Overview and Application of xAPI, cmi5, and xAPI Profiles

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The Learner Will…

- Be able to describe xAPI Concepts and how they relate to cmi5
- Understand the use cases of cmi5 and its value to enable other xAPI solutions
- Be able to describe xAPI Profiles and the best practices needed for data interoperability
- Be able to design learning resources using xAPI and xAPI Profiles within a cmi5 framework
- Understand available cmi5 resources and whether products are cmi5 compliant or not

Overview/Topics

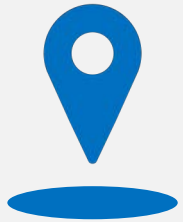
- Experience API Basics
- cmi5 Deep Dive
- xAPI Profiles
- Designing xAPI Solutions Inside cmi5
- Best Practices and Available Resources

Expected Learning Outcome #1

1

The learner will gain a baseline understanding of xAPI, such that the additional requirements of cmi5 imposed on xAPI will be comprehendible. This will include the role and structure of Statements, the Learning Record Store, and additional xAPI Resources/Endpoints that are used in a holistic approach to distributed learning.

Why xAPI?



Learning can be recorded wherever it occurs

Learning analytics

- Not restricted to customized reports
- Not restricted to basic data (scores, pass/fail)

Learning does not have to be "launched" from an LMS

- Mobile apps
- Social Networking
- Serious Games & Simulations
- Correlation of general activity with learning data

What is xAPI?

Basic Definition (Remember this one):

xAPI statements are data generated by a Learning Record Provider (LRP) and sent to a Learning Record Store (LRS).

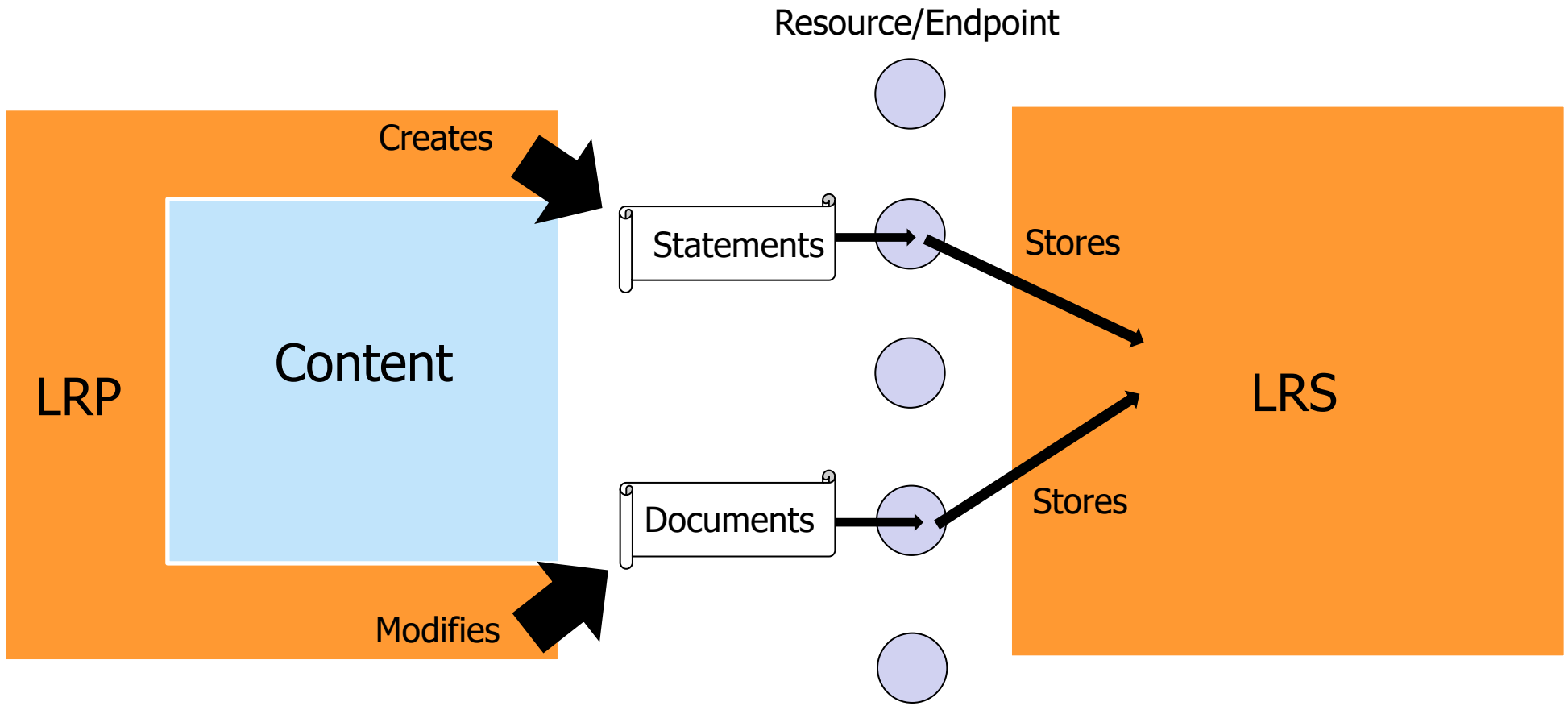
Technical Definition (Look once and forget if you want):

Experience API (IEEE 9274.1.1) is the 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.

