

## **A Web Service Architecture for Integrating Didactic and Experiential Learning**

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### **ABSTRACT**

In recent years, the training community has shown an increased interest in techniques for integrating distributed learning and simulation-based training. BBN, together with its sponsor, the Joint ADL Co-Lab, has implemented an architecture that supports both traditional, SCORM-based training, and experiential, simulation-based training. This architecture allows integration of traditional didactic and experiential content, makes it easier for content developers to integrate new training content, improves ease-of-use for the student, and improves training value. The architecture focuses on two components: the SCORM Run-Time Environment, and a new Distributed Training Event Coordination Service (DTECS). While the SCORM Run-Time Environment launches and records student performance on traditional, didactic content, the DTECS coordinates configuring, launching, and reporting results from simulation-based training systems. This separation of function allows the DTECS to handle the unique requirements of simulation-based training. The architecture uses the W3C web services standards (including XML, SOAP, and Web Services Description Language) to provide communications among the SCORM Run-Time Environment, the DTECS, and the training systems. The use of web services provides an open, reliable, and extensible distributed architecture. This architecture supports the development of independent components, such as user databases, content repositories, and assessment engines, which can be easily integrated with existing components through web services. The integration of didactic and experiential training is supported not only in the architecture, but also in the selection and configuration of training content. A student's performance on didactic content informs the selection and configuration of experiential training systems. Likewise, the student's performance in experiential training drives the selection of new or remedial didactic content. This coupling improves the training value for students by providing opportunities to practice what they have just learned, and to remediate in precisely the areas in which they have demonstrated a lack of understanding.

### **ABOUT THE AUTHORS**

**Virginia Travers** joined BBN Technologies in April 1975. She is a Senior Scientist, currently working as the Principal Investigator for the Joint ADL Co-Lab project focused on integrating simulation-based training with the SCORM Run-Time Environment. She is also the technical lead for the DARWARS project. Ms. Travers has worked on a variety of projects for BBN, both as a technical contributor and project manager, including the COVE project (a simulated training environment for ship handling), and the DARPA sponsored ALP and Cougaar projects for developing distributed agent-based technologies. Ms. Travers holds a Bachelor of Science in Computer Engineering from Case Western Reserve University.

**Bruce Roberts** is a Division Scientist at BBN Technologies in Cambridge, MA, where he has led the development of numerous simulation-based intelligent tutoring systems. Projects include an operational tutor for teaching flight-line troubleshooting to Air Force technicians, and a virtual environment based ship-handling tutor. His interest in intelligent tutoring systems extends back to some of the earliest work incorporating simulation, computer graphics, and expert systems in training; namely, STEAMER, which taught principles of operation for steam propulsion plants on Navy ships. As a researcher at the MIT Artificial Intelligence Laboratory, he implemented one of the first

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**Ray Tomlinson** joined BBN Technologies in June 1967. He is a principal engineer, currently working on the JADL IPA Project, a project for the Joint Advanced Distributed Learning Co-Laboratory integrating support for simulation-based training with more conventional SCORM training. He is also working on the TASM project that will provide testing and data services for mission flight planning and on the Intelligent Learning project that is advancing the state of machine intelligence by learning to perform tasks based on observation of an expert demonstration of the task. Previous projects that Mr. Tomlinson has worked on include the design of several network protocols (TCP/IP, TELNET, FTP) and their implementations. Other projects include the DARPA sponsored ALP and Cougar projects for developing distributed agent-based technologies. Mr. Tomlinson wrote the first network email program and sent the first network email message. Mr. Tomlinson holds a Bachelor of Science in Electrical Engineering from Rensselaer Polytechnic Institute and a Master of Science in Electrical Engineering from the Massachusetts Institute of Technology.

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### INTRODUCTION

In recent years, the training community has shown an increased interest in techniques for integrating traditional, didactic distributed learning and simulation-based training. BBN, together with its sponsor, the Joint ADL Co-Lab, has developed an architecture that supports both traditional, SCORM-based training, and experiential, simulation-based training. This architecture supports integration of traditional didactic and experiential content, makes it easier for content developers to integrate new training content, improves ease-of-use for the student, and improves training value. BBN implemented key components and interfaces in this architecture, and used these to build and demonstrate integrated didactic and experiential training.

The architecture focuses on two components: the SCORM Run-Time Environment, and a new Distributed Training Event Coordination Service (DTECS). While the SCORM Run-Time Environment launches and records student performance on traditional, didactic content delivered by a Web client, by itself, it is unable to interface with stand-alone simulation-based training systems. The DTECS coordinates configuring, launching, and reporting results from simulation-based training systems. This separation of function allows the DTECS to handle the unique requirements of simulation-based training. In addition, the DTECS maintains more detailed training profiles, based on the richer trainee feedback that can be provided by simulations, thus allowing instructors to better assess a learner's progression and understanding of instructional material.

