# Motivation for a Direct Access Tunnel between Content Developers and Learning Objects

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## 1. Introduction

The current SCORM standard is silent on whether content developers (including both researchers and commercial developers) should be allowed to access learning objects after they have been published and uploaded to learning management systems (LMS). Content developers are often forced to rely on inconsistent LMS functionality to provide both read and write access to learning objects. The lack of such direct access not only makes it difficult for content developers to make bug fixes to content, but also constrains researchers from collecting useful data associated with the learning object SCO. In this white paper, we make the case for a direct access tunnel between the content developers and learning objects to address this issue.

The rest of this white paper is organized as follows: Sections 2 and 3 discuss two problems related to the current SCORM standard with respect to the direct access and the proposed solution. Section 4 gives two scenarios which elaborate on the problems. Section 5 discusses who will be affected, while Section 6 goes into some technical details. Section 7 illustrates the need for such access in the context of a specific example for researchers: a research project called Intelligent Learning Object Guide (iLOG) that aims to track user interactions with learning objects and subsequently tags each learning object with empirical usage metadata. Section 8 concludes and provides a recommendation for SCORM 2.0.

## 2. Problem Definition

The current SCORM standard makes it difficult to do the following:

1) Perform minor updates to existing learning objects (LO) stored in learning management systems (LMS).
2) Log user interactions associated with LOs including (but not limited to) the assessment component

Most LMSs which are SCORM-compliant restrict access to LOs after they have been uploaded to the LMS. For example, the Blackboard LMS does not allow the zip file containing the LO to be modified after it has been uploaded. The LO is stored in an internal database which is inaccessible to the developers. To *perform minor updates*,

content developers must use the graphical user interface (GUI) provided by the LMS to first remove the LO and then upload it again. Using a GUI is tedious when the update must be performed on multiple instances of the same LO (e.g. updating an LO for twenty different institutions) and should be automated. The lack of any application programming interface (API) for Blackboard makes it difficult to do so. The first use case (Section 4.1) provides additional ramifications for updating existing LOs. The direct access tunnel proposed in the next section would alleviate this problem by giving content developers the ability to update LOs, directly, without relying on functionality provided by the LMS.

The current SCORM Application Programming Interface (API) provides methods for tracking the assessment component for learning objects. User interactions with content in the learning object other than the assessment are ignored by LMS. Content developers interested in *logging such user interactions* are forced to improvise. One solution is to intercept and store user interactions using a wrapper such as the Easy SCO Adapter for SCORM (http://www.ostyn.com). Unfortunately, such user interactions are only stored in the wrapper for the duration the LO is active. They must be sent to an external database using a communication bridge such as Asynchronous JavaScript and XML (AJAX) before the LO closes. The above approach is used in the example for researchers described in Section 7. Such a communication bridge is a workaround that is difficult to implement, because current internet browsers (e.g. Firefox, IE7) restrict AJAX due to security concerns. The proposed direct access tunnel, combined with the existing CMI model which allows for comments to be written directly to the SCO, would allow content developers to log user interactions beyond the assessment.

## 3. Proposed Solution

The solution we propose for inclusion in the new SCORM 2.0 standard is to **make LOs directly accessible to content developers**. This is analogous to a direct tunnel through the LMS between the content developers and the LO. We propose a two-way tunnel as shown below in Figure 1, providing both *write* and *read* access to the LOs for both researchers and content developers. The proposed direct access should be implemented using secure file transfer protocol (SFTP) over the internet. SFTP is widely used and provides much better security than the basic file transfer protocol (FTP). The learning management systems will need to provide existing location information (such as port number) for the learning objects to the content developers. However, if SFTP is used for direct access the LMSs will not need to provide additional security to prevent data interception (e.g. packet sniffing). SFTP is also platform independent, supporting developers using different operating systems and machines.

