ADL: Preliminary Systems and Content Integration Research within the Next Generation Learning Environment

Thomas N. Archibald
The Tolliver Group, in support of the Advanced Distributed Learning Co-Lab
Alexandria, VA
Thomas.archibald.ctr@adlnet.gov

Jonathan Poltrack
Problem Solutions, in support of the Advanced Distributed Learning Co-Lab
Alexandria, VA
Jonathan.poltrack.ctr@adlnet.gov

ABSTRACT

The Office of the Secretary of Defense (OSD) is planning to develop the next generation training and learning environment that will prepare learners for optimal performance in the increasingly complex environment in which they live and work.

A key contributor to the increasingly complex environment in which we live is the rapid pace of emerging technological innovations. Each of the new technologies provides unique strengths and instructional value. However, not all systems are able to communicate with one another in a way that is easy and useful for learners, instructors and system administrators.

The Advanced Distributed Learning (ADL) Initiative, under the direction of OSD Training Readiness & Strategy (TRS), has conducted preliminary research on the content and systems integration piece of the next generation learning environment that allows data sharing between and across systems by leveraging new and innovative technologies as they enter the market. This preliminary research includes prototype technology that facilitates this communication among emerging technologies. Components of this preliminary research include custom data models and Web Services APIs consisting of virtual world support, social networking and learning profiles support, and legacy content support. Each of these new developments will enable Content-as-a-Service (CaaS). This paper discusses the preliminary R&D specifically regarding the content and systems integration piece of the next generation learning environment.

ABOUT THE AUTHORS

Tom Archibald, PhD is the Advanced Distributed Learning (ADL) Co-Lab Hub Director of Operations. In this position, under the direction of Dr. Kristy Murray, Dr. Archibald is responsible for the management and execution of the ADL Co-Laboratory Hub and partnership lab projects. Dr. Archibald assists in providing direction for the strategic vision and continued expansion of the ADL Initiative. Dr. Archibald has more than 10 years of experience in the educational technology and human performance technology field working on variety of training, education, modeling, and simulation projects. Dr. Archibald also completed 8 years as a U.S. Navy Reserve Intelligence Analyst.

Mr. Jonathan Poltrack is the ADL Technical Team Lead. Jonathan has been involved with the ADL initiative since 1999 where he was an early contributor to the SCORM. As a software engineer, he has contributed to many ADL software projects including the SCORM Test Suite, the Sample Run-Time Environment, the ADL SCORM RELOAD Editor and numerous content examples. Recently, Jonathan has led efforts aimed at transitioning the SCORM while specifying a new learning platform to support new types of systems and content. This includes, but is not limited to, coordination with international specification and standardization bodies.

This article references unpublished work of other ADL personnel to include Kristy Murray, EdD, Elaine Raybourn, PhD, Dean Marvin, Aaron Silvers, Nikolaus Hruska, Shane Gallagher, PhD, Peter Berking, and Jay Allen.

ADL: Preliminary Systems and Content Integration Research within the Next Generation Learning Environment

INTRODUCTION

In the fall of 2010, the Office of the Under Secretary of Defense (OSD) Personnel & Readiness (P&R) updated its Strategic Plan for the Next Generation of Training for the Department of Defense. This new Strategic Plan focuses on the transformation of training and education of the Total Force. In response to this updated Strategic Plan, OSD is planning to develop the next generation training and learning environment that will prepare learners for optimal performance in the increasingly complex environment "characterized by uncertainty, complexity, rapid change, and persistent conflict" (Capstone Concept for Joint Operations, 2009; p. 2) in which they live and work.

In an effort to support this vision, OSD TR&S's goal (long term; 5-10 years) is to create an adaptive, intelligent capability (Personal Intelligent Tutor) that anticipates needs, engages our senses and interoperates seamlessly with yet-to-be-available information; gathering and sharing capabilities with total transparency. This immersive, personalized, intelligent system will:

- Hone cognitive agility, affective understanding, complex decision making, and creative thinking
- Be scalable for small teams and large organizations training in distributed, information-rich, or degraded operations
- Facilitate transformational learning for the Total Force and improve competencies in areas such as information, civil affairs, culture, language, cyberspace, nuclear, missile defense, and space
- Be interoperable across agencies and multi-national partners to permit combined and whole-of-government/nations training
- Facilitate the discovery, access, delivery, management, assessment, and tracking of learning content

In order to support this long-term goal, ADL intends to guide the research and prototype efforts (short term; 1-3 years) of next generation learner capabilities and an Enabled Learning Environment.

