

Experiences of SCORM Implementation Process in Cyber Security Course Content

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Abstract

Content is the king in the context of any form of learning; with no exception to e-learning. In this paper we address various issues related to content development and offering in e-learning mode. Various issues related with content are Reusability, Accessibility, Interoperability and Durability. Implementation of content standards during the content development process would result in reducing the content related issues. There are various worldwide standards available among which Sharable Content Object reference Model (SCORM) has gained wide acceptance. The authors are involved in developing the content for Cyber Security course to offer in e-learning mode. This paper presents a specific case study in developing content to be offered in the e-learning mode for "Cyber Security" course. This course is intended to be offered for network system administrators, Information Security officers and general users. This paper describes the implementation of SCORM standards in developing the content which includes generating metadata, content aggregation and content packaging. The authors gained experience using ADL's tools for SCORM conformance test.

1. Introduction

At present, in the world of distance education e-learning is in the forefront. As in any form of education, content is the crux in e-learning too. Content development is a systematic approach to gather, analyze, design and interpret the information for a particular topic in a specified manner. Since the content evolves over time, maintainability of the content has to be considered. This allows easy management of the content. Among other issues central to the content development, portability and interoperability take the spotlight. The solution for this problem is standardization of the content development process. The process of standardization wraps all other

processes involved in the development of content to address the above said issues.

Standards impose certain order, providing more uniform and precise access and manipulation to e-learning resources and data. Designers and developers of on-line learning materials have a variety of software tools at their disposal for creating learning content. These tools range from presentation software packages to more complex authoring environments. They are very useful by giving the opportunity to the developers to create learning resources that might otherwise require extensive programming skills. Unfortunately, a number of software tools available from a wide variety of vendors produce instructional materials that do not share a common mechanism for finding and using the resources. In addition to this, the content developed for one Learning Management System (LMS) may or may not be launched by another LMS. So there is need for standards to define the framework for e-learning content. So standards are desirable for interoperability, convenience, flexibility, and efficiency in the design, delivery and management of the learning content.

2. Content development Standards and SCORM

There are number of organizations working to develop specifications and standards such as IMS, ADL, ARIADNE, IEEE, ISO etc to provide framework for e-learning architectures, to facilitate interoperability, content management, Learning Object Meta data, course sequencing, content packaging etc. One of the widely accepted content development standards is Sharable Content Object Reference Model (SCORM) defined by Advanced Distributed Learning (ADL) initiative.

SCORM is a suite of technical standards that enable e-learning environments to find, import, share, reuse, and export learning content in a standardized way. SCORM provides abilities such as content Reusability, Accessibility, Interoperability, and Durability. SCORM references specifications, standards and guidelines developed by other organizations and

adapted and integrated with one another to form a more complete and easier-to-implement model. SCORM has implemented the Learning Object Metadata (LOM) from IEEE standards and content packaging specifications from IMS. SCORM has become widely accepted e-Learning standard in content development and most of the vendors are providing support in their products to test SCORM compliant content. It defines a Web based learning Content Aggregation Model and a Runtime Environment for learning objects. Content Aggregation Model Content Aggregation Model (CAM) provides means to identify and describe the learning content. Asset and Sharable Content Object (SCO) are the components of the content as defined under CAM. Asset is an electronic representation of media, text, images, sound, web pages, assessment objects or other pieces of data that can be delivered to a Web client. A SCO represents a collection of one or more Assets that include a launching mechanism through SCORM Run-Time environment (RTE) to communicate with LMS. A SCO represents the lowest level granular learning resource that can be tracked by an LMS using the RTE. Asset and SCO are associated with metadata to identify and describe the content and to make them reusable.

The SCORM Content Aggregation Model further defines how learning content can be aggregated into a course or portion of a course. Content Organizations provides different paths of learning by aggregating different SCOs. Content packaging provides a standardized way to exchange SCOs between different systems or tools. Content Packaging also defines the structure and the intended behavior of content organizations.

3. Run-Time Environment

The purpose of the SCORM Run-time Environment is to provide a means for interoperability between SCORM content packages and LMS. A requirement of the SCORM is that learning content should be interoperable across multiple LMSs regardless of the tools used to create the content.