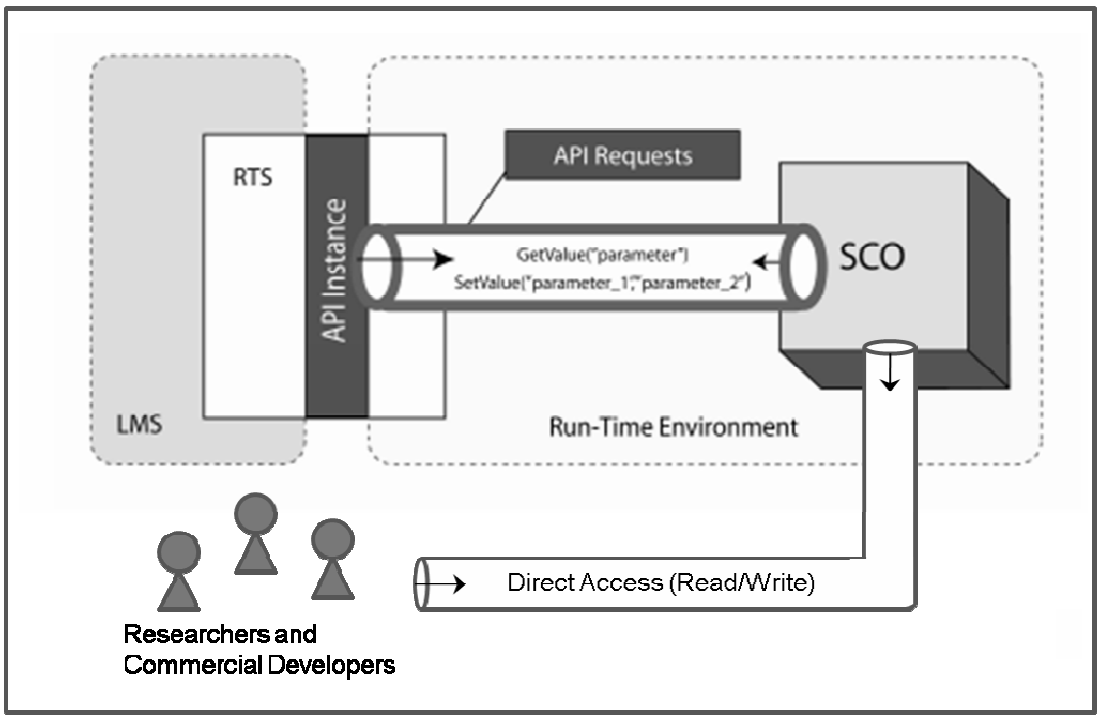


**Figure 1:** SCORM 2004 Run-Time Environment (SCORM_RunTimeEnv.pdf, pg.65) modified to include the proposed directed access tunnel. The tunnel provides both read and write access to content developers.

## 4. Use Cases

This section described two use cases which assume the direct access tunnel between the LO and the content developer described in the previous section. The first case describes how commercial developers can update learning objects to make minor bug fixes. The second case describes how researchers can use the same direct access to collect information about page navigation.

### 4.1. Commercial Developer

Companies such as McGraw Hill commercially develop numerous learning objects which are then deployed to LMS such as Blackboard. In the current SCORM model, uploading the LO to Blackboard requires the use of a graphical user interface (GUI). This requires the LO to be uploaded manually, by a different person, at each company, agency or institution that wants to use the LO. Suppose that two months after release a bug is found in the LO: an answer for the third assessment multiple choice question was mistakenly set to 'C' and not 'D'. While it is trivial to fix the LO at McGraw Hill, the dissemination of the updated LO is not. The fixed LO must be updated manually for each Blackboard LMS be removing the old and uploading the fixed version. Because this action is performed by a different person, there is no guarantee of concurrency: users at one agency may be using the old version of the LO. McGraw Hill is blamed when users start to complain about their assessment scores. If SCORM 2.0 allows the proposed direct

access, McGraw Hill can provide content updates and verification for their LOs resulting in increased customer satisfaction.

