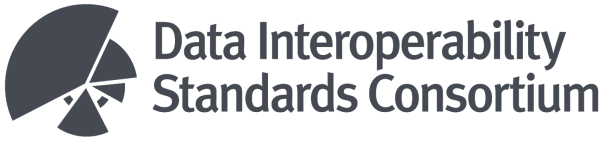
The Experience API (xAPI) Certification Program Recommendations for Learning Record Stores

Robert Todd, Research Lead



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Introduction

USB, short for Universal Serial Bus, is a specification supported by its own non-profit corporation, the USB Implementers Forum[1] (http://usb.org/), and is considered an industry standard that defines the cables, connectors and communications protocols used in a bus for connection, communication, and power supply between computers and electronic devices[2]. USB has a lot of implementations — among them are computer keyboards. ISO/IEC 9995-1 provides a standard description of computer keyboards[3]. In the marketplace, USB and ISO/IEC 9995-1 are leveraged together to manufacture the USB keyboards that are used in workspaces around the world. However, even with these standards, there are differences in the computing platforms that depend on USB keyboards as interfaces, such that Microsoft, Apple and even Linux distributions such as Red Hat have product certification programs to ensure that a given computer keyboard (among other peripheral devices) are compatible with their respective systems.

The Experience API (xAPI) specification is well on its way to becoming an industry standard with technical information relevant for a variety of uses and audiences. Like the purchasers of USB keyboards, purchasers of xAPI-enabled systems need confidence that the software or hardware they buy will work with other xAPI-enabled systems. Certification of xAPI-conformant products will provide consumers with the confidence they need to make analytics an integral part of their learning strategy and infrastructure. If the twenty-one years of USB's success provides guidance on how to approach the challenge of xAPI-related certification programming, product certifications defined by market-driven organizations are built on trust in the testing of functional conformance to a given specification.

In keeping with this idea, the Data Interoperability Standards Consortium (DISC), contracted by the Advanced Distributed Learning Initiative (ADL) to support Learning Record Store (LRS) Conformance Testing, offers the following as its recommendation for certification of LRS functionality ("LRS Certification"). This document builds on the community-developed xAPI Conformance Requirements for Learning Record Stores version 1.0.3 and on broad input from other xAPI stakeholders.

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[1] "About USB Implementers Forum, Inc." Universal Serial Bus. USB Implementers Forum, n.d. Web. 13 Apr. 2017. <http://www.usb.org/about>.
[2] "USB." Wikipedia. Wikimedia Foundation, 11 Apr. 2017. Web. 13 Apr. 2017. <https://en.wikipedia.org/wiki/USB>.
[3] "ISO/IEC 9995." Wikipedia. Wikimedia Foundation, 05 Apr. 2017. Web. 13 Apr. 2017. <https://en.wikipedia.org/wiki/ISO/IEC_9995#ISO.2FIEC_9995-1>.

Purpose of this document

The document describes a program for LRS Certification, including: governance roles and responsibilities for ADL, opportunities for organizations beyond ADL to develop product and technology certification programs that employ xAPI's LRS functionality, testing procedures and supporting business processes.

LRS-as-a-function of xAPI vs. LRS-as-a-product

The xAPI specification is very clear on the definition of a Learning Record Store (LRS).

> "Learning Record Store (LRS): A server (i.e. system capable of receiving and processing web requests) that is responsible for receiving, storing, and providing access to Learning Records."[4]

The specification describes functionality rather than a product category. Nevertheless, in the learning technology marketplace of 2017, there exist products that are called Learning Record Stores. In other spaces, they are similar to Data Warehouse applications. For the purposes of this document, the term Learning Record Store or LRS refers to the functionality defined in the xAPI specification and not any given implementation of that functionality in the form of a product or service.

About the xAPI Community

Throughout its evolution, xAPI has been driven by an enthusiastic community of practice. The xAPI Community remains the driving force behind development of the Specification, its companion Vocabulary document, the Conformance Requirements, the Conformance Test Suite and this certification program recommendation.

