Using the Common Cartridge Profile to Enhance Learning Content Interoperability

Ricardo Queirós & José Paulo Leal
CRACS & INESC-Porto LA, Faculty of Sciences
University of Porto, Portugal
Outline

1. Context & Motivation
2. Research work
3. Common Cartridge specification
4. Case Study – evaluation of programming exercises
5. Conclusion
1. Context & Motivation

- **eLearning systems are evolving**

**1st Generation**
- Monolithic
- Single Domain
- No interoperability
- No Standards

**2nd Generation**
- Component Based
- Multiple Domains
- Content Sharing
- Learners Management
- Emerging Standards (LO)
- Basic Interoperability

**Future**
- Service Based and Sharing
- Specialized Domains
- eLearning frameworks
- Semantic Aware
- LO Sequencing/Adaptability
- Standards Based
- Total Interoperability
- Cloud eLearning Services

Timeline:
- 1980
- 2000
- 2020
1. Context & Motivation

- eLearning systems are evolving
  - Current systems follow a component-oriented architecture
  - The trend is service orientation
1. Context & Motivation

- Issues & Challenges in e-Learning
  - Heterogeneous systems
  - Standards fragmentation
  - Evaluation in complex domains
1. Context & Motivation

- Issue #1 – Heterogeneous systems

- Managing educational activities involves the work in unison of several learning system types:
1. Context & Motivation

- Issue #2 – Standards fragmentation
1. Context & Motivation

- Issue #3 – Evaluation in complex domains

- IMS QTI specification is insufficient for the requirements of programming exercises
  - collection of files (e.g. test cases, solution programs, exercise descriptions, feedback) and special data (e.g. compilation and execution lines)
1. Context & Motivation

- Some generic questions arise
  - How to guarantee the communication among these disparate systems?
  - How to guarantee that teacher’s material does not become unusable when he moves to another institution or the institution’s LMS changes?
  - How to guarantee that the evidence of students’ work does not disappear when they finish studies
2. Research work

- Analysis of the IMS Common Cartridge (CC) specification
  - a standard way to represent digital course materials
  - comprises two interoperability levels:
    - Content – description and packaging of resources
    - Communication – web service invocation and data exchange between LMS and other applications

- Case Study – automatic evaluation domain
  - Evaluate the applicability of IMS CC
  - automatic evaluation of programming exercises
  - programming exercises defined as IMS CC packages
3. Common Cartridge specification

- Includes a set of open standards for
  1. content and packaging
  2. metadata
  3. authorization
  4. test items, tests, and assessments.
  5. online discussion forums
  6. launching and exchanging data with applications
1. Content and packaging
   - Format for exchange of content between systems
   - Content described in a manifest
   - Resources in the package or referenced by URL
   - Builds upon a profile of the IMS Content Packaging (CP v1.2 schema).
2. Metadata

- Common Cartridges must be searched and accessed through learning object repositories
- Use of simple Dublin Core Metadata Element Set (mapped to the corresponding elements in LOM)
- The metadata could be include at two levels:
  - Cartridge - Common Cartridge profile of the IEEE LOM (loose binding)
  - Resources - use the original IEEE LOM namespace
- Extensible to allow other metadata schemas.
3. Authorization

- Authorization standard (access rules) for each component

- 3 levels: on cartridge import, on cartridge usage and on usage of specific resources in the cartridge

```xml
<manifest>
  <metadata/>
  <organization/>
  <resources/>
  <cc:authorizations access="cartridge" import="false" xmlns:cc="http://www.imsglobal.org/cc">
    <cc:authorization>
      <cartridgeId>12345</cartridgeId>
      <webservice>http://publisher.com/authme</webservice>
    </cc:authorization>
  </cc:authorizations>
</manifest>
```

- The address of the web service must support the Authorization Web Service as described in IMS CC Authorization Web Service
4. Question & Tests

