USING STANDARDS AND WEB 2.0 TECHNOLOGIES FOR E-LEARNING MODULES - JOINT DEVELOPMENT OF AN EUROSDR COURSE ON CITYGML

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ABSTRACT:

E-learning in Europe has gained a sustainable impulse with the Bologna process, an agreement aiming at making academic degrees and quality assurance standards more comparable and compatible throughout European countries. The reorganization from traditional higher education to the bachelor and master studies, in which extensive phases of self-learning are an additional element, created an increasing demand for new e-learning services. Moreover, a reflection on didactics was initiated and additional pedagogical models were discussed leading from teacher to learner centred lessons, promoting the shift from teaching factual knowledge to students' responsibility. These challenges have influenced the development of new, high quality e-learning material. Since content development is cost-intensive, sharing knowledge and enforcing cooperation between institutes, universities in national or international partnerships becomes more relevant. Adopting high specialized module parts or using drawings, animations etc. of high quality will lead to improved e-learning material, but also gives the instructor the flexibility to arrange material which fits to his needs and his individual profile.This paper reports on a training course within the European Organization for Spatial Data Research (EduServ) framework, that takes place in March/Mai 2008, focussing on CityGML. The course is co-hosted by Berlin University of Technology (Prof. Thomas Kolbe) and University of Gävle (Prof. Anders Östman).

1. INTRODUCTION

Developing e-learning courses requires a lot of effort from the original idea to the final product. Innovative approaches to learner interactions have complicated the process. For producing interactions for e-learning, appropriate tools such as Adobe Flash, Java, JavaScript, Active Server Pages (ASP), (XML Extensible Markup Language), etc. are necessary.

Needs for international cooperation and partnerships in education are increasing and involves integration or exchange of learning material for sharing and re-use. In order to transfer e-learning contents to another software environment interoperability and standardization are necessary. In the educational community standards are often associated with restricting creativity and flexibility. On the other hand, standards reduce development costs, and allow users to be independent from proprietary software and allow re-use of well-known e-learning content after software changes. The following sections will focus on the most important e-learning standards.

2. STANDARDS

2.1 IEEE learning object metadata (IEEE LOM)

Object Metadata (LOM) IEEE 1484.12.1 – 2002 is an open standard published by the Institute of Electrical and Electronics Engineers Standards Association (IEEE). The main aim of LOM is to facilitate search, retrieval, acquisition, and the use of learning objects, either by humans or by automated query. For that purpose the well-structured LOM data model was specified.

The corresponding XML-binding – the way LOM records should be represented in XML – is defined in IEEE 1484.12.3.

LOM consists of nine categories with a set of hierarchically structured elements as shown in figure 1. The guidelines for each category's elements can be downloaded in PDF format from the CanCore Website (http://www.cancore.ca - Accessed April 20, 2008). CanCore is the most thorough guide to the LOM.

When implementing the LOM, it is not necessary to support all the elements shown in the data model. The report on Learning Object Metadata Editors by Norm Friesen (2005) can be found on the Cancore-webpage, which refers to various helpful tools (http://www.cancore.ca/editors.html).

