have no metadata currently and have to be manually inserted.

8.7.2.3 Content Access

The contents are currently on a DVD-ROM and are not located in a repository. A place to store and access the materials is needed from OpenScout. During the project, a Creative Commons licensing scheme will be used for the contents. The usage of the content and access rights (IPR) follows Creative Commons ShareAlike v2.0 license.

8.8 NCSR - Educanext

8.8.1 About Educanext

Educanext's primary objective is to share knowledge through an easy-to-use technological application and in a digital environment free and open for all. Users and stakeholders are able to submit their feedback and comments through an online feedback system that is available to all on the platform.

EducaNext supports acquisition of high skills as per demand of the European industry and need of the global market. It supports the creation and sharing of knowledge between university and other educators. It also enables collaboration among participants by providing a complete package of services to support the exchange and delivery of learning resources. EducaNext acts as a collaboration facilitator and at the same time as a marketplace. Thus it can be primarily considered as a business-to-business service, which enables partnerships among institutions of higher education and industry to provide the right expertise at the right time.

EducaNext aims at:

- Supporting the creation, exchange and dissemination of knowledge using Information and Communication Technology (ICT);
- fostering collaboration among higher education institutions, research institutions, and other organizations producing knowledge, both at an individual and institutional level using ICT;
- increasing excellence in teaching, learning and research;
- developing, deploying and maintaining an Internet portal to facilitate the exchange of learning resources;
- encouraging the creation of learning resources by sharing ICT-based tools and services;

- sharing technological know-how to implement similar knowledge sharing spaces on the basis of the Universal Brokerage Platform or other suitable technologies

8.8.2 Content

8.8.2.1 Content Features

EducaNext is one of the world-leaders in learning brokerage, with more than 1,500 learning resources on offer, over 3,000 users and 700 registered Institutions. The portal www.educanext.org received over 150,000 visits and over 1 million page views (2008-09).

8.8.2.2 Content Metadata

EducaNext design is based in open standards, such as XML/RDF metadata representations of the learning resource offers, SOAP interfaces for communication or URN for object references. The IEEE LOM standard has been used for metadata representation, although extensions have been necessary to support the representation of educational activities. The learning object metadata are represented in XML/RDF, in order to make the UBP an early example of the W3C Semantic Web initiative.

8.8.2.3 Content Access

The Educanext has the principal objective to offer a personalize environment to permit users to exchange educational material and informative digital resources about IT.

It is necessary to log in and when a user accesses the portal he/she can create his/her own community, to build his/her repository. The control panel gives the chance to have one personal “platform” to manage and to keep the previous query and the application and “service” of most frequent use by the user.

9 Appendix - OpenScout Full Element Set

Nr	Name	Explanation	Size	Order	Value space	Datatype	Obligation	Example
1	General	This category groups the general information that describes this learning object as a whole.	1	unspecified	-	-	Mandatory	-
1.1	Identifier	A globally unique label that identifies this learning object.	smallest permitted maximum: 10 items	unspecified	-	-	Mandatory	-
1.1.1	Catalog	The name or designator of the identification or cataloging scheme for this entry. A namespace scheme.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	Mandatory	"ISBN", "ARIADNE", "URI"
1.1.2	Entry	The value of the identifier within the identification or cataloging scheme that designates or identifies this learning object. A namespace specific string.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	Mandatory	"2-7342-0318", "LEAO875", "http://www.ieee.org/documents/1234"
1.2	Title	Name given to this learning object.	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	Mandatory	("en", "The life and works of Leonardo da Vinci")

1.3	Language	The primary human language or languages used within this learning object to communicate to the intended user. NOTE 1:--An indexation or cataloging tool may provide a useful default. NOTE 2:--If the learning object had no lingual content (as in the case of a picture of the Mona Lisa, for example), then the appropriate value for this data element would be "none". NOTE 3:--This data element concerns the language of the learning object. Data element 3.4:Meta-Metadata.Language concerns the language of the metadata instance.	smallest permitted maximum: 10 items	unordered	LanguageID = Langcode ("-"Subcode)* with Langcode a language code as defined by the code set ISO 639:1988 and Subcode (which can occur an arbitrary number of times) a country code from the code set ISO 3166-1:1997. NOTE 4:-`This value space is also defined by RFC1766:1995 and is harmonized with that of the xml:lang attribute. NOTE 5:--ISO 639:1988 also includes "ancient" languages, like Greek and Latin. The language code should be given in lower case and the country code (if any) in upper case. However, the values are case insensitive. "none" shall also be an acceptable value.	CharacterString (smallest permitted maximum: 100 char)	Recommended	"en", "en-GB", "de", "fr-CA", "it" "grc" (ancient greek, until 1453) "en-US-philadelphia" "eng-GB-cockney" "map-PG-buin" (Austronesian –Papua New Guinea – buin) "gem-US-pennsylvania"
1.4	Description	A textual description of the content of this learning object. NOTE:--This description need not be in language and terms appropriate for the users of the learning object being described. The description should be in language and terms appropriate for those that decide whether or not the learning object being described is appropriate and relevant for the users.	smallest permitted maximum: 10 items	unordered	-	LangString (smallest permitted maximum: 2000 char)	Recommended	("en", "In this video clip, the life and works of Leonardo da Vinci are briefly presented. The focus is on his artistic production, most notably the Mona Lisa.")