The architecture uses the W3C web services standards (including XML, SOAP, and WSDL<sup>1</sup>) to provide communications among the SCORM Run-Time Environment, the DTECS, and the training systems.

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<sup>1</sup> Simple Object Access Protocol (SOAP) and Web Services Description Language (WSDL)

The use of web services provides an open, reliable, and extensible distributed architecture. This architecture supports the development of independent components, such as training record repositories, shared state persistence, content repositories, and assessment engines, which can be easily integrated with existing components through web services.

The integration of didactic and experiential training is supported not only in the architecture, but also in the selection and configuration of training content. A student's performance on didactic content informs the selection and configuration of experiential training systems. Likewise, a student's performance in experiential training drives the selection of new or remedial didactic content. This coupling improves the training value for students by providing opportunities to practice what they have just learned, and to remediate in precisely the areas in which they have demonstrated a lack of understanding.

### MOTIVATION

We are focused on integrating fully-immersive, PC-based, experiential training with traditional, didactic instruction. These experiential training systems are often simulation-based and provide a fully immersive environment, generally by running as stand-alone applications that control the entire desktop environment.

The first impediment to integrating experiential training with SCORM-conformant didactic content is that the SCORM Run-Time Environment (RTE) standard mandates browser based delivery of instructional materials. Although advances in Web technology support browser delivery of rich multi-media material, including simulations, browser-based simulations still fall short of the fully immersive training experience that can be provided by stand-alone applications. Several projects have demonstrated the benefits of tightly integrating SCORM-conformant content and stand-alone, simulation-based training applications. However, these projects were focused on single applications or

specific technologies, and did not provide a general framework for integrating SCORM content with stand-alone applications.

The SCORM requirement that Sharable Content Objects (SCOs) be delivered by a Web browser, and communicate through that browser to the SCORM Run-Time environment effectively prevents a stand-alone application, such as a PC-based training system, from acting as a SCO. This requirement necessitates the use of browser-based SCOs as intermediaries between the runtime environment and the application. Furthermore, the requirement for browser based delivery introduces increasingly tight security restrictions, appropriate for protecting Web clients, but inappropriate and unnecessarily restrictive for stand-alone applications, which in fact, should include their own security measures.

In order to support the training that can be provided by stand-alone applications, while at the same time providing the benefits from adherence to the SCORM standard, we first developed a web services version of the SCORM ECMAScript interface. Although this interface alone provides all the necessary support for a stand-alone application to be integrated with SCORM content, use of this interface points out the need for additional tools, in order to provide a general method for SCORM-simulation integration and a coherent user interface. In particular, tools are needed to configure and launch stand-alone training systems and to match appropriate training systems and configurations of those systems with relevant SCORM content.

Training is improved by configuring the SCORM and experiential training to address the same training objectives, specifically:

- Configuring the experiential portion of the course to train for the objectives in the SCORM portion of the course.
- Recording performance in the experiential portion of the course as scores against training objectives.
- Using performance in the experiential portion of the course to direct the trainee to appropriate SCORM material.
- Providing seamless, single sign-on training that encompasses both SCORM and experiential training.
- Providing training that can be customized at the local level, by selecting appropriate configurations of locally approved training systems.

## THE STATE OF THE ART

The state of the art in *integrated* SCORM and experiential training can be characterized in the following ways:

*Use of didactic instruction and simulation-based training with no formal connection between the two modes of instruction.*

