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ASPECT

Best Practice Report for Content Use

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e*Content*plus

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

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1 Specifications and standards for content use

The objective of the WP3 within ASCPECT project is to foster adoption of standards and specifications of educational content use. The approach is to bring all content partners up to speed on a range of standards and specifications, to propose a methodology for how these standards and specs can be applied to resources being made by ASPECT partners, provide technical support, train staff and investigate the strength and weakness of different standards based solutions to similar issues.
WP3 will integrate the work of WP2 about metadata, search and discovery. In WP 5 is the technical work done by content providers, which are supported by WP3. Also WP3 will provide demonstrators which are then used for tests.
Understanding the potential and limitations of complex specifications is not an easy task. This document is for everyone who is concerned with complex digital learning content to be exchanged between different organisations and systems. Among the intended readers are:

- Content providers addressing a large audience – for example publishers, developers of content for computer based training or blended learning
- Tool vendors, both commercial and open source, providing authoring tools to produce content, learning management systems or players for rendering content. This document should be of interest for their management staff and it should be suited as initial reading for technical staff
- eLearning support unit staff in charge of decisions whether particular content or tools should be recommended for use
- Content authors who need to know whether their objectives can be realised while they follow standards to reach a larger audience.

We are convinced that the end user – the teacher, instructor and learner – should not need to bother about technical standards. For her/him it should be sufficient to know which standards a specific tool and content support, in order to decide whether it can be used with the tools at her/his disposal. End users with a deeper interest in particular specifications will find a first orientation in the subsequent sections.
The following text is by no means intended to be a replacement for the original specification documents. In particular best practice documents and sample data provided with the specifications often provide help in getting a quick impression of potentials and limitations.
This document, in its first part, gives an overview about eLearning-specific activities in standardisation organisations, which concern standards for content use. A section on application profiling describes possibilities which are available to adapt specifications and standards from these organisations to the needs of particular communities as, for example, European needs.
The following sections describe the basic features of the specifications SCORM 2004, Common Cartridge and QTI as well as their current status, their acceptance, tool support, known issues and perspective. These specifications have been selected since they are the ones which are currently most used in practice. The ability of these specifications to support European content use and exchange will be evaluated in the further work of the ASPECT project.
We are aware that many organisations currently use some proprietary formats for distributing content. Reasons for this situation are explored in the survey provided by the project. The results are presented in Section 5. These proprietary formats are not intended for exchange on a broad scale and are out of scope for this Deliverable. We also do not discuss the use of

standard data formats for individual documents like JPEG, MPEG or Open Document Format which have not been designed specifically for educational purposes.
A section on Digital Rights Management (DRM) explains the LRE approach to DRM that will be further pursued. The evaluated use of specifications in the ASPECT consortium and results of two content audit surveys will show the current state of the art. Details of the survey results are deferred to an Appendix. The document is completed with a summary and recommendations for further work.
The world of eLearning standards and tools is under continuous change. A revised and updated version will be provided in March 2010 as project Deliverable D3.5. The tools mentioned in this report have been developed in a number of projects. Not all are under continuous maintenance. We have checked that these tools are available at the time of writing this (February 2009). An evaluation of those tools will be made in preparation of Deliverable D3.3 due in September 2009. This Deliverable is planned to include recommendations for tools covering the complete content life cycle.

2 Standardisation organisations

Some organisations are working on standards for e-learning. These organisations create standards for the development and adoption of technology-enabled learning. This section will give an insight into the world of international (pre-)standard organisations, the trends and their actually activities. Members of all those organisations belong to the Consortium of the ASPECT project. They do not only ensure that the work of the project is in-line with the current standardisation activities. Beyond that they feed back the findings of the project into the standardisation processes of the organisations listed below.

2.1 IEEE

The IEEE Standards Association (IEEE-SA, http://standards.ieee.org/) develops global industry standards in a broad-range of industries, including Power and Energy, Transportation, Biomedical and Healthcare, Nanotechnology and Information Technology. Its standards development program offers balance, openness, due process, and is based on consensus. Each year, the IEEE-SA conducts over 200 standards ballots, a process by which proposed standards are voted upon for technical reliability and soundness. IEEE-SA is a membership organisation with more than 20,000 participants.

The IEEE Learning Technology Standards Committee (LTSC, http://ieeeltsc.org/) is chartered by the IEEE Computer Society Standards Activity Board to develop internationally accredited technical standards, recommended practices, and guides for learning technology. Its working groups develop standards for Computer Managed Instruction, Learning Object Metadata, Resource Aggregation Models and Competency Data.

More specifically, the Learning Object Metadata (LOM, http://www.ieeeltsc.org/working-groups/wg12LOM/) working group developed the LOM standard about 5 years ago. A reaffirmation process to re-confirm the standard is almost complete. Work on LOM corrigenda is about to enter ballot stage. Work on a mapping of LOM to the abstract Dublin Core model is underway in the DCMI-LTSC task force (http://dublincore.org/educationwiki/DCMIIEEELTSCTaskforce). Over the last year or so, there has been quite a bit of discussion on how we want to make LOM evolve over the longer term. That discussion is ongoing.

2.2 CEN/ISSS Workshop Learning Technologies

About the Organisation: The CEN/ISSS (European Committee for Standardisation/ Information Society Standardisation System) is the European Standardisation Body. As part of this organisation, workshops are used as a pre-standardisation instrument, supporting project, initiatives and individual experts and stakeholders to in pre-standardisation activities. All activities in this workshop are based on *good practises* throughout Europe. Therefore, the results should be taken into account for both, input to the design process as well as a dissemination and evaluation instrument.
The main goal is to achieve European consensus within the global standardisation environment (see figure below).

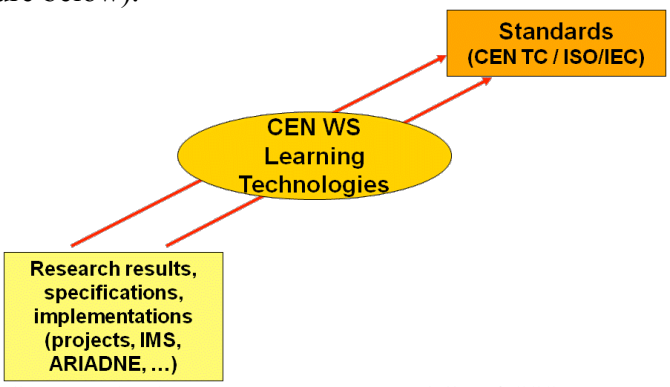

Figure 1: Standardisation Process: The Role of CEN/ISSS (Pawlowski, 2008)

Activities and Initial Recommendations: The activities of the workshop currently consist of different areas which have a particular importance for European stakeholders. Currently, the following activities are of relevance for ASPECT and the surrounding community:

- **Quality Management**: The workshop on Learning Technologies (WS LT) was founded in 1999 and has since that date produced guidelines and recommendations (e.g. 17 CEN Workshop Agreement, CWA). Several CEN Workshop Agreements (CWA) have been developed, focusing on recommendations for stakeholders. In particular, a process model was developed. This model has been input to the ISO/IEC standard ISO/IEC19796-1 "Reference Model for the Description of Quality Approaches". This model provides around 70 basic processes for the development of E-Learning and can be used as an orientation for process-oriented approaches within ASPECT as well as for the quality assurance activities. Furthermore, recommendations for learners and providers have been developed. Also those specifications are taken into account in the international standardisation process.
  Within ASPECT, the CWA should be taken into consideration as guidelines for users as well as other stakeholders when the focus is transparency, i.e., providing the right information for different target groups.

- **Simple Query / Publishing Interface (SQI / SPI)**: Those two specifications deal with the harvesting and publishing of metadata in federated repositories. A first CWA has been published for the Simple Query Interface, the CWA for the Simple Publishing Interface is currently under development. Both specifications should be considered in the process of information exchange between federated repositories. More details can be found in the Deliverables of WP2.

- **Metadata for Learning Opportunities** is a harmonised specification to describe learning opportunities such as the courses available at a university such that these descriptions can be aggregated by other services such as advice centres, search engines, or brokerages. This specification has been developed on the basis of national specifications from Germany, UK, FRANCE, Sweden, and Norway. The common MLO model takes those specifications into account and enables the adaptation of the (European) model based on the needs of stakeholders. MLO is, as a next step, forwarded to the CEN Technical Committee "Information and Communication Technologies for Learning, Education and Training" (CEN TC 353). This model should be considered for course / content providers in ASPECT as a common basis.

- **Metadata Application Profiles**: The WSLT has produced guidelines for application profiles which are widely used throughout the community. Furthermore, the workshop has developed a registry for application profiles, providing a reference source for stakeholders developing their own application profiles. Just recently. The workshop has developed a new CWA on agricultural metadata. As a recommendation, the above mentioned sources should be taken into account in the application profile development and discourse process within ASPECT.

As a conclusion, the results of the CEN/ISSS WS Learning Technologies reflect a variety of experiences. Even though the CWA produced do not directly relate to the issue of content use, related activities will benefit from the use of the above mentioned specifications and recommendations. The workshop should furthermore be used as a source to reach further stakeholders, both experts and users.

Trends:
The CEN/ISSS Workshop on Learning Technologies will continue to produce specifications and pre-standardisation recommendations in the next years. Within the ASPECT project we shall carefully consider which of the project's results are mature for further standardisation efforts. These can be new / improved specifications, but also guidelines, best practices, and application profiles. The intense discourse within the workshop is highly recommended as well on the level of prototypes as the workshops' experts can be involved within the dissemination and evaluation.
Furthermore, more mature results should be considered for submission to the CEN/ISSS Technical Committee 353. This committee has been established in 2007 and is starting its operations and first results.

2.3 IMS Global Learning Consortium

IMS Global Learning Consortium was founded in 1997. It is a global non-profit organisation for the development of technical specifications and guidelines. IMS has more than 120 contributing members – educational institutions from higher education and the school sector, commercial publisher and vendors from the eLearning industry as well as governmental organisation. Regularly contributing members pay an annual fee and contribute personnel resources to the work of IMS. The broad range of members and the resources provided by its members make IMS unique among the organisations dealing with eLearning specifications. It is reflected in a very broad range of specification activities.

Based in Lake Mary, Florida, and with most of its members in the USA, IMS maintains a global view with a US focus. Nevertheless over the last year's activity and influence of IMS members outside the USA has been increasing. 3 of the 14 IMS directors are from Europe. The UK, Australia and South Korea are countries with particularly active IMS member organisations. From the ASPECT consortium European School net, The Open University UK, Icodeon and the University Koblenz-Landau are contributing members of IMS.

Within IMS most work is performed in Special Interest Groups (SIGs) with weekly teleconferences. Only contributing members or specially invited experts from non-member organisations can work in an IMS SIG. Important decisions are made by the IMS Technical Advisory Board (TAB) where each contributing member has one vote. In particular the TAB decides on the creation of SIGs, on the release of specifications as public draft and on the final release of specifications. Once released, IMS specifications and guidelines are made available for royalty-free download.
IMS runs the IMS web site at http://www.imsglobal.org and maintains a technical infrastructure for the IMS SIGs and the TAB. It distributes regularly internal and public electronic newsletters. Every three months an IMS quarterly meeting is held which consists of a public and a closed part. Over the last years annually one of these meetings was held in Europe, the next being scheduled for Barcelona May 11-14 2009 in Barcelona (see http://www.imsglobal.org/learningimpact2009/index.html). Surveys, webinars and the Learning Impact Award are further activities of IMS.
In the work of IMS a tendency can be observed to increase observation of and support for the actual take-up of specifications by the various communities. A directory of current conformant products is maintained, application profiling guidelines, tools and sample data to support the development of conformant content and applications have been provided by IMS. Application Profile Management Groups (APMGs) are being established to trace the take-up of specifications after their final release.

Within the work of IMS two interrelated fields can be identified.

- Data format specifications. These are developed as structured information models and UML diagrams. From these UML diagrams XML schemas are generated for binding the information models to well-defined data formats. All IMS work concerning data format specifications is bundled in the IMS Common Cartridge Alliance.
- Service specifications. These target a wide range of types of interoperable web services including student information and campus management services. Published results of this work mostly take the form of guidelines. These, from 2004/2005, are currently under revision in the respective SIGs.

The ASPECT consortium has concluded a Memorandum of Understanding with IMS Global Learning Consortium. This MoU provides ASPECT members preferred access to IMS resources. It also provides ways to review ASPECT results by IMS, to feed ASPECT results into the work of IMS and to disseminate ASPECT results through IMS channels.

2.4 LETSI – International Federation for Learning-Education-Training Systems Interoperability

About the Organisation:
LETSI is a consortium of e-learning associations, standards bodies, systems integrators, policy makers, adopters, and product and services vendors. LETSI promotes the advancement

of technology-supported education and training by creating interoperability frameworks for software systems: content delivery, content authoring, content management, learning management and related systems like Human Resource systems and engineering documentation.

LETSI's activities include promotion of interoperability solutions, harmonisation of the work done across the diverse e-learning communities and standardisation bodies, and support of the associated software development community (product vendors, systems integrators, and adopters). LETSI is committed to open standards and an open process.

LETSI's efforts span all markets sectors, including schools, higher education, enterprise job training and further education, and professional education and certification. Multi-sector activities aim to leverage investments in innovation and accelerate the dissemination of new e-learning techniques and tools across these sectors.

LETSI is organised as a program of the IEEE's Industry Standards and Technology Organisation, Inc. (ISTO). IEEE ISTO is a U.S. 501(c)6 non-profit corporation.
Activities: One of LETSI's major activities is to re-evaluate the Sharable Content Object Reference Model (SCORM), in the context of modern enterprise software and emerging teaching and learning strategies. The long term goal is to develop a new version of SCORM (tentatively denoted SCORM 2.0). Following the SCORM 2.0 Workshop in October 2008, requirements gathering and general planning continues. Technical workgroups are currently (January 2009) focused on (1) developing business requirements, business models and potential outputs from LETSI as an organisation and for SCORM 2.0 as an output; (2) developing a proposed technical architecture for SCORM 2.0 supporting forward-looking features; (3) gathering requirements from instructional designers and educators describing what they want to do and how to enable it; and (4) evaluating requirements for sequencing and delivery of content.

Trends:
The exact scope and purpose of SCORM 2.0, and of LETSI itself, are still to be determined; requirements gathered to date are broad. While many suggestions for operational models, outputs and processes have been put forth, all work is still in a formative stage; no immediate technical deliverables have been planned.

Technical work presumes a new interoperability model focused on service-based communications for core SCORM 2004 functions (content exchange and run-time communications) using open LET and technology standards. Potential additional capabilities would support multi-learner training, use of network resources and non-browser-based content delivery. Future releases would address capabilities such as competency models, student records, games and simulations, and use of authoritative-source technical documentation in training content.

The US Department of Defence has recently determined that they cannot assign Intellectual Property rights to SCORM 2004 to another organisation, and that the Advanced Distributed Learning Initiative (ADL) will retain stewardardship and maintenance of SCORM 2004. While LETSI aims to produce a new SCORM 2.0, the impact on LETSI and the future of SCORM 2004 and its positioning outside of the Advanced Distributed Learning Initiative remain unclear.