For this to be possible, there must be a common way to launch learning content, to

communicate with an LMS and a predefined language or vocabulary forming the basis of the communication. These three aspects of the RTE are Launch, Application Program Interface (API) and Data Model. The Launch mechanism defines a common way for LMSs to start learning content. The communication protocols are standardized through the use of a common API. The API is the communication mechanism for informing the LMS of the state of the learning content such as initialized, finished or in an error condition. Also the getting and setting data (e.g., score, time limits, etc.) between the LMS and the SCO is achieved through the APIs. A Data Model defines elements that both the LMS and SCO are expected to “know” about such as the status of the learning content.

Understanding the importance of standards conformance in a e-learning course, we decided to implement SCORM in the Cyber Security course.

4. Design and development of an e-Learning course with SCORM specifications

To develop a course that follows the specifications of SCORM, we need to implement the process to perform all the steps involved. The process is discussed here.

4.1 Development of Cyber Security Course confirming to SCORM

We have developed course content for Cyber Security, which is intended for System administrators and Information security officers. This course has a requirement of being offered through e-learning mode. In view of delivery of the course in e-learning mode, we took an approach to implement the SCORM standards to make it interoperable with LMSs. This activity required a study to understand SCORM in depth, chalking out a process to implement it specific to the course and meeting the course objectives at the same time. After thorough study of SCORM, we have come out with a process for implementing it in the course. The major

activities of this course development include formulation of course syllabus based on SCORM standards, Identification of SCOs, Identification of metadata specific to the course, defining a learning path for content delivery and evaluation methodology.

4.2 Design of Course Syllabus

The syllabus of the course was designed in consultation with domain experts. The structure of the course is also important as it defines the learning paths for different target audience. Design of course syllabus is the basis for identifying the SCOs.

4.3 Identifying the SCO

A SCO can contain a single learning object or a collection of learning objects, tests, scenarios etc. Additional aspect of SCO that one has to keep in mind while designing it is, a SCO must be standalone. This restricts a SCO from having any dependencies with other SCOs.

The contents of Cyber Security is structured in a hierarchical fashion. Unit is at the highest level of this hierarchy and lesson at the lowest level. In this hierarchy a lesson by itself can provide learning experience to the user. So we have identified lesson as a SCO as it forms the most granular object that can be tracked and delivered by an LMS. The structure of a unit is shown here.

4.4 Course: Cyber Security

Unit – 2: Network Security

Module-1: Access Control Systems and Methodologies

Lesson-1: Identification and Authentication Techniques

Lesson-2: Various Identification and Authentication Techniques

Lesson-3: Access Control Issues

Module-2: Virtual Private Network

Lesson-1: Introduction to VPN

Lesson-2: Cryptography for VPNs

Lesson-3: Layer-3 IP VPNs

Lesson-4: Securing Application Streams

Lesson-5: IPSec VPN Design & Deployment and VPN Case Study

Module-3: Intrusion Detection Systems and Vulnerability Assessment systems**Lesson-1:** Overview of IDS**Lesson-2:**IDS Types (Host Based IDS & Network Based IDS)**Lesson-3:** Monitoring, Logging, responding to an Attack & Vulnerability Assessment**Lesson-4:** Intrusion Prevention Systems**Module-4: Firewalls****Lesson-1:** Overview of Firewall**Lesson-2:** Types of firewalls (Packet Filtering, Application Gateways & Stateful Inspection)**Lesson-3:** De Militarised Zones & Firewall Features**Module-5: Server Management****Lesson-1:** User Management & Setting up User Privileges**Lesson-2:** DNS Security & Load Balancing**Module-6: Telecommunications & Internet Security****Lesson-1:** Fax Security**Lesson-2:** Security Risk Analysis for voice-over-Internet**Lesson-3:** Next Generation Networks**Lesson-4:**Voice-over-packet service architectures, standards & emerging products, which address key security issues**4.5 Identifying the metadata attributes**

The metadata forms the basis of SCORM. The mandatory metadata attributes specified by SCORM and a subset of optional metadata attributes specific to the course were considered. The list of the metadata attributes for a SCO i.e Basics of Communication Systems & Issues in Computer Networking are

1. general identifier
2. general identifier entry
3. general identifier catalog
4. general title
5. general description
6. general keyword
7. lifecycle version
8. lifecycle status
9. lifecycle role