Community Engagement

The xAPI community includes both individual and institutional participation from a different group that includes xAPI-conformant tool and platform developers, independent learning designers and consultants, commercial providers of learning content and experiences, and internal learning functions of government agencies, military services and corporations.

Participation in the xAPI Community has included:

[4] ADL. "Adlnet/xAPI-Spec." GitHub. Advanced Distributed Learning, 2016. Web. 13 Apr. 2017. <https://github.com/adlnet/xAPI-Spec>.

The xAPI spec group (launched in 2012)	**283** members
Participants in xAPI camps (launched in 2015)	**690** individuals
Countries with government-led xAPI-centered initiatives for learning analytics	**15**

DISC

The Data Interoperability Standards Consortium (DISC) is a US-based, Pennsylvania-registered Not-for-Profit, dedicated to extending data interoperability. Its mission is to create a data environment where systems can be successfully designed, built, and grown on common expectations of data. When successful, this mission enables increased interoperability, data ownership, and advancements in analytics.

Since 2014, the DISC principals have led initiatives in ADL's stead (the IEEE xAPI Study Group) and advanced industry adoption of xAPI by running conferences, supporting vendors and standards groups from different verticals (HR Open Standards, MedBiquitous, Jisc, LACE, SoLAR) in their work to adopt and create specifications and standards that leverage xAPI.

Concerned with meeting US DoD stakeholder needs around xAPI conformance and certification, and those needs in other industry verticals, DISC began a dialogue with ADL to establish a working relationship through which the consortium could act in concert with ADL's mission, accelerating the development of requirements and processes to couple with the technical research and development efforts within ADL to produce a software test for xAPI conformance.

In June of 2016, ADL awarded a contract to DISC under ADL BAA 12-001 to develop conformance and certification requirements for xAPI such that it can establish and manage an xAPI LRS certification program.

xAPI LRS Certification Program Overview

Through conversations with stakeholders, DISC has been considering alternative models for certification to support several sometimes-conflicting needs. This section provides a brief overview of a proposal for certification requirements and governance. These ideas will be covered in more detail in the sections that follow.

Certification Needs

- Promote consumer confidence via product certification
- Meet the different needs and priorities of multiple communities of practice in extending LRS functionality for learning (e.g. security, data architecture, resource testing,

vocabulary management)

- Support ongoing innovation around xAPI, some of it extending outside of learning (data warehousing, Internet of Things, etc.)
- Resolve the conflict between providing support for continued innovation and the need to provide a stable technical specification that will enable real-world interoperability
- Provide long-term support via an organizational structure that can facilitate the operations and maintenance of a distributed certification program

Certification Model

To meet the competing needs for stability, support for innovation and the differing priorities of individual communities of practice - a modular approach to certification could be ideal. In this model, the core xAPI LRS functionality defined in the conformance requirements document and the xAPI conformance test suite would form the basis for **xAPI LRS Certification**. Additional functional requirements that extend xAPI LRS functionality to meet the needs of one or more communities of practice could be codified in **xAPI-Conformant Product Certifications**.

Under no circumstances may a product or product certification program that leverages xAPI LRS Certification change or break xAPI conformance. For all intents and purposes, any product certification that leverages the xAPI LRS Certification must treat the functional certification as a prerequisite — not to be consumed as part of a larger certification program. ADL would own and continue to evolve the xAPI LRS specification on its own timeline and with inputs from a variety of stakeholders while interested communities would have the latitude to extend xAPI functionality via Product Specifications that address additional functional needs.

Supported Use Cases

The recommended approach to developing a certification program for xAPI takes advantage of ADL's significant role as both the governing body for the xAPI specification and related canonical documents *and* its role as an interface between the commercial market for learning technologies and the US Armed Forces, which commands a significant segment of the total learning technology market spend. This approach positions ADL appropriately as a safeguard to the needs of its US military stakeholders without entangling ADL (or the US Department of Defense, by extension) into a commitment to xAPI any longer than it finds valuable while safeguarding the burgeoning market for xAPI against the potential for disruptive changes in funding, staffing or policy within US DoD. As well, the recommended approach supports a multitude of organizations who are likely to develop internal or publicly available product

certification programs that require LRS Certification.