Information provided by LETSI (The Federation for Learning-Education-Training Systems Interoperability, Avron Barr, Nov 2008) and taken from the LETSI web site: http://www.letsi.org/display/welcome/Home

2.5 ADL – US Advanced Distributed Learning Initiative

About the Organisation:
US Advanced Distributed Learning Initiative is a program within the Office of the Under Secretary of Defence for Personnel and Readiness (OUSD P&R) of the US Department of Defence (DoD). The ADL Initiative grew out of the US President's Task Force on Training Technology from the White House Office of Science Technology and Policy (OSTP), with the program being assigned to the DoD by an by Executive Order of the President.
The ADL program is funded through the US DoD Budget and is staffed both by US DoD civilian personnel and by support contractors. The program maintains both formal and informal ties to other US government departments and agencies, including the Departments of Labour, Treasury and Homeland Security. Operationally the ADL program is led from the ADL Hub Co-Laboratory (Co-Lab) and includes other Co-Labs (both DoD-funded supporting DoD, activities and externally-funded, supporting non DoD activities) and International Partnership Labs established through agreements between the US DoD and the agency in the partner country (e.g., the foreign Ministry of Defence, other department, or NGO).
The ADL's broad mandate is to improve training for all US Government personnel. To do so, its work has been in collaboration with other agencies, the academic and commercial sector, and foreign liaisons. While its work has focused on training, its output has been applied to all sectors, including schools and higher education.

Activities:
ADL's activities can be grouped into two broad categories: developing and maintaining ADL technologies and supporting the training improvement in the US Government.

ADL Technologies: ADL is involved in the development of three key "ADL Technologies":

- SCORM: SCORM defines a model for the structure and behaviour of training content and components. This model relies on adapting existing learning technology standards and specifications to describe the structure and the requisite behaviours. ADL has developed and maintained SCORM through several versions, and distributes SCORM documents and supporting software. ADL supports public online forums and a help desk for all SCORM users, organises SCORM-related events, maintains lists of SCORM "adopters" and manages a SCORM conformance and certification testing program.
- ADL-Registry: The ADL-Registry provides an operational infrastructure for the discovery of SCORM content. Currently open to only US DoD content repositories, the ADL-Registry provides a federated metadata discovery mechanism to locate content. ADL continues to directly develop, support and maintain the ADL-Registry.
- Job Performance Aids: Through the ADL Job Performance Technology Center (JPTC), ADL is investigating how to integrate job performance and training aids and systems with other types of learning technologies. Recent work has focused on integration of authoritative-source content descriptions for materiel systems, e.g., equipment operations and maintenance documents based on original engineering documents, with SCORM.

ADL Support: ADL supports, both through formal liaisons and informal contacts, the use of ADL technologies and the overall use of technologies to support training across the US Government. ADL acts both as an advocate for technologies and their uptake, and provides direct support and training to US Government programs.
In addition, ADL supports work on gaming, simulation and intelligent tutors through prototype projects, reports and studies.

Trends:
As an internal DoD program, the ADL does not release a public work plan.
ADL continues to support SCORM 2004 though its various activities. ADL has not announced plans for further changes to SCORM 2004 beyond the release of SCORM 2004 4th Edition in 2009.
The ADL had discussed transition of their work that was of broad interest to the general community, e.g., SCORM, to other organisations. In 2008, the US DoD determined that they could not initiate such transfer of ownership of ADL intellectual property to a new organisation. The US DoD plans to continue to support and maintain the various ADL technologies.
Significant ADL resources go towards supporting their direct customers and sponsors, the US DoD and other US Government agencies. All ADL activities must be responsive to these needs, and ultimately, the program must be responsible its US DoD managers.
There has been a turn-over of almost all senior ADL management and technical personnel and their DoD supervisors and managers within the last year. The new US Presidential Administration may bring further changes as the Under Secretary of Defence for Personnel and Readiness is a Presidential appointee. While the new US Presidential Administration has a goal of increasing US employment and training, and has meet with the ADL, the impact on ADL of all of the changes is not known. All of these changes, combined with US Government and US DoD priorities, and the impact of the current economic situation on the US DoD Budget make it impossible to predict long-term trends.

3 Application Profiling

Ten years of using open technical specifications in education have provided ample evidence that communities of practice only too often have specific needs which have not been foreseen in the specifications. Those communities can be from a specific sector, region or continent; even a specific content or LMS provider may have the need to use features which are not supported by the specifications.
Each data specification describes the set of documents that are compliant with this specification. But for particular communities slightly different sets of documents may be relevant. A description, how this specific set deviates from the set of documents described in the specification, is called an *application profile*.
For example some elements which are optional in the specification may be mandatory or prohibited in the specific profile. There may be also the need to include data which are only of interest for this particular community and which have not been foreseen in the specification. Or for particular fields only a community specific set of values is allowed.
In practice, applications often use several specifications simultaneously. For example a specification for packaging content may be used together with a specification for the metadata which describe the content. When several specifications together with description of how they are to be combined, are adapted to the needs of a community, this is called a *domain profile*.

Modern specifications take these needs into account. They mandate only very few elements and they offer extension points where domain specific data structures can be inserted. External specific vocabularies can be replaced without changing the base specification. Conformant systems are supposed to tolerate these extensions if they cannot make sense of them.
Each application can potentially read or write specific documents. A description of this set of documents is called the *read profile* respectively the *write profile* of the application. A source application can send documents to a target application if each document which is conformant to the write profile of the source application is also conformant to the read profile of the target application.
If each document which conforms to a domain or application profile of a specification also conforms to the specification itself, then the profile is called *restrictive*. If an LMS fully implements a specification then it can import all documents which conform to a restrictive profile of this specification. In the literature application profiles are often assumed to be restrictive.
An application profile can be described as a set of modifications of the information model or of a binding description of a specification. The same information model/profile can be realised by many formats. Therefore, while information models alone foster the development of translations from one compliant document format to another, they are not sufficiently precise to foster interoperability of systems and automated compliance checking. As information models are not given in a machine readable way, their profiles are not machine readable as well.
For further reading on application profiling the reader is referred to the IMS Application Profiling Guidelines (see http://www.imsglobal.org/ap/).
2004-2006 the European IST project *Telcert* has developed a way to encode domain profiles of XML schema based specifications in a machine readable way. The project has implemented the open source profile editor *SchemaProf* and a technology to create automated compliance test systems from *SchemaProf*-generated profiles. An IMS approved version of the *SchemaProf* tool is available from the IMS web site. Also the IMS Test System for the Common Cartridge domain profile is based on the *Telcert* technology.

4 Specifications

4.1 SCORM® 2004: Sharable Content Object Reference Model

4.1.1 Rationale and Domain

The motivation for SCORM follows from data indicating that individualized instruction and tutoring is, for skills-related instruction, significantly more effective than traditional classroom-based learning but this approach is costly. Using technology to create individualized instruction, while effective, traditionally has been expensive also as these systems have been hand-crafted, one-off systems. SCORM attempts to address both the benefits and costs of using technology to provide individualized learning by focusing on key characteristics of content and system components:

- Accessibility: component and content management (storage and discovery) is separate from use, deployment and delivery (instruction).
- Adaptability: existing components and content can be easily modified to meet differing needs.

- Affordability: cost and time of development is reduced; productivity and efficiency in development and instruction is increased.
- Durability: impacts of technological evolution and change are minimized.
- Interoperability: components and content are interoperable across a range of systems, tools, contexts, locales and delivery environments.
- Reusability: combinations of content and components can be built from existing, disparate individual pieces, each of which can be used in multiple contexts.

To achieve these characteristics, SCORM defines a model for the structure and behaviour of content and components. This model relies on adapting existing learning technology standards and specifications to describe the structure and the requisite behaviours.
SCORM focuses on web-based learning; it is based on assumptions of ubiquitous access and availability of web-based technologies. The model further assumes:

- Content is explicitly authored and prepared for use in a SCORM environment.
- Content delivery and instruction is coordinated through a "learning management system" (LMS) that is responsible for managing the learner's instructional experience (deliver, track, report, manage content).
- Content delivery and learner interaction is within a web-based technology environment (typically using web browser).

SCORM content is designed as "objects": reusable chunks of learning that can be developed independent of their "context" and can be assembled into more granular structures that are aligned with specific instructional goals.
In SCORM:

1. The content alone determines what instruction the learner sees and what data is provided to control the learning experience (content aims to be context free).
2. The LMS alone determines how to deliver, present, manage and track the learner through the learning experience (based on data from how the learner interacts with the content) and an overall specification of the instruction that is uncoupled from the specifics of the content itself.
3. The tools are built using web-based technologies, providing a low-cost, ubiquitous delivery platform.

SCORM does not specify a particular learning approach, content structure, presentation style or pedagogy. It has been successfully applied in all domains: schools, higher education, further education, training, professional accreditation. Due to the nature of the underlying learning technology standards incorporated (both their capabilities and limits), the model of content as objects independent of context, and the limits of web-based technology, SCORM is better suited for:

- Individual learning versus group learning: the standards and specifications used in SCORM do not define how to coordinate the management or tracking of multiple individuals in a cohort.
- Pre-authored content versus content developed during the learning experience: adaptation and reuse assume pre-existing assets are available to be reused.
- Directed learning versus unstructured learning: SCORM includes features to define complex content structures and to control the learner's path through the content. It does not preclude simple content presentations with open access to a fixed content structure without any control, but does not include capabilities for discovery-based

instruction. Nor does SCORM define how to dynamically adapt learner paths during instruction.

- Managed learning versus unmanaged learning: SCORM includes features to track learner interactions with content. While not required, not using these capabilities implies that SCORM is only used to provide content modelling and exchange. Using the management features does require use of an LMS, not just a simple web browser for content delivery.

While SCORM does not include many potentially useful features (described in more detail below), it does not preclude that additional features and capabilities are incorporated into content or components. Many demonstration projects have illustrated how SCORM could be extended to support other types of instruction and behaviours. But since there is no formal agreement on these approaches, there is no way to create interoperable content and components when such additional features are used.

4.1.2 Description of Structure of the Specification

SCORM, as its name states, is a reference model, i.e., it is a collection of different standards and specifications that have been chosen and combined to solve a particular problem and that are individually profiled (specialized via additions or restrictions) so that they combine into a comprehensive, consistent whole, addressing inconsistencies and gaps in the independently developed, underlying components.
SCORM 2004 is built from seven different standards and specifications, organised into three groups (denoted the "books" of SCORM). SCORM takes each of the standards and specifications and selects the features and capabilities of each to use and defines extensions for each. This process is aimed at meeting the overall goals and at harmonising the standards and specifications to work together. SCORM then adds to these standards and specifications the additional capabilities needed to create the comprehensive, consistent whole. The three "books" are:

Content Aggregation Model (CAM)
SCORM's content model is a hierarchical structure of content objects, derived from the *AICC CMI Guidelines*. These structured collections may be packaged into representations for exchange between systems using a profiled version of the IMS Content Packaging Specification (*IMS Content Packaging Specification* (IMS CP 1.1.4)). The content objects in a package may have associated discovery learning object metadata, described using the IEEE LOM Standards (originally from Ariadne) (*IEEE Standard for Learning Object Metadata* (IEEE 1484.12.1-2002) and *IEEE Standard for Learning Technology-Extensible Markup Language (XML) Schema Definition Language Binding for Learning Object Metadata* (IEEE 1484.12.3-2005)). The Content Aggregation Model describes interoperability for content exchange and discovery: how to put content together, move it and the descriptions used to find it.

Run-Time Environment (RTE)
The SCORM Run-Time Environment describes how content interacts with an LMS. An LMS delivers content to a web browser for learner interaction; the content communicates with the LMS via an ECMAScript interface to pass data between the content and LMS. The LMS can use this data for reporting and tracking. The ECMAScript interface used in content to communicate with the LMS is defined by the IEEE CMI API Standard (*IEEE Standard for Learning Technology-ECMAScript Application Programming Interface for Content to Runtime Services Communication* (IEEE 1484.11.2-2003)). The information that can be

communicated between the content and LMS (read by content from the LMS and used by the content to control its behaviour, or passed from the content to the LMS for tracking and control) is defined by the IEEE CMI Data Model (*IEEE Standard for Learning Technology-Data Model for Content to Learning Management System Communication* (IEEE 1484.11.1-2004)). Both of these standards were derived from the *AICC CMI Guidelines*. The Run-Time Environment defines interoperability for the operational portability of content between delivery platforms: how to deliver content to the learner, how track it, what data the content can use to control its behaviour.

Sequencing and Navigation (SN)
Authored, directed learning paths and content interactions are defined through sequencing rules that are used by a sequencing engine within the LMS to control the selection of content to be delivered and the available learner navigation controls used to select and move through the content. The rule language and behaviour specification was derived from the IMS Simple Sequencing Specification (*IMS Simple Sequencing Specification* (IMS SS 1.0)); navigation behaviours were developed by ADL. Sequencing and Navigation defines how to provide a consistent learner experience across different delivery platforms: how to define, control and present sophisticated learning strategies.

While these three parts make up SCORM 2004 as a whole, they are not independent.

- Content objects defined in the Content Aggregation Model include ECMAScript interfaces defined in the Run-Time Environment.
- Content exchange packages defined in the Content Aggregation Model include sequencing and navigation rules defined in Sequencing and Navigation.
- The Run-Time Environment provides the defined sequencing behaviour specified in Sequencing and Navigation.

SCORM 2004 defines all the necessary profiles of the underlying standards to ensure consistency across all of these interdependencies.
In addition to these three “books”, SCORM 2004 documentation includes an *Overview* and two supporting components:

Conformance Requirements
The *SCORM 2004 Conformance Requirements* describe the tests, criteria and requirements used to determine conformance of an LMS, a content package or a Sharable Content Object (SCO) to SCORM 2004 (there are separate conformance requirements for each of these). Associated with the SCORM 2004 Conformance Requirements is the *SCORM 2004 Conformance Test Suite*, a collection of test software, test data and test procedures used to test an LMS or content against the SCORM 2004 Conformance Requirements. Self testing of SCORM 2004 components or content against the SCORM 2004 Conformance Test Suite is used to assess conformance to the SCORM 2004 Conformance Requirements. The same test suite is used by approved, independent external organisations to issue statements of SCORM “Certification”.

Sample Run-Time Environment (SRTE)
The *SCORM 2004 Sample Run-Time Environment* is an open source implementation of a simple, single user LMS that supports many of the key features of SCORM 2004 (content import using content packaging, delivery of content from and communications of content to an LMS, tracking of the learner through the content and controlling the selection of content to

deliver using the sequencing rules in the content package). The SRTE illustrates how an LMS can satisfy *some* of the SCORM 2004 Conformance Requirements.