Next Generation Learner

Next generation learner research will focus on exploring ways to help learners acquire an "adaptive stance" and increase their learner skills. The term "adaptive stance" refers to an individual's ability to repeatedly try new or different strategies to solve problems, while incorporating useful feedback with the purpose of improving overall success (Grisogono, 2010). Multiple research areas have been identified as possibilities to advance the state of the art in complex decision-making/adaptive thinking training and education (Nelson et.al., 2010). Some of these areas include the assessment of adaptive and complex decision-making behavior patterns over time, measurement of adaptability and complex decision-making in the field and over the course of a career, and effective utilization of micro-world environments or other simulations to a variety of complex situations.

OSD is in the preliminary stages of researching tools that enhance Warfighter skills in problem solving, decision-making, self-regulation, and emotional control.

A significant challenge associated with developing a next generation learner is providing appropriate opportunities which encourage learners to acquire and apply the right types of learning skills suitable for complex, information-saturated environments or

degraded, information-poor environments. Dealing with the abundance of information now available to the Warfighter or employee provides OSD with an opportunity to empower them at a higher proficiency level than ever before. The Warfighter must be able to evaluate information and situations to make correct decisions at the moment. Developing the skills to make sound decisions will require a holistic approach.

Next Generation Learning Environment

OSD recognizes that creation of a next generation learning environment is required in addition to researching and enabling next generation learner capabilities.

The rapid pace of emerging technological innovations further complicates this increasingly complex environment in which we live. Although new technologies afford unique strengths and instructional value, they are all not able to communicate with one another in a way that is easy and useful for learners, instructors and system administrators. This lack of communication among and between systems and content is a key focus area of the Advanced Distributed Learning (ADL) Initiative, under the direction of OSD.

ADL has completed preliminary R&D regarding the content and systems integration piece of the next generation learning environment that allows data sharing between and across systems by leveraging new and innovative technologies as they enter the market. This paper focuses on the preliminary R&D surrounding the content and systems integration piece, or the Enabled Learning Environment, of the next generation learning environment.

ENABLED LEARNING ENVIRONMENT

The enabled learning environment will enable/provide the following:

1) Sharing and integration of performance data across content and systems. Such systems include virtual worlds, complex simulations, Learning Management Systems (LMS), and intelligent tutoring systems.

2) Launch and sequencing of content on remote content servers (Content as a Service (CaaS)).

3) Common data representation to help alleviate problems associated with industry divergence in regard to common data standards.

4) Foundational architecture upon which the Personal Intelligent Tutor can operate to interface with and interpret and use data from other content and systems.

Preliminary R&D progress has been made on individual components of the enabled learning environment. Some of these components include Web Service API integration of virtual world, social networking, learning profiles, and legacy content. Progress has also been accomplished with regards to custom data models. Each of these new developments will enable CaaS. A brief overview of these components and their progress is described in the following paragraphs.

Web Service APIs Development

As described previously, a significant challenge associated with the current technological landscape is the lack of standardized communication between various types of content and systems. For example, when using legacy learning platforms, it is not possible to track learner data from out-of-browser content, content hosted in an external server or repository and content without access to JavaScript. Therefore, ADL has begun looking into the R&D of Web Service APIs that will enable this communication. These new APIs will be built using existing industry standards and will leverage other ongoing efforts. One such effort is the Run-Time Web Service (RTWS) API[1] that modernizes the communication between content and LMSs using a standardized, common data model. Another effort, Project Tin Can,[2] is intended to create an "Experience API" that captures learning experiences in a common way in various types of content and systems.

ADL will incorporate feedback from the efforts listed above and others that support a tailored learning experience to create these new APIs. The following

[1] Created by the Learning Education and Training Systems Interoperability (LETSI) organization

[2] Rustici software is leading this effort. Funds were awarded to Rustici by ADL in response to a Broad Agency Announcement (BAA).

outlines some of the preliminary API research that has been completed to date.

LMS Web Service API

Much legacy content does not communicate securely or in a manner that is congruent with web 2.0/cloud computing. Further, the JavaScript API cannot be used to track data from content hosted on a domain other than that of the LMS. In order to overcome this limitation, ADL has completed proofs-of-concept with a web service API enabling communication between a sample LMS and sample learning content. Prototypes include a Unity serious game, an Android tablet application, a virtual world and hosted content. Each of these components uses the new API to track learner data. In addition, the Android tablet application illustrates an instructor's view of content and enables the instructor to store data about the learner in the LMS. Several of the prototypes above are detailed in the sections below. These proofs-of-concept demonstrate how content launched on different domains and servers share the capability to communicate between an LMS and both in and out-of-browser content using a web service architecture.