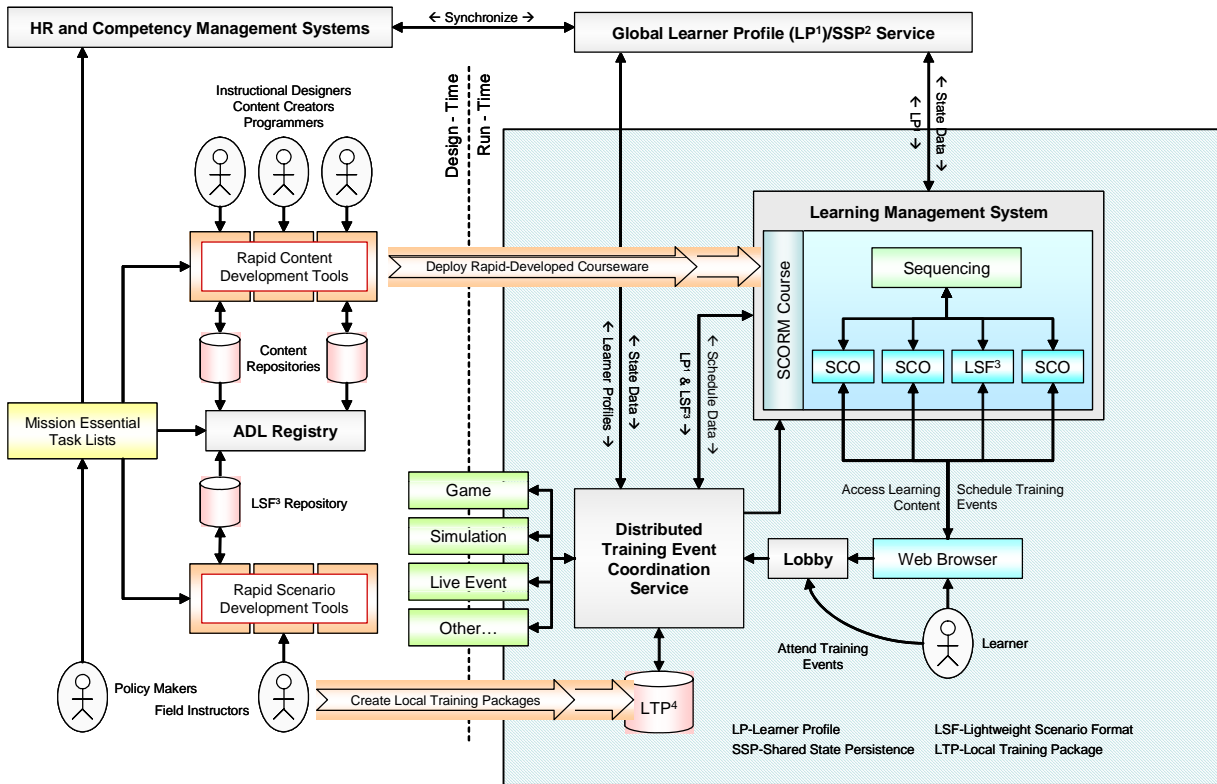
Although both didactic and simulation-based training are widely used, they are generally not well integrated. Didactic and experiential training are delivered by different systems at different times. For example, an instructor may introduce material using a PowerPoint presentation, or students may study procedures in on-line or printed manuals. At some later point, students practice the skills they learned using a simulation. Simulations may return scores against objectives, but more often rely upon an instructor to assess each students' performance. In these cases, there is typically no effort to "pre-test" the students' familiarity with the didactic content, and configure the simulations to match the students' knowledge, nor is there any effort to use the students' performance in the simulations to direct the students to the appropriate follow-on or remedial content.

*Experiments in integrated didactic and experiential training.*

Several experiments have been performed in integrating didactic and experiential training, including several JADL funded prototype development efforts. Recent work (Biddle et al., 2006) has advanced the state-of-the-art by demonstrating the benefits of integrated training to potential users. In these projects, didactic and simulation-based training were well matched, so that user's learned skills in the didactic portion of their courses and practiced those skills in simulations. Furthermore, results from simulations were captured in SCORM objectives and used to direct students to the appropriate follow-on SCORM content, using SCORM sequencing and navigation. This integration of a SCORM course and a simulation worked within the SCORM standards requirement that SCOs launch and communicate through a Web client. Integration of the SCORM course with the simulation was accomplished using ECMAScript and Java applets for launching the stand-alone simulation, and for collecting simulation data, and assessments. While this and other JADL prototype efforts<sup>2</sup> successfully demonstrated the

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<sup>2</sup> See the final reports for "Simulation-based Intelligent Training and Assessment", "Integration of HLA and



**Figure 1: An architecture for supporting integrated training; the shaded area indicates components and interfaces used or developed under this effort**

principled integration of a SCORM course and a simulation, these efforts did not produce a general-purpose framework for integration, which has been the focus of our work.

functionality that could be achieved through enhancements to the standards, help to drive the process of acceptance of an integrated SCORM and simulation-based training environment.