4.1.3 Supporting Tools and Services

The official SCORM 2004 documents and tools are available directly from the ADL web site, including:

- SCORM 2004 Documentation Set:
  - *SCORM 2004, 3rd Edition, Overview*
  - *SCORM 2004, 3rd Edition, Content Aggregation Model*
  - *SCORM 2004, 3rd Edition, Run-Time Environment*
  - *SCORM 2004, 3rd Edition, Sequencing and Navigation*
- SCORM 2004 Conformance Test Suite:
  - *SCORM 2004, 3rd Edition, Conformance Requirements*
  - *SCORM 2004, 3rd Edition, Conformance Test Suite: LMS Test Content Packages*
  - *SCORM 2004, 3rd Edition, Conformance Test Suite: Self Test*
- SCORM 2004 Sample Software:
  - *SCORM 2004, 3rd Edition, Run-Time Environment*
  - *SCORM 2004, 3rd Edition, XML XSDs*
  - *SCORM 2004, 3rd Edition, Content Examples*

There are three ADL Certification Testing Centers that are authorized to test content and components and to issue formal "SCORM Certified" labels.
The ADL web site also includes a collection of informal documents and web-based community discussion forums.
In addition to the formal ADL support, documents and tools, there are numerous third-party tools and documents available. The ADL web site alone currently (December 2008) lists 291 "adopter products", i.e., a vendor listing that include content, services, authoring tools, LMSs, etc. that have passed the conformance self test and 262 products that have been "SCORM Certified" by the independent testing centers.
A variety of other resources are available directly from third parties, either freely available or as part of commercial offerings. Select tools (in addition to the ADL tools) and content have been made available to the partners of the Aspect Consortium, including:

- Authoring Tools:
  - *Reload Editor* (Eclipse Based V1.0.0): create SCORM 2004 and IMS Content Packages; includes the LSAL SCORM 2004 Sequencing Templates (http://www.reload.ac.uk/new/editor_eclipse.html)
- Testing Tools:
  - *Diagnostic SCO*: testing the SCORM RTE (Run-Time Environment) (http://ostyn.com/standards/scorm/samples/proddingSCOwrap.htm)
  - *SCO Test Wrapper*: monitor SCO-to-RTE communications (http://ostyn.com/standards/scorm/samples/scorm2004testwrapwrap.htm)
  - *SCORM 1.2 Adapter*: play SCORM 1.2 content in a SCORM 2004 LMS (http://ostyn.com/standards/demos/SCORM/wraps/easyscoadapterdoc.htm SCO Adapter)
- SCORM Player/Run-Time:
  - Icodeon SCORM Player (Java and .NET Editions): SCORM Run-Time with support for IMS Content packaging, SCORM 1.2, SCORM 2004 (http://www.icodeon.com/product.html)

- SCORM Guides:
  - *SCORM Best Practices Guide for Content Developers*, 2nd Edition (http://lsal.org/)

4.1.4 Ongoing Maintenance

SCORM has been developed and maintained throughout its life by the US Advanced Distributed Learning Initiative (ADLI, but commonly known as just ADL) (cf. Section 2.5). SCORM and ADL have evolved in several versions and through several milestones since their inception in 1996.

- 1996 – US President's Task Force on Training Technology from the White House Office of Science Technology and Policy (OSTP) set forth a plan to improve training for US Government personnel.
- 1999 – The task of managing the ADL program was assigned to the US Department of Defence by Executive Order of the President; DoD in turn established the Advanced Distributed Learning Initiative.
- 1999 – SCORM 0.7.3. ADL produced the initial draft of SCORM.
- 2000 – SCORM 1.0. The first complete release of SCORM. It included both a content model and a model for content in a browser environment to communicate with an LMS. SCORM 1.0 was essentially a profile of the *AICC CMI Guidelines*.
- 2001 – SCORM 1.1. Primarily a technical "cleanup" and editorial revision. The major technical change was to delete from SCORM substantial functionality that was part of the AICC CMI model but which was not widely adopted.
- 2001 – SCORM 1.2. SCORM 1.2 introduced metadata to describe content, based on the IEEE LOM draft standard, and added the IMS Content Packaging Specification as the mechanism to exchange content structures between systems.
- 2004 – SCORM 2004. SCORM 2004 provided the three main components of the current SCORM model as described above. The original metadata draft standard and CMI run-time specifications were replaced by their equivalent IEEE Standards. Sequencing, from the IMS Simple Sequencing specification, was added, along with an ADL-developed model for content display and navigation controls.
- 2004 – SCORM 2004 2nd Edition. Ongoing editorial and technical changes and corrections without major new functionality. The draft IEEE CMI data model specification was replaced by the final published version.
- 2006 – DoD Instruction. The US DoD issued an "instruction" requiring the use of SCORM for new content developed within the US DoD.
- 2006 – SCORM 2004 3rd Edition. Ongoing editorial and technical changes and corrections without major new functionality. Updates to use IMS Content Packaging specification V1.1.4 and final IEEE LOM XML binding.
- 2009 – SCORM 2004 4th Edition. Ongoing editorial and technical changes and corrections without major new functionality.

The ADL continues to coordinate the development and maintenance of SCORM, through both internal and external activities.

Externally, the ADL maintains a public web site for distribution of the SCORM documents, sample content and tools. It operates a help desk where issues and problems may be submitted, and maintains and monitors open community forums for discussion. ADL holds "Plugfests" as conferences and interoperability testing events on an ad hoc schedule. The ADL also coordinates the activities of the SCORM Technical Workgroup (TWG), a group of SCORM software developers, vendors and adopters, most of them are from the commercial vendor sector. Icodeon (an ASPECT consortium partner) is a SCORM TWG member.

The TWG meets informally, in person or online, to discuss and make recommendations for changes and modifications to SCORM.
Internally, the ADL maintains a help desk and problem/issue tracking system. ADL technical staff (support contractors) handle many issues directly. Those that require changes to either SCORM or any of the associated tools are forwarded to the SCORM Change Control Board (CCB), a group of ADL staff and personnel who review the issues and make recommendations, either for changes to SCORM or for the issue to be presented to the SCORM Technical Workgroup for their input. All final decisions regarding the maintenance of SCORM are made by the ADL and implemented through new releases of SCORM, the support tools and test suites that are maintained by the ADL technical staff. Strategic decisions about future directions for SCORM and major technical changes are made by ADL management.
In recent years, the ADL has made statements indicating a desire to turn over the maintenance and development of SCORM to an external organisation. In 2008, the US DoD determined that they could not initiate a transfer of ownership of SCORM intellectual property to a new organisation and that the US DoD plans to continue to support and maintain SCORM 2004. ADL has not announced plans for further changes to SCORM 2004 beyond the release of SCORM 2004 4th Edition in 2009. Traditionally, as newer versions of SCORM are released, support and maintenance for older versions is curtailed. [Sources: see the references]

4.2 Common Cartridge Specification V1.0

4.2.1 Rationale and Domain

In order to support the exchange of learning material, IMS has created the IMS Content Packaging specification (CP). An IMS content package provides a set of files together with one or more organisations of those file in hierarchical tables of contents. An LMS importing a content package can make the files in the package available to the user and it can use any of the tables of content (organisations) to render for the user navigation facilities in the LMS specific way.
The IMS Common Cartridge specification (CC) was developed in order to support the exchange of more complex and interactive learning materials. In particular CC extends CP by providing support for

- Questions and tests
- The initiation of discussion forums
- Basic authentication to protect the content delivered
- More detailed description of the way in which the importing LMS is supposed to render links to specific web resources.

Practice with a large variety of specifications in the eLearning domain has shown that just "following a specification" is not sufficient to achieve interoperability. In the past, specifications have been built with the intention to support all kinds of data exchange that might be relevant. In contrast, each content provider uses only a specific subset of those specifications. Similarly, developers of LMS tend to implement support for only those features of the specifications which they perceive as relevant. The consequence is, that an LMS may not support some features required by a content package, resulting in a failure of interoperability. Using the application profiling terminology from the introduction, this can be expressed stating that the write profile of the content provider fails to be a restriction of the read profile of the LMS vendor.

When designing the IMC Common Cartridge specification, this issue was addressed by a paradigmatic change. CC does not intend to support all desirable features for content packages; instead it is based on a current practice analysis which captured what is currently supported by most LMS vendors and content providers which are supporting open specifications for content use. This paradigmatic shift was emphasized by the IMS requirement that, at the time of release of the specification, prototypical implementation as well as test content should be available. Many of the apparent restrictions posed by CC are therefore due to the fact that possible extensions are not supported by current and near-by implementation practice.
With more than 500 cartridges, many of them from The Open University UK, and around 5 implementations at the release date of December 19th, 2008, this objective was met. In addition, auxiliary services are available, for example an authorisation service, a test system from the University in Koblenz and a converter from SCORM packages to Common Cartridges from Icodeon – to mention only the ASPECT partners prominently involved.
A further specifics of CC is that it has only very few possibilities for extensions by the user. The background for this design decision was the intention that the content buyer could rely that all features of the acquired cartridge are supported by all LMS which conform to the respective version of CC. It is expected that this will lower the barriers for take-up and ease market penetration.
The price to pay for this increased support for interoperability is envisioning a much more rapid development of the CC than for more traditional specifications. In order to support this regular development of the specification, IMS has formed the Common Cartridge Alliance and a Common Cartridge Application Profile Management Group. The objective of these groups is to support CC use and further development in order to keep up with emerging best practice.
A promising step in this emerging best practice is the presentation at Educause 2008 of a Common Cartridge combined with support for an external assessment tool based on the IMS Tools Interoperability Guidelines (TI). It is in particular the University of Michigan which is leading this development. This can lead to a generic way – in the next version of CC – how content imported into an LMS can interact with third party tools.

4.2.2 Structure of the Common Cartridge Specification

The Common Cartridge Specification Version 1.0 consists of application profiles of a number of pre-existing specifications. The Common Cartridge Specification Document [http://www.imsglobal.org/cc/ccv1p0/imscc_profilev1p0.html] describes only the modifications made to these base specifications. The following paragraphs are intended to provide a first overview of the specification. They cannot replace reading of the original specification document.

4.2.3 IMS Content Packaging V 1.2

Common Cartridges are IMS content packages, i.e. they are zip-compressed folders containing proper content files and a file named imsmanifest.xml which describes the structure of the cartridge. The imsmanifest file contains

- Metadata for the cartridge according to the cartridge level profile of IEEE LOM
- At most one hierarchical organisation of content items. Each content item below the root of the hierarchy must have a title. Only end points of the hierarchy represent learning objects and only those must have a reference to a resource (see below)
- A list of resources. Each resource contains a list of references to data files or URLs of files on the web. Frequently each resource is represented in the cartridge by a directory containing the respective content files. Files used by several resources can be collected

in a special resource which is not referenced by any item in the cartridge organisation. However it is important to note that each file referenced by a resource must exist and that each file in the cartridge, except the file imsmanifest.xml, needs to be referenced by at least one resource. Aside of the file references, a resource can have metadata according to the resource level profile of IEEE LOM. Each resource must have one of six learning application object types (see below). Depending on the type of the learning object there may be further restrictions to the files that can be referenced by the resource. Resources can be declared as protected. Any system displaying a cartridge with a protected resource is obliged to execute a required authorisation procedure (see below).

- Optionally the imsmanifest file may contain authorisation information (see below).

Exactly the following types of learning application objects are supported by CC.

- Cartridge **web content** represents web content that may be referenced by any Learning Application Object in the cartridge. If a cartridge web content resource is linked from a Learning Application Object link Item object in the organisation of the cartridge it must have a Href characteristic object which represents the launchable resource.
- **Associated content** represents web content that is scoped to a particular resource. If the associated content resource is linked from a Learning Application Object link Item object it must have a Href characteristic object which represents the launchable resource. The Resource object may contain Dependency objects which reference Resource objects with Type 'webcontent'.
- A **Discussion Topic** is a Learning Application Object that is used to initiate Discussion activity. Such a resource must reference a file with a discussion topic descriptor according to the IMS Discussion Topic Specification.
- A **Web Link** is a Learning Application Object that represents a URL. Such a resource must reference a file with a web link descriptor according to the IMS Weblink Specification.
- **Assessment objects** describe assessments. An assessment object resource must reference a file which conforms to the Common Cartridge profile of the IMS QTI Specification Version 1.2 (see below). It may contain Dependency objects which reference Resource objects of type *web content* or *associated content.*
- **Question bank objects** describe collections of test items. A question bank resource must reference a file which conforms to the Common Cartridge profile of the IMS QTI Specification Version 1.2 (see below). It may contain Dependency objects which reference Resource objects of type *web content* or *associated content.*

Note in particular that a cartridge cannot contain subcartridges, SCORM packages or accessibility information. It is, however, possible to reference as web content or associated content a launchable SCORM player which plays a particular SCORM package. It is not excluded that a future version of CC includes learning application objects representing SCORM packages. According to the paradigm shift described, this would presuppose the availability of common cartridge players with integrated SCORM players.

4.2.4 IEEE LOM Metadata

CP uses two application profiles of the IEEE LOM specification Version 1.0. IEEE LTSC, Learning Technology Standards Committee. IEEE 1484.12.1-2002 Standard for Learning Object Metadata, 2002 comes in three versions: The *strict* version which is non-extensible, the *custom* version which is incomplete and the *loose* version which is extensible. Both profiles used in CC are based on the loose version of IEEE LOM.

- For metadata at the cartridge level, CC defines a profile that allows only the metadata elements of the unqualified Dublin Core specification [http://dublincore.org/]. Unlike Dublin Core, the description of rights can be expressed in a structured way as in IEEE LOM.
- For metadata at the resource level, all features of IEEE LOM are allowed, except that for the *intendedEndUserRole* field only the values *Learner* and *Instructor* are allowed. Resources for which the value 'Instructor' has been set are to be presented to teachers only. Such resources may contain, for example, solutions of exercises or didactic hints.

4.2.5 Authorisation

A cartridge may contain either no authorisation requirements or it can specify a number of ways for authorisation. If authorisation is required there must be given at least a cartridge ID and optionally the end point of an authorisation web service. Moreover it needs to be specified which type of protection is required:

- Requiring authorisation on cartridge import
- Requiring authorisation on cartridge usage
- Requiring authorisation on usage of specific resources in the cartridge

It is important to note that CC does not specify any mechanism to enforce authorisation. It only specifies ways to describe which kind of authorisation is required and how authorisation can be obtained. CC conformant cartridge players are supposed to support at least a web service authorisation. For developers a test authorisation service is available through the Common Cartridge Alliance (http://www.imsglobal.org/cc/alliance.html). Cartridge players which are "CC conformant light" do not need to support authorisation. They are supposed to display only unprotected resources.
The authorisation specification is the only subspecification of CC which is not a profile of another pre-existing specification.

4.2.6 Question and Test Interoperability (QTI) V. 1.2 (httpp://www.imsglobal.org/question/index.html)

Common Cartridge v1.0 supports profiled instances of the following question types:

- Multiple Choice – single response
- Multiple Response – like multiple choice but with multiple correct answers
- True/False
- Simple Fill in the Blanks – provides single answer box with single correct answer
- Fill in the Blanks Pattern Match – provides single answer box but supports 'contains' and regular expressions
- Essay

Questions can only be included in a cartridge either as components of an assessment resource or a question bank resource.