### 4.2. Researcher

A researcher wants to collect navigation information on specific learning objects. Her goal is the creation of an intelligent software agent that will monitor student usage patterns on learning objects and determine which pages are prerequisite to other pages. This will assist in delivering the LO pages in a customized order to subsequent users. Initially, the LO provides a table of contents and students are allowed to go through the content pages in any order (e.g. front to end, skip to assessment, etc.). The order viewed and amount of time spent on each content page are written to the SCO. Assuming SCORM 2.0 allows direct access, the software agent can periodically download the LO and extract the navigation information. From this navigation information, the agent observes students skip over page 5 and read page 7 (i.e. spend more time) before returning to page 5. The agent reasons that page 7 contains content prerequisite to 5 and updates the LO manifest, placing it before page 5. The above research example is nearly impossible in the current version of SCORM.

## 5. Stakeholders

Both commercial developers and researchers will benefit from the proposed direct access change in SCORM 2.0. Commercial developers will be able to update content (e.g. fix bugs) in learning objects directly. In addition to providing increased customer service, the direct access tunnel should simplify the update process compared to using a GUI provided by the LMS, resulting in labor cost savings. Researchers also benefit from the ability to access data written to the SCO by the LMS directly. We expect the proposed direct access change would foster numerous interest and projects revolving around collecting usage information and providing dynamic updates to the LOs. Such projects should result in improvements to the content for the next generation of LOs (e.g. the dynamic presentation discussed in the second use case) and improvements to the selection of learning objects (e.g. automatic metadata generation discussed in Section 7) resulting in more appropriate or effective LOs for learners. Thus, the proposed direct access will benefit not just content developers, but learners as well.

## 6. Integration and Technical Issues

Writing data to the SCO is already supported by the SCORM 2004 CMI in comments from learning and comments from user.

The SCORM standard should also address the client-side security issue. Direct access to a learning object should be password protected. Only content developers or researchers who know the password should be able to access it. Precautions will need to be taken to prevent unauthorized access (i.e. hacking) to one learning object from affecting other LOs. LMSs already employ similar security to prevent unauthorized users from

modifying LOs, so the additional security for direct access should not be too much of an imposition.

## 7. Existing Implementations and Prototypes

The Intelligent Learning Object Guide (iLOG) project team has developed a suite learning objects (LO) for deployment to introductory computer science courses at the University of Nebraska, Lincoln. These LOs cover a range of topics including functions, sorting and looping. The Lectora authoring tool (http://www.lectora.com) was used to produce LOs that were aesthetically pleasing and the design and structure of the content was based on collaboration with an educational expert at the Nebraska Center for Research on Children, Youth, Families and Schools. The LOs were deployed to students using the Blackboard Learning Management System (LMS).

The purpose of the iLOG project (http://cse.unl.edu/agents/ilog/) is to develop a system for automatically generating metadata for LOs. This metadata will assist instructors in the selection of appropriate LOs. To accomplish this, iLOG needs to collect interactions between the LMS and the users. The user interactions iLOG is interested in go beyond the assessment component of an LO and include: 1) the amount of time spent on specific pages in the LO, 2) the number of clicks on interactive Flash and Java animations, and 3) and the answers to the assessment questions. From the interactions collected for multiple students on the same LO, the iLOG system derives statistics such as the average number of clicks on Flash animation 2 in the Looping LO and the maximum time spent on page 3 in the Functions LO. The iLOG system uses the statistics, along with machine learning, to create metadata tags automatically for the LO. Content diagnosis is one application of the metadata that will be generated by iLOG (e.g. students in the CS 0 class had trouble with question 2 on sorting, while students in the CS 1 class did not).

As discussed in Section 2, the current SCORM standard makes it difficult to collect the user interactions with learning objects. We were forced to create a wrapper around the SCORM Application Programming Interface (API) to intercept user interactions with the LMS and send them to an external database. Initially, we used Asynchronous JavaScript and XML (AJAX) to serve as the communication bridge. However, current internet browsers such as Mozilla Firefox severely curtail AJAX due to security concerns. The entire development cycle for the wrapper and database communication required a great deal of time and effort to create an ad hoc solution shown in Figure 2. Although iLOG is now capable of capturing user interactions and developing metadata, we are unable to upload the metadata to the learning objects in the LMS. Thus, other researchers have no way of accessing the iLOG metadata from inside the LMS.