10. lifecycle entity
11. lifecycle date
12. metametadata identifier entry
13. metametadata identifier catalog
14. technical format
15. technical size
16. technical location
17. technical requirement or composite type OS
18. technical requirement or composite type browser
19. technical other platform requirements
20. technical duration
21. educational interactivity type
22. educational learning resource type
23. educational intended end user role
24. educational difficulty
25. educational typical learning time duration
26. rights cost
27. rights copyright and other restrictions
28. rights description

4.6 Naming and storing the Files:

When content development is being done, many people would handle the content. So it is always better to have a Content Repository. Along with it some naming conventions have to be followed.

For example, presentation material in Lesson1 of Topic1 of Module1 and Unit1 could be given the name as Unit1_Module1_Topic1_Lesson1.ppt. It is important to keep in mind that underscores should be used as separator as some operating systems may not be able to identify a filename with blank spaces or any other delimiters as separators. Also the content should be stored in a central repository with the directory structure following the same naming convention.

4.7 Metadata Repository

The SCORM implementation guide specifies creation of a central repository for the content metadata. We have developed a central repository for the metadata using MS Access. The metadata of all the SCOs are entered into this repository. The metadata repository schema is shown in fig.2

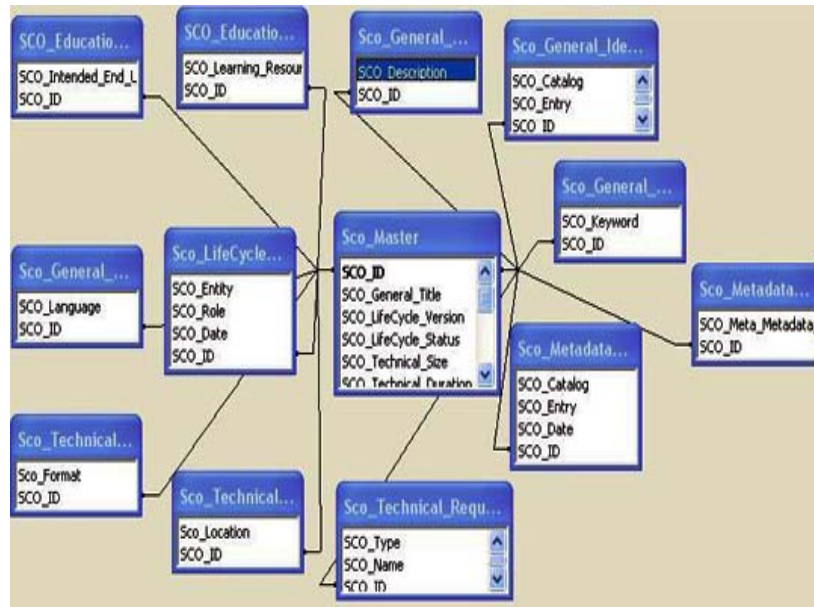


Figure 2 Metadata repository schema

4.8 Generating the Metadata

For the purpose of generating the metadata, a web-based application has been developed. It provides the GUI to facilitate

entry of all the metadata values and generates an XML file for the inputs given. Below is the snapshot of the interface developed for generating metadata in XML format.

Figure 3 Metadata Generator for SCO metadata

4.9 Packaging the Content:

Once metadata has been generated, the SCO has to interact with the LMS so that it can be launched by the LMS. For this, each SCO must be embedded with JavaScript functions that would communicate with the LMS. Each Lesson of Cyber Security Content, has been embedded with the JavaScript functions that are provided by ADL. There are two JavaScript files available for this purpose- SCOFunctions.js and APIWrapper.js. We have made the content launchable by embedding the

functions loadPage(), unloadPage() provided in SCOFunctions.js file.

The next step in this process is sequencing and packaging the content. Default sequencing as per the course structure was defined before packaging the course content. Using the Reload Editor the contents were arranged into organizations and these organizations have been packaged as a zip file. A package descriptor (imsmanifest.xml) has been created by the Reload Editor for this zipped content. The content organization created using Reload editor for unit 2 is shown in Fig.4.