2.2 IMS content packaging (IMS CP)

Standardised content packages for easy exchange and reuse of learning products between learning management system (LMS) authoring tools are specified by the IMS (Instructional Management System) Global Learning Consortium, a worldwide non-profit organization. IMS specifications form internationally accepted de facto standards for delivering learning products and services. IMS specifications and related publications can be found on the web-page www.imsglobal.org. A content package is used in e-learning to define learning content or an assessment that can be delivered, for example by a LMS. It is a standard way of describing learning content that can be interpreted by other IMS compliant programs, guaranteeing a straightforward import.
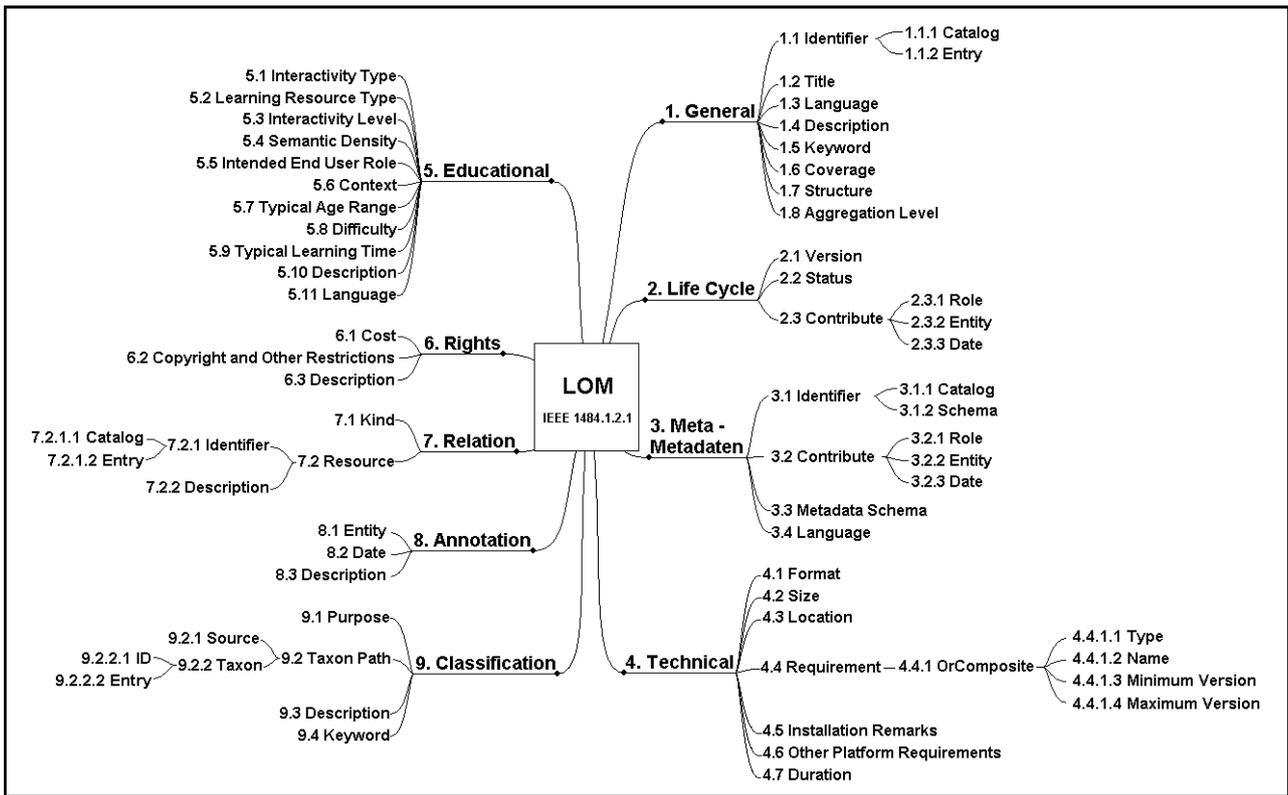
Figure 1．The elements and structure of the LOM conceptual data schema. Adapted from IMS Meta-data Best Practice Guide for IEEE 1484.12.1-2002 Standard for Learning Object Metadata, Version 1.3 Public Draft - http://www.imsglobal.org/metadata/mdv1p3pd/imsmd_bestv1p3pd.html

The IMS Content Packaging specification consists of two components:

- the Information Model which describes the data structure, and
- the Content packing XML binding which defines its representation using XML.

Figure 2 schematically sketches the Package Interchange File, a zip file that includes the XML manifest file (`imsmanifest.xml`) containing the information needed for transparent content exchange. Metadata used for description of the package correspond to the LOM-standard previously described. The organization section as the key element contains the structure of the learning resource.
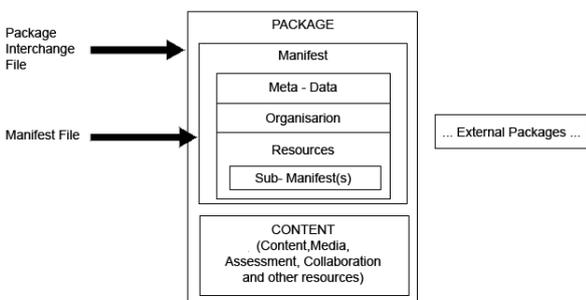