IMS

IMS is an organization with its own standard for learning analytics, Caliper. Caliper is very similar to xAPI — so much so that in 2016 ADL re-joined IMS to support discussions on any number of possibilities for convergence among Caliper and xAPI. While it is uncertain (maybe unlikely) that Caliper will evolve into a straightforward xAPI Profile, that possibility would be more enabled if IMS could retain control over Caliper's Product Certification program. Should this recommendation for LRS Certification be followed, IMS would not have governance over the core xAPI specification, but it would be able to govern its own certification program that leverages LRS Certification as a prerequisite. IMS could be licensed by ADL as a Certified Testing Provider, developing its own product certification programs for Caliper assuming their Caliper certification testing would not negate anything in the LRS Certification test.

OPM

In order to accelerate the deployment of learning technologies, it is foreseeable that the Office of Personnel Management may wish to roll in LRS Certification into its acquisition and deployment processes. In such a scenario, OPM could be licensed by ADL as a Certified Testing Provider, including LRS Certification testing as part of a number of tests it deems necessary to deploy learning technologies as part of the USA LEARNING program.

DISC

As ADL is the interface for the market into the needs of US Armed Forces, DISC is an interface for ADL and many other organizations into stakeholders for xAPI that come from different industry verticals and different nations. For vendors, stakeholders and partnering organizations wanting to take advantage of a shared facilitator focused on navigating complex business demands for xAPI in implementation, DISC (and likely other organizations like it) could certify product categories applicable to multiple industry vertical that depend on data interoperability provided by products such as Data Warehouses, which lack software certification programs broadly and need to support LRS functionality to support xAPI in broader enterprise adoption.

As the Commonwealth of Pennsylvania's Information Technology Standard for "Data Warehouse Standards" states,

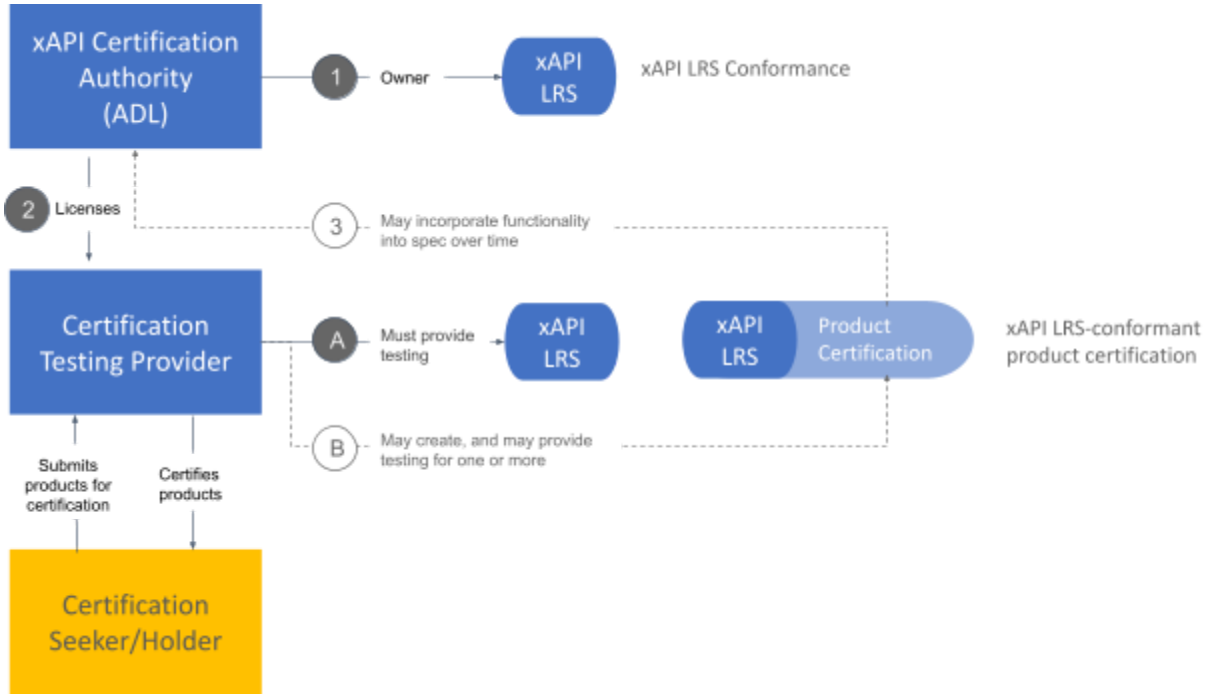
> *"Data Warehousing is a process for building decision support systems and a knowledge-based application environment in support of both everyday tactical decision making and long-term business strategy. Data Warehouses and Data Warehouse applications are designed primarily to support the decision-making process by providing the decision makers with access to accurate and consolidated information from a variety of sources. The primary objective of Data Warehousing is to collate information from*