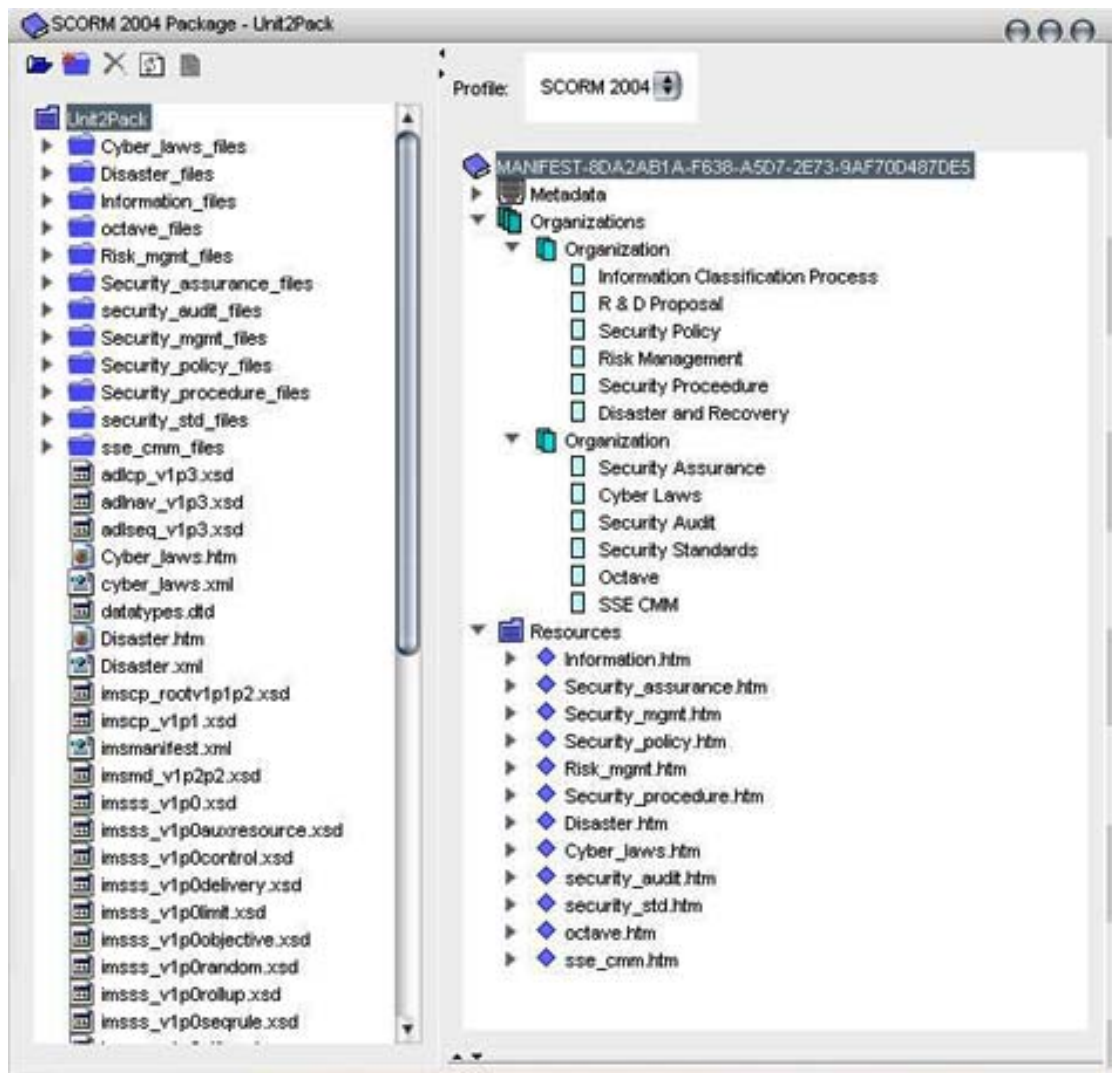


Figure 4 content organizations of Cyber Security Course Contents

4.9 Validating the SCO metadata and the Package Descriptor using ADL Test Suite

ADL has provided a test suite using which the SCO metadata and Package descriptor can be validated. In this cyber security course, the SCO metadata generated by the

Metadata Generator for all the SCOs and the package descriptor generated by Reload Editor after packaging the content have passed the ADL SCORM conformance tests.