Necessary Context

Learning Management System (LMS)	An entire suite of web services used in traditional (SCORM) distributed learning solutions
Learning Record Provider (LRP)	Sender in xAPI
Learning Record Store (LRS)	Receiver (Web Service) in xAPI
Statement	Single artifacts of activity in xAPI – “I Did This”
Documents	Large sets of data (name, value) that keep state in xAPI
Resource/Endpoint	Interface within xAPI to programming methods (Means by which to send/receive)
Content	Any learning asset deployed in a Distributed Learning environment

xAPI Components



LRP = Learning Record Provider, LRS = Learning Record Store

Statement Parts

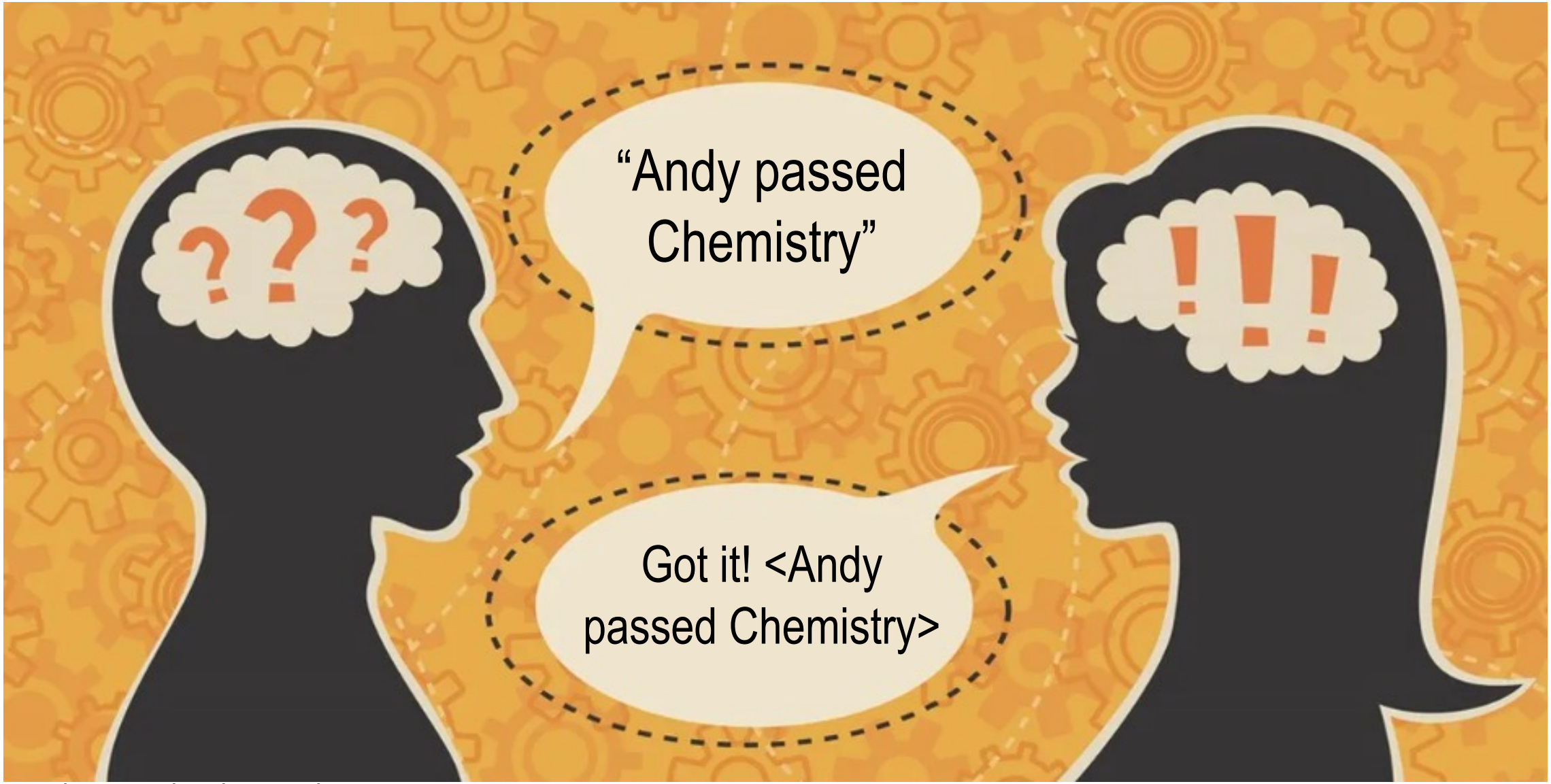
Actor	Doer in the Statement
Verb	Action in the Statement
Object	“Direct Object” in the Statement, often an actual web activity
Results/Context	Additional necessary information
Timestamp	When the experience happened

These allow the basic construction of human/machine readable expressions

Sample Statements

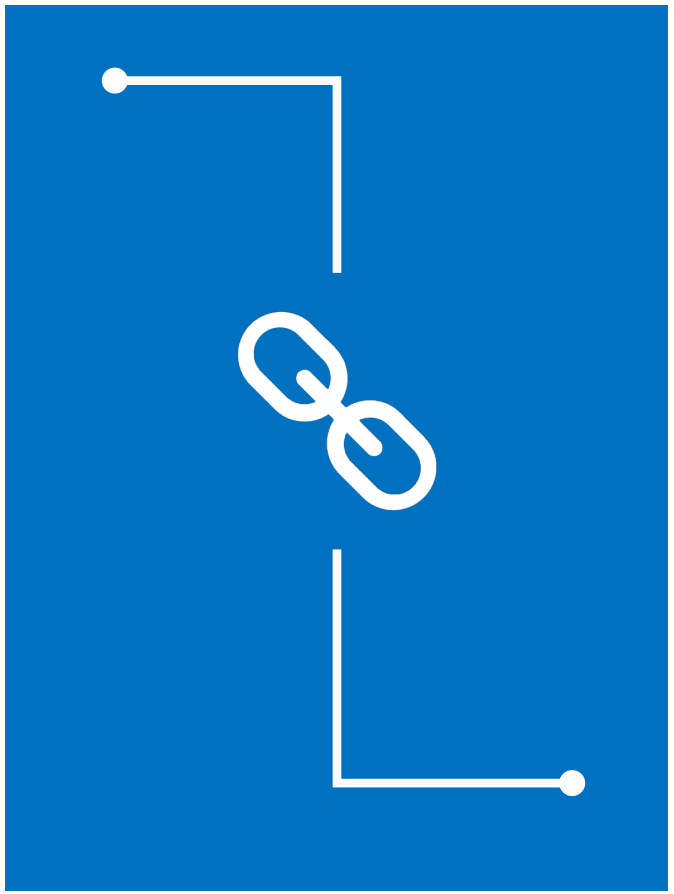
Andy	launched	Chemistry Quiz (Activity ID)
Andy	initialized	Chemistry Quiz
Andy	answered	Question 1 with choice “A”
Andy	passed	Chemistry Quiz
Andy	completed	Chemistry Quiz
Andy	terminated	Chemistry Quiz
Andy	satisfied	Chemistry Quiz
Andy	satisfied	Chemistry Unit