disparate database sources and place the information in a format conducive to the decision-making process. This objective necessitates a set of activities more complex than merely collecting data and reporting against it. Data Warehousing requires both business and technical expertise…"[5]

Certification Governance

This modular approach would extend to certification governance, allowing ADL to focus on its core mission of shepherding a stable and rigorous xAPI specification without the distraction of operating testing and certification centers for different communities and geographies and with reduced pressure to evolve the core xAPI LRS specification to meet the evolving needs and timelines of various communities.

xAPI Certification Program Roles And Responsibilities



[Note: the terms used to define roles and responsibilities here are placeholders and will likely change where they conflict with existing terms of art and legal definitions.]

xAPI Certification Authority - ADL

As the xAPI Certification Authority, ADL will be responsible for continued development of the xAPI specification, conformance requirements and conformance test suite, and will license

[5] "Data Warehouse Standards." INFORMATION TECHNOLOGY STANDARD (2016): n. pag. Department of Human Services. Commonwealth of Pennsylvania, 9 Feb. 2016. Web. 18 Mar. 2017. <http://www.dhs.pa.gov/cs/groups/webcontent/documents/document/p_032402.pdf>.

Certification Testing Providers (CTPs). The Certification Authority is not necessarily responsible for xAPI-Conformant Product Certifications.

Certification Testing Provider (CTP)

Certification Testing Providers will be licensed by ADL to test and certify xAPI LRS Conformance as a stand-alone test or as part of a 3rd party Product Certification. CTPs will provide testing services for one or more communities and will meet basic service level guidelines defined by ADL. CTPs are potential developers of 3rd party product certifications and partners for ADL in gathering community requirements, but 3rd party developers do not have to be CTPs, and CTPs will not necessarily be developers of 3rd party product certifications.

The details of the licensing of CTPs are to-be-determined in a future phase of work, perhaps performed by DISC, should the option to develop the certification program be exercised by ADL.

Certification Research Findings

The certification approach outlined above was developed based on input gathered from the xAPI community through several channels organized by DISC in September 2016–January, 2017.

Sep, Oct 2016, Weekly	Online meetings with practitioners	Open forum, community needs and best practice sharing
Nov, Dec 2016, Monthly	Broader, online community meetings	Open forum, community needs and best practice sharing
Sep 2016	Online discussion board	Elicit open feedback on what is needed to support xAPI interoperability
November 2016	2 online surveys	Gather community input on certification priorities
Nov, 2016 - Jan, 2017	30+ Telephone, VC and face-to-face interviews with vendors and stakeholders in US government and military, commercial enterprise, higher education and standards organizations	Discuss certification needs and priorities

The xAPI community is far from homogenous. The community includes: a core set of vendors who have made xAPI a foundation of their value proposition, older LMS and authoring tool vendors who are more cautiously adding xAPI support, and a growing cadre of learning technologists and instructional designers – from evangelists for new ways of designing learning to professionals just trying to stay current with the next technology trend.

Necessarily, the community engagement process that led to the development of this proposal, which continues today, was largely discovery-based – open-ended conversations with different stakeholders to understand their needs. In only a few cases quantitative tools were used to seek more objective data on community needs, but they did provide helpful directional guidance on community priorities.