- Uses the QTI specification as a data model for questions & tests
- Allows systems to understand imported assessments as natively
- Represented on the manifest through two LAO resource types:
  - Assessments - ordered question set (e.g. Multiple Choice, True/False, Fill in the Blanks, Pattern Match, and Essay) and may include optional attributes (e.g. number of attempts, time limit and whether late submission is allowed)
  - Question banks - can embed any of the question types supported by the CC v1.1 profile of QTI
5. Discussion Topics

- Populates online discussion forums for collaboration among students with potential exercises, discussion threads, etc.
- LAO resource used to initiate a discussion activity
- Upon import, the discussion topic content is stored by the tool using its own internal representation (tool discussion forum)

```xml
<topic xmlns...>
  <title>The Psychology of Faces</title>
  <text texttype="text/html">Differences from LMS and CMS? &lt;br/&gt;
  &lt;img src="$IMS-CC-FILEBASE$/images/img01.jpg"/&gt;</text>
  <attachments>
    <attachment href="/images/img02.jpg"/>
  </attachments>
</topic>
```
6. Basic LTI

Standard way to describe how the target tool of the cartridge (usually a LMS) should communicate with other remote web applications using the IMS Basic LTI specification.

XML file contains a link in a Tool Consumer (e.g. LMS). Upon the user’s click, the execution flow passes to a Tool Provider along with contextual information about the user and Consumer.

```
<resource identifier="MyBLTILink" type="imsbasiclti_xmlv1p0">
  <file href="BasicLTI.xml"/>
</resource>
```
4. Case Study

- Case study – evaluation of programming exercises
  - Test the applicability of CC interoperability levels by
    - defining a new CC LO for representing programming exercises
    - exchanging the LOs in a network of eLearning systems
      - Learning Management Systems (LMS)
      - Evaluation Engines (EE)
      - Learning Objects Repositories (LOR)
      - Integrated Development Environments (IDE).
4. Case Study

- We created **PExIL (Programming Exercises Interoperability Language)** – aiming to consolidate the data required in the programming exercise life-cycle, from when it is created to when it is graded, covering the resolution, the evaluation and feedback.
4. Case Study

- Resources section of the IMS CC LO manifest of a programming exercise
- The cartridge includes a LTI to allow a secure integration of the cartridge from the place where it is referenced (e.g. LMS) to the place where it will be used (e.g. IDE).
4. Case Study

- Validation of the IMS CC package
  - Using the IMS validator at [http://validator.imsglobal.org](http://validator.imsglobal.org)
  - IMS CC Validator test the whole cartridge verifying the following type of constraints:
    - Static: the parameters (e.g. file names) are fixed in the profile (e.g. imsmanifest.xml must exist at the root of the package)
    - Dynamic: the parameters are taken from an instance document in the package (e.g. href attribute of a resource element must point to a QTI file)
    - Conditional: the constraint depends on a condition (e.g. If parameter ‘contenttype’ is ‘question’ then the href attribute must point to a QTI file).
4. Case Study
4. Case Study

- Prototype
4. Case Study

- Prototype
5. Conclusion

- Present a comprehensive study on the new IMS CC specification.
- We analyzed this specification at 2 interoperability levels:
  - content
  - communication
- The applicability of IMS CC was tested in a specialized domain: the automatic evaluation of programming exercises.
  - Generation of programming exercises as IMS CC packages
  - Validation of the package content on the IMS validator
  - Use of a prototype for the creation of exercises (teacher) and for the solving of exercises (student)
5. Conclusion

- Major conclusion:
  - IMS CC has a number of improvements when compared with the base specification, the IMS CP. The BLTI support and the access control at the resource level.
  - The Basic LTI (BLTI) will be instrumental in binding a programming exercise with an environment where the student can resolve it.
  - The access control at the resource level enables an eLearning system (e.g. a LMS) to present the problem solution to the teacher while hiding it from students.
Questions?

Thanks

Ricardo Queirós
(ricardo.queiros@eu.ipp.pt)