Designers and Developers Speaking The Same Language



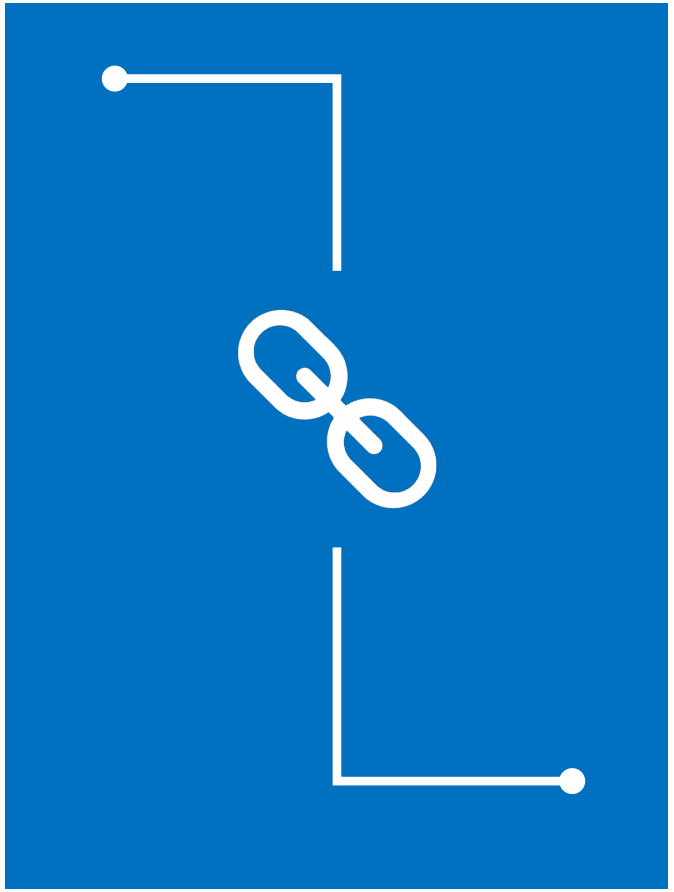
Credit: www.theodysseyonline.com

Let's Talk About Linked Data (Semantic Web)



- Linked Data is a methodology of publishing data that allows machine-readable connections on the web, allowing concepts that may have been created separately to find each other
- xAPI, through both Statements and Documents, creates semantic data relationships
- Statements especially, being "triples", have a natural integration into systems that can use the semantic web, which uses a language that effectively links two resources together with a property type

xAPI's Semantic Data



- All of the basic xAPI Statement parts are identified uniquely, but are intentionally Uniform Resource Identifiers (URIs)
- URIs are resolvable to allow for more readily available information, but also unique entities on the web, allowing machines to "crawl" them for more information
- This can allow for important relationships to be defined, such as "Quiz A" is a part of "Lesson B" but is not a part of "Lesson A"
- Can also be used to trace version history and derived works

Let's Talk About "The Fridge"

- To put a bow on "How language in xAPI works", Let's enable a "Smart Fridge".
- Different "Actors" interact with the Fridge, including the Fridge itself
- Different actions or "Verbs" would align to functions the Fridge can perform
- Different "Objects" can interact with the Fridge, these may be tangible (apples, cheese, bacon) or intangible (temperature setting)
- Sometimes more details are needed, so "Results" or "Context" is used
  - Becky supplied apples to fridge
  - Tommy received bacon from the fridge
  - Fridge adds bacon (to shopping list)