*The work of the SCORM-Sim Study Group.*

**THE ARCHITECTURE**

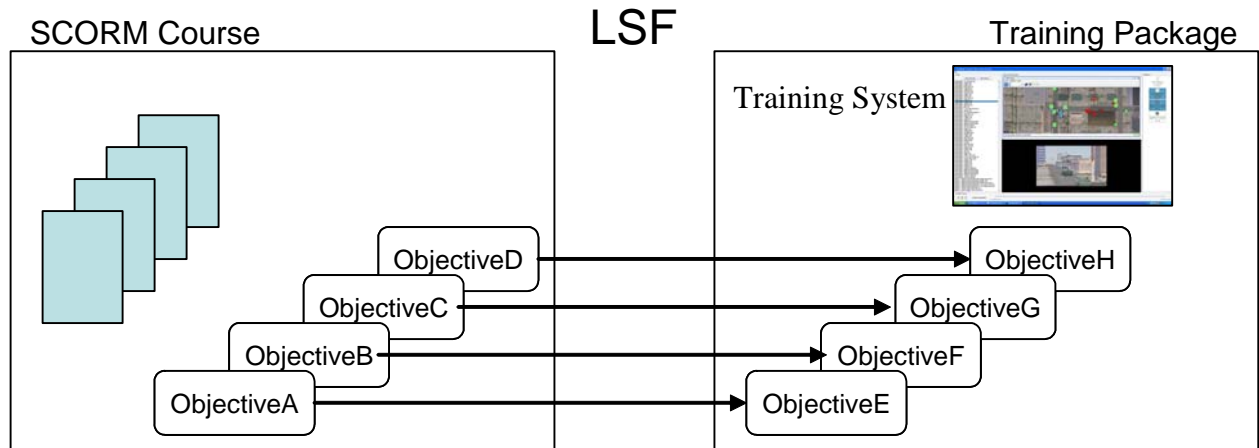
The SISO SCORM-Sim Study Group<sup>3</sup> is studying the issue of integrating SCORM and simulation-based training. The Study Group is focused on surveying the technical and pedagogical state-of-the-art in integrated SCORM and simulation-based training, and producing appropriate SISO Product Nominations or Product Authorization Requests for IEEE standards. We have been participating in this group since its inception in February, 2006. While this group is focused on the next steps in the standardization process, our effort has been focused on demonstrating how enhancements to the SCORM standards could be used to support integrated SCORM and simulation-based training. Both the standards effort, and our demonstrations of the

Figure 1 illustrates an architecture for designing and delivering SCORM content and experiential training. This architecture was developed by the Joint ADL Co-Lab to illustrate one potential concept of how multiple components with well-defined interfaces could be designed in order to support the vision of integrated training. The shaded areas indicate the components and interfaces that are the basis and products of our work. It is useful to consider the motivation for each component of the architecture. This helps to define the functionality provided by each component, and explain the architecture from the standpoint of training selection and delivery.

**Learning Management System (SCORM RTE)**

The essential components of the architecture are the SCORM RTE and the training systems. The RTE functions as a Learning Management System, providing access to traditional, didactic training content and

SCORM”, and “Integration of HLA and SCORM in a Multi-Student Context” available at <http://www.jointadlcolab.org/research/2004/index.aspx>  
<sup>3</sup> SISO Study Group on SCORM-Simulation Interface Standards



**Figure 2: The LSF maps SCORM objectives to Training System objectives**

tracking students' performance. The value of training systems, especially stand-alone applications, has been described above. The addition of the Web Services interface to the SCORM RTE enables communications from the stand-alone application to the RTE, allowing stand-alone training systems to both obtain and record information about student objectives using a standard data model.<sup>4</sup>

Having enabled communications from stand-alone training systems to the SCORM RTE, one of the first questions that arises from an instructional viewpoint is how to align SCORM content with the experience of using a training system. How does a course designer, instructor, or student determine that a training system provides appropriate instruction or practice for a particular SCORM course? If there are multiple configurations of a training system that provide different experiences, and hence have different instructional goals, how is the correct configuration selected?

### LTP, LSF and DTECS

The need to match SCORM content and training systems is the motivation for three key components of the architecture: the Lightweight Scenario Format (LSF) data structure, the Local Training Package (LTP) data structure, and the Distributed Training Event Coordination Service (DTECS).

- The Local Training Package identifies the training system, its runtime parameters, and the objectives for

which it provides training. Multiple training packages may be defined for the same training system. For example, the FOPCSIM simulation can be configured to teach three different techniques for calling for fire. Separate training packages can be defined for teaching each of these techniques.