In general, a question consists of the following elements:

- Question Label/Title
- Question Text (may include HTML, Intra-Packages References, URLs, formatting)
- Question Answer Choices (may include HTML, Intra-Packages References, URLs, formatting, images, video, audio)
- Question Answer Choice Points

- Feedback (may include HTML, Intra-Packages References, URLs, formatting, images, video, audio)
- Question Answer Presentation Settings
- Question Hints (may include HTML, Intra-Packages References, URLs, formatting, images, video, audio)
- Question Settings (e.g. time, etc.)
- Question Meta-data.

The profiles for each of these question types describe how they support:

- feedback
- hints
- sample solutions
- relative scoring

In addition, questions support a number of metadata attributes which describe:

- a suggested weighting for the question in the assessment
- a category for the question.

Instances of these questions may be included in an assessment or a question bank.
An assessment can contain for example number of attempts, time limit and whether late submission is allowed.
A CC Question Bank refers to a QTI Object Bank, constrained to hold just those question types supported in the CC profile. Question Banks are meant to represent unordered sets of questions with no associated information applying to the set as a whole (though metadata is permitted). Question banks should have no representation in the organisations section of the manifest and if used, only one question bank can be present in a cartridge. A question bank may contain additional questions to be used by the teacher which are not linked to any particular content. Assessments, on the other hand, can be referenced from end points of the organisation table of content. In this way chapters in a cartridge can be augmented with specific tests.
Assessments as well as question banks can contain plain lists of questions only, no further structuring into sections of tests is supported.
It is expected that future versions of CC will replace the profile of IMS QTI 1.2 by a corresponding profile of a more recent version of QTI (for example of QTI 2.1). In accordance with the CC design guideline to support current practice, this will only happen when sufficient experience has been gained with the new QTI version and if a critical mass of cartridges using the new QTI profile can be provided.

IMS Web Links V1.0 (http://www.imsglobal.org/cc/ccv1p0/imscc_profilev1p0.html#0_pgfId-1754101)
The IMS specification for web link descriptors allow to reference resources on the web, making – compared with a simple href attribute – further requests on the browser window that renders the link target. There are no modifications or restrictions of this specification made in CC.

IMS Discussion Topics V1.0
(http://www.imsglobal.org/cc/ccv1p0/imscc_profilev1p0.html#0_pgfId-1753664)

The IMS specification for discussion topic descriptors has not been modified or restricted. It allows to initiate a discussion forum by giving a name for the discussion topic, providing introductory statements and referencing other materials that can aid the discussion. An example for a discussion topic description is available at http://www.imsglobal.org/cc/ccv1p0/imscc_profilev1p0.html#0_pgfId-1754033.

4.2.7 Supporting Tools and Service

With the release of the specification, IMS has provided a Common Cartridge Test System. This can be downloaded for free after a registration at (http://www.imsglobal.org/cc/testdata.html). The Test System has been implemented with funding from the CC Alliance by the University Koblenz-Landau, being a member of the ASPECT consortium. The Test System aids developers in producing correct cartridges. Within an agreement with the ASPECT project IMS has agreed to provide ASPECT with specifically tailored test tools for application profiles of the CC specification that ASPECT may develop to suit European needs.
Icodeon, also a member of the ASPECT consortium, provides an open source converter from SCORM to CC and will be making available to consortium partners a Common Cartridge Player by the end of Q1 2009.
Due to the wide usage of SCORM and SCORM tools, this, as well as a similar converter under development by JISC/CETIS in the UK, will ease the production of Common Cartridges considerably. Of course these converters can only preserve the SCORM features which can be represented in CC, in particular the organisation and presentation of content.
A sizeable number of system vendors have publicly support for Common Cartridges in their systems. We mention only a few.

- Moodle – an Open Source LMS (http://www.imsglobal.org/pressreleases/IMSPR-CCsupport29October2008.pdf)
- ATutor - an Open Source LMS from the University of Toronto (http://www.atutor.ca/)
- Giunti Learn eXact LMS and HarvestRoad Hive repository (http://www.imsglobal.org/pressreleases/IMSPR-CCsupport29October2008.pdf)
- UCompass Common Cartridge Desktop – part of the Enrich content management system for integration into LMS (http://enrich.ucompass.com/)
- Pearson Learning Object Repository – a facility to export Common Cartridges from the Pearson publisher repository (http://pearsoned.com/)
- Icodeon Common Cartridge Player – Icodeon is a member of the ASPECT consortium (http://www.icodeon.com/)
- ANGEL Learning management Suit (http://www.angellearning.com/)

It is yet a problem for the take-up of the specification that at the time of this writing (January 2009) neither a native CC authoring tool nor a CC player are public available. However it can be expected that this will change soon. . By the end of March 2009, Icodeon will make a CC player available to the Aspect Consortium members. Funded by the CC Alliance, the University of Utah is currently working on an open source CC editor. A number of companies have already in 2007 demonstrated a CC player. Among those are players integrated into commercial LMS, standalone player and even a player working on an iPhone. From the ASPECT consortium, Icodeon is planning to release a CC player within the near future.

4.2.8 Existing Application Profiles

CC is itself a collection of Application Profiles. No further profiles of the CC profiles have been created so far.

4.2.9 Ongoing Maintenance and Perspective

Maintenance of the specification is led within IMS by the CC Application Profile Management Group (APMG). As stated above, it is expected that new releases of the specification will appear as the CC usage develops. Already one month after the release of the specification the APMG has started collecting requirements for the next version of CC. Ongoing work suggests two major lines of development.

- Adding to cartridges support for the description of curricula, in particular to aid teachers in schools. This is of special interest for the ASPECT project. Members of the project are actively supporting this development within the respective IMS work group
- Adding support for using cartridge content with external tools, interfacing with CC players according to the IMS Tools Interoperability Guidelines. This is part of the Digital Learning Connection Collaboration (see http://www.imsglobal.org/pressreleases/pr081030.html). Once this is supported a CC player or an LMS can reserve a screen area where external players (like a SCORM player or QTI renderer) can operate with content of the cartridge and can return results of user interaction to the host. In October 2008 the University of Michigan has demonstrated the feasibility of this approach.

The ASPECT project has concluded with IMS Global Learning Consortium an agreement that it will capture any modification it wishes to make to the CC specification in an application profile which will be examined by the IMS CC APMG. The results of this examination will feed directly into the further development of the specification. If confirmed, such European profiles will be disseminated through the official IMS web site.

4.3 Comparing ADL SCORM vs. IMS Common Cartridge

SCORM as well as Common Cartridge support the transfer of digital content from a content provider to a learning management system. Naturally, the question arises which of these specifications should be used for a particular purpose. In practice, this decision depends on the fitness of the specification for that purpose as well as from the technical ability of the audience addressed to make use of a specific format.
While the objectives of both specifications are overlapping, there is still also a considerable difference between both when it comes to packaging interactive content. While SCORM is targeting the single learner who is self-directed and self-paced, the main objective of Common Cartridge is to support blended and collaborative learning scenarios where a teacher/instructor integrates the content in a course. Consequently, both specifications support different features and none is a replacement for the other.
Both specifications support interactivity, but in different ways. While SCORM content usually implements interactivity on its own, passing back interaction results to the LMS through a JavaScript API, Common Cartridges leave it totally to the LMS how interactivity is implemented[1].

[1] It is likely that future versions of the Common Cartridge specification will support the IMS Tools Interoperability Guidelines. This will enable the hosting LMS to call a third party system to handle parts

SCORM is a very powerful and complex specification and experience shows that only a small fraction of its features are in broad use. In comparison, Common Cartridge is simpler but intends only to support the most commonly used features.
The following table from the IMS Global Learning Consortium compares features of the current, apparently final, version of SCORM 2004 with the envisaged features of Common Cartridge. In this table we have highlighted those features which are already available in the current version 1.0 of the Common Cartridge specification.

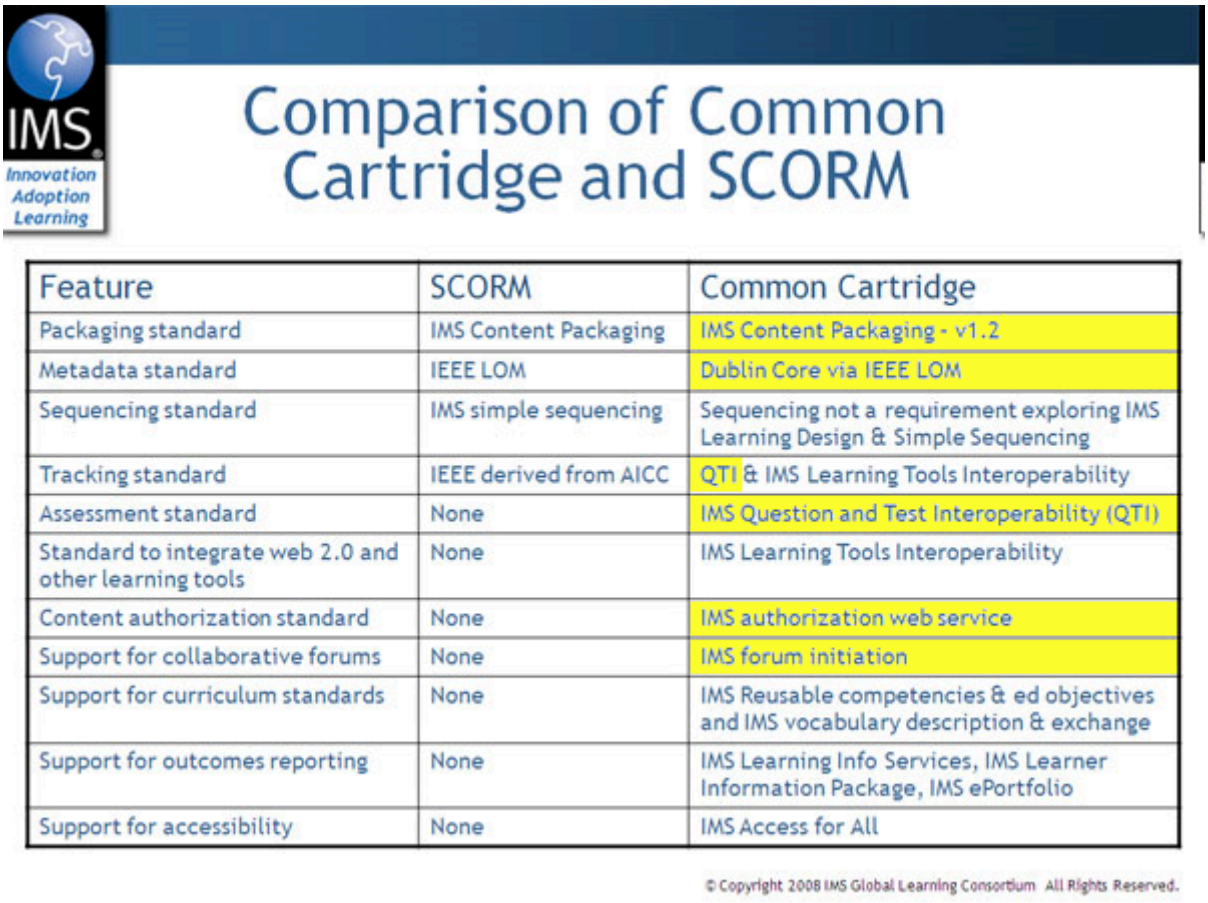

Figure 2: Common Cartridge and SCORM Comparison

IMS maintains a web site with frequently asked questions concerning the Common Cartridge specification. This includes several questions concerning the relation of Common Cartridge and SCORM (see http://www.imsglobal.org/cc/ccfaqs.html#14).
We expect that both, SCORM and Common Cartridge, are here to stay. In the last part of this document we shall describe ways for them to coexist in the ecosystem of digital educational content.

4.4 Question & Test Interoperability

4.4.1 Rationale and Domain

The IMS Question & Test Interoperability specification is a data model designed for representation of tests, questions and reporting their results. The data model is described abstractly with UML to support the exchange between many authoring tools.

of the cartridge content. However, unlike for SCORM content, the cartridge will not implement interactivity by itself.

QTI is applicable to all systems that access or supply digital test items or tests - such as learning platforms (LMS, CMS, VLE, IMS), digital content, content management/repository systems, test item banking systems, mobile technology, authoring tools, assessment systems and data analytics systems.
The main purpose of the QTI specification is to define an information model and associated binding that can be used to represent and exchange assessment items. For the purposes of QTI, an item is a set of interactions (possibly empty) collected together with any supporting material and an optional set of rules for converting the candidate's response(s) into assessment outcomes.

The most widely used version of QTI is version 1.2, which was finalized in 2002. This works well for exchanging simple question types, and is supported by many tools that allow the creation of questions. A number of issues had been raised by using and implementing QTI. Some are more fundamental issues that would require extensive clarification or significant extension of the specification to resolve.
QTI Version2.0 was released in 2005 with an addendum attached in 2008 to a draft v2.1.
It should be noted that this specification is focusing on the Item. It is not updating Section and Assessment from v1.x. The QTI V2.0 release of the specification concentrated only on the individual assessmentItem and did not update those parts of the specification that dealt with the aggregation of items into sections and test results. The QTI V2.1 release completes the update von 1.x to 2.x by replacing the remaining parts of the specification.

4.4.2 Definitions in QTI

Simple items and composite items
Simple items are items that contain just one point of interaction, for example a simple multi-choice or multi-response question.
Composite items are items that contain more than one point of interaction. Composite items may contain multiple instances of the same type of interaction or have a mixture of interaction types.

Response Processing and Feedback
For simple scenarios, use of the response processing templates is encourage as they improve interoperability between systems that *only* cater for a limited number of fixed scoring methods.
Feedback consists of material presented to the candidate conditionally based on the result of response Processing. In other words, feedback is controlled by the values of outcome variables. There are two types of feedback material, modal and integrated. Modal feedback is shown to the candidate after response processing has taken place and before any subsequent attempt or review of the item. Integrated feedback is embedded into the itemBody and is only shown during subsequent attempts or review.

Adaptive items
Adaptive items are a new feature of version 2 that allows an item to be scored adaptively over a sequence of attempts. This allows the candidate to alter their answer following feedback or to be posed additional questions based on their current answer. Response processing works differently for adaptive items. Normally (for non-adaptive items) each attempt is independent and the outcome variables are set to their default values each time responseProcessing is carried out. For adaptive items, the outcome variables retain their values across multiple attempts and are only updated by subsequent response processing. This difference is indicated by the value of the adaptive attribute of the assessmentItem. Adaptive items must of course provide feedback to the candidate in order to allow them to adjust their response(s).

Item template
Item templates are a new feature of version 2 that allows many similar items to be defined using the same assessmentItem.

Test assessment
A test assessment consist a set of items sharing a single fragment of leading material.

Item Bank
An item bank is a system for collecting and managing collections of assessment items. An itemBank-Manager with responsibility for managing a collection of assessment items will administrate it.