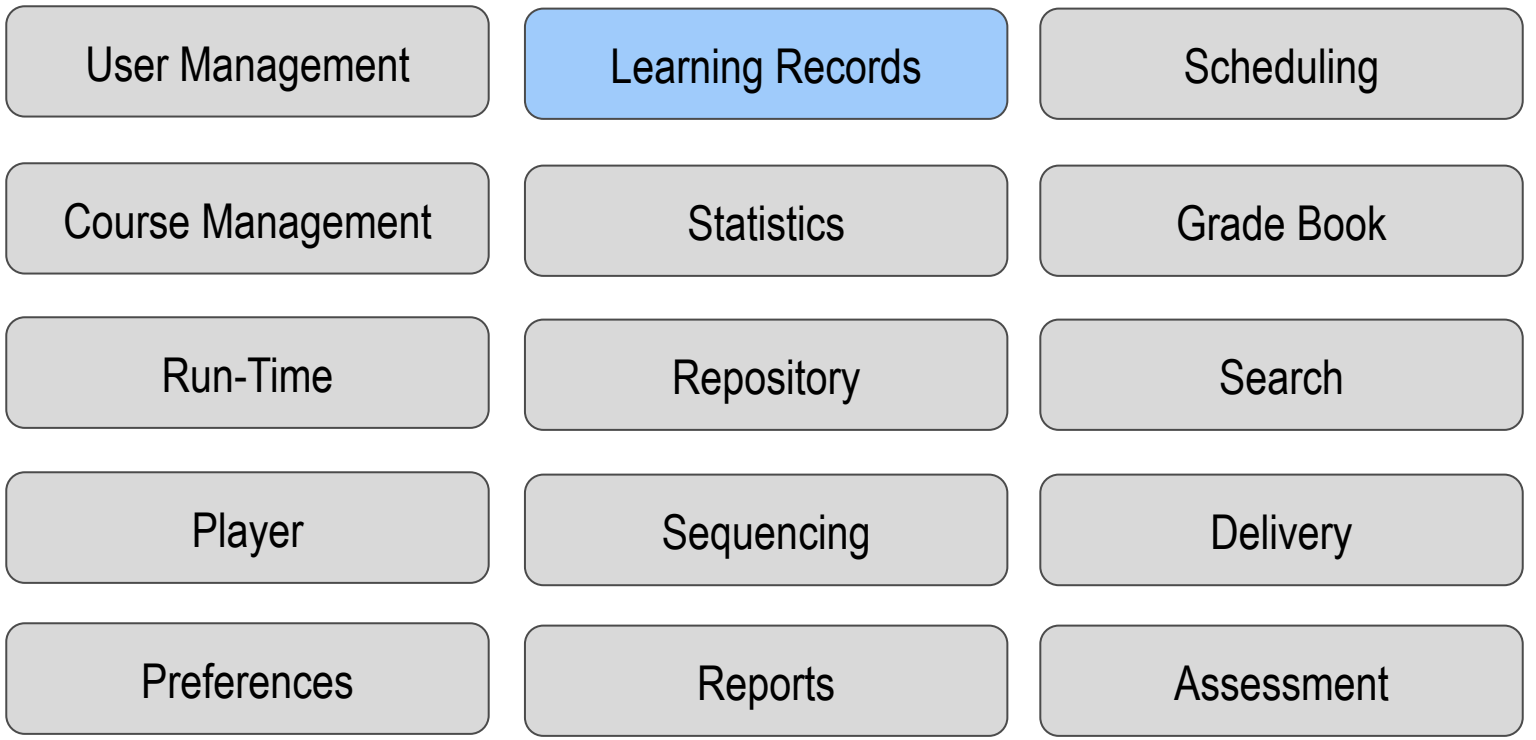
Linked Fridge Data

- IRIs for food can resolve to food resources and other concepts
- Stores can have their items resolve to these, and link prices and availability
- Could link any food resource to vitamins contained, calories, average cost, recipes that contain it, etc.
- Can then order food, plan a shopping list, make a budget, plan meals
- In the context of distributed learning, could have competencies that interrelate, are achieved by individuals, and aggregate for higher achievement
- This can be true of learning resources as well – Courses that have “this video” are effective/ineffective

Statements Go To the LRS

- Server-Side Implementation of xAPI
- The Learning Record Store is a “triple store” Actor/Verb/Object which is RESTful
  - RESTful refers to web services that are light weight, highly scalable and maintainable by following a set of constraints
- Very little validation is done at run-time, which makes it fast and flexible
- Won’t throw out “Andy friended Biochemistry quiz”
- Other services will extract meaning from the data and expose it in interesting ways to the learner

LMS and LRS Capabilities



LMS

LRS

Why Do I Need a Learning Record Provider ?

If Content Sent Statements wildly to the Learning Record Store	If LRS accepted Statements that were sent from “Content”
▪ Is my content sending data correctly? ▪ Does my content have permission on that system? ▪ Will I get credit? ▪ Does the institution/instructor of my content know who I am and can they get that to the LRS?	▪ Is the learner who they say they are? ▪ Is the institution/instructor on this Statement real? ▪ Did they pay for the rights to take the content?

The Learning Record Provider is the trusted partner of the Learning Record Store, ensuring data is reliable and valid

Expected Learning Outcome #2

2

*The learner will understand the subject matter of the cmi5 specification, such that it can be described using instructional design language as well as understand specific coding concepts to create cmi5 data. The learner will understand the data flow, authentication, session management, and storage capabilities of cmi5 as well as the additional requirements of a cmi5 LMS over the lesser functioning xAPI Learner Record Store (LRS). Learners will be able understand the difference between **cmi5 defined** and **cmi5 allowed** Statements.*

Why cmi5?

SCORM Negatives

- To frame or not to frame! The pop-up issue
- Content must reside in same domain as LMS
  - Cannot put content on Content Distribution Network
  - Inefficient bandwidth
- SCORM content MUST be run in a browser
  - Mobile and Offline use cases do not function
  - Notion of a “local server” fails
- Easier to Cheat
  - LMS Accepts “blindly” what is sent to it
  - No timestamps = no “paper trail”

What is cmi5?

- cmi5 is a set of “extra rules” to apply to xAPI that fit the current Distributed Learning paradigm, but readily enables future paradigms
  - cmi5 INCLUDES xAPI
- cmi5 specifically addresses:
  - Content Launch Mechanism
  - Authorization (NOT Authentication)
  - Session Management
  - Reporting
  - Course Structure
  - Satisfaction Criteria

History of cmi5

- Originally started in the AICC (Aviation Industry Computer-Based Training Committee) in 2010
- cmi5 was expected to replace both AICC and SCORM
- cmi5 was “rebooted” in 2012 and the previous architecture was replaced with xAPI after the group saw benefits and a clearer path to adoption
- In 2014, the AICC dissolved and formally transferred cmi5 to the ADL
- The cmi5 project is still guided by its original goals

Which Use Cases Does cmi5 Enable?

"Minimal LMS"	Support for dynamic amounts of information, but not as a ton of "optional" fields
"Content-defined Data"	In other words, content so specific that only the content needs it, but is still critical (Simulations, especially)
"Content as a service (CaaS) model of delivery"	Allow content to be stored on other domains
"Device/OS/browser independence"	Allow for content to be independent of a browser in order to communicate or be launched
"Share data between learning activities"	And between learners!

cmi5 Roles and Responsibilities

Assignable Unit (AU) – Content + LRP (loosely)