The direct access tunnel described in Section 3 combined with CMI, already part of SCORM 2004 standard, *would eliminate the need for the above ad hoc approach for iLOG and greatly simplify* the collection of user interactions from the LO and the addition of metadata to the LO.

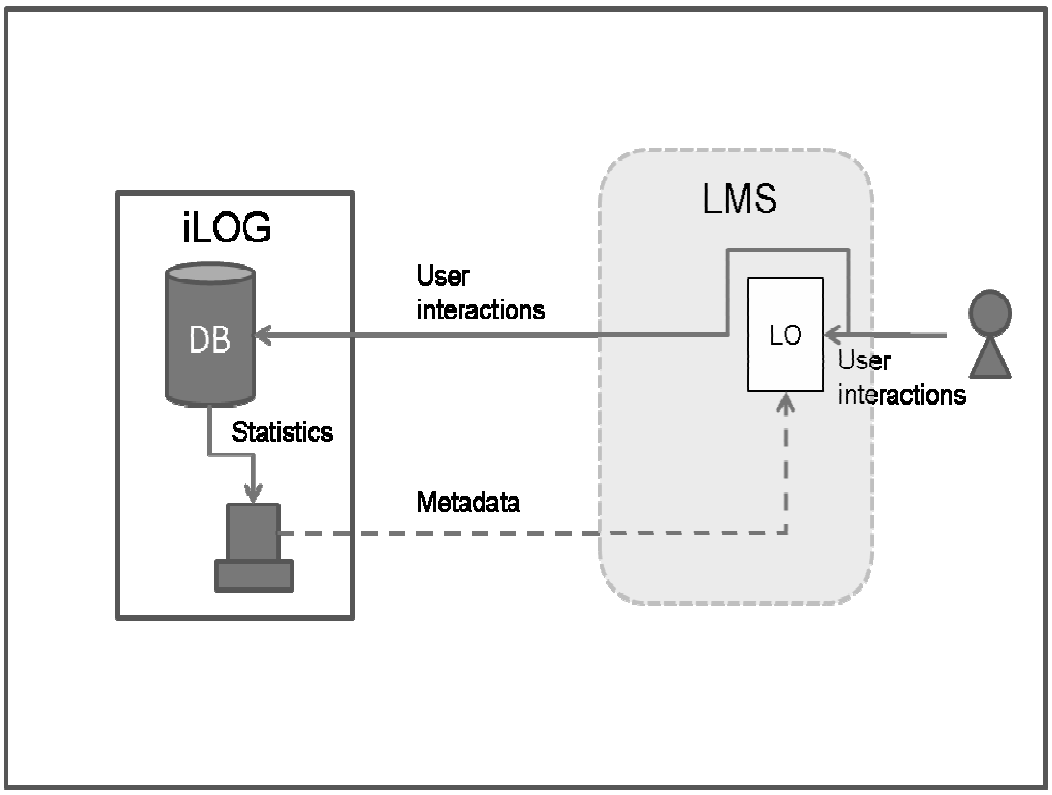


**Figure 2:** Current approach used by iLOG. With difficulty, user interactions are intercepted and sent to an external database. The iLOG system creates metadata using statistics and machine learning, but is unable to append this metadata to the LO.

## 8. Summary and Recommendations

We propose a direct access tunnel through the LMS allowing content developers to read and write to their LOs. Use cases were provided for both commercial developers and researcher. For commercial developers this will reduce labor costs associated with bug fixes for content, while researchers will benefit from direct access to data written to the SCO. We suggest using the secure file transfer protocol (SFTP) for direct access and discuss security implications. We described the Intelligent Learning Object Guide (iLOG) system which currently uses an ad hoc approach involving a wrapper and an external database. The difficulty with re-uploading the LOs and recovering them from the LMS has complicated the iLOG research project considerably.

We recommend a change to SCORM 2.0 *to provide content developers with direct access their LOs*. Developers should be able to both ***read*** from and ***write*** to the LOs without having to rely on the LMS. This recommendation would be a boon to both research and content developers, but ultimately it is the users of the LOs which have the most to gain from bug free content and improved LOs resulting from research in a wide variety of disciplines.

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