Figure 2: IMS Content framework. Adapted from IMS

Content Packaging Best Practice and Implementation Guide Version 1.1.4 Final Specification – 4. October 2004 (excerpt)

There are at least three possibilities to build an IMS Content Package. The first way is manual which requires to collect the files needed and to create the `imsmanifest.xml`-file using a text or XML editor and finally generate the zip archive. A more comfortable solution requires Adobe's Dreamweaver software. A plug-in (Content Packager for IMS) is ready for download from the Adobe website. The RELOAD Content Package and Metadata Editor provides another easy to handle procedure. This freely downloadable Java tool includes support for IEEE LOM, IMS MD 1.2.4, IMS CP 1.1.4 and also SCORM 2004 (3rd ed.).

2.3 Sharable Content Object Reference Model (SCORM)

Harmonizing the variety of e-learning specifications has led to SCORM, a widely adopted standard accomplished by the US Secretary of Defence Initiative 'Advanced Distributed Learning (ADL)'. SCORM combines the specifications of the Aviation Industry CBT Committee (AICC), IMS Global Learning Consortium, the IEEE standards, and the work initiated by the Alliance for Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE). SCORM conform content will work with any SCORM conform LMS.

In principle SCORM follows the LOM metadata concept and the IMS content packaging. Comparable to IMS CP, a SCORM package contains a zip-archive described by a XML-formatted manifest-file. The package consists of so-called Sharable Content Objects (SCO), which could be a module, a chapter, or a page including all the necessary files (assets) required to function properly. Additionally, it contains a SCORM Application Program Interface (API) -adapter client software,

which allows communication with a SCORM compatible LMS. A SCO has to be independent from other SCOs, to be reused in other learning modules.

Learning resources are usually organized hierarchically. This is in the form of a Content Organization that is represented in SCORMs content package as a single `<organization>` element as seen in figure 3. Each item in the structured hierarchy represents an instructionally relevant learning unit consisting of SCO and assets.
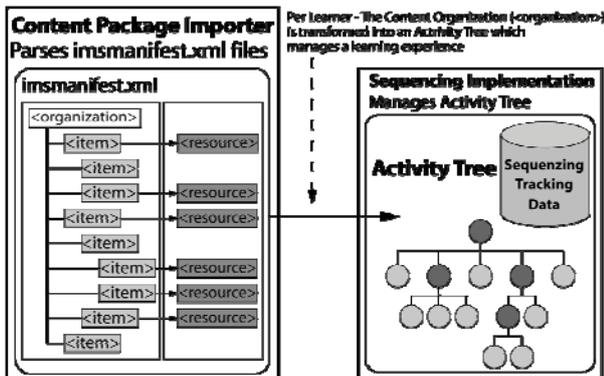

Figure 3: Relationships between a Content Organization and an Activity Tree. Adapted from: SCORM® 2004 3rd Edition Sequencing and Navigation, Version 1.0, p SN-2-4

In the 'SCORM 2004 3rd edition' the idea of sequencing is introduced in order to present a specific learning experience as intended by an author or content developer. "This learning experience may be free play, in which the learner can choose any item in the content organization in any order, or it may be guided by a flow through the structure of the content organization. The learning experience can be adaptive, with different behaviours that depend on the learner's performance or other variables that can be tracked by the LMS. In those cases, the content developer can define specific sequencing information that prescribes how an LMS will manage the learning experience" (SCORM® 2004 3rd Content Aggregation Model, Version 1.0, p CAM-3-13 – see ref.). For that purpose so-called Activity Trees are introduced, defining the order in which a learner is supposed to experience content objects. A reference implementation presenting SCORM conformal Photoshop course examples can be downloaded from ADLs website:
http://www.adlnet.gov/downloads/DownloadPage.aspx?ID=143 (accessed April 20, 2008). The examples demonstrate sequencing the same content in nine different instructional strategies.

2.4 Further developments

Up to now many e-learning projects were focused on the production of single learning modules. With the ongoing reorganization of Europe's higher education system and the introduction of the bachelor and master courses, demand for self-learning services is increasing. New techniques supporting the change from teacher to student-centred lessons are necessary. In this context Web 2.0 / e-learning2.0 is discussed. Web 2.0 is not a redesign of web-technology but a merge of (often long existing) web-based services and features. File repositories, wikis, podcasts, folksonomic tagging, blogs,

syndication etc. are techniques to set up social-networking sites facilitating collaboration and sharing between users.