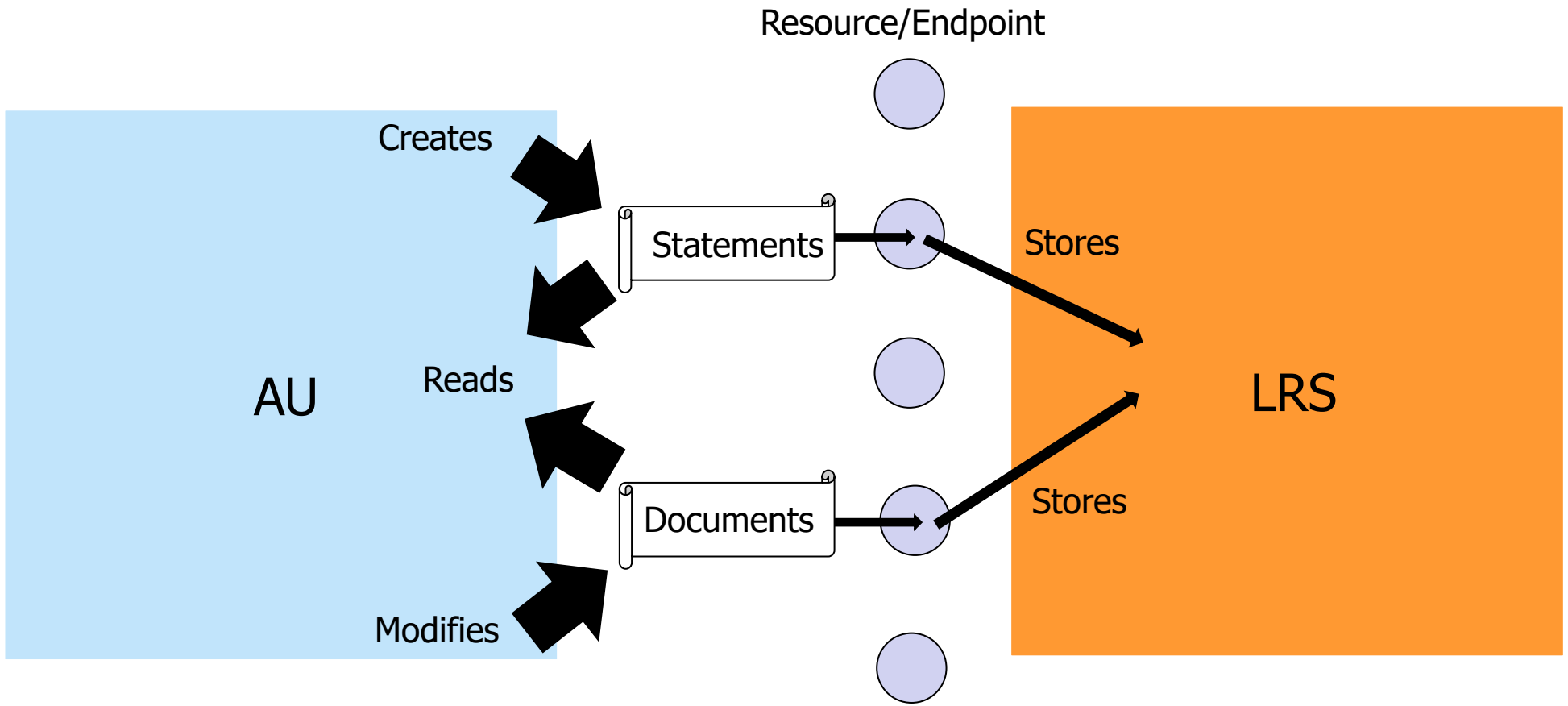
- Functions as content would be expected in xAPI – like a course.
- Parses the parameters from the launching environment to determine where the LMS location is and initiate communication with the LMS.
- Acting as a "client", sends and receives messages using the xAPI defined transport mechanism(s) and associated commands as prescribed in this specification.
- Formats all data according to the defined data types and vocabularies that are defined in this specification.
- Sends a "terminate" statement prior to terminating the AU's execution.

cmi5 Roles and Responsibilities Cont.

Responsibilities of the LMS

- Create and maintain course structures.
- Act as a "server" - receive and reply to messages using the xAPI defined transport mechanism(s) and associated commands as prescribed in this specification.
- Format all data according to the defined data types and vocabularies that are defined in this specification.
- Launch the specified AU contained in the content within the defined environment(s).

cmi5 Components

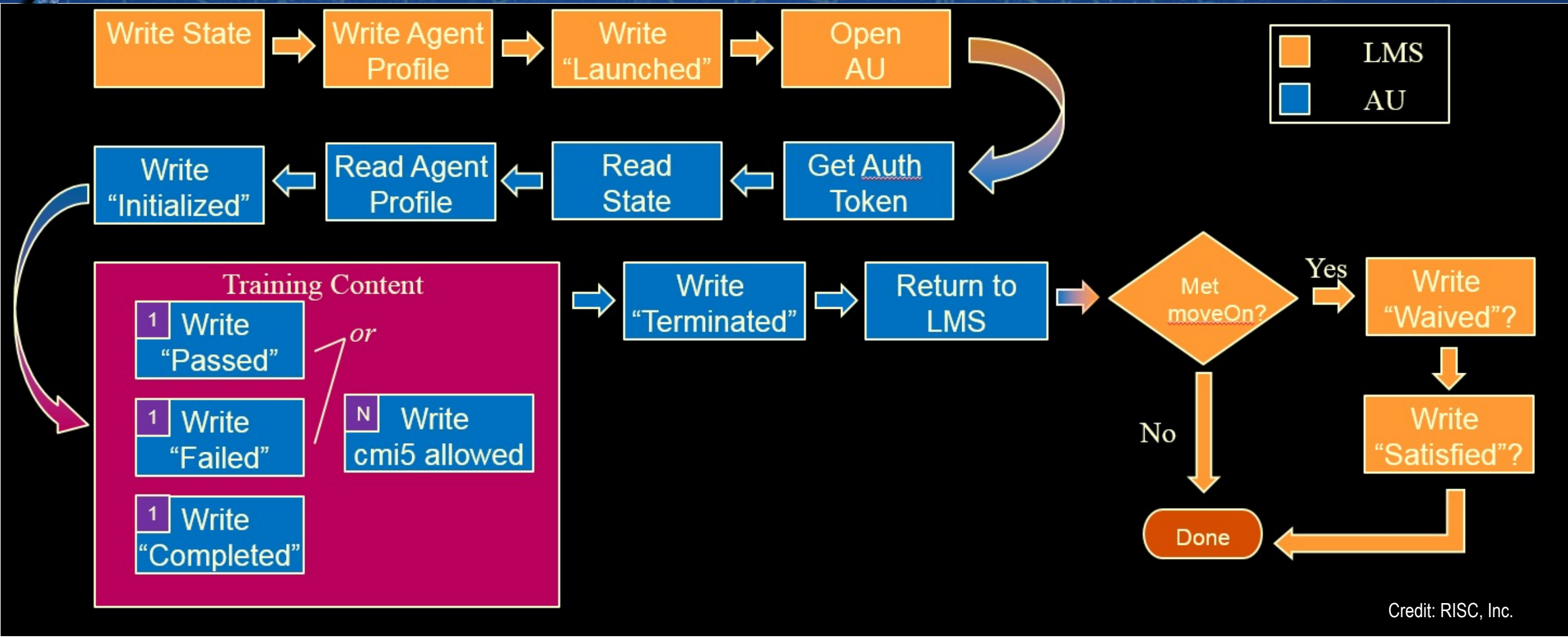


AU = Assignable Unit, LRS = Learning Record Store

The Nine cmi5 Verbs

Launched	Initialized	Completed
Passed	Failed	Abandoned
Waived	Terminated	Satisfied

cmi5 Data Flow



Credit: RISC, Inc.