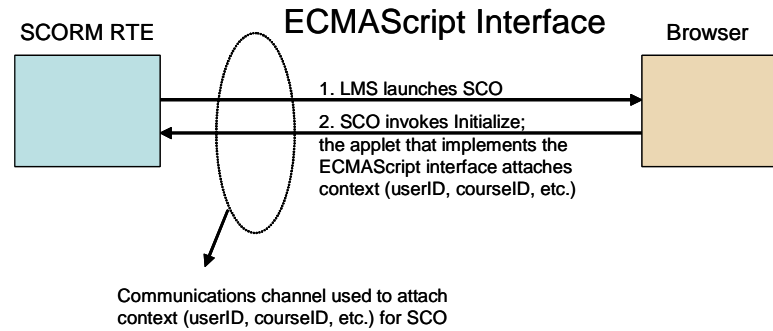
- The Lightweight Scenario Format is a uniquely named mapping between the objectives defined in Local Training Packages and the global objectives defined in SCORM course manifests. The LSF is explained in more detail below.
- The DTECS interprets the LSF in order to select LTPs that match the user's training requirements, and then uses the information in the LTP to identify and configure the training system to meet the objectives in the LTP.

*This capability to match SCORM content with appropriate training systems is one of the primary contributions of our work to supporting integrated SCORM and simulation-based training. Prior integration efforts have integrated a SCORM course with a training system, but this was done at development time, for a specific course and training system. Our effort has produced a general framework for matching SCORM courses with simulations.*

### LSF

Borrowing on both SCORM development, and the DARWARS effort (MacMillan et al., 2005), we characterize training systems, and specific configurations of training systems, by the training objectives that they address. Sharable Content Objects in a SCORM course can set a student's scores against training objectives dependent on their performance in Web-delivered tests. Similarly, training systems can set

<sup>4</sup> SCORM 2004 3<sup>rd</sup> Edition Content Aggregation Model, JADL, (SCORM 2004 3<sup>rd</sup> Edition is available at <http://www.adlnet.gov/scorm/index.aspx>)



**Figure 3: The Initialization process using the ECMAScript Application Programming Interface for Content to Run-Time Services Communication**

scores against training objectives dependent on the student's performance in the training system. The LSF, which is used to match SCORM content to simulation-based training, is a uniquely named mapping between the two sets of objectives. It is defined and stored in the DTECS. Figure 2 illustrates a LSF. The SCOs in the SCORM course reference local SCORM objectives, which are mapped to global SCORM objectives in the course manifest. The training system references a different, but presumably related, set of training objectives. The Local Training Package defines the Training System, its configuration, and the objectives it addresses. The LSF defines the mapping between the SCORM objectives and the training system objectives.

This approach provides the flexibility to develop SCORM content and training systems independently, and provides the ability to integrate existing SCORM courses and training systems. Another important aspect of training objective mapping is that it supports local selection of training systems. A single SCORM course can be paired with a complex training system, where the resources to support that training system are available. In the field, the same SCORM course can be matched with a completely different training system, designed to use fewer resources while addressing the same objectives.

The LSF is included in the SCORM manifest as a resource, using the IMS Content Packaging XML Binding and extensions defined through the use of XML Namespaces and XML Schemas.<sup>5</sup> When the SCORM Sequencing and Navigation component identifies the LSF as the next activity, the RTE delivers the LSF to the DTECS where it is used to select and

launch the matching training system as described in the next section.<sup>6</sup>

### DTECS

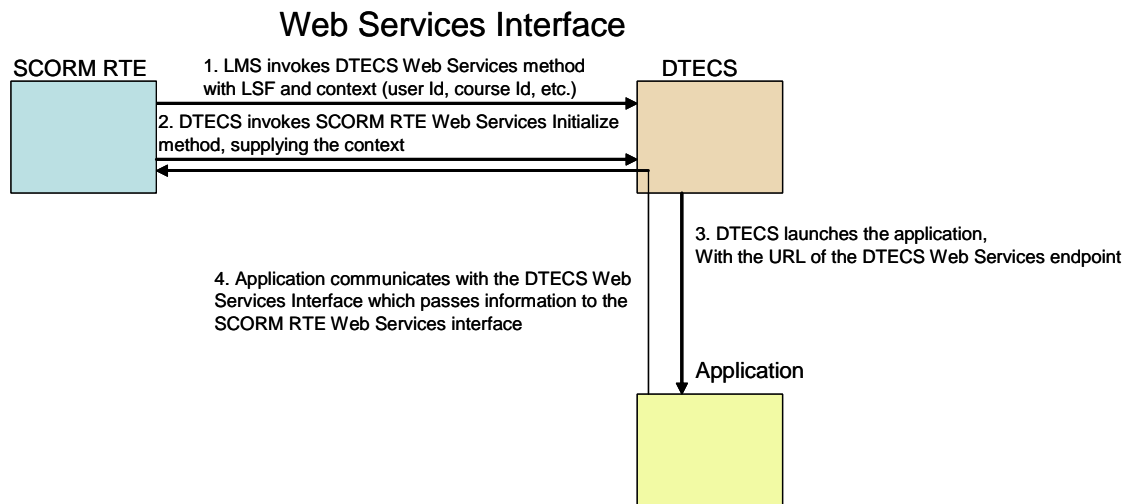
The primary functions of the DTECS are to match SCORM content with specific configurations of training systems, to launch the training systems, and to collect scores against training objectives for transmission to the SCORM RTE. The previous discussion has explained the need for matching SCORM content to training systems; in this section, the additional roles of the DTECS are explained.