Most Common Themes

The following issues have emerged as priorities from the discussions, interviews and surveys with the xAPI community. They are presented here as the voice of the community. They may be addressed through in the spec, in an xAPI-Conformant Product Certification or they may be deferred until best practices have been established

Business Needs

Reducing Dependencies/Risk–the vendor community, appreciating the crucial role of ADL in the ongoing development and adoption of xAPI, would like to reduce dependencies on any single organization for the development of the specification and delivery of a certification program.

Prioritization of certification goals – the vendor community also commented, through an online survey, on overall priorities for an xAPI certification program. Vendors were asked to prioritize 5 potentially competing goals which were synthesized from community conversations. Two of the 5 goals were identified by a majority or near majority of the 16 survey respondents as their 1st or 2nd priority (n=14).

1. Simplicity for the customer in buying xAPI certified products – 57%
2. Reducing cost and complexity for vendors – 50%

Certification Governance: Roles and Responsibilities

Role of the xAPI Certification Authority

The LRS is the hub of xAPI interoperability. By maintaining stewardship of the xAPI spec and conformance requirements and licensing 3rd parties to test and certify xAPI LRS conformance, ADL maintains its central governance role, while creating a framework for innovation by others who seek to extend the xAPI environment with authoring tools, analytics engines, data warehouses and other xAPI LRS-based products.

Specification Governor

As Certification Authority, ADL will be aware of the needs of the different communities using and extending xAPI functionality and will have the ability and the responsibility to update the spec where and when it will benefit the overall interoperability of technologies in the xAPI environment.

Licensor of CTPs

As Certification Authority, ADL will set basic requirements for CTP capabilities and Service-Level Agreements (SLAs) that would ensure CTPs are benefitting the overall xAPI community. ADL will grant a license and/or establish a Memorandum of Understanding (MOU) with such CTPs and make their contact information available.

Role and Qualification of Certification Testing Providers

CTPs will provide a basic set of services, defined by the Certification Authority, in support of xAPI-LRS certification and testing and may provide similar services for 3rd party Product Certifications.

xAPI Evangelists and Educators

Certification testing providers have a stake in the success of xAPI and the people and organizations that are adopting xAPI. As such, they should be engaged in some meaningful way in evangelizing the benefits of xAPI and in educating their communities about effective use of xAPI conformant solutions. It would be difficult and likely counterproductive to set specific performance standards for education and evangelism, but it should be clear that there is a community of practitioners that rely, or likely will rely on the organization as a source of xAPI information and support.

Certification Testing and Support

CTPs should have the technical and domain (e.g. learning, education) expertise to conduct testing and to provide support to certification applicants including:

- Test execution and technical support for applicants in resolving conformance issues
- The customer service skills to assist applicants in preparing for and moving efficiently through the certification process
- Sufficient knowledge of the institutional domain of the communities they serve
- Timely review and approval of testing registrations

Certification Website

ADL will provide a core set of supporting resources for xAPI LRS conformance. A CTP should provide a well-maintained and (as appropriate) localized, or audience-specific portal that provides:

- The core support docs from ADL
- An overview of the testing process including FAQ and instructions for test preparation
- A testing registration form and calendar/reservation system
- Asynchronous technical support for entities that have completed the self-test and are seeking help to resolve technical issues in preparation for certification testing
- Access to badging and documentation related to a given certified product
- A public record of the products they have certified

Role of 3rd Party Developers of Product Specifications

Any party may create a specification that leads to a 3rd Party Product Certification that include xAPI LRS Certification as a prerequisite, but only an official ADL CTP can test for xAPI LRS Certification. Therefore an organization that wants to propagate a Product Certification that extends xAPI will either need to be a CTP or partner with a CTP to provide the xAPI LRS Certification testing upon which the 3rd Party Product Certification relies.