cmi5 = "xAPI with Rules"

Actor	▪ Uses "account" for security purposes
Verbs	▪ There can be only one! (use of each Verb) ▪ Specific order of Verbs, corresponding to events
Object	▪ Is the AU and matches the activityId (content) ▪ AU used quite ubiquitously in this specification
Score	▪ Not required, lumped in with pass/fail
Success/Completion	▪ Designer (or Admin) decides the "how", but success can directly relate to assessment
Registration	▪ Establishes unique relationship between Actor and "course" ▪ Registrations are handled at the course level (AU registrations not allowed)

"cmi5 Defined" vs. "cmi5 Allowed"

cmi5 categorizes the xAPI Statements during use:

"cmi5 defined"	Statements using cmi5 defined verbs ▪ Uses specific "category id" value for cmi5
"cmi5 allowed"	Statements using any verb and **does not** use the cmi5 specific "category id" ▪ Issued between "initialized" and "terminated" verbs
"cmi5 not-allowed"	Any statements not conforming with the cmi5 specification
Both "cmi5 defined" and "cmi5 allowed" use a "context template"	Context template is State information exchanged between the AU and LMS

cmi5 Additional Features

Authorized Launch Mechanism

- AU may provide launch parameters that the LMS will use when launching the AU.
- In addition, when the LMS launches the AU the parameters include Actor, content id (of the AU), registration, and a URL for obtaining authorization.

Course Structure

- Similar to the content package of SCORM… and different
- Supports 1 or more Assignable Units (AU)
  - Optionally nested within Blocks
- Designed for interoperability across systems

Course Structure Format

cmi5 = Assignable Units and Blocks

Lesson Name	Type	Required	Comp%	Status	Action
Geologic materials	Block	☐			
Rock and rock cycle	E-Learning	☑		Not Started	Run
Unconsolidated material	E-Learning	☐		Not Started	Not Available
Whole-Earth structure	Block	☐			
Plate tectonics	E-Learning	☑		Not Started	Not Available
Structure of the earth	E-Learning	☑		Not Started	Not Available
Geologic time scale	Block	☐			
History and nomenclature of the time scale	E-Learning	☑		Not Started	Not Available
Current official geologic time scale	Block	☐			
Phanerozoic	Block	☐			
Cenozoic	E-Learning	☑		Not Started	Not Available
Mesozoic	E-Learning	☑		Not Started	Not Available

Credit: RISC, Inc.

cmi5 Versatility

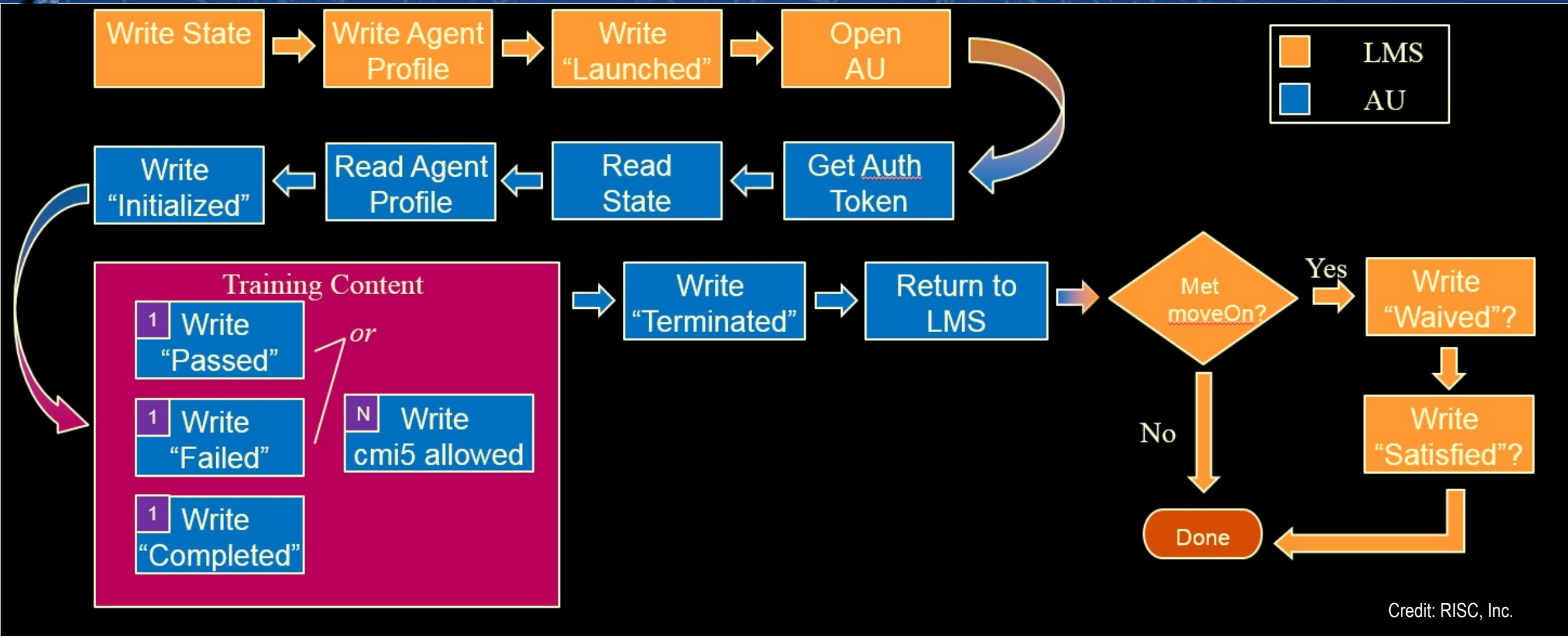
Session Tracking

- State API (ex: bookmarking)

Completion Criteria

- cmi5 defines “Move On” criteria
  - Passed?
  - Completed?
  - Completed and Passed?
- Mastery Score
  - Different scores for different roles
- External Intervention
  - Allows "testing out" external to taking content (Administration)

cmi5 Data Flow (Revisited)



