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Learning technology — JavaScript Object Notation (JSON) data model format and Representational State Transfer (RESTful) web service for learner experience data tracking and access —

Part 1-1: xAPI using JSON serialization and RESTful data transport

Technologie de l'apprentissage — Format de modèle de données JavaScript Object Notation (JSON) et service web Representational State Transfer (RESTful) pour le suivi des données de l'expérience de l'apprenant et l'accès à ces données —

Partie 1-1: xAPI utilisant la sérialisation JSON et le transport de données RESTful

Reference number
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IEEE Std 9274.1.1™-2023

IEEE Standard for Learning Technology—JavaScript Object Notation (JSON) Data Model Format and Representational State Transfer (RESTful) Web Service for Learner Experience Data Tracking and Access

Developed by the
Learning Technology Standards Committee
of the
IEEE Computer Society

Approved 30 March 2023

IEEE SA Standards Board

Abstract: This standard is a collaborative effort to improve and standardize the 1.0.3 version Experience Application Programming Interface (xAPI) specification. This Standard describes a JavaScript Object Notation (JSON) data model format and a Representational State Transfer (RESTful) Web Service Application Programming Interface (API) for communication between Activities experienced by an individual, group, or other entity and a Learning Record Store (LRS). The LRS is a system that exposes the RESTful Web Service API for the purpose of tracking and accessing experiential data, especially in learning and human performance.

Keywords: Experience API, IEEE 9274™, IEEE 9274.1.1™, JavaScript object notation, JSON, Learning Record Provider, Learning Record Store, LRP, LRS, representational state transfer, REST, xAPI

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Experience API Specification documents are a product of Research and Development efforts led by the Advanced Distributed Learning Initiative, which is a DoD program under the Office of the Deputy Assistant Secretary of Defense (Force Education and Training).

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Introduction

This introduction is not part of IEEE Std 9274.1.1-2023, IEEE Standard for Learning Technology—JavaScript Object Notation (JSON) Data Model Format and Representational State Transfer (RESTful) Web Service for Learner Experience Data Tracking and Access.

Today's learning ecosystems, digital applications, content, and web-based tools take advantage of large amounts of learning data to provide learning analytics to improve curricula, to apply artificial intelligence for the purpose of making recommendations, to visualize data in ways that leverage advances in both data logistics and human-centered computing, and many other emerging use cases. Due to a lack of standardized technologies for these use cases, the vendors creating these platforms are forced to create proprietary solutions. The result is a locked-in environment where a single vendor may levy undue control over all parts of a learning ecosystem—to the detriment of learning objectives.

In response to this modernization, an Open-Source collaborative effort resulted in the creation of the Experience API (xAPI). This Standard is a collaborative effort involving that same community, partnered with the IEEE to improve upon and standardize version 1.0.3 of the xAPI. Artifacts and the latest versions of this specification can be found at https://opensource.ieee.org/xapi/xapi-base-standard-documentation.

This standard describes a JavaScript Object Notation (JSON) data model format and a Representational State Transfer (RESTful) Web Service Application Programming Interface (API) for communication between Activities experienced by an individual, group, or other entity and a Learning Record Store (LRS). The LRS is a system that exposes the RESTful Web Service API for the purpose of tracking and accessing experiential data, especially in learning and human performance.

Historical contributors

In collection of requirements for the xAPI, many people and organizations provided invaluable feedback to the SCORM, distributed learning efforts, and learning technology efforts in general. While not an exhaustive listing, the white papers gathered in 2008 by the Learning Education and Training Standards Interoperability (LETSI) group, the Rustici Software UserVoice website, one-on-one interviews and various blogs were important sources from which requirements were gathered for the xAPI specification.

ADL's role in the Experirence API (xAPI)

The Advanced Distributed Learning (ADL) Initiative took on the roles of steward and facilitator in the development of the xAPI. The xAPI is seen as one piece of the ADL Total Learning Architecture (previously the Training and Learning Architecture), which facilitates learning anytime and anywhere. ADL views the xAPI as an evolved version of Sharable Content Object Reference Model (SCORM) that can support similar use cases but can also support many of the use cases gathered by ADL and submitted by those involved in distributed learning that SCORM could not enable.

How to contribute

To contribute to this effort, please register to join the IEEE SA 9274.1.1 Working Group

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IEEE Standard for Learning Technology—JavaScript Object Notation (JSON) Data Model Format and Representational State Transfer (RESTful) Web Service for Learner Experience Data Tracking and Access

1. Overview

The Experience API (xAPI) is a standard that describes an interoperable means to document and communicate information about learning experiences. It specifies a structure to describe learning experiences and defines how these descriptions can be exchanged electronically.

In assessing candidates' suitability for positions or their capability for performing various tasks, there is a need to consider a wide range of formal and informal learning experiences, both on and offline. That information, more often than not, is scattered across a wide variety of sources.

Out of this decentralized environment, the Advanced Distributed Learning (ADL) Initiative created the original xAPI community and specification. The working group effort was moved to the IEEE in 2019.

xAPI assumes that:

— There is a need to be able to analyze information about learning experiences and their outcomes distributed across a wide variety of sources, platforms and technologies.