1.5	Keyword	A keyword or phrase describing the topic of this learning object. This data element should not be used for characteristics that can be described by other data elements.	smallest permitted maximum: 10 items	unordered	-	LangString (smallest permitted maximum: 1000 char)	Optional	("en", "Mona Lisa")
1.6	Coverage	The time, culture, geography or region to which this learning object applies. The extent or scope of the content of the learning object. Coverage will typically include spatial location (a place name or geographic coordinates), temporal period (a period label, date, or date range) or jurisdiction (such as a named administrative entity). Recommended best practice is to select a value from a controlled vocabulary (for example, the Thesaurus of Geographic Names [TGN]) and that, where appropriate, named places or time periods be used in preference to numeric identifiers such as sets of coordinates or date ranges. NOTE 1:--This is the definition from the Dublin Core Metadata Element Set, version 1.14 .	smallest permitted maximum: 10 items	unordered	-	LangString (smallest permitted maximum: 1000 char)	Optional	("en", "16th century France") NOTE 2:--A learning object could be about farming in 16th century France: in that case, its subject can be described with 1.5:General.Keyword=("en","farming") and its 1.6:General.Coverage can be ("en","16th century France").

1.7	Structure	Underlying organizational structure of this learning object.	1	unspecified	atomic: an object that is indivisible (in this context). collection: a set of objects with no specified relationship between them. networked: a set of objects with relationships that are unspecified. hierarchical: a set of objects whose relationships can be represented by a tree structure. linear: a set of objects that are fully ordered. Example: A set of objects that are connected by "previous" and "next" relationships.	Vocabulary (State)	Optional	NOTE:--A learning object with Structure="atomic" will typically have 1.8:General.AggregationLevel=1. A learning object with Structure="collection", "linear", "hierarchical" or "networked" will typically have 1.8:General.AggregationLevel=2, 3 or 4.

1.8	Aggregation Level	The functional granularity of this learning object.	1	unspecified	1: the smallest level of aggregation, e.g., raw media data or fragments. 2: a collection of level 1 learning objects, e.g., a lesson. 3: a collection of level 2 learning objects, e.g., a course. 4: the largest level of granularity, e.g., a set of courses that lead to a certificate. NOTE 1:--Level 4 objects can contain level 3 objects, or can recursively contain other level 4 objects.	Vocabulary (Enumerated)	Optional	If the learning object is a digital picture of the Mona Lisa, 1.7:General.Structure=Atomic and 1.8:General.AggregationLevel=1. If the learning object is a lesson with the digital picture of the Mona Lisa, 1.7:General.Structure=Collection or Networked (since there are two descriptions of the same type of Structure) and 1.8:General.AggregationLevel=2. If the learning object is a course on the Mona Lisa, 1.7:General.Structure=Linear if the documents are intended to be viewed linearly and 1.8:General.AggregationLevel=3. If the learning object is a collection of lessons on the Mona Lisa from different sources, 1.7:General.Structure=Collection and 1.8:General:AggregationLevel=3. Lastly if the learning object is a set of courses with a full history, description, interpretation, etc. of the Mona Lisa, NOTE 2:--A learning object with AggregationLevel=1 will typically have 1.7:General.Structure="atomic". A learning object with AggregationLevel=2, 3 or 4 will typically have 1.7:General.Structure= "collection", 1.7:General.Structure=Linear or Hierarchical and 1.8:General.AggregationLevel=4. "linear", "hierarchical" or "networked".

2	Life Cycle	This category describes the history and current state of this learning object and those entities that have affected this learning object during its evolution.	1	unspecified	-	-	Optional	-
2.1	Version	The edition of this learning object.	1	unspecified	-	LangString (smallest permitted maximum: 50 char)	Optional	("en", "1.2.alpha"), ("nl", "voorlopige versie")
2.2	Status	The completion status or condition of this learning object.	1	unspecified	draft final revised unavailable NOTE:--When the status is "unavailable" it means that the learning object itself is not available.	Vocabulary (State)	Optional	-
2.3	Contribute	Those entities (i.e., people, organizations) that have contributed to the state of this learning object during its life cycle (e.g., creation, edits, publication). NOTE 1:--This data element is different from 3.3:Meta-Metadata.Contribute. NOTE 2:--Contributions should be considered in a very broad sense here, as all actions that affect the state of the learning object.	smallest permitted maximum: 30 items	ordered	-	-	Optional	-

2.3.1	Role	Kind of contribution. NOTE 1:--Minimally, the Author(s) of the learning object should be described.	1	unspecified	author publisher unknown initiator terminator validator editor graphical designer technical implementer content provider technical validator educational validator script writer instructional designer subject matter expert NOTE 2:--"terminator" is the entity that made the learning object unavailable.	Vocabulary (State)	Conditional - if 2.3.2 present or - if 2.3.3 present	-
2.3.2	Entity	The identification of and information about entities (i.e., people, organizations) contributing to this learning object. The entities shall be ordered as most relevant first.	smallest permitted maximum: 40 items	ordered	vCard, as defined by IMC vCard 3.0 (RFC 2425, RFC 2426).	CharacterString (smallest permitted maximum: 1000 char)	Optional	"BEGIN:VCARD\nFN:Joe Friday\nTEL:+1-919-555-7878\nTITLE:Area Administrator\, Assistant\n EMAIL\;TYPE=INTERN\nET:jfriday@host .c om\nEND:VCARD\n"
2.3.3	Date	The date of the contribution.	1	unspecified	-	DateTime	Optional	"2001-08-23"
3	Meta-Metadata	This category describes this metadata record itself (rather than the learning object that this record describes). This category describes how the metadata instance can be identified, who created this metadata instance, how, when, and with what references. NOTE:--This is not the information that describes the learning object itself.	1	unspecified	-	-	Mandatory	-