In order to understand why the DTECS is responsible not only for selecting training systems, but also for launching those systems, it's necessary to delve a little deeper into the SCORM RTE, to understand how traditional SCOs are launched and communicate with the RTE. According to the SCORM RTE standard<sup>7</sup>, SCOs are launched through a Web client, and must communicate back to the RTE by invoking an Initialize ECMAScript function. In the ECMAScript interface, the only parameter that a SCO must supply to the Initialize method is an empty string. However, within the Web client side interface, additional code captures the current context (user id, course id, etc.) and attaches this to the communications session from which the SCORM RTE can retrieve it. On receipt of the Initialize request, the SCORM Sample RTE retrieves the additional context information from the underlying communications channel between itself and the SCO in order to reference the correct state and data in response to subsequent requests from the SCO. Figure 3 illustrates these interactions.

<sup>5</sup> IMS Content Packaging Information Model, Version 1.1.4 Final Specification. Available at <http://www.imsglobal.org>

<sup>6</sup> The LSF resource references an "alternate" html file that the SCORM RTE will display in the event that the it does not support our extensions.

<sup>7</sup> SCORM 3<sup>rd</sup> Edition Run-Time Environment, ADL



**Figure 4: Launching a Training System using the DTECS**

While the details of how this information is associated with the SCO are not spelled out in the SCORM standard, it is clear that the association must be made in order for the RTE to correctly process requests from the SCO.

By contrast, the initialization process using the DTECS and its Web Services interfaces, is depicted in Figure 4. When the SCORM Sequencing and Navigation component identifies the LSF for delivery to the student, the SCORM RTE contacts the DTECS Web Services interface and supplies the context (user name, course id, etc.) in which the training system matched to that LSF will run. After the DTECS has selected the appropriate training system, the DTECS invokes the SCORM RTE Web Services interface Initialize method (which is analogous to the corresponding ECMAScript method) supplying the context (user Id, course Id, etc.). The DTECS then launches the training system supplying the parameters that the training system needs to establish a Web Services interface to the DTECS. The training system establishes a Web Services interface to the DTECS, which acts largely as a pass through to the RTE.

The DTECS Web Services interface for training systems comprises the same methods that are in the SCORM RTE Web Services interface plus additional methods that allow the training systems to store training records at the DTECS. Training systems can store training records at the DTECS in the form of scores against objectives. The DTECS using the LSF and its associated mappings, then sets the appropriate scores for SCORM objectives using the SCORM RTE Web Services interface. The use of the DTECS to interpret

objective mappings allows SCORM course designers and training system developers to work independently, and supports the use of both legacy courses and training systems. The objectives used by a SCORM course can be obtained from the course manifest. The objectives used by a training system can be obtained from the Training Packages defined for the system at the DTECS. Finally, a third party can use the DTECS Objective Editor to define the mappings between the two sets of objectives.

The DTECS and LSF provide important new functionality: they support integrating SCORM content and training simulations that have been developed independently, they support matching different courses to the same simulation and vice versa, and they support integrating SCORM content and training simulations by course designers and instructors, rather than developers. Earlier prototype efforts have used ECMAScript and applets to achieve this integration, hence tying a training simulation to a SCORM course at development time.

*The use of Web Services interfaces among the SCORM RTE, the DTECS, and the training systems is an important contribution of our work to solving the problem of SCORM-simulation integration. While previous efforts have succeeded in integrating SCORM content and simulations without the addition of Web Services interfaces, the solutions have depended on a complex blend of software encompassing web pages, ECMAScript, and signed applets. These solutions have integrated a specific SCORM course with a specific training system at development time. The addition of Web Services interfaces supports a re-usable*

framework for integrating SCORM courses and simulation-based training systems by course designers and instructors as well as providing the necessary hooks to integrate with additional components being developed independently, including assessment engines, shared state persistence components and registries.

### USE CASE

The following use case, which we implemented under this effort, illustrates our technical approach and demonstrates the role of each of the components in the runtime portion of the JADL architecture as depicted and expanded upon in Figure 5.