3. EuroSDR

The European Organization for Spatial Data Research (EuroSDR) is an organisation that undertakes applied research projects in the fields of photogrammetry, remote sensing and GIS. It supports collaborative, hosts focussed workshops, publishes an official series of reports, contributes to the development of specifications and standards by OGC, ISO and CEN and participates in the drafting of the INSPIRE implementing rules. Moreover, EuroSDR commenced its education service (EduServ) in October 2002, an annual series of short distance e-learning courses based on specific research projects or on the recommendations of workshops.
In this context, the EuroSDR committee decided to offer a blended learning training on the City Geography Markup Language (CityGML), in the sixth round of annual courses. The EduServ6 module on CityGML started with a two-day introductory seminar at the Stuttgart University of Applied Sciences in March 2008. It is followed by a two-week distance learning course over the Internet. The e-learning content development on CityGML for EduServ6 is a joint activity of the department of Geodesy and Geoinformation Science at the Technische Universität Berlin (Germany) and the GIS Institute at the University of Gävle (Sweden). Therefore, the use of standards is essential for implementing material in a coherent way.

4. CityGML

Virtual 3D city models gain more and more importance in geo-information science. For visualization and navigation purposes, only graphic and geometric information is needed. But the increasing number of more complex applications and objectives require more sophisticated models. Adding semantic information and 3D topology is necessary e.g. for analysis in urban planning, for disaster management, and for environmental simulations. CityGML, an adopted Open Geospatial Consortium (OGC) Best Practice Paper, is designed to contain all of these properties. It defines classes and relations for the most relevant topographic objects in cities and regional models and allows the description of these objects in five well-defined consecutive Levels of Detail (Gröger et al., 2007).

Training on CityGML will require approximately thirty hours of on-line participation. Within the course, basics and general characteristics of CityGML are explained. Examples in various application areas will give course participants a good impression of CityGML's potential.

5. TECHNICAL REALISATION

The course is hosted by two university institutes in different countries. This assumes a close cooperation concerning the content, but it is also necessary to achieve a homogeneous visual impression and look-and-feel, and to ensure a certain degree of corporate identity.

5.1 Learning management system

In order to simplify the handling of the training course for trainees as well as for lecturers and tutors, an open source learning management system (LMS) is used. Moodle – as for other LMSs – is designed to handle administrative functions, deliver online content, provide tracking and reporting, offer assessments, and to report testing scores, measure learner competencies, and to support portability and standards. Moreover it gives the e-learning modules a unique, area-wide visibility and corporate design. Moodle forms the technical platform of the course.

Figure 4: Moodle LMS for CityGML course

5.2 Lectures-on-demand

In order to offer participants the possibility to consolidate their knowledge, lectures based on MS PowerPoint slides are recorded, stored in Adobe Flash format and open for continuously repetition during the follow-up work. Also those students who could not attend the presentation because of time constraints and other commitments can now easily catch up the speech or learning unit. Using an Internet browser with windows media services allows participants to view live video of the teacher giving his speech, along with synchronized images of his presentation slides and all the annotations and comments. The lecture-on-demand (LOD) can be recorded with manageable effort if an appropriate tool such as iSpring Ultra is used, which produces interactive Flash movies from a given PowerPoint document.
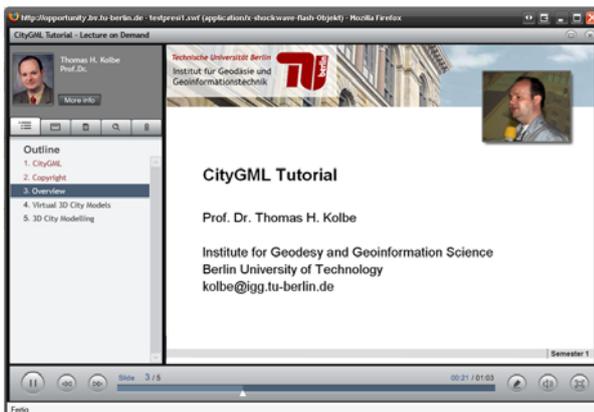

Figure 5: Lecture-on-demand

As you can see in figure 5 the screen splits into several parts: The biggest window takes the lecture content complemented by an audio/video film on top of the slides in which the lecturer explains the subject matter. To the left of the content window, the module's outline is displayed which can be represented by text information or by thumbnails. In both cases the student is able to start a specific page of interest just by clicking. A search function for locating desired slides is also an integral part of the lecture-on-demand module. Furthermore, the system allows creating a SCORM compliant document.