3.1	Identifier	A globally unique label that identifies this metadata record.	smallest permitted maximum: 10 items	unspecified	-	-	Mandatory	-
3.1.1	Catalog	The name or designator of the identification or cataloging scheme for this entry. A namespace scheme.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	Mandatory	"ARIADNE", "URI"
3.1.2	Entry	The value of the identifier within the identification or cataloging scheme that designates or identifies this metadata record. A namespace specific string.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	Mandatory	"KUL532", "http://www.ieee.org/descriptions/1234"
3.2	Contribute	Those entities (i.e., people or organizations) that have affected the state of this metadata instance during its life cycle (e.g., creation, validation). NOTE:--This data element is concerned with contributions to the metadata. Data element 2.3:Lifecycle.Contribute is concerned with contributions to the learning object.	smallest permitted maximum: 10 items	ordered	-	-	Mandatory	-
3.2.1	Role	Kind of contribution. Exactly one instance of this data element with value "creator" should exist.	1	unspecified	creator validator	Vocabulary (State)	Mandatory	-
3.2.2	Entity	The identification of and information about entities (i.e., people, organizations) contributing to this metadata instance. The entities shall be ordered as most relevant first.	smallest permitted maximum: 10 items	ordered	vCard, as defined by IMC vCard 3.0 (RFC 2425, RFC 2426).	CharacterString (smallest permitted maximum: 1000 char)	Mandatory	"BEGIN:VCARD\nFN:Joe Friday\nTEL:+1-919-555-7878\nTITLE:Area Administrator\, Assistant\n EMAIL\;TYPE=INTERN\nET:jfriday@host .c om\nEND:VCARD\n"

3.2.3	Date	The date of the contribution.	1	unspecified	-	DateTime	Mandatory	"2001-08-23"
3.3	Metadata Schema	The name and version of the authoritative specification used to create this metadata instance. NOTE:--This data element may be user selectable or system generated. If multiple values are provided, then the metadata instance shall conform to multiple metadata schemas.	smallest permitted maximum: 10 items	unordered	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 30 char)	Optional	"LOMv1.0"
3.4	Language	Language of this metadata instance. This is the default language for all LangString values in this metadata instance. If a value for this data element is not present in a metadata instance, then there is no default language for LangString values. NOTE 1:--This data element concerns the language of the metadata instance. Data element 1.3:General.Language concerns the language of the learning object.	1	unspecified	see 1.3:General.Language For this data element, "none" shall not be an acceptable value. NOTE 2:--"none" is unacceptable, because the metadata instance is in one or more human languages. "none" is acceptable for 1.3:General.Language, as the learning object itself may be in no particular human language. For example, a picture of the Mona Lisa has "none" for 1.3:General.Language. If its description (i.e., metadata instance) is in Swedish, then 3.4:Meta-Metadata.Language has value "sv".	CharacterString (smallest permitted maximum: 100 char)	Optional	"en"
4	Technical	This category describes the technical requirements and characteristics of this learning object.	1	unspecified	-	-	Mandatory	-

4.1	Format	Technical datatype(s) of (all the components of) this learning object. This data element shall be used to identify the software needed to access the learning object.	smallest permitted maximum: 40 items	unordered	MIME types based on IANA registration (see RFC2048:1996) or "non-digital"	CharacterString (smallest permitted maximum: 500 char)	Recommended	"video/mpeg", "application/x-toolbook", "text/html"
4.2	Size	The size of the digital learning object in bytes (octets). The size is represented as a decimal value (radix 10). Consequently, only the digits "0" through "9" should be used. The unit is bytes, not Mbytes, GB, etc. This data element shall refer to the actual size of this learning object. If the learning object is compressed, then this data element shall refer to the uncompressed size.	1	unspecified	ISO/IEC 646:1991, but only the digits "0".. "9"	CharacterString (smallest permitted maximum: 30 char)	Optional	"4200"
4.3	Location	A string that is used to access this learning object. It may be a location (e.g., Universal Resource Locator), or a method that resolves to a location (e.g., Universal Resource Identifier). The first element of this list shall be the preferable location. NOTE:--This is where the learning object described by this metadata instance is physically located.	smallest permitted maximum: 10 items	ordered	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	Mandatory	"http://host/id"
4.4	Requirement	The technical capabilities necessary for using this learning object. If there are multiple requirements, then all are required, i.e., the logical connector is AND.	smallest permitted maximum: 40 items	unordered	-	-	Optional	-
4.4.1	OrComposite	Grouping of multiple requirements. The composite requirement is satisfied when one of the component requirements is satisfied, i.e., the logical connector is OR.	smallest permitted maximum: 40 items	unordered	-	-	Optional	-