Using a field manual on “Forward Observer” Call for Fire procedures, we developed a SCORM course comprising 13 SCOs. Each SCO was associated with a global SCORM objective. Initially, each SCO was presented to the user. At the end of these lessons, the user was directed to a simulation (FOPCSIM) in order to practice what they had learned. The simulation set scores against a related set of training objectives; the

LSF mapped the scores on these training objectives to scores on the SCORM objectives. Finally, SCORM Sequencing and Navigation was used to remediate through the lessons, by presenting each SCO only if the user had a low score on the associated SCORM objectives.

The specific steps in the use case, as illustrated in the figure below, are:

1. Through interactions with the SCORM RTE, and traditional SCOs, the trainee is presented with appropriate training material on the doctrine and procedures related to a forward observer calling for fire.
2. Upon the trainee’s completion of appropriate SCOs, the SCORM sequencer encounters a Lightweight Scenario Format (LSF). The LSF identifies the mapping between SCORM objectives in the course and training objectives in training simulations.
3. The SCORM RTE contacts the Distributed Training Event Coordination Service (DTECS),

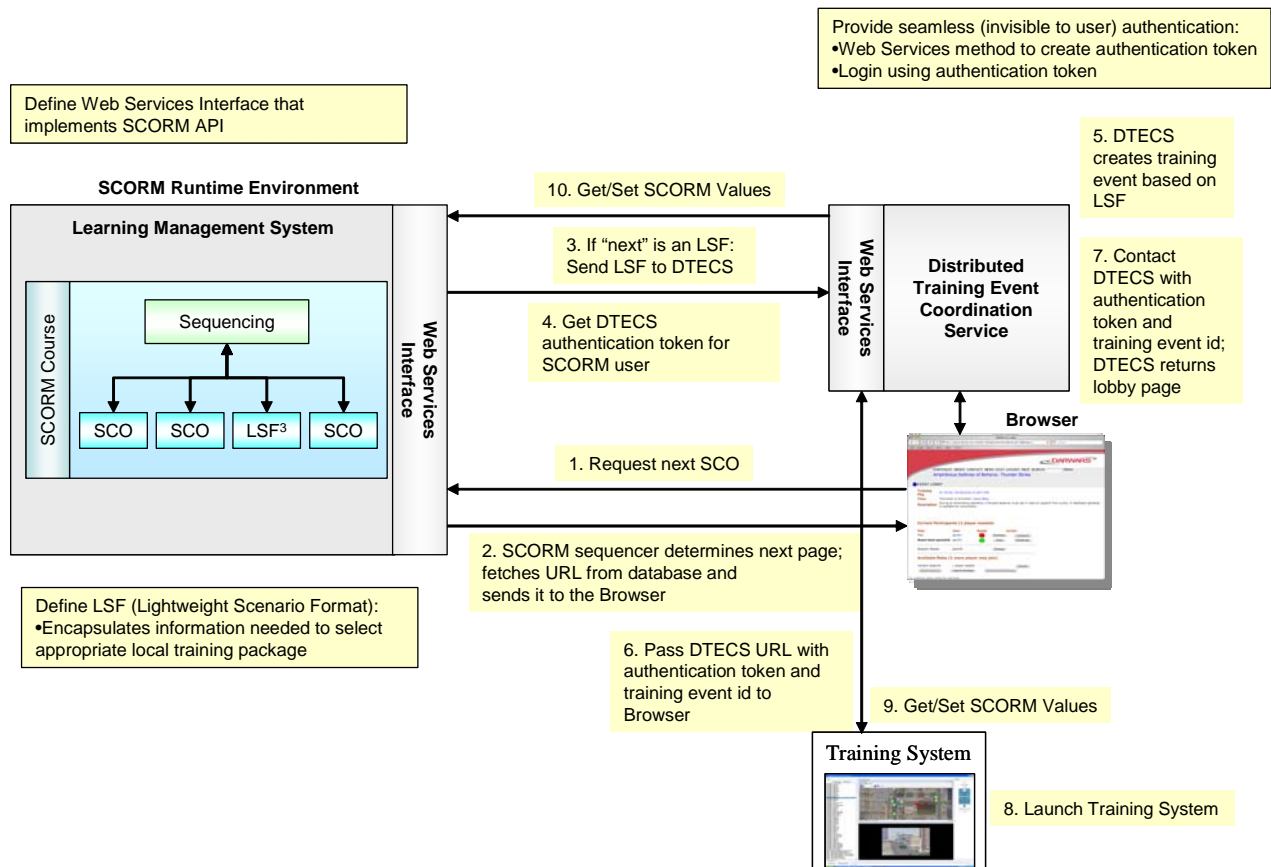


Figure 5: Use Case for Integrating a SCORM course and a Training System

providing the LSF.