5.3 CityGML Modules

The short distance e-learning course on CityGML started on 19th May 2008, with a duration of two weeks. The e-learning modules follow an introductory face-to-face seminar held in Stuttgart in March, in which the participants received guidance and background information on the topic.

The CityGML course is separated into two sections. The first part focuses on the Extensible Markup Language (XML), the Geographic Markup Language (GML) and other related standards used by CityGML. The lecturer Prof. Anders Östman, Division of Geomatics at the University of Gävle, concentrates on the theoretical background of standards for modelling 3D geographic features.

Prof. Thomas H. Kolbe, Institute for Geodesy and Geoinformation Science at the Technische Universität Berlin, is responsible for the second part. Within this part, participants will get familiar with applying these standards for CityGML besides CityGML's benefits, capabilities and applications.

The course content is structured in several lectures and exercises. Every chapter of the second part is enriched with lecture-on-demand modules as described in section 5.2. Required test data and relevant publications are offered for (free) download. Links provide access to further information and software that is needed for the exercises.

The course consists of following learning units:
Unit 1: Introduction to XML: XML syntax, elements and attributes. DTD, XSL, XPath, XML parsers and editors
Unit 2: Introduction to GML: Feature schemas, geometry schemas (simple features, spatial reference systems)
Unit 3: Advanced GML: Coverages, X-linking
Unit 4: CityGML: CityGML related topics are explained in four days. During an introduction phase the participants will learn about the benefits and capabilities of CityGML. The hands-on-exercises will start with setting up the environment for getting first experience with CityGML test data. For that purpose installation of two software packages is mandatory:

- Open Source GML3 3D viewer application *Aristoteles*, which can not only be used for display of CityGML data but also is able to fetch models directly from Web Feature Services by a graphical user interface. Moreover Aristoteles can be used to validate GML3 instance documents and is capable to handle CityGML application domain extensions. Further information can be found on the Aristoteles project homepage http://www.ikg.uni-bonn.de/aristoteles/.

- Free CityGML viewer application *LandXPlorer*. The latest version is 2.6.2. It already supports the new CityGML version 0.4.0 which allows the presentation of different appearances of an object (e.g. summer/winter

appearance). Further information and download is available at the webpage of 3DGeo Company (http://www.3dgeo.de/citygml.aspx).

Next topic of unit 4 (second day) focuses on the representation of objects with different resolution or accuracy and appearances. Every geo-object can be saved in five levels of detail (LoD). With increasing LoD, objects do not only obtain a more precise and finer geometry, but do also gain a thematic refinement.

Appearance, which may be stored for each city object, relates to any surface-based theme, e.g. infrared radiation or noise pollution, not just visual properties. Each LoD of a feature can have an individual appearance.

Participants will learn how several datasets can be merged to form a new CityGML data file and how to select objects with specific features defined by different search criteria.
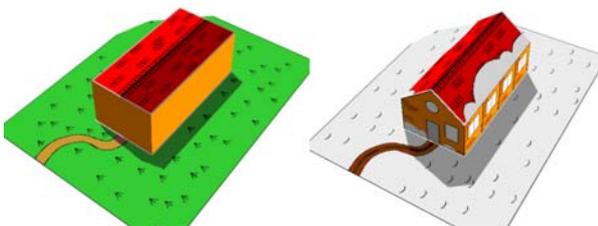

Figure 6: CityGML LoD and appearance example
LoD1 building in summer   same as LoD2 in winter time

During the 3rd day participants will gain a closer look to the internal data structure of CityGML. Based on a small dataset representing a building and a garage participants have to edit the XML-files manually in order to change feature attributes and to add new building parts. Also manipulating appearance will be part of the exercises.