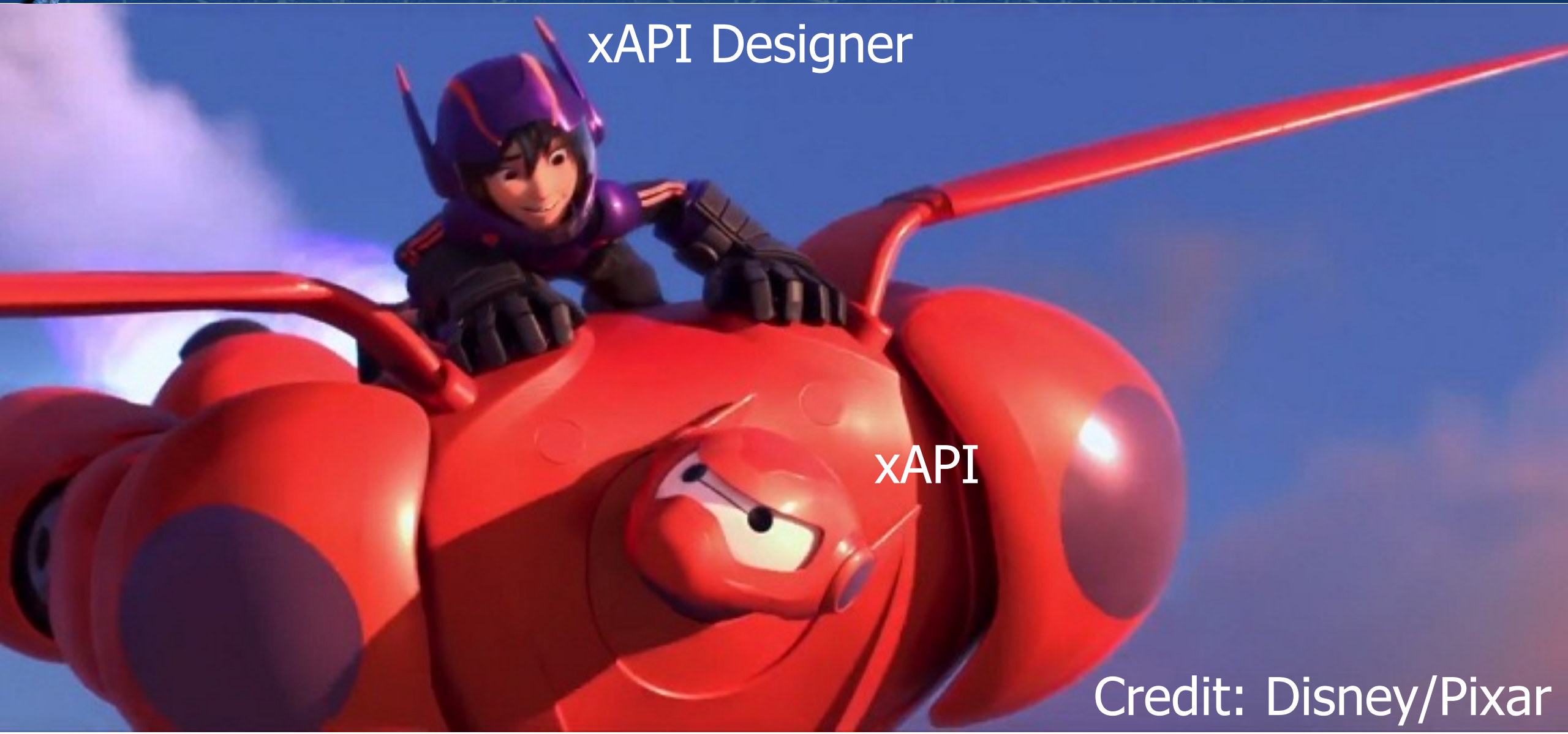
Credit: RISC, Inc.

Expected Learning Outcome #3

3

The learner will understand the application and use of xAPI Profiles. The learner will understand and be able to apply best practices for design of xAPI data for interoperability. The learner will understand how to "tag" xAPI statements with multiple profiles and how that functions within cmi5.

xAPI Designer



Credit: Disney/Pixar

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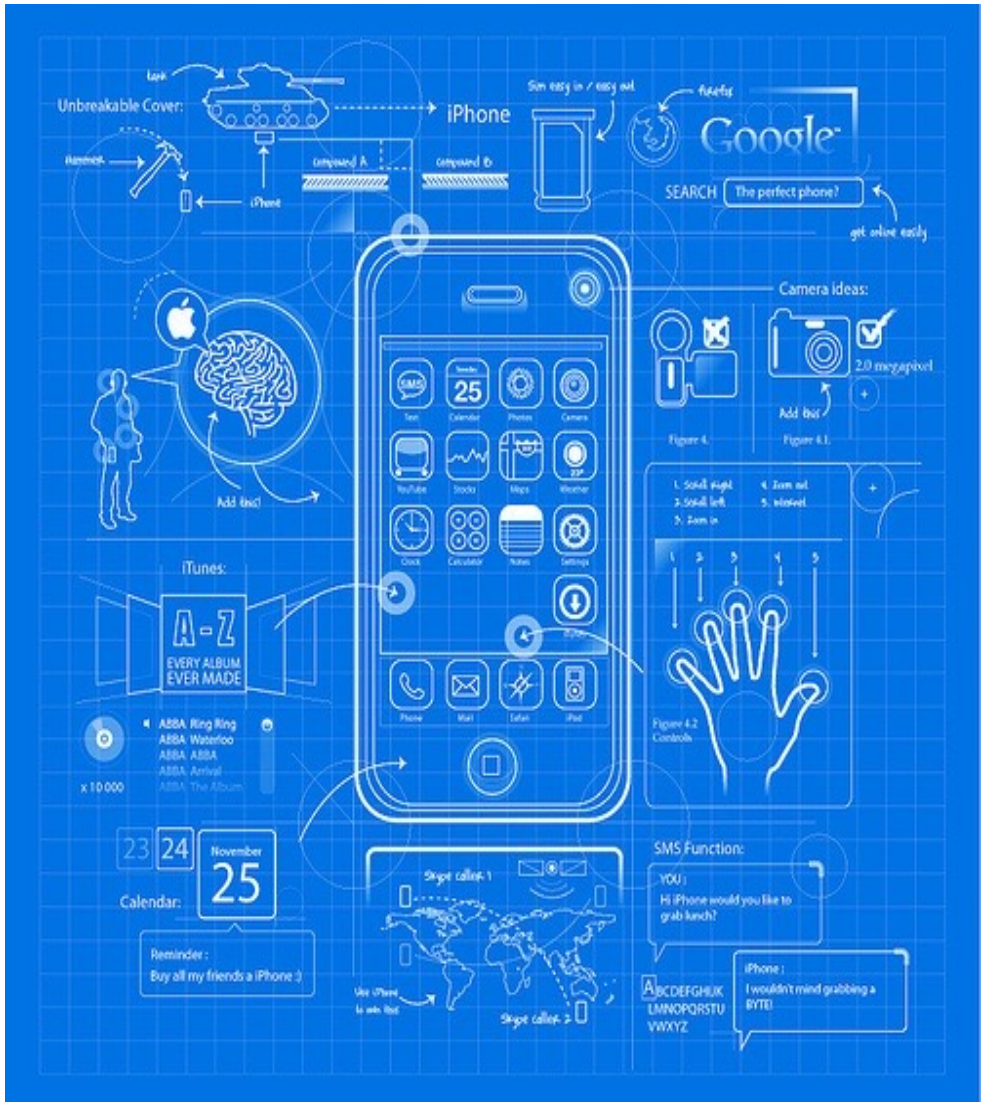
Profiles – Where Do They Come From?