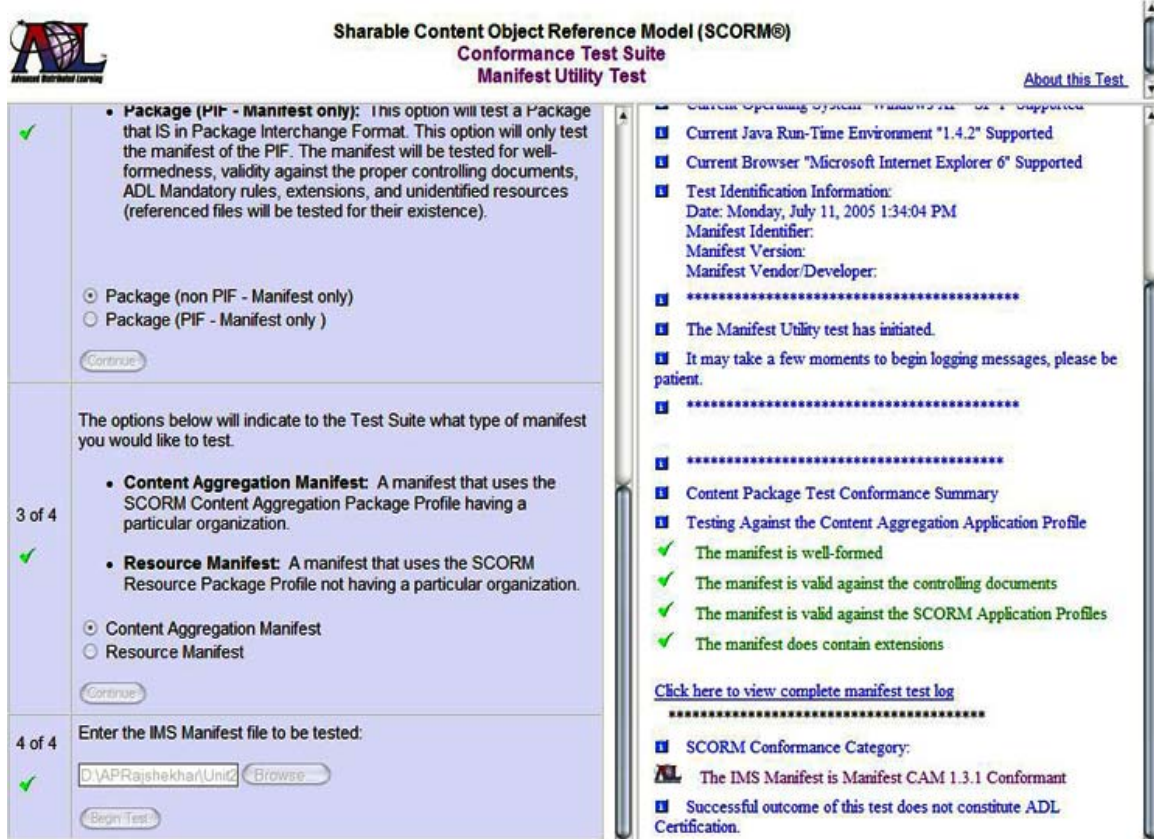


Figure 5 Conformance Test Suite

To carry out conformance test, ADL also provides a sample RTE that can deliver a content package if the package is SCORM conforming. The Cyber Security content package was imported successfully and delivered in the Sample RTE.

<http://www.edtech.vt.edu/edtech/id/index.html>
<http://www.lsal.cmu.edu/lisal/expertise/papers/presentations/techlearnisd2002/techlearnisd2002.pdf>

We have also ported this course content onto Atutor which is a open source e-learning tool. The RTE implementation of Atutor has delivered the course package according to the default sequence provided in the imsmanifest file.

Conclusion

Developing online courses using SCOs has a lot of future potential. This provides the ability to access a repository for anytime, anywhere and reusable learning content. At the same time we should be conscious about the issues related with the implementation. They are, identifying SCO, which can be standalone and reused and repurposed in different contexts. Next is the selection of metadata specific to the course. Development or using the existing tools for metadata repository and learning content repository decide the ease of maintaining the course. Based on our design team experiences, we believe these efforts are possible for implementing SCORM standards in e-learning course content development.

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