Interoperability of eLearning Applications with Digital Libraries

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Research Problem

The most important application of Digital Libraries (DL) is to support knowledge and learning purposes. However, DLs and their standards have been developed independently of eLearning applications and their standards. For that, interoperability issues between digital libraries and eLearning applications are risen (complex and multilevel problem). In order to enable the construction of eLearning applications that easily exploit DL contents it is crucial to bridge the interoperability gap between digital libraries and eLearning applications. Task 5.4 is exploring the interoperability of eLearning applications and Digital Libraries looking particularly at data models, standards and workflows. The aim is to study the major standards for digital libraries (e.g. METS), eLearning (e.g. SCORM) and audio-visual content description (e.g. MPEG-7), and to produce mappings among them. Based on this, the objective is to develop an integration framework and a service-oriented architecture which will be validated by a specific demonstrator.

Task Objectives and Followed Approach

The task has sought to answer the following questions: (a) What are the major architectural requirements and workflows for effectively supporting eLearning applications running over digital libraries? (b) What are the major interoperability requirements for DL and eLearning standards? (c) What are the management requirements and tools for audiovisual material and 3D object representations, which form the basis for many collections of learning resources?

The task focused on the design and implementation of appropriate tools which can be deployed across the wider DL practitioner community. Initial work has addressed developing models for an architectural framework and workflow, producing mappings and transformations between relevant metadata standards, implementing the GraphOnto tool (Tsinaraki, Polydoros & Christodoulakis, 2005), implementing aspects of the architecture and documenting the issues in a series of reports.

In associated work, models for supporting semantic 3D information to be used in a variety of eScience applications have been derived and functionality requirements investigated. Two ontologies for 3D scenes, based on formal and de facto standards have been developed (Kalogerakis, Christodoulakis & Moumoutzis, 2006). They are available on DELOS WP3 testbeds and demonstrators site for downloading: http://astral.ced.tuc.gr/delos/. This work is complementary to the work in the Task 3.8 “Description, matching and retrieval by content of 3D objects”, which does not consider semantic descriptions.

Current Demonstrator and Future Plans

The Architecture for Supporting Interoperability between Digital Libraries and ELearning Applications (ASIDE) (Arapi, Moumoutzis & Christodoulakis, 2006) has been designed and implemented during JPA2. ASIDE addresses the identified interoperability problems in a layered architecture where eLearning (and other) applications are built on top of digital libraries and utilize their content. ASIDE offers a generic framework for the automatic creation of personalized learning experiences using reusable A/V learning objects. It is service-oriented and conforms to the IMS Digital Repositories Interoperability (IMS DRI) Specification. The IMS DRI specification provides recommendations for the interoperation of the most common repository functions enabling diverse components to

communicate with one another: search/expose, submit/store, gather/expose and request/deliver. It is recommended that these functions should be implementable across services to enable them to present a common interface.
The ASIDE architecture consists of the following layers:

- The **Digital Library Layer**, where digital objects are described using METS+LOM (eLearning context), and MPEG7 (A/V descriptions) building this way interoperable A/V learning objects, which can be transformed to SCORM and delivered to eLearning applications (METS/SCORM transformation component).
- **Applications Layer**, where e-Learning Applications (e.g. Learning Content Management Systems, Learning Management Systems etc.) discover, access, and use the content of the A/V content of the digital library through appropriate services (resource utilizers). The generated personalized A/V learning experiences are delivered to the applications in the form of SCORM packages. Any SCORM-compliant system can recognize and "play" these packages.
- The **Middleware Layer**, which consists of the following components:

a) The **METS/SCORM transformation component**, which is responsible for the transformation of the METS descriptions pointing to LOM and MPEG7 descriptions to SCORM Content Packages. This includes not only simple transformation from METS XML file to SCORM manifest file, but also the construction of the whole SCORM package (PIF). More-over, the mime-type of the files is taken into account and, if needed, intermediate html pages are constructed with links to these files (e.g. in case of video files).

b) The **Personalized Learning Experiences Assembler (PALEA)**, which, taking into account the knowledge provided by the Learning Designs (abstract training scenarios) and the Learner Profiles described later, constructs the personalized learning experiences and delivers them in the form SCORM Packages. The dashed arrow in the left side of PALEA indicates that using this component is optional and that digital library services can be directly accessed (e.g. a teacher wants to find appropriate learning objects to construct manually a learning experience).

- **Ontologies** providing knowledge to the PALEA for the automatic construction of personalized learning experiences:

a) **Domain Ontologies** that provide vocabularies about concepts within a domain and their relationships.

b) **Instructional Ontology** that provides a model for the construction of abstract training scenarios. These are pedagogical approaches (instructional strategies/didactical templates), which can be applied to the construction of learning experiences. This ontology developed in T5.4 has the important characteristic that learning objects are not bound in the training scenarios on design time, as in current eLearning standards and specifications (e.g. IMS Learning Design and SCORM). Whereas, pedagogy is separated and independent from content achieving this way reusability of learning designs or parts of them that can be used from the systems for the construction of "real" personalized learning experiences, where appropriate learning objects according to the learner profile are bound to the learning experience at run-time.

- **Learning Designs** are abstract training scenarios in a certain domain built according to the model given in the instructional ontology.
- The **Learner Profiles** constructed using the vocabulary given in the Learner Profile Ontology, which represents a learner model for the creation of learner profiles. Elements from IEEE PAPI and IMS LIP specifications have been also used in this model. Some important elements of this model are: learner goals, competencies, previous knowledge, educational level and learning style.

The interoperability architecture has been implemented using the following technologies: Web services, JavaTM 2 Platform, Standard Edition, v1.5, Berkeley DB XML, Jena API, SPARQL RDF Query Language (Prud'hommeaux & Seaborne, 2005) and XQuery for querying the XML-based metadata descriptions of the digital objects stored in the digital library.

During JPA3, T5.4 plans to work on three major objectives: 1) implement further extensions to the GraphOnto tool, which are needed for metadata management on top of integrated repositories of various kinds (audiovisual, 3D graphics etc.). This objective directly contributes to the development of the SMMF envisioned in WP3 by providing an enhanced core component for the management of ontologies for audiovisual and non-traditional objects, 2) development of an Earth Sciences' digital library according to the T5.4 eLearning environment for the provision of eLearning in Geography, and 3) support of interoperability and semantics for 3D objects. This objective is complementary to Delos Task 3.8 and is related with the envisioned SMMF of WP3 by studying the semantic aspects of 3D objects and their integration in multimedia DLs.

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