Consider a company (like IBM) that licenses other manufacturers (like Toshiba) to develop OEM server appliances with embedded software to provide an enterprise data warehouse (as IBM does with Yet Core). Should they wish to certify third-party providers as part of their quality control process, they likely would develop a product specification that addresses many functional elements of the appliance that go beyond the scope of the xAPI specification and still require xAPI LRS certification to be passed to ensure interoperability of their LRS functionality. In the case of IBM, this wouldn't be an "IBM xAPI Certification."

Further planning should be put towards any naming constraints that go into a 3rd Party Product Certification that relies on (or presupposes) xAPI LRS Certification. There may be a need to reserve some terms to be blacklisted from product certification naming conventions that may

be included in licensing terms to CTPs, among them “xAPI” and “LRS” to avoid market confusion.

Certification Applicant - All certification seekers

Any person or organization that can pass the freely available base conformance self-test. While it is not mandated that a CTP charges fees for certification testing, a CTP may demand fees and make their system available for testing to a CTP is eligible for xAPI LRS certification. These fees and any terms associated with them must be explicit and transparent to any person considering the certification test. Certification applicants will be asked to:

Evaluate readiness

- Read and familiarize themselves with certification requirements
- Run the ADL xAPI LRS Test Suite
- Correct any areas of non-conformance

Register for testing

- Submit an application for certification with results from a clean conformance self-test
- Schedule a certification test and pay the testing fee prior to the test date
- Provide necessary credentials for system access and identify a technical contact who will be available during the testing window

Resolve any areas of non-conformance

- Maintain availability of technical contact during testing
- Respond to non-conformance issues in a timely manner to allow for the completion of certification testing and award of certification

Certification Scope

The requirements for xAPI-LRS Certification are described in the xAPI Conformance Requirements Document. All tested requirements, stated as “must,” are to show successful outcomes in full for certification.

Certification Testing Procedure

Overall approach

Certification testing should be rigorous to enhance interoperability. All efforts should be made to help product developers build and submit robust, conformant products to be certified. Whatever efforts can be reasonably made for developer success will benefit the community by making the testing process as painless as possible for all parties.

Certification applicants may pay a fee to cover the costs involved with certification testing and to help sustain the ongoing operations of CTPs. At the time of this writing, more work is needed to scope and better estimate the cost and level of effort required for the worst-case certification testing scenario. It is recommended that ADL set a reasonable and standard fee for the issuance of the functional certification. This allows CTPs to provide quality service to applicants at costs and with policies established by the CTPs and establishes a common expectation for baseline cost of the certification on applicants and organizations.

Automated testing will be conducted using ADL's LRS Conformance Test harness to assess each conformance requirement as supported by the Conformance Test. If a technology fails any part of the test, the Certified Testing Provider will provide appropriate guidance to the Certification Applicant as to the test(s) that failed and possible approaches to remedy. CTPs should have some discretion in managing the level of support they are providing to applicants who fail the test repeatedly.

Certification Term and Recertification Process

For certified products, recertification is triggered under any of the following conditions:

- ADL releases a new version of the xAPI specification with breaking changes - a dot-release or a major release represent such revisions, assuming semantic versioning[6] is respected.
- The certified technology changes.

Breaking Changes to the xAPI Specification

It is recommended that the xAPI LRS Certification term persist until a new dot-release or major

[6] Preston-Werner, Tom. "Semantic Versioning 2.0.0." Semantic Versioning. N.p., n.d. Web. 14 Apr. 2017. <http://semver.org/>.

release (a “1.x” or a “2.x”) of the xAPI Specification, its related Conformance Requirements and Conformance Test are publicly available. When such a release happens, it is recommended there is a six-month window for a dot-release and a year-long window for a major release for a given technology to re-certify to the new version of the specification.

Barring a new dot-release or major release of the xAPI specification, it is recommended that as long as a given technology is not modified from the version that is tested (and passes) for certification, a granted certification should remain valid.

This in-keeping with the certification license terms for USB[7], Wi-Fi[8] and other baseline technologies that are used broadly across industry verticals.

In the advent of a dot-release or a major release of the specification, their associated windows for re-certification may be reasonable for product vendors, especially certified product vendors, to update their software in preparation for re-certification.