4.4.3 Description of structure of the specification (http://www.imsglobal.org/question/index.html)

The specification is spread over a number of documents as an introduction to use QTI:

- Implementation Guide: A document that takes you through the data models by example.
- Assessment Test, Section, and Item Information Model: The reference guide to the main data model for assessment tests and items. The document provides detailed information about the model and specifies the requirements of delivery engines and authoring systems.
- Meta-data and Usage Data: A document that describes a profile of the IEEE Standard for Learning Object Metadata [LOM] data model suitable for use with assessment tests and items and a separate data model for representing usage data (i.e., item statistics).
- Results Reporting: A reference guide to the data model for result reporting. The document provides detailed information about the model and specifies the associated requirements on delivery engines.
- Integration Guide: A document that describes the relationship between this specification and other related specifications such as IMS Content Packaging [IMS_CP], IMS Simple Sequencing [IMS_SS], and IMS Learning Design [IMS_LD].
- XML Binding: A document describing the way the data models have been bound to [XML].
- Conformance Guide: A document that describes conformance requirements and provides a data model for the construction of QTI profiles.
- Migration Guide: A document aimed at people familiar with version *1.x*. It takes you through the main changes that have been made to the data model and includes an alphabetical listing of version 1 elements providing detailed information about how the same information is represented in version 2.

4.4.4 Supporting tools and services

At http://wiki.cetis.ac.uk/Assessment_tools%2C_projects_and_resources are commercial and non commercial QTI products to find.

Commercial QTI products

- Central Question Cambridge-based company which offers assessment authoring tools, surveys and a QTI conversion service.

- Question Writer Assessment tool which can export items as QTI 1.2. The Personal Edition is free for personal use.
- Questionmark Perception One of the most popular commercial products available.
- Respondus Popular assessment authoring tool which allows the exchange of items and assessments in QTI, WebCT, BlackBoard and eCollege.
- RM Test Author QTI 2.1 compliant test authoring system.

Other QTI tools

- APIS: Assessment Provision through Interoperable Segments Open source QTI v2.0 assessment rendering toolkit. Funded by JISC as part of the eLearning Frameworks and Tools Programme from May - October 2004.
- AQuRateItem authoring tool. Part of a larger consortium with the ASDEL and Minibix projects. Funded by JISC as part of the eLearning Capital Programme from March 2007 - March 2008.
- ASAP: Automated System for the Assessment of Programming Code checking and code plagiarism detection tool. Funded by JISC as part of the Distributed eLearning programme from September 2004 - March 2005.
- ASDEL: Assessment Delivery Engine for QTIv2 Questions Assessment delivery, marking, feedback management and associated functions such as scheduling, user management and results retrieval. Part of a larger consortium with the AQuRate and Minibix projects. Funded by JISC as part of the eLearning Capital Programme from March 2007 - March 2008.
- ASSIS: Assessment and Simple Sequencing Integration Services Tool for integrating formative assessment within innovative learning activities and sequences of activities. Funded by JISC as part of the Distributed eLearning programme from September 2004 - March 2005.
- Minibix Item banking system for both high- and low-stakes content. Part of a larger consortium with the AQuRate and ASDEL projects. Funded by JISC as part of the eLearning Capital Programme from March 2007 - March 2008.
- MQAT: MathQTI And That A free, open source collection of resources for manipulating MathQTI documents, including an authoring tool, QTI DOM and MathQTI DOM interfaces and implementations, a MathML/OpenMath engine and a MathQTI rendering and processing engine.
- Onyx Open source QTI 2.1 implementation for web-based testing and evaluation.
- PyAssess Toolkit which uses web services to link an assessment delivery system with a remote response processing engine. Funded by JISC as part of the eLearning Frameworks and Tools Programme from April - October 2005.
- QTI migration tool - Python release Invaluable tool for converting items from IMS QTI v1.2 to 2.0.
- R2Q2: Rendering and Response processing services for QTIv2 questions A web services based engine for QTI v2 rendering and response processing. Funded by JISC as part of the eLearning Frameworks and Tools Programme from March - August 2006.
- Samigo IMS QTI-based testing tool available as part of the Sakai 1.5.1 release.
- Serving Maths Addressing issues around the use of mathematical expressions in assessment. Funded by JISC under the Distributed eLearning programme from September 2004 - March 2005.
- SPAID: Storage and Packaging of Assessment Item Data A range of web services to enable the development, population and operation of assessment item banks. Funded

by JISC under the eLearning Frameworks and Tools Programme from April - October 2005.

- TOIA: Technologies for Online Interoperable Assessment Homepage for the TOIA project, a JISC X4L Strand B project which produced an online assessment management system for distribution throughout the UK Further and Higher Education communities.

4.4.5 Ongoing maintenance and perspective

The v2.1 Public Draft Version 2 specification is a draft and liable to change before the completion of the final specification. This draft addresses many of the issues raised with the v2.0 specification, resolution of other remaining issues will be included in the Final release. Some LMS are using SCORM including features from QTI, but the used versions and features are very different in the use.

The last changes, revisions and additions have been documented by the IMS Question and Test Interoperability Addendum of version v2.1 (Public Draft v.2.0 update) in March, 2008. Because of the reorganisation of the direction there are no new activities started or trends to find.

4.5 Digital Rights Management

4.5.1 Introduction

The Learning Resource Exchange (LRE) is a pan-European infrastructure for exchanging educational content. It federates learning resource repositories and provides a seamless access to their collections to educational applications (e.g., educational portals, learning content management systems). When the LRE was officially launched in December 2008, it counted 21 participating repositories and already offered more than 145,000 educational resources covering virtually all curriculum subjects. These resources were all "open", meaning that they can be freely used by anyone, and in some cases they can also be adapted and redistributed.

As new content providers, including commercial content providers, want to use the LRE to distribute their content, it becomes necessary to allow them to protect their learning resources. A content provider may want to request payment prior to any use of a learning resource, or make sure that it will only be used in a non-commercial context, or limit the type of use that is allowed. Even for open educational content and freely accessible content, some usage restrictions may be applied (some rights reserved).

The existing LRE Digital Rights Management (DRM) was developed to mainly support two distribution models: Open educational content (freely accessible content) [Col.Mass.]] and institutional license (in which the provider grants access rights to a collection of objects for a group of users) [Sim.Col]. As commercial content developers and leading technology providers are joining the LRE, a key challenge the LRE has to face consists of specifying a common service for content protection that bridges different distribution models and technical implementations.

The proposed LRE DRM mechanisms aim at controlling access to the learning content offered by LRE members regardless of the variety of distribution models and technologies. This LRE DRM service will allow requestors and providers a unified view of access authorisation. The distributions models include, but not limited to, open educational content, license-based access, and credit-based access. From a technical standpoint, resource

requestors and providers will communicate under the supervision of the DRM service that acts as a trusted third party. A trusted component among the different members of the LRE allows the LRE DRM service to get the providers' information, to audit access to learning content, to record transactions among members...

The rest of this document is structured as follows: Section 2 provides an overview of the LRE. Section 3 introduces three possible models for distributing content through federations such as the LRE. Section 4 proposes a digital rights management solution that supports these models. Section 5, look at how, in practice, this solution can be applied to the distribution of IMS Common Cartridges. Finally, Section 6 discusses the pros and cons of the proposed solution and how it compares to previous DRM approaches.

4.5.2 Learning Resource Exchange (LRE) overview

The Learning Resource Exchange (LRE) is a service designed to unlock the educational content hidden in digital repositories across Europe and share it among all partners of the LRE and their users. The service is offered to actors providing digital content: Ministries of Education, regional educational authorities, commercial publishers, broadcasters, cultural institutions and other non-profit organisations who are offering extensive but heterogeneous catalogues and repositories of online content to schools [D.Mass.].

From a technical standpoint, the LRE consists of an infrastructure that:

- Federates applications that provide learning resources (e.g., learning resource repositories, authoring tools) and
- Offers a seamless access to these resources to educational applications that consume them (e.g., educational portals, VLEs).

As depicted in figure 3, the LRE supports multiple ways of collecting and exposing metadata.

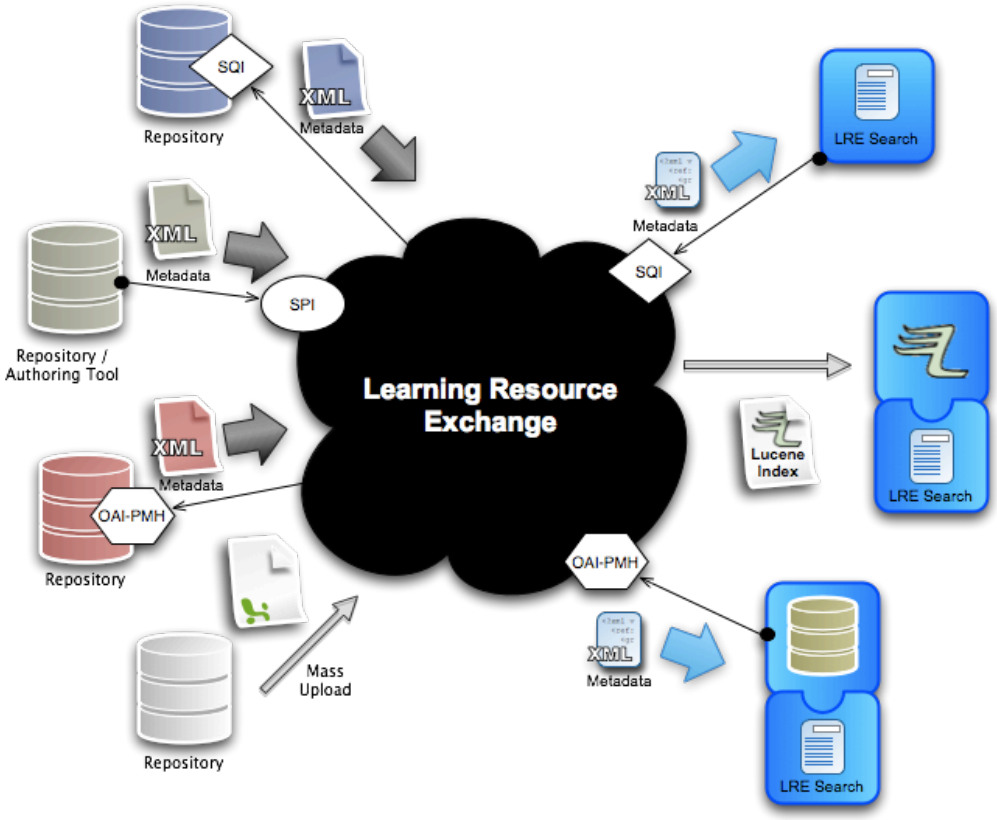

Figure 3: Learning Resource Exchange

4.5.3 LRE Distribution Models

In a federation, it is up to the members to decide which distribution models they support. However, it is possible to divide these models into three main categories: open educational content, license-based access, and credit-based access. In this document, a provider is a LRE member who provides learning objects. A requestor is a LRE member who wants to access learning objects. Rights apply to digital objects, and can be seen as the result of a transaction between a requestor and a provider. 'Access' could mean play, print, transfer, or any action that applies to a learning object.

4.5.3.1 Open educational content

Open educational content is defined as learning content that resides in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others. Open educational content can be freely accessible thought a federation. However, some usage restrictions may be applied. Open educational content is identified by its use of open licence type's especially Creative Commons license types. The distribution of open content may thus require first the acknowledgment of applicable license prior to actual resource access.

Creative Commons License
In Europe, many Ministries of Education maintain collections of national web-based learning materials for schools. Copyright law prohibits the use, exchange, and modification of any learning resource without the explicit consent of its copyright owner. Therefore, to authorize

the usage of their resources in the federation, participant Ministries of Education agree to release them under Creative Commons licenses. These contributions of free resources make it possible to reach the critical mass of quality content necessary to attract users.

4.5.3.2 Licence-based access

The second popular distribution model is the License-based access. In this model, buying learning content is similar as buying software. An individual user or a group of users or all end users of a LRE member can access a learning object or a group of learning object when the license is granted. A license agreement between the requestor and the provider must be obtained before the requestor sends an access request.

In the LRE, it is desirable to create an institutional license, because it matches the distribution model in place at various content providers. Based on the agreement between the requestor and the provider, the end user's affiliation and the object characteristics, the provider will grant the access or not.

4.5.3.3 Credit-based access

In this model end-users ´purchase' access to digital resources by spending LRE credits. Basically, users have a certain amount f LRE credits that they may choose to spend to gain access or usage of LRE content. This station is similar to that where an end-user would go to a shop buying some good with real money. The requestor presents his money to the provider that checks that the amount is correct and provides the good in return.

Applying the idea of 'currency' in the real world, this model allows the use of different credits. From a technical standpoint, this model will apply a LRE-EURO-based payment system. I.e. a user could acquire and pay with a common currency 'LRE-EURO' but he or she could also pay with another credit.

4.5.4 LRE DRM Model

We propose a DRM solution that provides a unified way to grant the access for all distribution models. As soon as the provider joins the LRE, it registers its provided models to the LRE via the LRE Registry service (see Workpackage 2 Deliverable D2.2). Thanks to the ASPECT Registry service, the LRE DRM can query the provider's information. Although, it is not necessary for a provider to support all distribution models but as a content provider, it is required to implement at least one distribution model.

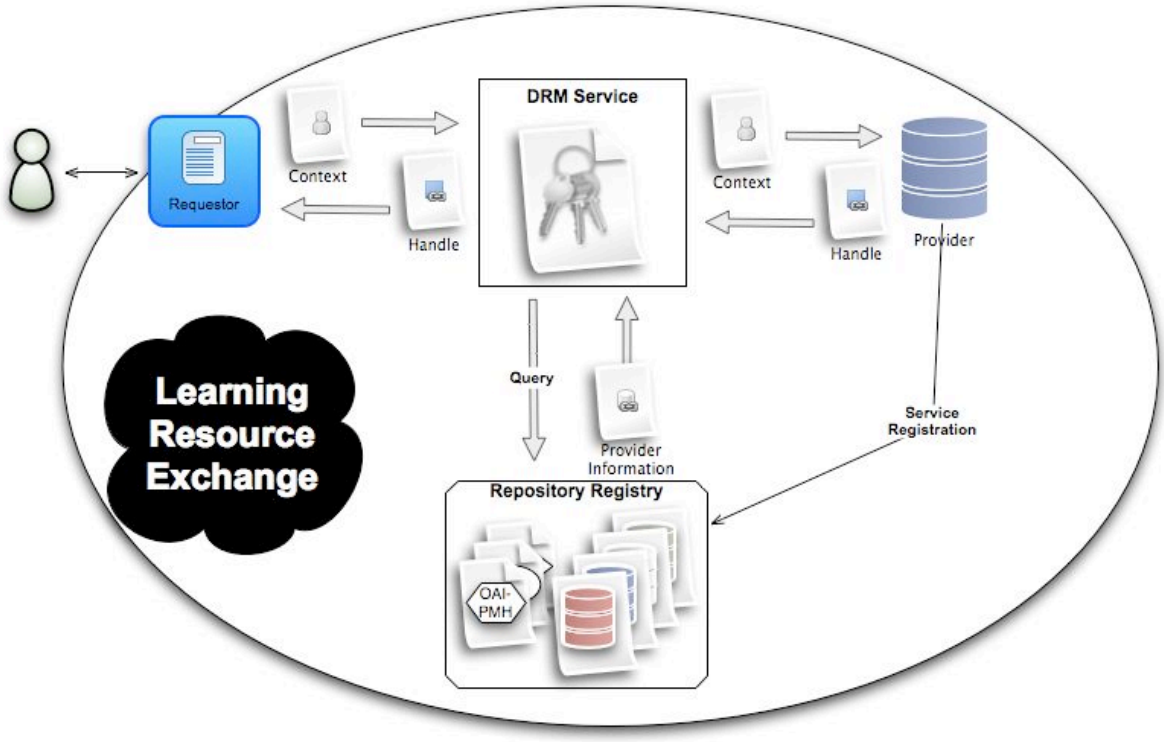

Figure 4: The Digital Rights Management Protocol

Every transaction in the LRE will be started by a requestor thought the LRE DRM protocol, which is shown in the Figure 2. First, the requestor requests access to a resource from a provider by sending a request to the DRM service, specifying the resource identifier, the provider identifier as well as a DRM context, that contains all necessary information that the provider will need to make an authorisation decision. Then, the LRE DRM service checks the request validity, queries a LRE Registry service to retrieve the endpoint corresponding to the (provider, distribution model) pair, and forwards the request to that endpoint. Finally, the LRE DRM service receives the result, in the form of a DRM handle that is then returned to the requestor. The DRM handle contains all necessary information for the requestor to access the resource or to figure out if access to the resource is granted or not.