Extending CityGML by the so-called Application Domain Extensions (ADE) is in the focus of the 4th day. ADEs define domain specific extensions to CityGML by augmenting existing CityGML feature types with further spatial and non-spatial properties. ADEs are specified using XML schema having their own namespaces. This preserves the possibility for XML validation even of extended CityGML files.

The exercise will give an overview of the ADE realised for mapping of environmental noise in the state of North-Rhine Westphalia, Germany. During the practical work participants will have to identify buildings with the lowest and highest noise immision rates using both the noise pollution maps and the CityGML data. The exercise also shows embedding CityGML data in a web services environment.

Unit 5: Relations to other standards
Up to now most virtual 3D city modelling efforts mainly focus on visualization by providing only graphic or geometric models. Semantic and topological aspects of the buildings and terrain being modelled are neglect. The module gives an overview on different approaches to virtual 3D city modelling formats such as X3D, KLM, Collada, 3D shapefiles, and IFC. Beyond the theory participants will learn how to convert IFC data to CityGML and will get knowledge on export filter transforming CityGML data to 3D-PDF, to ESRI's shapefile format and how to work with an Oracle GeoDatabase.
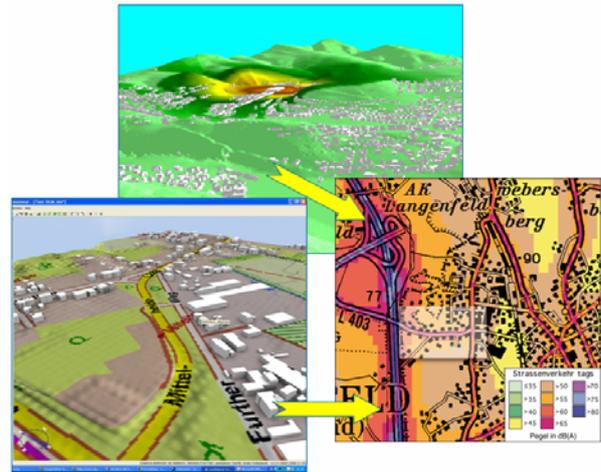

Figure 7: generation of noise pollution maps by noise dispersion simulation; result visualization using web services

5.4 Communication Tools

Since the course on CityGML only takes two weeks the modules are based on instructional packets that were delivered to students. The role of the student consists in learning from the readings and preparing exercises. Participants have to upload their results and were evaluated by the teachers. Feedback will be given by 2pm on the following day. In order to connect tutors and students the tools offered by Moodle, discussion board threading, wiki and real time textual chat, are open for use.

Social software such as blogs, podcasts etc., which are inspired by the Web 2.0 were not used in the first instance of this course.

5.5 Use of standards

In order to make use of the benefits of having standard based teaching material SCORM compatible e-learning modules were generated. To facilitate the work the Java based metadata and content packaging editor RELOAD was used (see figure 8).
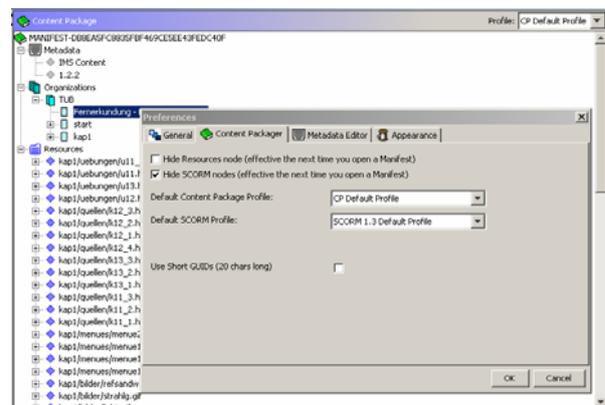

Figure 8: RELOAD screenshot

The tool has proven to be mature for creating IMS and SCORM achieves. Once the zip-archive is created, the e-learning material can be uploaded to the Moodle LMS or exchanged and re-used in SCORM compliant systems, without the need to convert the material into new formats.

6. SUMMARY

This paper has reviewed common e-learning standards and reported on an EduServ course on CityGML.

Since the online course takes place after the deadline for paper submission no statement can be made concerning acceptance and success. But the authors are confident that this approach is particularly suitable for online training of the interested public.

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