4.4.1.1	Type	The technology required to use this learning object, e.g., hardware, software, network, etc.	1	unspecified	operating system browser	Vocabulary (State)	Optional	-
4.4.1.2	Name	Name of the required technology to use this learning object. NOTE 1:--The value for this data element may be derived from 4.1:Technical.Format automatically, e.g., "video/mpeg" implies "multi-os". NOTE 2:--This vocabulary includes most values in common use at the time that this Standard was approved.	1	unspecified	if Type="operating system", then: pc-dos ms-windows macos unix multi-os none if Type="browser" then : any netscape communicator ms-internet explorer opera amaya	Vocabulary (State)	Optional	-
4.4.1.3	Minimum Version	Lowest possible version of the required technology to use this learning object.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 30 char)	Optional	"4.2"
4.4.1.4	Maximum Version	Highest possible version of the required technology to use this learning object.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 30 char)	Optional	"6.2"
4.5	Installation Remarks	Description of how to install this learning object.	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	Optional	("en", "Unzip the zip file and launch index.html in your web browser.")
4.6	Other Platform Requirements	Information about other software and hardware requirements. NOTE:--This element is intended for descriptions of requirements that cannot be expressed by data element 4.4:Technical.Requirement.	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	Optional	("en","sound card"), ("en","runtime X")

4.7	Duration	Time a continuous learning object takes when played at intended speed. NOTE:--This data element is especially useful for sounds, movies or animations.	1	unspecified	-	Duration	Optional	"PT1H30M", "PT1M45S"
5	Educational	This category describes the key educational or pedagogic characteristics of this learning object. NOTE:--This is the pedagogical information essential to those involved in achieving a quality learning experience. The audience for this metadata includes teachers, managers, authors, and learners.	smallest permitted maximum: 100 items	unspecified	-	-	Optional	-

5.1	Interactivity Type	Predominant mode of learning supported by this learning object. "Active" learning (e.g., learning by doing) is supported by content that directly induces productive action by the learner. An active learning object prompts the learner for semantically meaningful input or for some other kind of productive action or decision, not necessarily performed within the learning object's framework. Active documents include simulations, questionnaires, and exercises. "Expositive" learning (e.g., passive learning) occurs when the learner's job mainly consists of absorbing the content exposed to him (generally through text, images or sound). An expositive learning object displays information but does not prompt the learner for any semantically meaningful input. Expositive documents include essays, video clips, all kinds of graphical material, and hypertext documents. When a learning object blends the active and expositive interactivity types, then its interactivity type is "mixed". NOTE:--Activating links to navigate in hypertext documents is not considered to be a productive action.	1	unspecified	active expositive mixed	Vocabulary (State)	Optional	active documents (with learner's action): · simulation (manipulates, controls or enters data or parameters); · questionnaire (chooses or writes answers); · exercise (finds solution); · problem statement (writes solution). expositive documents (with learner's action): · hypertext document (reads, navigates); · video (views, rewinds, starts, stops); · graphical material (views); · audio material (listens, rewinds, starts, stops). mixed document: · hypermedia document with embedded simulation applet.

5.2	Learning Resource Type	Specific kind of learning object. The most dominant kind shall be first. NOTE:--The vocabulary terms are defined as in the OED:1989 and as used by educational communities of practice.	smallest permitted maximum: 10 items	ordered	exercise simulation questionnaire diagram figure graph index slide table narrative text exam experiment problem statement self assessment lecture Extension of original value space of the LOM standard: case study working paper	Vocabulary (State)	Optional	-

5.3	Interactivity Level	The degree of interactivity characterizing this learning object. Interactivity in this context refers to the degree to which the learner can influence the aspect or behavior of the learning object. NOTE 1:--Inherently, this scale is meaningful within the context of a community of practice.	1	unspecified	very low low medium high very high	Vocabulary (Enumerated)	Optional	NOTE 2:--Learning objects with 5.1:Educational.InteractivityType="active" may have a high interactivity level (e.g., a simulation environment endowed with many controls) or a low interactivity level (e.g., a written set of instructions that solicit an activity). Learning objects with 5.1:Educational.InteractivityType="expositive" may have a low interactivity level (e.g., a piece of linear, narrative text produced with a standard word processor) or a medium to high interactivity level (e.g., a sophisticated hyperdocument, with many internal links and views).

5.4	Semantic Density	The degree of conciseness of a learning object. The semantic density of a learning object may be estimated in terms of its size, span, or --in the case of self-timed resources such as audio or video--duration. The semantic density of a learning object is independent of its difficulty. It is best illustrated with examples of expositive material, although it can be used with active resources as well. NOTE 1:--Inherently, this scale is meaningful within the context of a community of practice.	1	unspecified	very low low medium high very high	Vocabulary (Enumerated)	Optional	*Active* documents: user interface of a simulation · low semantic density: a screen filled up with explanatory text, a picture of a combustion engine, and a single button labeled "Click here to continue" · high semantic density: screen with short text, same picture, and three buttons labeled "Change compression ratio", "Change octane index", "Change ignition point advance" *Expositive* documents: · medium difficulty text document o medium semantic density: "The class of Marsupial animals comprises a number of relatively primitive mammals. They are endowed with a short placentation, after which they give birth to a larva. The larva thereafter takes refuge in the mother's marsupium, where it settles to finish its complete development." o high semantic density: "Marsupials are primitive mammals, with short placentation followed by the birth of larva, which thereafter takes refuge in the marsupium to finish its development."