The DRM context will be different in each distribution model. It can be an empty context in the open educational content simply because the resource is freely accessible. In case of the license-base access, the DRM context might be a pair which contains the user or the requestor identifier and the access code. It is also possible for the LRE DRM protocol to process a very complex context to grant the access to a requestor based on the license agreement. Of course, the DRM context can be the user identifier and the available amount of credits when the requestor want to access to the learning content via the credit-base access distribution model.

Similar to the DRM context, the DRM handle maybe a very simple handle, holding the learning content URI or maybe a very complex handle. For instance, the handle could point to the encrypted content and include a cryptographic key what allows the content to be read. In this LRE DRM model, an optional expiration date provided by the authorisation service is included in the DRM handle. It is possible to keep (cache) the DRM handle for a later access to avoid going to the provider for any single access request.

4.5.5 Discussion

The proposed DRM model is a new extension of existing DRM models presented in [3] and [4], which were only able to support the open educational content and institutional license (a special case of license-base access). What we want is to bridge different DRM systems and to provide a unified view of DRM model.

This new DRM model is developed to meet different requirements of current content providers who participated in the first workshop held in Leuven, Belgium in December 2008. The DRM implementation is supposed to be an independent service in the LRE. At the first step, strong DRM techniques (like encryption) are not applied because there is no real business requirement for those, and economic advantage of such solution could not be established.

This DRM model can be validated by ensuring that all available distribution models are supported. Note that, the CC DRM protocol can be considered as an illustration of this DRM protocol. I.e., the cartridge provider and cartridge requestor must be able to join the LRE without any difficulty. This proposed DRM model will be only useful if it encourages end-users of the LRE members to access learning content offered by the whole federation.

This model requires some prior works before a LRE member can join the LRE: First, the provider must register itself to the LRE Registry Service. Second, between a requestor and a content provider (who supports license-based access) must have an agreement. Third, the credit-based access content provider must define a credit-exchange rate and the requestor must know how to issue credit for its users... However, these problems exist for any DRM service.

One of the main innovative aspects of the proposed solution is that it builds a bridge between different heterogeneous DRM or content protection systems.

4.5.6 Conclusion

In this document, we have presented a DRM model to meet the need of the current LRE. These DRM mechanisms are supposed to protect learning resources offered by content providers, especially commercial content providers. These DRM mechanisms allow requestors a unified way to access to learning content though the LRE. It is up to the providers to select which distribution models they implement.

This LRE DRM model is designed to support three main distribution models: Open educational model, license-based access, and credit-base access. These distribution models cover all models in places supported by current LRE members. The license-based access is dynamic enough to apply for any authorisation service which based on license agreements such as CC DRM model. The credit-base access is also flexible to allow new commercial content providers to join the LRE.

An open issue is how to reduce external efforts prior to actual access in this LRE DRM model. For instance, how we can define and adjust the credit-exchange rate among the LRE members. Future works also include a ‘single sign on’ mechanism in the whole LRE. However, at the current stage, the proposed DRM model is supposed to solve all main protection problems raised by the current LRE members.

5 Use of Specifications

One of the results of the ASPECT project is to have a strategic impact on standardisation. Also supporting the content provider to use standards, help also European Schoolnet and partners to implement the development plan for the LRE and provide standards.
To do this, it's important to get known about problems and to have an overview about the current situation. Two content audit surveys had been started and helped to find answers.

5.1 First content audit survey

The first content audit survey presented questions about content characteristics, metadata, implemented standards, content packaging, quality management and underlying technology. For WP3 the area of content packaging is important.
16 content providers have participated in the first content audit survey. The most used standard for content packaging is SCORM (often CAM and RTE, only one consortium member used sequencing). The IMS content packaging format was used by four content providers. Only one user applied QTI. 75% of the questions used by this partner were multiple choice questions. He delivers both test items and complete tests. An application profile of the IEEE LOM specification was used by one content provider because of the need of a specific vocabulary.
The target systems were supposed to import or render the contents are mostly LMS like Moodle or Blackboard. Some answered the question for the most used browsers like IE, Firefox and MACOSX. To make sure that the target systems can use the content the providers implement the content inside the LMS, implement the standards and do manual tests.
Our content providers have no special or formal procedures to handle interoperability problems, most have a support team.
Role-based content access is not often used. Most content providers do deliver complete content packages to their users as well as individual resources. The download of content is web-based. Access control mechanisms are used by four providers, the others don't have an access control.
Over the next three years the content providers expect changes in content delivery, in particular more requests for platform-agnostic content, more flexible content formats and the possibility to recombine learning objects, also the delivery for mobile devices.
After these results, a second survey was launched to find out what the content provider's needs to use standards are and how they could be supported . The second survey was especially created for WP3.

5.2 Second content audit survey

This time 12 participants sent their answers and explanations. To get a structured view, the questions were divided into separate categories. The following sections summarize the feedback. The detailed report is attached to the deliverable.

5.2.1 Organisational considerations

The reasons for not following standards are different. The content providers are producing DVD's for DVD players, intend to implement standards like SCORM or use Adope Flash as a "standard".
Their systems weren't designed around existing standards and the design philosophy of the standards is perceived as different from the design philosophy of the systems in use. Some replied that there was no available standard fulfilling their requirements.

If there is a choice between standards of different complexity, they implemented the simpler standard that meets the requirements. They don't use standards when there is no request from customers to do this. There is missing knowledge which standards are useful for them and there is no common acceptance of the SCORM standard for example.

5.2.2 Tools and standards

Text based material is usually developed using a word processor and then converted to PDF format. Flash and HTML editors, format converters and image editors are also in use. Some partners use content management tools like Sulinet Digital Knowledge Base or the Learn eXact packager software. Some partners develop their content in XML based formats. To what extent standards, like Content Packaging, SCORM and QTI, are used depends also on the level of standard implementation by the tools in use. Some problems to create metadata were reported.

5.2.3 Technical issues

There are different 'interoperability-related' problems while importing or using content in particular problems with different implemented versions of standards and/or with not fully supported standards (e.g. SCORM in Moodle). Some participants have access to support from experts or administrators when there is trouble.

5.2.4 Use of content standards and specifications

Reasons for not using SCORM, Common Cartridge and QTI are different. Some content providers create content only for making it accessible on a web site. In these cases there is a lack of need to use the specifications and a lack of experience. Some content providers are interested in distributing content through the LRE. IMS Common Cartridge is only used by The Open University because it's a new specification. Also for QTI, and there is little knowledge how to use IMS QTI. There is a little demand for SCORM and Common cartridge from the customers.

But some content providers are just about to start producing mostly online content. It is assumed that increased support would help to start using these standards. There is a need to create the relevant import/export configurations and service interfaces for the tools in use. The core of the systems doesn't need to change to support these standards. It would help to provide and discuss information about standards, to choose adapted tools and to train staff. In particular advice is required how to connect metadata with content.

Technical help how to use standards in an efficient way would be needed: detailed documentation, samples, validation tools, and - most important - test environments. On a higher level: use cases, scenarios and best practices, test platforms, good integration of players into our portals of content providers would be helpful. Sufficient information on standards and software to package content would help to use standards.

Easy descriptions about standards for non-specialists are needed. Technical support to assist implementation would be helpful, specifically where the standard is open to interpretation. Technical information about content players and a special training how to package content (incl. questions and tests) and how to use them is needed too.

Some participants would prefer a helpful training and a helpdesk on standard would be convenient for some subjects.

Exchange of experiences would be helpful in implementing a strategy for converting "classical" audiovisual content to valuable and reusable online content or helping schools to use structured online content. There is a need for more information on the practical use of these standards, mainly best practices. Shared information about all the aspects related to standard content, from authoring tools to content rendering would be useful.

5.2.5 Testing of standards compliance

Most of the participants have no tools or services to test their packages being compliant to standards and would like to have their packages be examined by using self-testing, automated web service, tools or external organisations.
While training and support for the use of standards is free of charge within the project, related costs for consultancy and for the development of supportive tools need to be covered for a sustainable support after the lifetime of the project.
Free support for members of a community or a payment by support case might be feasible to rise the required funding.

5.2.6 Certification of standards compliance

The value of a conformance certificate was rated differently. Seven participants acquired for a product a certificate for compliance with a specification or planned to acquire such a certificate.
There is no general need to certify products for standard compliance for some content provider pedagogical accreditation of the content is of higher priority at the moment. There are no ideas how the use of compliance certificates could be supported.

5.2.7 Business models and rights

There a no business models to distribute open or non-open content through a federation such as the LRE. One content provider needs to reimburse the costs of productions by selling them to individual persons, local authorities of German states. Other content providers are in the process of planning and discussions. MELT and ASPECT are the only projects at this time where this issue is relevant for the consortium members. OpenLearn content from The Open University is, except for third party materials and unless otherwise stated, made available under a Creative Commons Attribution.
License models in use are LRE and Creative Commons. OpenLearn does not use DRM. The creative commons license travels with the content packages.

5.3 SCORM

5.3.1 Take-up of the specification

General

Since its initial release, anecdotal evidence (there are no broad authoritative surveys of use and uptake) indicates that SCORM has been widely adopted worldwide, is used in all sectors, is supported by numerous vendors (including most major LMS vendors) within their product offerings and is supported by a robust user community. Estimates are that there are several hundred SCORM products and several million content objects that support some version of SCORM. SCORM appears to be the most widely adopted general learning technology specification, in part due to the lack of any significant competition and in part from the general benefit of components and content adhering or conforming to a recognised standard. Having a recognised standard provides both a marketing differentiator for vendors and selection criteria for consumers.
Since SCORM 2004 was initially released in 2004, its uptake rate appears to have been slower than for the previous editions, but SCORM 2004 uptake is still increasing. Based on the current ADL LMS certifications, approximately 55% of the certified products support SCORM 1.2, 28% support SCORM 2004 2nd Edition and 17% support SCORM 2004 3rd Edition. As each product version must be independently certified against each version of SCORM, and since certification is optional, the data is not conclusive. But this data appears to confirm the broader anecdotal evidence: SCORM 1.2 had been more widely supported in

products than SCORM 2004, but SCORM 2004 adoption is continuing to increase with newer products and versions adopting the latest version of SCORM.

In the Consortium

The initial survey of Consortium partners indicated that most (9 of 14) have content packages that use some version of SCORM. These 7000 content packages account for slightly more than 50% of the available content.
Details of which versions of SCORM are used are more difficult to assess. Only 3 of the vendors indicated that some, but not all, of their content uses SCORM 2004. The other responses did not provide sufficient detail, but it appears that most of the consortium partners are only using SCORM 1.2 (half were explicit in declaring that they used SCORM 1.2 and use of SCORM 1.2 can be deduced from the other responses). Thus, less than 20% of the SCORM content (1200 packages) is available as SCORM 2004 packages, and most is SCORM 1.2. Within the SCORM 2004 content, all appears to use all of the SCORM 2004 features: the SCORM Run-Time Environment along with Sequencing and Navigation in addition to content packaging. By conclusion, content developers adopt SCORM 2004 over SCORM 1.2 only when its additional features are used. Thus the trends among the consortium partners appear to parallel those of the broader community.
The follow-on survey also indicated that certification and compliance testing currently are not of particular value to the consortium content provider partners.

5.3.2 Common Problems

Beyond the technical problems that are inherent in interpreting and using standards (and which are addressed through the normal SCORM maintenance process), and those that result from underlying implementations (e.g., differences in ECMAScript implementations in different web browsers), there are a collection of more general problems, either real or perceived. For presentation these are grouped into major categories. Again, these problems are based on anecdotal evidence, not formal studies or surveys.

5.3.3 Functional Capabilities

By design, SCORM provides only a limited, fixed set of capabilities. It does not incorporate many widely-used learning technology standards and specifications or other potentially desirable capabilities, including:

- Formal assessment model or use of assessment specifications.
- Linking of content to competencies.
- Management of learner profiles.
- Multi-learner instruction.
- Inclusion of gaming and simulation technologies.
- Transfer of data to back office systems, e.g., registration, course catalogs.
- Digital rights management of content.

These and others (see *Technical Evolution of SCORM* for more examples) are errors of omission; SCORM does not include these features (by intent), but does not preclude that it could be extended to include them. As noted, many demonstration projects have shown how to include such features, but the features have not moved from demonstrations to accepted practice and wide community support, let alone to formal inclusion in SCORM.
SCORM's sequencing and navigation capabilities are also controversial:

- They are complex to implement (both in tools and in content) and to fully comprehend.

- Supporting tools for content authoring are still lacking; tools do not hide the complexity and focus on needs of content developers.
- Sequencing is more complex than is needed for many common instructional approaches.
- Sequencing is too simple for many complex instructional approaches.
- Models of navigation between content and the run-time environment have been developed ad hoc.

5.3.4 Meeting Goals

SCORM appears to be meeting its key goals of interoperability (conforming content can generally run on any conforming system; any conforming system can run most conforming content), durability (changes in web platforms or vendor tools do not impact content), affordability (introducing SCORM as a content exchange and deployment mechanism is known to be more cost effective than not using an interoperability solution; large in-house SCORM deployments have been a cost effective means of delivering training), and accessibility (content is uncoupled from delivery). It has been less effective in meeting the goals of content adaptability and reuse.
Minimal content reuse is not a technical problem per se, because content can be reused, but it is not. Likely problems impeding reuse are:

- No simple discovery mechanism to find SCORM content for reuse.
- Inadequate metadata tagging to describe content. With SCORM 2004, metadata is no longer required and there are many divergent metadata guidelines yielding no consistent descriptions of content.
- Commercial and business issues restrict content availability for reuse.
- No simple tools and techniques to repurpose and reuse content.
- Specialised content with little reuse value.
- A lack of a culture of content reuse instead of new development, coupled with a lack of a community of content developers.