— Developing a commonly-accepted framework for gathering, storing and exchanging this information represents the best way of achieving this.

The goals of the xAPI are:

— To make it easier to understand and compare learning experiences and their outcomes recorded across a wide variety of contexts, platforms and technologies.

— To maximize interoperability of services which create, gather, store and process information about learning experiences.

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— To provide a guide to those who want to build applications that conform to and implement this specification.

— To provide criteria against which conformance to this specification can be tested.

The xAPI Base Standard is an IEEE Open Source Project hosted on the IEEE Open Source Platform (it is licensed under the terms of the Apache 2.0 License and copyright the IEEE XAPI Authors see xAPI About for licensing and copyright information as well as additional information on contributing to this open source project). You can find this document and other open source resources related to the xAPI Base Standard at https://xapi.ieee-saopen.org.

Additional xAPI Base Standard resources are available as described below:

— xAPI Base Standard documentation

— xAPI Base Standard markdown

— xAPI Examples (See also Annex A)

1.1 Scope

This standard describes a JavaScript Object Notation (JSON) data model format and a Representational State Transfer (RESTful) Web Service Application Programming Interface (API) for communication between Activities experienced by an individual, group, or other entity and a Learning Record Store (LRS). The LRS is a system that exposes the xAPI RESTful Web Service API for the purpose of tracking and accessing experiential data, especially in learning and human performance.

1.2 Purpose

The purpose of this standard is to provide an interoperable means to store and retrieve learning experience data as required by modern, data-intensive learning technologies.

1.3 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).[6,7]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

[6] The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.

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FIPS PUB 180-2, Secure Hash Signature Standard (SHA2).[8]

IEEE Std 754™, IEEE Standard for Floating-Point Arithmetic.[9,10]

IETF RFC 2046, Multipurpose Internet Mail Extensions (MIME) Part Two: Media Types.[11]

IETF RFC 2616, Hypertext Transfer Protocol – HTTP/1.1.

IETF RFC 3629, UTF-8, a transformation format of ISO 10646.

IETF RFC 3987, Internationalized Resource Identifiers (IRIs).

IETF RFC 4122, A Universally Unique IDentifier (UUID) URN Namespace (IRIs).

IETF RFC 5646, Tags for Identifying Languages.

IETF RFC 7231, Hypertext Transfer Protocol (HTTP/1.1): Semantics and Content.

IETF RFC 7515, JSON Web Signature (JWS).

IETF RFC 8259, The JavaScript Object Notation (JSON) Data Interchange Format.

ISO 639, Code for the Representation of Names of Languages.[12]

ISO 3166-1, Codes for the Representation of Names of Countries and Their Subdivisions—Part 1: Country Codes.

ISO 8601, Date and time—Representations for information interchange.

SemVer, Semantic Versioning 1.0.0.[13]

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[13] Available at: https://semver.org/spec/v1.0.0.html.

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3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.[14]

Activity: A type of Object making up the "this" in "I did this"; it is something with which an Actor interacted. It can be a unit of instruction, experience, or performance that is to be tracked in meaningful combination with a verb. Interpretation of Activity is broad, meaning that Activities can even be tangible objects such as a chair (real or virtual). In the Statement, "Anna tried a cake recipe," the recipe constitutes the Activity in terms of the Experience API (xAPI) Statement. Other examples of activities include a book, an e-learning course, a hike, or a meeting.

Activity Provider (AP): Now referred to as a Learning Record Provider (LRP). This change differentiates that the Activity itself is not always the responsibility of software, rather just that the tracking portion is.

Actor: An individual or group representation tracked using Statements performing an action within an Activity. The Actor is the "I" in "I did this."

Application Programming Interface (API): A set of rules and standards created to allow access into a software application or tool.

authentication: The concept of verifying identity. Authentication allows interactions between two "trusted" parties.

authorization: The affordance of permissions based on role; the process of making one party "trusted" by another.

client: Refers to any entity that might interact through requests. Some examples could be a Learning Record Provider, a Learning Record Consumer, a Learning Record Store (LRS), or a Learning Management System (LMS).

community of practice (CoP): A group of practitioners connected by a common cause, role or purpose, which operates in a common modality. CoPs are focused on implementing xAPI within a specific knowledge domain or use case. CoPs, or independent developers, can create domain-specific vocabularies, profiles, and recipes. These practices usually involve work around defining use cases and curating the various vocabulary terms, synonyms, and other related metadata that might be preferred within a CoP. They can also reuse existing vocabularies, profiles, and recipes already published by other CoPs or participants of the xAPI community.

document profile resource: A construct where information about the learner or activity is kept, typically in name/document pairs that have meaning to an instructional system component. Not to be confused with profile.

endpoint: An entry point in a service-oriented-architecture. xAPI mirrors this approach with document profile resources by defining the Internationalized Resource Identifier (IRI) from which communication takes place as an endpoint.