							Optional	· easy video document o low semantic density: The full recorded footage of a conversation between two experts on the differences between Asian and African elephants; 30 minutes duration. o high semantic density: An expertly edited abstract of the same conversation; 5 minutes duration · difficult mathematical notation o medium semantic density: The text representation of the theorem: For any given set j, it is always possible to define another set y, which is a superset of j. o very high semantic density: The symbolic representation (formula) of the theorem ("j $y: y É j)

5.5	Intended End User Role	Principal user(s) for which this learning object was designed, most dominant first. NOTE 1:--A learner works with a learning object in order to learn something. An author creates or publishes a learning object. A manager manages the delivery of this learning object, e.g., a university or college. The document for a manager is typically a curriculum. NOTE 2:--In order to describe the intended end user role through the skills the user is intended to master, or the tasks he or she is intended to be able to accomplish, the category 9:Classification can be used.	smallest permitted maximum: 10 items		teacher author learner manager	Vocabulary (State)	Optional	An authoring tool that produces pedagogical material is a typical example of a learning object whose intended end user is an author
5.6	Context	The principal environment within which the learning and use of this learning object is intended to take place. NOTE:--Suggested good practice is to use one of the values of the value space and to use an additional instance of this data element for further refinement, as in ("LOMv1.0","higher education") and ("http://www.ond.vlaanderen.be/ onderwijsinvlaanderen/Default.htm" , "kandidatuursonderwijs")	smallest permitted maximum: 10 items	unordered	school higher education training other	Vocabulary (State)	Optional	-

5.7	Typical Age Range	Age of the typical intended user. This data element shall refer to developmental age, if that would be different from chronological age. NOTE 1:--The age of the learner is important for finding learning objects, especially for school age learners and their teachers. When applicable, the string should be formatted as minimum age-maximum age or minimum age-. (NOTE:--This is a compromise between adding three component elements (minimum age, maximum age, and description) and having just a free text field.) NOTE 2:--Alternative schemes for what this data element tries to cover (such as various reading age or reading level schemes, IQ's or developmental age measures) should be represented through the 9:Classification category.	smallest permitted maximum: 5 items	unordered	-	LangString (smallest permitted maximum: 1000 char)	Optional	"7-9", "0-5", "15", "18-", ("en","suitable for children over 7"), ("en","adults only")
5.8	Difficulty	How hard it is to work with or through this learning object for the typical intended target audience. NOTE:--The " typical target audience" can be characterized by data elements 5.6:Educational.Context and 5.7:Educational.TypicalAgeRange.	1	unspecified	very easy easy medium difficult very difficult	Vocabulary (Enumerated)	Optional	-

5.9	Typical Learning Time	Approximate or typical time it takes to work with or through this learning object for the typical intended target audience. NOTE:--The " typical target audience" can be characterized by data elements 5.6:Educational.Context and 5.7:Educational.TypicalAgeRange.	1	unspecified	-	Duration	Optional	"PT1H30M", "PT1M45S"
5.10	Description	Comments on how this learning object is to be used.	smallest permitted maximum: 10 items	unspecified	-	LangString (smallest permitted maximum: 1000 char)	Optional	("en", "Teacher guidelines that come with a textbook.")
5.11	Language	The human language used by the typical intended user of this learning object.	smallest permitted maximum: 10 items	unordered	See 1.3:General. Language	CharacterString (smallest permitted maximum: 100 char)	Optional	"en", "en-GB", "de", "fr-CA", "it" NOTE:--As an example, for a learning object in French, intended for English-speaking students, the value of 1.3:General.Language will be French, and the value of 5.11:Educational.Language will be English.
6	Rights	This category describes the intellectual property rights and conditions of use for this learning object. NOTE:--The intent is to reuse results of ongoing work in the Intellectual Property Rights and e-commerce communities. This category currently provides the absolute minimum level of detail only.	1	unspecified	-	-	Mandatory	-
6.1	Cost	Whether use of this learning object requires payment.	1	unspecified	yes no	Vocabulary (State)	Optional	-

6.2	Copyright and Other Restrictions	Whether copyright or other restrictions apply to the use of this learning object.	1	unspecified	yes no	Vocabulary (State)	Mandatory	-
6.3	Description	Comments on the conditions of use of this learning object.	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	Mandatory	("en", "Use of this learning object is only permitted after a donation has been made to Amnesty International.")
7	Relation	This category defines the relationship between this learning object and other learning objects, if any. To define multiple relationships, there may be multiple instances of this category. If there is more than one target learning object, then each target shall have a new relationship instance.	smallest permitted maximum: 100 items	unordered	-	-	Optional	-
7.1	Kind	Nature of the relationship between this learning object and the target learning object, identified by 7.2:Relation.Resource.	1	unspecified	Based on Dublin Core: ispartof: is part of haspart: has part isversionof: is version of hasversion: has version isformatof: is format of hasformat: has format references: references isreferencedby: is referenced by isbasedon: is based on isbasisfor: is basis for requires: requires isrequiredby: is required by	Vocabulary (State)	Optional	-
7.2	Resource	The target learning object that this relationship references.	1	unspecified	-	-	Optional	-