Virtual World Support

Tracking learner performance data within an LMS from environments other than the browser (ex. virtual worlds, simulations, mobile devices, etc.) is not currently accomplished in a standardized manner. The primary learning standards are tightly coupled to browser-based content.

However, non-browser-based applications with network access can make web service calls. To test this potential capability, ADL leveraged OpenSim, an open source virtual world platform, and the enabled learning environment prototype LMS as the web service provider to demonstrate tracking of OpenSim experiences using the enabled learning environment prototype LMS. This shows that an LMS can track learner performance data in an interoperable manner within a non-browser-based application (virtual world).

Social Networking and Learner Profiles

Robust learner profiles can be used to enable tailoring of learning content to meet the specific needs of each learner. Unfortunately, the standard learner profile data collected by LMSs (ex. accessibility preferences for language, volume, speed of text-to-speech, and the user's choice for captions) is limited. This limited data does not provide sufficient profile data required to adequately characterize a learner to enable tailored learning delivery; however, social networking sites do. The base majority of these sites contain APIs to access relevant data, including user profiles. Many of these social networking APIs are also openly available and allow access to emerging technologies to perform analytics on users' explicitly shared data.

In order to test these open APIs, ADL prototyped the collection of select users' 'skills' from LinkedIn to see if they could be leveraged to tailor learning materials. The resulting prototype successfully extracted skills from LinkedIn and used the skill data to tailor the learning experience. For example, one sample learner asserted mastery of introductory programming in their LinkedIn skills profile. The enabled learning environment prototype LMS was configured to associate those skills with a legacy global objective. The enabled learning environment prototype LMS used skills information from LinkedIn to skip the introductory programming content module while the user was experiencing the intermediate programming course. The proof-of-concept demonstrates potential integration with learner profile data gathered from social networking services for tailored content delivery.

Legacy Content Support

Agencies, organizations, and institutions both inside and outside of the government are heavily invested in their collections of legacy content. ADL recognizes this investment and understands the need to enable backward compatibility of existing content to be launched and tracked in the enabled learning environment. In order to meet this need, ADL created a wrapper for legacy content that allows backward compatibility. ADL has prototyped a wrapper for SCORM Version 1.2 content to communicate via new APIs. The SCORM Version 1.2 wrapper behaves as a simulated LMS, thus allowing the unmodified SCO to run as originally intended. When the SCO completes its communication session, the wrapper converts all of the communication data from the SCO to a single web service request. This approach is efficient because no changes to existing content are required. Further, after the generic wrapper is created, it can be leveraged to support all legacy content conformant to the same version of SCORM with minor configuration.

Another common issue in today's learning environment involves interoperability errors due to several supported versions of SCORM. The wrapper technique can be leveraged to support content conformant to any version of SCORM by emulating several versions. This prototype demonstrates the ability to support legacy content within this new environment.

Data Models

Current data models are limited. First, legacy content run-time data[3] does not have a standardized representation for transport between systems. Second, no standardized mechanism exists to support new, unique data models created by communities of practice in the current technological landscape.

A simplified, common data model, with customization capabilities, could enable support for legacy content as well as provide LMS vendors and others flexibility to define custom extensions. This added flexibility would allow advanced systems to gather more complex data from the custom extensions, while allowing simpler systems to only gather only required data.

A collaborative prototype effort using The Computer Managed Instruction (CMI)[4]5[5] is currently underway. The group involved in this effort has completed a proof-of-concept focusing on the ability to specify extended and custom data models using an XML binding and XML Schema Definition (XSD) for the emerging Aviation Industry CBT Committee's (AICC) CMI5 specification to be used in the enabled learning environment.

For example, a Unity game prototype was created to illustrate tracking of non-traditional data. The game featured two events, obtaining a coin and character died. The CMI5 prototype was extended to support this user-defined data. As a result, the enabled learning environment prototype LMS was able to store and report back this detailed interaction data. Although a simple example, this method could be extrapolated to a much richer simulation that requires tracking of minute interactions many times a second. A flight simulator could serve as a use case where this level of interaction data would be valuable for assessment or review at a later date.

This proof-of-concept demonstrates that the CMI5 concept is a future-proof technique to extend and develop new data models, and support legacy data models, without having to change the base specification. The resulting technology allows insertion of any data model within the CMI5 envelope.

Additionally, a 'wrapper' was created for legacy courses to enable launch in a CMI5-conformant system. The prototype demonstrates the simplicity and utility of CMI5 to exchange learner data with systems (ex. HR systems) without knowing the intricacies of existing learning standards.