Prior to a first dot or major release of the xAPI specification, ADL may revisit the recommended certification windows for a version-triggered recertification.

Modification to the Certified Technology

When a certified technology is modified from the version that has been certified, it should recertify prior to a public release of the modified technology. This is also in-keeping with the certification license terms for USB, Wi-Fi and other baseline technologies that are used broadly across industry verticals.

Workplan for Certification Program Development

Define and Document Business Process

- Draft certification business process and define support model and staff resources
- Define staffing qualifications for testing and process management
- Hire or contract program support staff
- Build certification website with an index of CTPs, an index of aggregated certified technologies and other resources specific to the support of functional certification of conformance.

[7] "Getting a Vendor ID." Universal Serial Bus. USB Implementers Forum, n.d. Web. 12 Mar. 2016. <http://www.usb.org/developers/vendor/>.
[8] "Certification Overview: Process." Process Intensification (2008): 21-45. Wi-Fi Alliance. Wi-Fi Alliance, 2008. Web. 3 Apr. 2017. <https://www.wi-fi.org/download.php?file=/sites/default/files/private/Certification%20Overview%20-%20Process%20v3.4.pdf>.

Launch Certification Program

- Hold community briefings on finalized certification requirements and process
- Issue a press release about the availability of certification
- Contact trade media to discuss story placement on the importance of xAPI to the evolution of learning and learning technology
- Make registration for testing available on the certification website

Appendix: Other Research Findings

Functional Enhancements to Support Interoperability

Based on the response from community members, there are several additional areas that are seen as important to the goal of real-world LRS interoperability AND are not included in the xAPI 1.0.3 Conformance Requirements. These findings lack direct bearing on LRS Certification, but as the research effort engaged a broad set of vendors and stakeholders, the findings herein merit ADL's attention.

The reasons why these areas are not addressed in the Conformance Requirements vary. In some cases, the candidate requirement is not a MUST or WILL in the current xAPI specification. In others, the candidate requirement is not addressed in the xAPI specification at all.

Profile validation
The most consistent area of need expressed in interviews with community members across roles and sectors is the ability to create profiles and have statements validated against those profiles. This is functionality that would be better reinforced with profiles and vocabulary sets supported with persistent identifiers and authoritative registries making profile schema available for validation.

Timestamp Behaviors
A current lack of specificity in the spec makes timestamp entries unreliable. Given that the duration and sequencing of activities in a learning experience is critical to understand the learning process, certification should include additional definition of timestamp behaviors such as ensuring that time is recorded in UTC to normalize timestamps in all statements. There may be other factors that make timestamp entries unreliable, and could merit further study.

Interaction Component Validation
In Section 2.4.4.2 of the xAPI Specification, several cmi.interaction models are referenced. It is highly requested that certified LRSs validate statements for appropriate response patterns for a given interaction type, specifically the behavior referenced that "An LRS, upon consuming a valid interactionType, MAY validate the remaining properties as specified for Interaction Activities and MAY return 400 Bad Request if the remaining properties are not valid for the Interaction Activity."

Security Practices
Interviews with stakeholders revealed challenges to a uniform approach to security and

authentication. For example, the Office of Professional Management recommends Fedramp certification, which connects NIST requirements for security with DISA requirements in the US Department of Defense. Logically, it follows that Fedramp certification would be sufficient to address cybersecurity and information assurance requirements. Our findings indicate that implementation of Fedramp is fragmented, with variants such as FedRamp Plus being implemented, but not uniformly. In other words, there are multiple approaches to security in practice, and while correlations exist, there is no visible pattern to how or with what a given organization secures itself. More study is needed to determine the scope of what may be expected. One constant that may be considered for initial LRS certification is the use of https. More study would be helpful to further detail what LRSs must support.

Consistently Supported Authentication Protocols

Interviews with stakeholders revealed challenges implementing an LRS with multiple learning record providers, each with different authentication mechanisms. Thus, some organizations expend considerable technical resources on custom approaches to abstracting authentication away from the LRS, creating middleware that supports multiple forms of authentication mapped to a token for identity that the LRS recognizes. More study is needed to determine the specific protocols that might be reinforced through certification, though in addition to mbox, the scope may require OAuth 1, OAuth 2, OpenID, SAML, and/or CAC card.