7.2.1	Identifier	A globally unique label that identifies the target learning object.	smallest permitted maximum: 10 items	unspecified	-	-	Optional	-
7.2.1.1	Catalog	The name or designator of the identification or cataloging scheme for this entry. A namespace scheme.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	Optional	"ISBN", "ARIADNE", "URI"
7.2.1.2	Entry	The value of the identifier within the identification or cataloging scheme that designates or identifies the target learning object. A namespace specific string.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	Optional	"2-7342-0318", "LEAO875", "http://www.ieee.org/"
7.2.2	Description	Description of the target learning object.	smallest permitted maximum: 10 items	unspecified	-	LangString (smallest permitted maximum: 1000 char)	Optional	("en","The QuickTime movie of the Mona Lisa on the web site of the Louvre museum.")
8	Annotation	This category provides comments on the educational use of this learning object, and information on when and by whom the comments were created. This category enables educators to share their assessments of learning objects, suggestions for use, etc.	smallest permitted maximum: 30 items	unordered	-	-	Optional	-
8.1	Entity	Entity (i.e., people, organization) that created this annotation.	1	unspecified	vCard, as defined by IMC vCard 3.0 (RFC 2425, RFC 2426).	CharacterString (smallest permitted maximum: 1000 char)	Optional	"BEGIN:VCARD\nFN:Joe Friday\nTEL:+1-919-555-7878\nTITLE:Area Administrator\, Assistant\n EMAIL\;TYPE=INTERN\nET:jfriday@host .c om\nEND:VCARD\n"

8.2	Date	Date that this annotation was created.	1	unspecified	-	DateTime	Optional	"2001-08-23"
8.3	Description	The content of this annotation.	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	Optional	("en", "I have used this video clip with my students. They really enjoy being able to zoom in on specific features of the painting. Make sure they have a broadband connection or the experience becomes too cumbersome to be educationally interesting.")
9	Classification	This category describes where this learning object falls within a particular classification system. To define multiple classifications, there may be multiple instances of this category.	smallest permitted maximum: 40 items	unordered	-	-	Optional	-
9.1	Purpose	The purpose of classifying this learning object.	1	unspecified	discipline idea prerequisite educational objective accessibility restrictions educational level skill level security level competency	Vocabulary (State)	Conditional - if 9.2 present or - if, 9.3 present or - if 9.4 present	-

9.2	Taxon Path	A taxonomic path in a specific classification system. Each succeeding level is a refinement in the definition of the preceding level. There may be different paths, in the same or different classifications, which describe the same characteristic.	smallest permitted maximum: 15 items	unordered	-	-	Optional	-
9.2.1	Source	The name of the classification system. This data element may use any recognized "official" taxonomy or any user-defined taxonomy. NOTE:--An indexation, cataloging or query tool may provide the top-level entries of a well-established classification, such as the Library of Congress Classification (LOC), Universal Decimal Classification (UDC), Dewey Decimal Classification (DDC), etc.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	LangString (smallest permitted maximum: 1000 char)	Optional	("en","ACM"), ("en","MESH"), ("en","ARIADNE")

9.2.2	Taxon	A particular term within a taxonomy. A taxon is a node that has a defined label or term. A taxon may also have an alphanumeric designation or identifier for standardized reference. Either or both the label and the entry may be used to designate a particular taxon. An ordered list of taxons creates a taxonomic path, i.e., "taxonomic stairway": this is a path from a more general to more specific entry in a classification.	smallest permitted maximum: 15 items	ordered	-	-	Optional	{["12",("en","Physics")], ["23",("en","Acoustics")], ["34",("en","Instruments")], ["45",("en","Stethoscope")]} A 2nd taxon path for the same learning object could be: {["56",("en","Medicine")], ["67",("en","Diagnostics")], ["34",("en","Instruments")], ["45",("en","Stethoscope")]}
9.2.2.1	Id	The identifier of the taxon, such as a number or letter combination provided by the source of the taxonomy.	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 100 char)	Conditional - if 9.1 present or - if 9.2 present or - if, 9.3 present or - if 9.4 present	"320", "4.3.2", "BF180"
9.2.2.2	Entry	The textual label of the taxon.	1	unspecified	-	LangString (smallest permitted maximum: 500 char)	Optional	("en", "Medical Sciences")
9.2.2.3	Min EQF	Minimum proficiency level of the respective competence expected to be achieved by the consumer of the LO.	1	unspecified	Proficiency levels defined in the European Qualifications Framework (EQF, http://ec.europa.eu/education/lifelong-learning-	Vocabulary (Enumerated)	Optional Extension of the LOM standard	

					policy/doc44_en.html)			
9.2.2.4	Max EQF	Maximum proficiency level of the respective competence expected to be achieved by the consumer of the LO.	1	unspecified	Proficiency levels defined in the European Qualifications Framework (EQF, http://ec.europa.eu/education/lifelong-learning-policy/doc44_en.html)	Vocabulary (Enumerated)	Optional Extension of the LOM standard	
9.3	Description	Minimum proficiency level of the respective competence expected to be achieved by the consumer of the LO.	1	unspecified	-	LangString (smallest permitted maximum: 2000 char)	Optional	("en","A medical instrument for listening called a stethoscope.")
9.4	Keyword	Keywords and phrases descriptive of the learning object relative to the stated 9.1:Classification.Purpose of this specific classification, such as accessibility, security level, etc., most relevant first.	smallest permitted maximum: 40 items	ordered	-	LangString (smallest permitted maximum: 1000 char)	Optional	("en", "diagnostic instrument")

10 Appendix – Comparison of Application Profiles in TEL

The following table shows the comparison of different application profiles developed in the domain of technology enhanced learning.