5.3.5 Use and Application

SCORM is not approachable to most. It is a complex technical document, targeted at component developers, e.g., LMS vendors. It was developed primarily by component developers with little input from content developers and end users (learners, authors, managers). Thus:

- There are limited resources targeted at content designers, authors, developers.
- Content development tools are aligned with technology and do not meet the needs of content developers. Tools are often highly technical and reflect or expose the structure of the underlying standards and are thus not aligned with the procedures, techniques and terminology of the users.
- The user community and support environment is primarily focused on component developers, not the end users.
- Entry costs are high.

5.3.6 Legacy Approach

From a purely technical approach, SCORM is “old technology.” Parts of SCORM are rooted in, and follow from, old specifications, e.g., the *AICC CMI Guidelines*. Some of the core

technological approaches predate the web (based on non-networked, pre-Windows PCs). Thus SCORM does not readily fit into:

- Semantic web technologies.
- Web 2.0 technologies.
- Service-oriented architectures.

5.3.7 Available Content

As noted above, anecdotal evidence indicates that there is a significant quantity of SCORM content available; tens of thousands of courses or content packages and millions of content objects (SCO). But as noted, precise data is not available and available data is self reported and thus subject to interpretation. Not withstanding, the results of the Consortium Partners survey confirm the availability of a significant quantity of content.
There is no single repository of content or a known list of all repositories, although several repositories claim to hold, or provide access to, hundreds of thousands of content objects. There is no mechanism to easily discover SCORM content; it is most often stored in private repositories that are not exposed to the public and there is no way to search for it on the public Internet it as SCORM content just appears as files that would require deep inspection to analyse. It is also difficult to assess claims of SCORM content; self-reported data often does not indicate which version of SCORM is used, or if the content conforms to SCORM.
The anecdotal data does align with the general trend for components: there is more SCORM 1.2 content than SCORM 2004 content. Depending on requirements, content may be developed that only requires a SCORM 1.2 system or a SCORM 2004 system, again with newer content adopting the latest version of SCORM 2004, and with little reworking of existing SCORM 1.2 content to use the features in SCORM 2004.
The results of the Consortium Partners survey confirm the general trends; significant SCORM content is available, most uses only SCORM 1.2. SCORM 2004 content uses all the features of SCORM.

5.4 Common Cartridge

5.4.1 Take-up in General and in the ASPECT Consortium

The specification has been public available since the summer of 2008 and it has been released only by December 19th, 2008. Therefore Take-up of CC is still in its early phase. Participation in IMS events and webinars shows a strong and wide-spread interest (see also http://www.imsglobal.org/pressreleases/pr081029.html for commitments from eLearning vendors). The ASPECT project has negotiated with IMS Global Learning Consortium a 50% discount for its members joining the Common Cartridge Alliance.
IMS has recently launched the Digital Learning Connection (http://www.imsglobal.org/dlc.html) as a special action to support take-up of the CC specification with content providers. The ASPECT dissemination activities, within the limits of the available resources, suit a similar purpose for European content providers.
Lacking particular tools for the creation of Common Cartridges (see below), content providers usually produce cartridges by implementing cartridge generation tools and integrating them into their production chain. Usually, professional content providers maintain their content in proprietary XML based formats. The cartridge generation tools convert content from these proprietary formats into the CC format. Thus, after an initial implementation effort, providers can start mass production of Common Cartridges. Within the ASPECT consortium, The Open University UK has been successfully following this approach. The OU will share its

experience in this field in the dissemination activities of the project with other content providers.
It can be expected that the take-up of CC will increase as more tools for creating and using cartridges become available (see below).

5.4.2 Common Problems

The main problem is a lack of information on the character of CC. The ASPECT project will strive to improve this in Europe by spreading the information through its dissemination activities. Beyond this, the web pages of the CC Alliance, in particular the comprehensive FAQ list on this site, provide useful information for anyone interested.
On the technical side, the most common problems in using CC are

- Incomplete or incorrect references. References can be incorrect for example by using lower case letters in file names where upper case is expected or by using incorrect encodings of special characters.
- Metadata or QTI files copied from existing material which does not obey the restrictions imposed by CC.
- Missing namespace declarations in XML files

5.4.3 Available Content

Though the specification was released only by the end of 2008, the IMS conformant product directory already lists more than 500 Common Cartridges. Those are mostly from The Open University UK, as an ASPECT member, and from Elsevier as a major commercial scientific publisher.

5.5 QTI

5.5.1 Take-up in General and in the ASPECT Consortium

The v2.1 Public Draft Version 2 specification with its addendum is a draft and liable to change before the completion of the Final specification. A result of the content audit surveys was that only one of the content providers who answered the survey was using QTI. Tests made in Koblenz with the LMS Blackboard, Moodle, Sakai and ILIAS showed that the exchange of materials between these platforms using QTI is not feasible.
Bildungsportal Sachsen, who is developing a database of assessments, reported that for their work the generic data model of QTI 2.1 provides valuable guidance for the development process.

5.5.2 Common Problems

There are problems to use the QTI specification. Content providers don't have tools to develop the contents under the guideline of specifications. Some content providers create resources only to make it accessible on a web site or with other software to build quizzes. Mainly there is a lack of need to use the specifications, since assessments are currently not exchanged, and a lack of experience.

5.5.3 Available content

The following itembanks are available on
http://wiki.cetis.ac.uk/Assessment_tools%2C_projects_and_resources.

Mathematics Question Bank
The project will establish a national repository for mathematics e-assessment questions for

UK higher education institutions drawing on the experience of different groups and systems currently employed within the UK HE community. Funded by JISC under the Repositories and Preservation Programme from January - December 2008.

Mathletics
Here are a number of downloadable mathematics assessments from GCSE to second year university level, written in Question Mark Perception 3.4, using MathML and SVG. Created by Martin Greenhow at Brunel, these are free for personal study and educational use.

Physical Sciences Question Bank
Free to use for UK FE and HE, this question bank provides a substantial number of physical sciences questions which can be exported for playing in Moodle, Questionmark Perception, WebCT, BlackBoard, SToMP or for printing.

PPlato
Downloadable paper-based mathematics for physics questions with worked solutions, from the PPlato project.

6 Summary and Recommendations

Open specifications aim to enable interoperability between systems of various origin. Of particular interest for the educational domain are specifications that enable to re-use content produced in one system in another system. This offers considerable benefits for a variety of stakeholders.

- Content providers, who want to serve a broad market with packaged content, save the effort of producing, testing and maintaining specific versions for each and every system on their target market. Compared with these savings, the additional marketing advantage from openly supporting standards is perceived as being of minor importance. If conformance of the product with the specification is thoroughly tested, this is a strong argument that in case of system incompatibilities the responsibility is not on the content provider‘s side.
- Tool vendors – vendors auf authoring tools as well as vendors of content renderers like learning management systems – provide their users (authors, teachers and learners) with access to a broader pool of readers and content by following open standards. They demonstrate that they give the user a technology choice. This increases the likelihood that the user will stay with the tool provider in case he changes other components of his suit of eLearning tools.
- Learning institutions have the highest interest to ensure the possibility of long-term re-use of their content. In many cases the value of the content in an institutional system considerably exceeds the value of the system itself. While it is relatively easy to replace a system the user is not satisfied with, re-producing the content in another proprietary format is usually impossible. Therefore learning institutions shoud prefer content in open standard formats in order to protect their investment.

It is worth noting, that these benefits are valid for commercial as well as for public and open source organisations. Introducing support for open standards requires certainly efforts and each stakeholder needs to determine whether his funding resources or the potential revenue from strategically envisaged markets permit this step.

Many content providers already have an XML based production workflow. When this is in place, producing content in a specific format is technically not a major issue. Nevertheless it requires technical expertise and some XML and software development competency, in particular when specific features are to be supported which are not foreseen in the current specifications.

A further investment to be considered is the support for authors in using the features provided by a new specification. Since authors cannot be expected to become specification experts, they need competent partners that help them to select and use the features which support their needs best. For example determining ways to calculate scores in QTI assessments or sequencing the content of a SCORM 2004 module is all but simple.

We don't support the claim that open standards aid in achieving a good learning experience. This experience is dependent from the pedagogic and scientific quality of the content and from the user friendliness of the respective sytem. However observing open standards can be crucial to even enable *any* learning experience at all with given content on a given system.

The public discussion on standards in the domain of learning reveals vague concerns that the use of standards limits the freedom of teaching. This point of view is not aware of the fact that technical standards confine only the format of the content, not the content itself. Hence they do not prescribe a "standard pedagogy".

Another form of the same concern is, that certain forms of content may be prevented when eLearning standards are observed. However most elearning specifications are nowadays extensible in order to allow for additional possibilities without breaking interoperability with existing systems (see Section 3 on Application Profiling). Being able to describe new types of content is just one part of a solution – in fact the part which is most easy to achieve. Such new forms of content become usable only if they are supported by new implementations of editors and content renderers.

In fact, the vast majority of content formats supported by current systems is also supported by current specifications and none of them, even of future formats, is excluded. An exception to this rule is the Common Cartridge specification which targets current practice and which is not extensible. This has for authors, teachers and learners the advantage that all features of a cartridge are probably supported by any cartridge player.

As current practice, the Common Cartridge specification is bound to evolve. The planned addition of support for the Tools Interoperability Specification in the forthcoming Version 1.1 will allow for inclusion of an unlimited variety of interactive content into cartridges. Without waiting, it is moreover possible to use the extension facility of the IMS Content Packaging specification to add new types of content to cartridges which are perhaps only supported by special systems. Then it is easy to maintain a CC V1.0 compatible version without these additional features for a broader audience aside of the fully featured special version.

Of the three specifications discussed in this paper so far only SCORM has found a significant take-up. It is well supported with editors and many Learning Management Systems have

SCORM support implemented. While the use of the current version SCORM 2004 is increasing, there is still a significant number of systems restricted to use only content conformant to the previous SCORM 2.1 specification. The take-up of SCORM has been considerably facilitated by the availability of a SCORM Conformance Test Suite and a Sample Runtime Environment. SCORM 2004 can be considered as stable; no changes are to be foreseen in the near future.

Though the IMS Question and Test Interoperability Specification (QTI) is available since 2000 it has not found significant take-up so far. Exchange of content following the QTI specification is all but seamless. Reasons for this situation can be the complexity of the specification, the restricted level of its implementation in LMS but in particular the low level of exchange of assessments and test items. The change from QTI 1 to the incompatible QTI 2 did not ease take-up either.

Nevertheless, QTI is unchallenged as the unique generally accepted format for the exchange of questions and tests. Therefore it remains the method of choice for this purpose. It can be observed that the actual use of online tests is remarkably increasing over the recent years. This is accelerated by the increased need for tests while introducing the Bachelor/Master in European HE. As a follow-up, this increased use of online tests raises the awareness of the value of well-designed assessments, which, in turn, can lead to an increased need for the exchange of such assessments. That might lead to an increased take-up of QTI as well. For the near future we do not expect major changes of the QTI specification.

In the paper-based world, tests are usually delivered bundled with the content in text books. The IMS Common Cartridge specification supports this. It has been available to the public only since a few months during which it found a remarkably vivid interest. A significant set of Common Cartridge content is available, though from very few content providers until now. Common Cartridge tools are announced for release in 2009. These tools can significantly influence whether the Common Cartridge specification is here to stay. As a specification tailored to support current practice, the CC specification can be expected to rapidly evolve, hopefully in a backward consistent way.

The survey we conducted revealed some critical success factors for the take-up of open specifications for content use.

- Following open specifications has the highest value for stakeholders with a broad customer base aiming to acquire new customers
- Augmenting existing LMS with facilities to use a specification is important to create a sufficient demand
- Content production tools used by authors need to provide the possibility to save content in the specified formats. Content authors should not need to know technical details of the specifications used
- Management of content providers and their personnel supporting authors need to be informed about the potential and limits of relevant specifications
- Technical staff of content providers must be enabled to integrate the production of content in the specified formats into the content production workflow

The further work of ASPECT WP3 will aim to strengthen these factors for European content providers. The central objective of this work is to enable content providers, including SMEs, to target a larger market with their products. For content users this should bring a broader choice of digital educational content.

In particular WP3 will provide information and training on the use of the open specifications discussed. Moreover it will test and recommend in Deliverable 3.3 and 3.6 tools for packaging content and for working with packaged content, including quizzes and assessments.

In general there is sufficient information on the use of standards available on the Internet. However this material is complex and addresses a wide variety of aspects, some educational and some technical. It is proposed to develop a set of recommended first readings for readers with particular interest. These can be explained and disseminated in ASPECT workshops.

While influencing LMS vendors, both commercial and open source, to support open content standards is important for the creation of a market, it goes beyond what the ASPECT consortium can achieve on its own. Other events - conferences, workshops, fairs – need to be used to contact LMS vendors. In support of this it would be helpful if the European Commission emphasizes the use of standards in eLearning projects, funded in particular within the IST program. ASPECT partners may support this at appropriate European events.

The next main objective of WP3 is to demonstrate the application of standards for content use through demonstrators that cover the complete content life cycle. It needs to be explored to what extent the various tools listed in this Deliverable are appropriate for this purpose. As a next step towards this objective, the project will create scenarios describing the content use cases to be supported.

In order to demonstrate how content production workflow can be organised to support open standard content production, solutions used by The Open University will be disseminated as current Best Practice. Since many content providers already have their content available in XML based formats, the guiding principles of those solutions should be widely applicable. However, since content providers frequently use proprietary XML formats, developing working solutions for individual vendors goes beyond the scope of the project. Nevertheless WP3 can offer consultancy support for such activities as a forum or help desk.

Ideally this work of WP3 will lead to a reference implementation for the concerted use of the available open specifications, where each of these specifications is used in an optimal way.