Testing tools

An extensive conversation with the Army DL team highlighted the need for testing tools that can validate the conformance of third party developed LRPs. The Army team has an extensive process for testing and validating SCORM content that blends ADL provided tools with internal processes. The amount of content they validate is extensive and they rely heavily on the these tools. The Army DL team also provided a list of functional requirements for mobile content that they indicated would apply to their expectations for xAPI. This has implications for Learning Record Providers and Learning Record Consumers and more study is needed.

Community prioritization of functional enhancements

The research captured frequently discussed functional enhancements. Community members rated their importance to the goals of certification. Seven functional enhancements were deemed important or very important to a majority of respondents.

Imp. or V. Imp.	Enhancement	Description
77%	**Timestamp Behaviors**	Requiring timezone be included and time recorded in UTC, etc)
72%	**Interaction Component Validation**	Requiring interactions identified in the xAPI specification to be validated by the LRS
69%	**Security Practices**	Requiring https and other practices
69%	**Profile Validation to a Specification**	Requiring existing profiles be validated, like the SCORM and CMI5 profile data models
67%	**Credential Enforcement**	Requiring the LRS enforce allowed behavior for specified credentials in all requests
62%	**Authentication Method**	OAuth 1, OAuth2, SAML, OpenID, and/or CAC cards
58%	**Agent Definition Rules**	Requiring the LRS to update its Agent Definition in a particular way

Implications for xAPI LRS specification development

As the governor of the xAPI specification, ADL will determine which, if any, functional enhancements referenced above should be added to those already documented in the xAPI Spec and Conformance Requirements for xAPI LRS Certification. If ADL chooses not to address these issues in the specification, the modular certification structure proposed in this document *could* provide a mechanism to allow some or all to be addressed by 3rd party Product Specifications and any associated certification programs. For a candidate functional enhancement to be considered, ADL should be able to confidently answer yes to all the following questions:

1. Does the benefit of the enhancement to the goals of certification outweigh the costs to xAPI community participants?
2. Is there a model/method for the enhancement in general use today, or can a model/method be defined from common practice?
3. Do a majority of community members support the proposed model/method?
4. Can the proposed model/method be specified with a similar level of rigor as the conformance requirements?

Appendix: List of Stakeholder Interviews

Office of Professional Management (OPM)

Paul Jesukiewicz

US Department of Defense

Army

Mitchell L (Mitch) Bonnett

Robert F. Hess

Lt. Col. Michael Pavek

Charles Touron

Navy

Daniel A Latourelle

Danny L Nuckols

Hank Reeves

Virgil Hart

Mike Hernandez

Katharine Garris

Air Force

Timothy Flora

Marines

Larry Smith

Joint Knowledge Online (JKO)

Joseph D. Camacho

Foreign Military

Bill Railer

Higher Education

Andrea Deau, University of Wisconsin
Kirsty Kitto, University of Sydney
Ellen Meiselman, University of Michigan

LMS and LRS Vendors

Robert Gadd, OnPoint Digital
Nick Washburn, Riptide Software
Art Werkenthin, RISC, Inc.
Mike Rustici, Watershed
Tim Martin, Rustici Software
Ben Betts, HT2 Labs
Shelly Blake-Plock, Yet Analytics

Organizational Stakeholders

Mark Oehlert, Amazon
Eric Nehrlich, Google
Adam Menter, Autodesk

Standards Bodies

Ian Dolphin, Apereo Foundation
Kim Bartkus, HR Open Standards
Valerie Smothers, MedBiquitous
Niall Sclater, Jisc

Authoring Tool Vendors

John Blackmon, Trivantis
Luke HIckey, DominKnow

Consulting Services

Phillip D. Antonelli, Conduent

Mike Hruska, Problem Solutions

Anthony Altieri, Omnes Solutions

Megan Torrance, Torrance Learning