Experience API (xAPI): The collection of rules articulated in this document which determines how learning experiences are defined, formatted, and exchanged so that independent software programs can exchange and make use of this information.

immutable: Adjective used to describe things which cannot be changed. With some exceptions, Statements in the xAPI are immutable. This helps to ensure that when Statements are shared between Learning Record Stores (LRSs), multiple copies of the Statement remain the same.

[14] *IEEE Standards Dictionary Online* is available at: http://dictionary.ieee.org. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.

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Internationalized Resource Identifier (IRI): A unique identifier which could be an IRL. Used to identify an object such as a verb, activity, or activity type. Unlike Uniform Resource Identifiers (URIs), IRIs can contain some characters outside of the ASCII character set in order to support international languages. IRIs always include a scheme. This is not a requirement of this standard, but part of the definition of IRIs, per RFC 3987.[15] What are sometimes called "relative IRIs" are not IRIs.

Internationalized Resource Locator (IRL): In the context of this document, an IRL is an IRI that when translated into a Uniform Resource Identifier (URI) (per the IRI to URI rules), is a Uniform Resource Locator (URL).

Inverse Functional Identifier (IFI): An identifier which is unique to a particular persona or group.

learning experience: An event associated with learning. It is highly diverse as far as what it can be. Examples include reading a book, taking an online course, going on a field trip, engaging in self- directed research, or receiving a certificate for a completed course.

Learning Management System (LMS): A software package used to administer one or more courses to one or more learners. An LMS is typically a web-based system that allows learners to authenticate themselves, register for courses, complete courses and take assessments (Learning Systems Architecture Laboratory definition). An LMS in this document is used as an example of how a user is identified as "trusted" within a system and able to access its learning experiences.

Learning Record Consumer (LRC): An Experience API (xAPI) Client that accesses data from Learning Record Store(s) (LRS(s)) with the intent of processing the data, including interpretation, analysis, translation, dissemination, and aggregation.

Learning Record Provider (LRP): An Experience API (xAPI) Client that sends data to Learning Record Store(s) [LRS(s)]. Often, the LRP creates learning records while monitoring a learner as a part of a learning experience.

Learning Record Store (LRS): A server (i.e., a system capable of receiving and processing web requests) that is responsible for receiving, storing, and providing access to learning records.

learning record: An account of a learning experience that is formatted according to the rules of xAPI. A Learning Record takes on many forms, including Statements, documents, and their parts. This definition is intended to be all-inclusive.

metadata consumer: A person, organization, software program or other thing that seeks to determine the meaning represented by an Internationalized Resource Identifier (IRI) used within this specification and/or retrieves metadata about an IRI. A Learning Record Store (LRS) might or might not be a metadata consumer.

metadata provider: A person, organization, software program or other thing that coins Internationalized Resource Identifiers (IRIs) to be used within this specification and/or hosts metadata about an IRI.

persona: A set of one or more representations which defines an Actor uniquely. Conceptually, this is like having a "home email" and a "work email." Both are the same person, but have different data, associations, etc.

profile: A specific set of rules and documentation for implementing an Experience API (xAPI) in a particular context. A profile provides a way to talk about vocabulary concepts, statement templates, and patterns for xAPI data. Not to be confused with document profile resource.

registration: An instance of an Actor experiencing a particular Activity.

Representational State Transfer (REST): An architecture for designing networked web services. It relies on hypertext transfer protocol (HTTP) methods and uses current web best practices.

service: A software component responsible for one or more aspects of the distributed learning process.

[15] Information on references can be found in Clause 2.

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Statement: A data structure showing evidence for any sort of experience or event which is to be tracked in Experience (xAPI) as a learning record. A set of several Statements, each representing an event in time, might be used to track complete details about a learning experience.

Verb: The action being done by the Actor within the Activity within a Statement. A Verb represents the "did" in "I did this."

3.2 Acronyms and abbreviations

AP Activity Provider

API Application Programming Interface

CoP community of practice

IFI Inverse Functional Identifier

IRI Internationalized Resource Identifier

IRL Internationalized Resource Locator

LRC Learning Record Consumer

LRP Learning Record Provider

LRS Learning Record Store

REST Representational State Transfer

URI Uniform Resource Identifier

xAPI Experience API

4. Learning Record Stores (LRSs)

Tracking in this standard is accomplished through HTTP Requests from the Learning Record Provider (LRP) to the Learning Record Store (LRS) (a server system with requirements defined in this document). Clause 4 details all requirements for the Learning Record Store. Accessing data in this standard is also accomplished through HTTP requests from a Learning Record Consumer (LRC).

4.1 LRS Communication

The primary function of the LRS within the xAPI is to store and retrieve Statements. Validation of Statements in the xAPI is focused solely on syntax, not semantics. Enforcing the rules that help ensure valid meaning among Verb definitions, Activity types, and extensions is the not the responsibility of the LRS, it should only enforce rules regarding structure.

The following table summarizes the Resources with which HTTP methods can interact. Implementation details for each resource can be found in 5.1.6. The LRS is interacted with via RESTful HTTP methods to the resources outlined in this clause.

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