The meanings of some symbols in the application profiles are :

M = mandatory element

O = optional element

R = recommended element

N/A = element not contained in the AP

O / M if condition = conditional element

Nr	Name	MACE AP[5]	ELEONET AP[6]	UK Learning Object Metadata Core[7]	SCORM[8] - Activity - SCO - SCA	SCORM - Asset	MoodleCore[9]	Celebrate AP[10]	RDN/LTSN LOM AP[11]
1	General	M	M	M	M	M	M	M	M
1.1	Identifier	M	M	M	M	M	M	M	M
1.1.1	Catalog	M	R	M	M	M	M	M	M
1.1.2	Entry	M	M	M	M	M	M	M	M
1.2	Title	M	M	M	M	M	M	M	M
1.3	Language	M	R	M	O	O	M	M	M
1.4	Description	O	M	M	M	O	O	M	M
1.5	Keyword	O	M	R	O	O	M	R	R
1.6	Coverage	O	O	O	O	O	N/A	O	O

[5] http://www.mace-project.eu/index.php?option=com_docman&task=cat_view&gid=58&Itemid=154

[6] http://www.medra.org/stdoc/eleonet_metadata_specifications.pdf

[7] http://www.google.de/url?sa=t&source=web&cd=2&ved=0CCEQFjAB&url=http%3A%2F%2Fmetadata.cetis.ac.uk%2Fprofiles%2Fuklomcore%2Fuklomcore_v0p2_may04.doc&ei=XYUNTJKEJISCOMyJ-OUP&usg=AFQjCNFbQK6lc4zu55Bm-N8xBE6XXQ-MuA

[8] http://www.imsglobal.org/ssp/sspv1p0/imsssp_prflv1p0.html

[9] http://docs.moodle.org/en/Metadata:MoodleCore

[10] http://celebrate.eun.org/docs/CELEB_AP_v1.1_2003-11-17.pdf

[11] http://www.intute.ac.uk/publications/rdn-ltsn-ap/

1.7	Structure	O	O	O	O	O	M	O	N/A
1.8	Aggregation Level	O	O	O	O	O	M	O	N/A
2	Life Cycle	O	M	M	M	O	M	O	M
2.1	Version	O	M	R	M	O	O	O	N/A
2.2	Status	O	M	O	M	O	O	O	N/A
2.3	Contribute	O	R	M	O	O	M	O	M
2.3.1	Role	O / R if 2.3.2 or 2.3.3 are present	R	M	O	O	M	O	M
2.3.2	Entity	O	R	M	O	O	M	O	M
2.3.3	Date	O	O / R if role = „publisher“	M	O	O	O	O	N/A
3	Meta-Metadata	M	M	M	M	M	M	R	R
3.1	Identifier	M	M	M	M	M	M	O	O
3.1.1	Catalog	M	R	M	M	M	M	O	O
3.1.2	Entry	M	M	M	M	M	M	O	O
3.2	Contribute	M	O	M	O	O	M	O	O
3.2.1	Role	M	O / M if 3.2 is present	M	O	O	M	O	O
3.2.2	Entity	M	O / M if 3.2 is present	M	O	O	M	O	O
3.2.3	Date	M	O	M	O	O	O	O	O

3.3	Metadata Schema	O	M	M	M	M	M	O	R
3.4	Language	O	O	M	O	O	M	R	O
4	Technical	M	M	M	M	M	M	R	M
4.1	Format	O	M	R	M	M	N/A	R	R
4.2	Size	O	O	R	O	O	M	R	O
4.3	Location	M	R	M	M	M	M	R	M
4.4	Requirement	O	O	O	O	O	N/A	O	N/A
4.4.1	OrComposite	O	O	O	O	O	N/A	O	N/A
4.4.1.1	Type	O / M if 4.4.1.2 is present	O	O	O	O	N/A	O	N/A
4.4.1.2	Name	O / M if 4.4.1.1 is present	O	O	O	O	N/A	O	N/A
4.4.1.3	Minimum Version	O	O	O	O	O	N/A	O	N/A
4.4.1.4	Maximum Version	O	O	O	O	O	N/A	O	N/A
4.5	Installation Remarks	O	O	O	O	O	N/A	O	N/A
4.6	Other Platform Requirements	O	O	O	O	O	N/A	O	O
4.7	Duration	O	O	O	O	O	N/A	O	N/A
5	Educational	O	O	R	O	O	M	M	R

5.1	Interactivity Type	O	O	R	O	O	M	O	N/A
5.2	Learning Resource Type	O	R	R	O	O	N/A	M	R
5.3	Interactivity Level	O	O	R	O	O	M	O	N/A
5.4	Semantic Density	O	O	R	O	O	O	O	N/A
5.5	Intended End User Role	O	O	R	O	O	M	M	N/A
5.6	Context	O	R	R	O	O	O	R	O
5.7	Typical Age Range	O	R	R	O	O	O	M	N/A
5.8	Difficulty	O	O	R	O	O	O	O	N/A
5.9	Typical Learning Time	O	O	O	O	O	O	R	N/A
5.10	Description	O	O	R	O	O	O	R	O
5.11	Language	O	O	R	O	O	O	M	N/A
6	Rights	O	M	M	M	M	M	M	M
6.1	Cost	O	M	R	M	M	M	R	N/A
6.2	Copyright and Other Restrictions	O	M	M	M	M	M	M	M
6.3	Description	O / M if 6.2 = „yes“	R	M	O	O	O	O / M if 6.2 = „yes“	R
7	Relation	O	O	O	O	O	O	O	O