4. The SCORM RTE obtains an authentication token from the DTECS that it will later pass to the user's browser. This authentication token supports single sign-on, enabling the trainee to communicate with both the SCORM RTE and the DTECS with one login.
5. The DTECS compares the training objectives identified by the LSF to the training objectives provided by local training systems. The Local Training Package repository at each DTECS includes information about the training objectives that can be met by each local training system configuration. By comparing the objectives identified by the LSF with the objectives in the Local Training Packages, the DTECS selects an appropriate configuration of a training system and creates a training event based on that.
6. One component of the DTECS is a web server that provides access to training selection, scheduling, and a Lobby for trainees and instructors. The Lobby web page includes controls that allow the user to indicate readiness to start training and to actually start the training system. The DTECS sends a reference to the Lobby web page to the SCORM RTE.
7. The SCORM RTE delivers the reference for the Lobby to the user's web browser. From the user's point of view, the Lobby web page is displayed as if it were another SCO; the hand-off to the DTECS is completely invisible.
8. Using the Lobby web page controls (e.g. hitting a "Start" button), the trainee starts the training system. In response to this single user input, the DTECS remotely starts the training system on the user's machine.
9. When the training system is launched, the DTECS provides it with a reference to its Web Services interface. The trainee interacts with the simulation-based training system, for example, using the compass, GPS, and range finder to locate the targets. The training system reports the trainee's performance in meeting the objective to the DTECS. The DTECS communicates this information to the SCORM RTE and may store it in a local repository of training records. The SCORM Sequencer uses this information to select appropriate follow-on or remedial SCOs or LSFs.

#### **BENEFITS OF THIS APPROACH**

There are benefits from this work, first, in providing integrated SCORM and experiential training, and second, in providing a framework to support this training.

While traditional didactic training and experiential training are used in conjunction now, these are typically not tightly coupled. Configuring SCORM courses and experiential training to meet the same training objectives reinforces training. Providing detailed scores against objectives in the experiential portion of the training, and then mapping these results to the objectives in the didactic training makes more efficient use of trainees' and instructors' time. This approach supports automatically directing the trainees to remediate specifically on the material they need. The ability to match didactic training with experiential training allows instructors a degree of autonomy in selecting the best locally available resources, while still supporting re-use of the individual courseware and training systems.

From an architectural standpoint, the use of Web Services interfaces to knit together components and the use of XML schemas to define the data structures exchanged, promotes independent commercial development of the DTECS, training systems, assessment engines and associated tools. Just as the definition of SCORM standards spawned a market in distributed learning, so too, this framework can lead to a market in new tools to support integrated SCORM and experiential training.

#### **CONCLUSION AND NEXT STEPS**

The ultimate goal of this work is to provide improved military training. There are several steps that should be taken in order to reach this goal:

- Deployment in a military training environment. This would provide both a showcase for the benefits of this approach and early feedback to the developers to ensure that the framework can support real-life training needs. At the same time, it will provide an early adopter the training benefits outlined above.
- Release to the distributed learning technical community. We are eager to have this community vet this approach, and to work with them to incorporate their input.
- Development of tools to support course designers and training system developers. In particular, tools are needed to create and edit SCORM course manifests that incorporate LSFs to support experiential training. We are in the process of

reviewing several SCORM course editors with an eye to supporting this level of integrated course creation and editing.

- Develop standards for programming interfaces (Web Services APIs) and data structures (XML Schema Definitions). Once the distributed learning community has vetted the design, the next step is to work through the various standards bodies to define the appropriate standards. Standards will encourage further development by protecting investments in development.
- Incorporate additional components in the architecture. Integrated training does not happen in a void. As envisioned in the IPA, the SCORM and DTECS components interface to additional components to support a complete training environment; these include user profile and training record databases, shared state persistence components to support data requirements of experiential training systems, assessment engines, etc.
- Interface to registries and repositories of course content. Both the SCORM RTE and the DTECS need to be integrated with registries and repositories of re-usable course content. What constitutes “re-usable content” for an experiential training system should be investigated; there are many possibilities for re-use, including sharing missions and scenarios, avatars, models, game engines, etc. Supporting re-use of each of these provides its own challenges and benefits.
- Support for team training. The Joint ADL Co-Lab is funding additional work on integrating didactic and experiential training for teams. As envisioned, team members will use didactic content to train for their individual roles, and then join together in a team

training event in which each member assumes the appropriate role. Performance in the team training event will be used to direct each trainee to remedial material, appropriate for their role.

#### ACKNOWLEDGEMENTS

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