Content as a Service (CaaS) Delivery

Just as Software as a Service (SaaS), a software distribution model wherein applications are hosted by a vendor or service provider and made available to customers over a network, typically the Internet, ADL is looking to enable Content as a Service (CaaS). CaaS would enable users to access content housed on a network, rather than having to upload content into their LMS using a content package (containing all content and a manifest to control launch and sequencing). CaaS could possibly shift the role of the LMS from a course storage, launch, and

[3] The Run-Time Data Model provides a standard set of data model elements used to define the information being tracked by/for a SCO. In its simplest form, the data model defines data model elements that both the LMS and the SCO are expected to *know* about. The LMS must maintain the state of the SCO's data model elements across learner sessions, and the SCO must utilize only these predefined data model elements to ensure reuse across multiple systems.

[4] The new standard incorporates advances in CMI architecture proposed from multiple organizations into one coherent standard.

The goal of the new standard is to simplify and update CMI standards to reflect changes in technology and content distribution practice and to provide a user-definable set of data elements and the option to manage content sequencing by the administrative system.

[5] CMI5 is a joint effort between ADL, AICC, Rustici Software and other learning consortiums to develop a simplified, common 'envelope' to pass learning data. The envelope allows any data model to be defined and passed through the enabled learning environment Web Services.

sequencing system to a content registration and performance tracking system. This would also simplify content lifecycle management as a course would only have to be updated once if a change were desired, rather than having to change the course, distribute the modified course, and uploading duplicates to each LMS.

ADL and the CMI5 working group have integrated their efforts with the LETSI CaaS working group to ensure that the CMI5 specification supports the needs of the CaaS community. Results of this integrated effort have yielded the development of a Course Structure (CSX) XML representation which may replace complex legacy manifest files with a simpler list of resources, which may be external to the LMS, without any sequencing rules.

A prototype CaaS course was created and hosted on a separate content server. The CaaS course was developed to render intelligently based on the delivery device (such as an iPhone, Android, tablet PC, or regular desktop). Server-side technology was used to enable the intelligent rendering. In current learning architectures, it is not possible to use server-side technologies because they cannot be packaged with a course and may not be provided or configured appropriately on the LMS. This proof-of-concept demonstrates successful content launching from 3rd party content servers, showcasing the capability to host learning content outside of the LMS.

Plans for Future Development

ADL plans to guide the further exploration and development of each component of the enabled learning environment through 2011 and 2012. Although ADL has completed preliminary R&D, ADL's role will be to work with partners providing oversight and management of the work moving forward. Given a consistent level of effort moving forward, each of these components should be sufficiently refined and releasable to the public in 2013.

WHY IS THIS IMPORTANT FOR LEARNING?

If you are a training professional, the enabled learning environment has the potential to positively affect your training capabilities in the future. The learning scenario below is intended to illustrate the potential the enabled learning environment enabled training benefits.

Enabled Learning Scenario

Bob, an Air Force Colonel, is required to learn about Information Assurance (IA). Bob has taken multiple IA courses in the past; however, this time Bob is required to take the *management level* IA course.

Bob is directed to a learning portal that knows he should be in this higher level course according to his learner profile data.

Within the learning portal, Bob has access to his Avatar (previously created and that he uses for any virtual world environment), a list of mobile applications with guidance on how best to employ them in this course (Bob can choose which mobile applications he would like to download onto his mobile device), and a list of possible useful references. Bob clicks on the course to view the information about the course. He does not have to separately log into an LMS but can access this information straight from his learning portal.

A requirement of this course is to join a cohort with which he will attend three specific collaborative sessions followed by the submission of a collaborative final product. Once he has committed to a cohort, the other learners' relevant and appropriate contact information appears. Bob notices that members of his cohort are distributed across the United States.

As the time for Bob's first session approaches, he enters the virtual world where he meets the other participants and the computer generated avatar that provides instructions for proceeding through the learning experience. The avatar explains that the emphasis of this IA course is on the analysis, synthesis, evaluation and creation of IA rules, guidelines, and policies. Specifically, this course is based on problems company X has been having with their employees regarding IA. The avatar finishes by explaining learners are free to use any of the resources in or out of the virtual world and the only requirements are to attend the three virtual sessions and submit a final IA employee manual. Some of these resources include real-world colleagues (via skype or other instant messaging services integrated into the virtual world), In-world bots (employees of Org X), legacy e-learning content, the computer generated coach, and reference documentation.

Bob and his cohort (4 team members) decide to break the manual into two sections with two people assigned to each section. Once that is complete, Bob

and his team member, Carol, decide to begin their efforts by interviewing company X's employees regarding IA challenges. These employee video vignettes are available in company X's virtual office.