7.1	Kind	O / M if 7 is present	O	O	O	O	M	O	O
7.2	Resource	O	O	O	O	O	M	O	O
7.2.1	Identifier	O	O	O	O	O	M	O	N/A
7.2.1.1	Catalog	O / M if 7.2.1 is present, or 7 is present an 7.2.2 is not	O	O	O	O	M	O	N/A
7.2.1.2	Entry	O / M if 7.2.1 is present, or 7 is present an 7.2.2 is not	O	O	O	O	M	O	N/A
7.2.2	Description	O / M if 7 is present an 7.2.1 is not	O	O	O	O	O	O	N/A
8	Annotation	O	O	R	O	O	O	O	O
8.1	Entity	O	O	R	O	O	M	O	N/A
8.2	Date	O	O	R	O	O	M	O	N/A
8.3	Description	O	O	R	O	O	M	O	O
9	Classification	O	O	R	M	O	O	M	O
9.1	Purpose	O / M if 9.2, 9.3 or 9.4 are present	O	R	M	O	N/A	M	O
9.2	Taxon Path	O	O	R	O	O	M	O	O
9.2.1	Source	O	O / M if 9.2 is present	R	O	O	M	O	O

9.2.2	Taxon	O	O / M if 9.2.1 is present	R	O	O	M	O	O
9.2.2.1	Id	O / M if 9.1, 9.2, 9.3 or 9.4 are present	O / M if 9.2.2.2 is present	R	O	O	M	O	N/A
9.2.2.2	Entry	O	O / M if 9.2.2.1 is present	R	O	O	M	O	O
9.3	Description	O	R	O	M	O	N/A	O	N/A
9.4	Keyword	O	R	O	M	O	N/A	O / M if 9.1 = “discipline”	N/A


OpenScout

11 Appendix – Analysis of OpenScout repositories

The following table contains the reference number of each metadata attribute of the LOMv1.0 Base Schema, the name of the attribute and an additional column identifying whether or not the repositories in OpenScout (Avicenna, INSEAD, OpenER, OpenLearn, SlideStar) offer the according metadata.

Nr	Name	Repositories
1	General	
1.1	Identifier	Avicenna
1.1.1	Catalog	OpenER, SlideStar
1.1.2	Entry	OpenER, OpenLearn, Slidestar
1.2	Title	Avicenna, INSEAD, OpenER, OpenLearn, SlideStar
1.3	Language	Avicenna, OpenER
1.4	Description	Avicenna, INSEAD, OpenER, OpenLearn
1.5	Keyword	OpenER, INSEAD, SlideStar
1.6	Coverage	
1.7	Structure	Avicenna, SlideStar
1.8	Aggregation Level	Avicenna, SlideStar
2	Life Cycle	
2.1	Version	OpenLearn, SlideStar
2.2	Status	SlideStar
2.3	Contribute	
2.3.1	Role	SlideStar
2.3.2	Entity	Avicenna, INSEAD, OpenER, OpenLearn, SlideStar
2.3.3	Date	Avicenna, INSEAD, OpenLearn
3	Meta-Metadata	
3.1	Identifier	OpenER, SlideStar
3.1.1	Catalog	SlideStar
3.1.2	Entry	
3.2	Contribute	
3.2.1	Role	SlideStar
3.2.2	Entity	SlideStar
3.2.3	Date	SlideStar
3.3	Metadata Schema	
3.4	Language	SlideStar
4	Technical	
4.1	Format	Avicenna, OpenER, SlideStar
4.2	Size	SlideStar, Avicenna
4.3	Location	INSEAD, OpenER, OpenLearn, SlideStar
4.4	Requirement	Avicenna, OpenLearn
4.4.1	OrComposite	
4.4.1.1	Type	

4.4.1.2	Name	
4.4.1.3	Minimum Version	
4.4.1.4	Maximum Version	
4.5	Installation Remarks	
4.6	Other Platform Requirements	
4.7	Duration	
5	Educational	
5.1	Interactivity Type	Avicenna
5.2	Learning Resource Type	Avicenna, OpenER, SlideStar, INSEAD
5.3	Interactivity Level	
5.4	Semantic Density	
5.5	Intended End User Role	Avicenna, SlideStar
5.6	Context	Avicenna, SlideStar
5.7	Typical Age Range	SlideStar
5.8	Difficulty	Avicenna, OpenLearn
5.9	Typical Learning Time	Avicenna, OpenER, OpenLearn
5.10	Description	Avicenna
5.11	Language	Avicenna
6	Rights	
6.1	Cost	SlideStar
6.2	Copyright and Other Restrictions	Avicenna, OpenER, OpenLearn, SlideStar
6.3	Description	Avicenna, OpenER, SlideStar
7	Relation	
7.1	Kind	
7.2	Resource	
7.2.1	Identifier	
7.2.1.1	Catalog	
7.2.1.2	Entry	OpenLearn
7.2.2	Description	
8	Annotation	
8.1	Entity	
8.2	Date	
8.3	Description	
9	Classification	
9.1	Purpose	SlideStar
9.2	Taxon Path	
9.2.1	Source	SlideStar
9.2.2	Taxon	
9.2.2.1	Id	SlideStar
9.2.2.2	Entry	SlideStar
9.3	Description	
9.4	Keyword	