7 References

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IEEELOM2	IEEE Standard for Learning Object Metadata (IEEE Std 1484.12.1-2002), IEEE Computer Society (Learning Technology Standards Committee), 2002
IEEELTD	IEEE Standard for Learning Technology-Data Model for Content to Learning Management System Communication (IEEE Std 1484.11.1-2004), IEEE Computer Society (Learning Technology Standards Committee), 2004
IEEELTE	IEEE Standard for Learning Technology-ECMAScript Application Programming Interface for Content to Runtime Services Communication (IEEE Std 1484.11.2-2003), IEEE Computer Society (Learning Technology Standards Committee), 2003
IEEEXML	IEEE Standard for Learning Technology-Extensible Markup Language (XML) Schema Definition Language Binding for Learning Object Metadata (IEEE Std 1484.12.3-2005),
IEEECS	IEEE Computer Society (Learning Technology Standards Committee), 2005
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IMSSS	IMS Simple Sequencing Specification (IMS SS 1.0), IMS Global Learning Consortium, 2003
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SCORMCT	SCORM 2004, 3rd Edition, Conformance Test Suite: LMS Test Content Package, V1.0.2, US Advanced Distributed Learning Initiative, 2007
SCORMCTS	SCORM 2004, 3rd Edition, Conformance Test Suite: Self Test, V1.0.2, US Advanced Distributed Learning Initiative, 2007
SCORMCAM	SCORM 2004, 3rd Edition, Content Aggregation Model, V1.0, US Advanced Distributed Learning Initiative, 2006
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8 Appendix

8.1 Analysis of the first content audit survey with 16 participants

Which packaging format do you use?
IMS 4x Version 1, very rarely
SCORM 9x Version 2 1x; 1.2 2x
QTI 1x
Other 2x ; proprietary format; IMS Common Cartridge; Moodle; OU XML, HTML

In the case of SCORM do you use? - Content aggregation – Used
5x, no comments
In the case of SCORM do you use? - Runtime environment - Used
4x, no comments
In the case of SCORM do you use? - Navigation – Used
2x, no comments
In the case of SCORM do you use? - Sequencing – Used
1x, no comments
In the case of QTI: - Do you deliver test items or complete test or both?
both
In the case of QTI: - Please list the question types that are in use?
multiple choice, true/false, fill-in, short answer, essay, matching, other
In the case of QTI: - Indicate the percentage of questions of a specific type?
multiple choice 75%, true/false 5%, fill-in 5%, short answer 5%, essay 5%, matching 3%, other 2%
In the case of QTI: - Do you use proprietary question types? If yes, pleas describe them.
Yes, my own private questions, labeling - students label parts of an image.

If your use of specifications deviates from the specification documents, please describe the main differences:
No deviation; For IEEE-LOM we use the application profile from Pubelo Flanders, which has other vocabularies than the official IEEE-LOM standard, but mapping is possible

What are the target systems that are supposed to import or render your content?
Not understood,

Pearson Web Publishing System (WPS), Blackboard, WebCT, Angel, Desire2Learn, others.

ie6+, ff2+, safari 3+ (MacOSX)

In-house e-learning platform

learning environments for secondary schools and adult education

Up to now, FWU online content has usually been accessed via catalogs. So the structure of the content is either atomic or it can be navigated in a simple HTML environment.

Sulinet Digital Knowledge Base; SCORM compliant learning platforms¸ Moodle for SCORM packages.

There is no specific target system that is supposed to import/render the content. However, IMS Common Cartridges have been validated and the OU does "In house testing of Moodle"

How do you make sure that the target systems can use your content?
No understood; Test / feedback; manual tests; There is a tracking system, sometimes there is a tutor evaluation the learning.
by implementing standards, by providing a lot of formats (SCORM 2004, AWT Lectora, AICC, ...)
Content is developed directly in the target system;L Test the content pack in the main target VLEs (e.g. Moodle and Kaleidos). It is very difficult to adequately support multiple VLE through lack of common specifications.

What are your procedures to handle interoperability problems which your user/customer may encounter?
Support; Product Support; bug registration - > verification -> correction -> next dispatch; Ad-hoc methods. There are no formal procedures; We have no specific procedures;
We follow up any issues as and when they arrive

Do your packages provide role-based content access (for example teachers and learners can access different content)?
4x don't know
3x yes
8x no

Do you deliver only complete content packages to the user/customer?
2x don't know
4x yes
9x no

Is there content that the user dynamically fetches from your server at runtime?
6x don't know
4x yes
5x no

Which mechanisms do you provide for users to download content?
Web-based download;
links to various files on http:// or ftp:// servers;
Usually there is no download. If some study materials are downloadable, they are in pdf format;
Our content is being used by regional systems, so usually teachers/students do not download anything from the FWU site;
Proprietary mechanisms;
Each LO is packaged as an IMS Content Package which can be downloaded as a zip file with an inline player for the user to extract.;
Download from the Web page.

zip file, http request, can also export units to DVD for other organisations on request

Which access control mechanisms are in place?
None, Pearson's Subscription Management System (SMS) ; this is only a content without access control; Based on identification of users by fiscal ID number or by the school code. Our users have to register; Local individual Accounts; Pre-assigned username and password.; None, free to everybody.; no access control mechanism;

Which changes in content delivery do you foresee over the next three years?

Online access; More requests for platform-agnostic content; Integration of SCORM for some new contents; There could be delivery for mobility devices (i.e. mobile learning, IPod etc.) and for Interactive whiteboard use (not aggregated contents);
users will have the possibility to recombine learning objects and export as new package (scorm or others);
FWU expects content packages to be used within VLEs finally to become also important in Germany
No other plans (except for implementing Aspect standards).
We are currently looking to mainstream OpenLearn content production across the Open University.

8.2 Analysis of the second survey with 12 participants

Organisational considerations

Reasons for not following standards are:

-Producing DVD´s for DVD players; intends to implement standards like SCORM;
-Using flash as a standard;
-Specific users needs or easier content development;
-The system wasn't designed around existing standards;
-Design philosophy is different from traditional systems;

-There are several reasons to this:
- there is few information in French language,
- the information available is for technicians and experts,
- the authoring tools are very complex,
- the use of authoring tools by teachers is not developed,
- the use of content standards limits the pedagogical possibilities: the teacher has to adapt his practice to a tool.

-Lack of demand;
-Where there is a choice between standards (ie LOM/DC) we have implemented the simpler standard that meets our requirements;
-Prioritisation and resource;
-No available standard fulfilling our requirements;
-If the standard does not help and is in contrast with our educational vision, then we do not use it.

-Difficulties in knowing which standards are likely to be most widely useful to our customers - e.g. there is no common acceptance of the SCORM standard, and learning platforms all require bespoke packaging. This cannot be supported with limited budgets and timescales. Use of standards also depends on the original purpose of the content. The conventional way to publish content commercially has been to develop standalone applications for the customer to purchase. Over the past several years this has begun to change, resulting in a more future proof approach to product development.

Tools and standards

Which software do you use to build new content?

- Using different tools but don't not know that closely.
- Most of the additional material on DVDs has been processed by using a word processing programme
like MS Word, converting the files to PDF format at the end, often using a PDF shell for navigating
the structure.
- In this case, Flash, html editors, MS PowerPoint and various format converters, image editors ...
(depends on the specific project/content).
- Tools of the Sulinet Digital Knowledge Base.
- MS-Word HTML editors.
- Converting existing content from print to XML, using XML spy and XML copy editor.
- Learn eXact_Packager_3_1_38_1 software.

Does this software support specific standards - if yes, which?

-Flash "standards".
-Depends on the software, we use the software that suits our needs (if we need to support a specific
standard, we use a software that supports that standard)
-Limited QTI import;
-XML standards;
-IMP CP and SCORM packages

Do you have problems to prepare content with the software?

- sometimes - depends on the software package
-Yes; the issues are fundamentally of the same type and importance as with any other content creation software.
- LO and metadata creators had some problems while creating metadata for SCORM packages using this software
- There are professionals using them. The pedagogical architecture and the contents are prepared
or coordinated by us.

3x no

5 x didn’t answer

Technical issues

Do your users experience 'interoperability-related' problems when importing or using your content? If yes, please describe typical issues.

- No; No, as far as we know

- They probably do; typically problems with different versions of standards and/or not fully supported standards (e.g. SCORM in Moodle)

- For individual end users, there might be some interoperability issues, as we don't have user interfaces for our export/import functions that we created for larger content creation/exchange projects (like MELT). The system itself, including both basic data structures and processes, is based around large scale import/export transformation procedures.

- Not that we are aware of. We did have an issue with importing our IMS content packages into a Tutor due to alternative interpretations of standard but this has been resolved.

- We distribute mostly content that can be rendered in a browser. When a user finds a content package (e.g., a SCORM package, he/she might not necessary have an appropriate player. We have difficulties expressing the nature of the object (package versus web-compatible content) in LOM metadata.

- No scientific research or case studies on packages usage were held in Lithuania. Centre for IT in Education had started to prepare SCORM packages only in 2006, and there is no common practice in schools to widely use these packages. There is training course on Teachers Computer Literacy (educational part) where the chapter on SCORM packages usage in Moodle VLE exists.

5 x didn’t answer

Do your users have access to support from experts or administrators when there is trouble?

4 x Yes:
-some kind of hotline (pedagogical editors, technicians);
-There is extensive technical support during content creation projects, and a helpdesk for general
users is being set up;
-via website forums;
-Moderators, online platform responsible etc.

3 x No:
-not from us, but maybe from administrators of their servers;
-Not yet. But we plan to put this in place as we will launch a public version of the LRE
-At the moment we have no practice in the field

2 x didn’t answer

Use of content standards and specifications

What are your reasons for not using SCORM, Common Cartridge or QTI?

- The resources to be created will be made accessible on a web site.

- See first question; mainly the lack of need. We can support imports/exports to these formats as need arises; importing content from other sources is a more difficult task than exporting.

- Lack of experience. Lack of content providers interested in distributing this kind of content thru the LRE.

- At the moment we do not use IMS Common Cartridge because it is new specification, and we did not use IMS QTI. We have used only content SCORM 2004 packages without questions and tests which were directly included in Moodle courses.

- We support IMS Common cartridge. We do not support SCORM - we have had little demand for SCORM and prioritised Common cartridge. Do not use QTI, it is too to simplistic to support our quiz system

- As described, FWU is just about to start to produce specific online content.
- Vision of e-learning

5 x no answer

What changes are necessary for you to start using these standards?

- In the past, German schools and ministries/local authorities have not been content aware. There are some repositories existing (In Germany they are called "media distribution systems"), but based mainly on proprietary solutions. It seems that the school market for specific online content is growing, regarding the increasing use of VLEs (namely Moodle) and electronic whiteboards.

- We need to create the relevant import/export configurations and service interfaces (like when we implemented SQI/OAI support). The core of the system does not need to change to support these standards.

- To communicate about standards; to choose adapted tools.

- QTI - would need to be significantly extended SCORM - we would implement SCORM if there was demand

- A good way to reference this content in metadata.

- Staff training is needed.
- That's something that has nothing to do with what we do online with teachers.

4 x no answer

What would help you to use standards in an efficient way?

- On a technical level, we need detailed documentation, samples, validation tools, and most important test environments. On a higher level, we'd like to see use cases, scenarios and best practices.
- Test platforms
- Good integration of players in our portals
- Sufficient information on standards and software to package content would help us to use standards.

8 x no answer

Would you need more information? If yes, what sort of information?

- We will need information as described in the above question, but right now we're in the planning phase and don't know the exact questions.

- Pedagogical information, easy descriptions about standards for non-specialists.

- Yes, technical support to assist implementation would be helpful, specifically where the standard is open to interpretation

- Technical information about players

- Yes, we need special training how to package content (incl. questions and tests) and how to use them, which software is used etc.

-No, it is not related to information

6 x no answer

Would more training be helpful? If yes, in which areas and in what form would you prefer the training?

- Yes. We need practical training or forums or FAQs.

- Maybe training on the tools provided by the technical ASPECT partners might be useful - as we will have to decide which tools to use in future within our production processes.

- At this moment, we don't see an urgent need for training, but this might change later on.

- No, training would not help, but improved information and support would be useful

- No; not necessarily.

6 x didn’t answer

Would a helpdesk on standard usage be convenient? For which subjects?

- Yes, to support implementation and interpretation of standard specifications

- A web page listing available standards and technologies to support them both open source and commercial) would certainly be useful especially if completed by a helpdesk for resolving more specific questions not covered in the doc.

- Yes, we do need helpdesk on standards compliant content creation and usage.

- No.

7 x no answer

Would more exchange of experiences with other providers be helpful? If yes, which areas should be covered?

- It seems that other ASPECT partners are as well on the step to implement standards. So areas of exchange might be:
    -implementing a strategy for converting "classical" audiovisual content to valuable and reusable online content;
    -helping schools to use structured online content.

- Yes. Apart from the technical area, we'd need more information on the practical use of these standards, mainly best practices.

- Exchange on experience is useful, of course, but we use the method of cooperative learning and group learning. Informal learning is part of our paradigm. Thus, use of standards like SCORM is very difficult.

- Yes - to ensure consistent interpretation.

- Yes, I think sharing information about all the aspects related to standard content, from authoring tools to content rendering would be useful.

-Yes, the same areas.

6 x no answer

Testing of standards compliance

Do you have tools or services to test your packages being compliant to standards?

1x yes, only IMS common cartridge (provided by IMS)

6x no packaging at all up to now

3 x no answer

If your answer is no, would you like to let your packages be examined for standards compliance?

2 x by an external organisation

6 x by your own organisation using self-testing tools

5 x by an automated web service running on the server of an external organisation

While training and support for the use of standards is free of charge within the project, related costs for consultancy and for the development of supportive tools need to be covered for a sustainable support after the lifetime of the project.

What ways might be feasible to raise the required funding:

2 x - Payment by support case
6 x - Free support for members of a community
1 x - Others
1 x - no answer

Certification of standards compliance

How do you rate the value of a conformance certificate?

4 x No value (my organisation would not be willing to pay for a certificate)
3 x Some value (my organisation would use it but would pay only a modest amount to enable it)
0 x High value (my organisation is likely to use it and to support it by payment or by the provision of supportive resources)
1 x no answer

A conformance certificate is issued by an authorized organisation following an inspection of the product to be certified for compliance with the standard. It can be used in marketing a product. Unlike self-declaration or self-testing of conformance, a conformance certificate is legally binding. See http://en.wikipedia.org/wiki/Certification_mark for further information on the meaning and value of conformance certificates.

Have you acquired for a product a certificate for compliance with a specification or do you plan to acquire such a certificate?

0 x - Yes – Certification
7 x - No – Certification
3 x - no answer

If not, what are your reasons for not aiming to certify your products for standard compliance?

- We have no need to do it

- For us the pedagogical accreditation of the content is of higher priority at the moment.

- Our users and partners have not demanded certification. As long as our downloads are usable certification has not been a priority. We support download - not upload - if hosting may be more important

- No needs at the moment

- No practice and insufficient information on the topic

How could the use of compliance certificates be supported?

No ideas

Business models and rights

What would be your business models to distribute open or non-open content through a federation such as the LRE?

- Like in our current business model, FWU needs to reimburse the costs of productions by selling them to individual persons, local authorities of German states.

- At present, we have no general model for distribution; we're still in the process of planning and discussions. MELT and ASPECT are the only projects at this time where this issue is relevant.

- OpenLearn content is, except for third party materials and unless otherwise stated, made available under a Creative Commons Attribution-NonCommercial-ShareAlike 2.0 Licence

- Actually we run the LRE :-)

- No business model at the moment

What are your requirements in terms of digital rights management to support these business models?

- LRE might become part of that model, at least managing the licenses that FWU gives to individual users or groups.
- Creative Commons
- We offer our content under CC license (BY-SA-NC)
- OpenLearn does not use DRM The creative commons licence travels with the content packages
- Our content is mostly open and free of charge at the moment.