As Bob progresses through the virtual world he checks his Learning Dashboard (LD) every so often to see what he has completed. The LD tracks all of Bob's activities and outlines Bob's only requirements—to attend and participate in each of the three sessions and submit a final product.

After listening to the first employee's story, Bob and Carol go into a room dedicated for discussion. In that room they begin to post their thoughts on the working document that is projected on the wall.

As Bob and Carol continue through their initial session, Bob receives a prompt to write a couple of sentences as to what he has learned so far that will be posted on the shared Yammer account. All of the participants will be able to share and learn from one another's posts throughout the course.

Bob and Carol continue to listen to employees' stories, sifting through the relevant and irrelevant information, and discussing each of the issues in the collaboration room. After time has passed during this first session, Bob and Carol realize they may need a refresher on IA principles, so they open an e-learning module on the topic.

At the end of session one, Bob and Carol exit the virtual world. However, as Bob is riding the bus home from work something sparks his memory of an employee's comment earlier, so he opens up the interview document on his mobile phone and reviews a few of the key points. He cross references these key points with the IA course also accessed via his mobile device and finds something interesting. He realizes company X employees are not following a key component of IA. Before Bob forgets, he decides to post a comment on his FaceBook area set up for his cohort so they can be sure to discuss during their next session.

Over the next few days, Bob and Carol continue to work on creation of their IA manual out of session reviewing more references, collaborating synchronously and asynchronously with other cohorts, and using the multiple tools available. After a week, Bob and Carol feel ready to submit their draft section of the IA manual to the computer generated coach.

Bob and Carol meet with the computer generated coach in-world (powered by a semantically-based Intelligent Tutoring System) that reads their manual and provides immediate, detailed feedback on their draft.

After obtaining feedback from the computer generated coach, Bob and Carol perform more research and rework specific sections of the draft until they are ready to present their section to the other team members.

During session two, Bob and Carol meet with the other two team members in their virtual world collaboration room where they share one another's sections, provide feedback, and implement the suggestions. When Bob and his cohort are satisfied with the entire IA manual, they submit the document.

Following submission of Bob's cohort's final draft, the document is returned again to Bob's cohort with specific feedback and guidance from the computer generated coach. The computer generated coach tells Bob's cohort that more revisions are required prior to obtaining a 90% passing score or higher.

Bob's cohort reviews the suggestions, implements the suggestions, and resubmits the IA manual. Finally, Bob's cohort receives a passing score of 94%.

Upon completion of this course, Bob and his cohort have leveraged technology appropriately to enable engagement in constructivist learning pedagogy, higher order thinking processes, meta-cognitive processing, adaptive thinking, team-building, and social interactions. They have completed this highly interactive, management level course in a distributed manner.

The creation of the enabled learning environment makes the scenario described above possible along with other types of highly interactive, highly engaging, and instructionally sound learning experiences.

The learning scenario described above demonstrates the following capabilities of the enabled learning environment:

1) Communication of disparate technologies and content that do not currently communicate

    a) LMS tracking of learner's actions in a non-browser based environment

b) Utilization of a learner profile with a learning portal

c) Access to an LMS using a mobile device

d) Integration of an ITS within a virtual world

e) Integration of social media applications within a virtual world

f) Implementation of Content as a Service (Caas)

CONCLUSION

In conclusion, ADL is conducting preliminary R&D toward the creation of the enabled learning environment. ADL realizes it cannot complete this undertaking alone and continues to leverage existing and seeks out new partnerships. Proofs-of-concept have been completed regarding Web Services API development, custom data models, and Content-as-a-Service (CaaS). Although preliminary proofs-of-concept have been completed, ADL will continue to guide the further development, refinement, and testing of these components throughout the coming year with the intention of releasing them for public adoption in 2013.

ADL is also guiding and facilitating the R&D regarding the practical application of the enabled learning environment from a learning perspective. Throughout the coming year ADL will continue to showcase potential applications of the enabled learning environment.

If you are interested in participating in these future efforts, please visit our website at www.adlnet.gov.

REFERENCES

Strategic Plan for the Next Generation of Training for the Department of Defense. (2010). Office of the Under Secretary of Defense (Personnel & Readiness) Readiness and Training Policy and Programs, Washington D.C.

The Capstone Concept for Joint Operations, v3.0. (2009). Department of Defense, Washington D.C.

Grisogono, A. M. (2010). Exploiting Adaptation. Presented at the Operational Adaptation Conference, 22-24 June, Edinburgh, Scotland, UK.

Nelson, J. K., Adis, C., Mueller-Hanson, R. A., and Ferro, M. (2010). Adaptability and Complex Decision-Making Conference, June 16-18 2010 Summary Report. Washington D.C. (contact authors for copy of report)