Communities of Interest (Practice)	Use Case + Technology Application
▪ Organizes Interested Parties in a Specific Subject Domain ▪ Forms a Working Group ▪ Defines Requirements ▪ Explores Solutions – Both Logistical and Technical	▪ cmi5 Working Group founded before technology solution, with a specific use case ▪ Later switched to an xAPI solution ▪ Required definition of data for specific events ▪ Inspired other xAPI solutions, effectively creating more xAPI Profiles

What Does a Profile Do?

- Is a Template of Technical Rules
- Validates Sets of Statements
- Employs Semantic Web Principles

Tale of Two "Profiles"



Examples of Parts of Each Profile

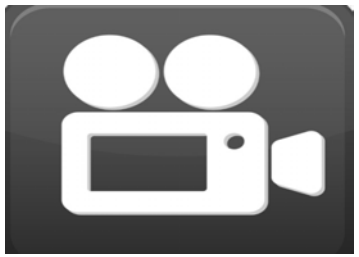
- The video profile requires videos to have the ability to track a “fast forward” or “rewind” and include both the starting and ending points of that operation.

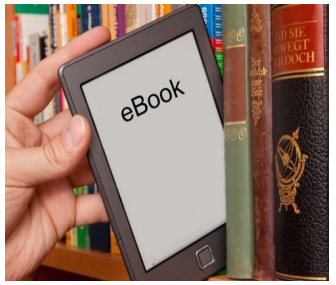

```
"id": "https://w3id.org/xapi/video/templates#seeked",
"type": "StatementTemplate",
"inScheme": "https://w3id.org/xapi/video/v1.0.2",
"prefLabel": {
    "en": "Seeked"
},
"definition": {
    "en": "The statement template and rules associated with a video seekbar being moved from and
},
"verb": "https://w3id.org/xapi/video/verbs/seeked",
"objectActivityType": "https://w3id.org/xapi/video/activity-type/video",
"rules": [
    {
        "location": "$.id",
        "presence": "included"
    },
    {
        "location": "$.timestamp",
        "presence": "included"
    },
    {
        "location": "$.result.extensions['https://w3id.org/xapi/video/extensions/time-to']",
        "presence": "included"
    },
    {
        "location": "$.result.extensions['https://w3id.org/xapi/video/extensions/time-from']",
        "presence": "included"
    },
    {
        "location": "$.context.extensions['https://w3id.org/xapi/video/extensions/session-id']",
        "presence": "recommended"
    }
```

Incorporating Multiple Profiles in Solutions

cmi5

xAPI





cmi5 Defined vs. cmi5 allowed

Profiles are “tagged” in xAPI within Context

This is the same way “cmi5 Defined” was described before

Any additional profile is “cmi5 Allowed” in addition to the other types

Multiple Profiles in a course, page, or even same Statement is okay!

xAPI Profile Best Practices

Profile Best Practices

More info at: http://xapi.vocab.pub/

(MAY UPDATE THIS LINK and Screenshot)

- Look for reuse first (entire profile or individual “concepts” (generic term for any xAPI Property)
- Conform and Test to xAPI Profile Specification
- Follow Best Practices for Identifiers
- Generate Quality Metadata
- Share Your Work

Creating Persistent Identifiers – Why?

- To ensure resolution of the identifiers used within xAPI, such that metadata can be retrieved
- Resolution is necessary to allow Statement “consumption” for the End User (or End User Application)
  - Dashboards and Analytics
  - Figuring out how to figure out what a verb REALLY means - when the display says “run”
- Consuming Statements allows traceability – “released” mean?
  - https://w3id.org/xapi/seriousgames/verbs/released
  - **11/5/2020 - Verb - Profile: Serious Games Profile**
    Indicates that the actor released the object from one's grip from or a specific state. Used when the player releases a previously pressed button.

Creating Persistent Identifiers – How?

- To create a URI (for any Verb, etc.) that is resolvable, it is recommended to have the entity "coining" that term be in charge of where it resolves
- In the current World Wide Web, this means a domain (www.adlnet.gov)
- To create a URI that is unique, the entity create a schema that will guarantee uniqueness from that entity
- This means simply appending to the already controlled domain (www.adlnet.gov/expapi/verbs/completed)
- But what if ADL changed domains, or was no longer a Government Initiative?
- Instead, we use Persistent URLs (PURLs) and have them redirect to a domain-controlled area

Creating Persistent Identifiers

- W3ID is a standards organization controlled domain that is recommended
- ADL controls the /xapi subdomain and gives out the next “layer” to working groups
- These (Domain)(xapi)(profile)(concept_type)(unique_taxon)
  - ”released” only needs to be unique TO the profile
  - Follow best practices regarding re-use and deconflicting
- https://w3id.org/xapi/seriousgames/verbs/released
- These redirect to a desired location (ADL Profile Server in this case)

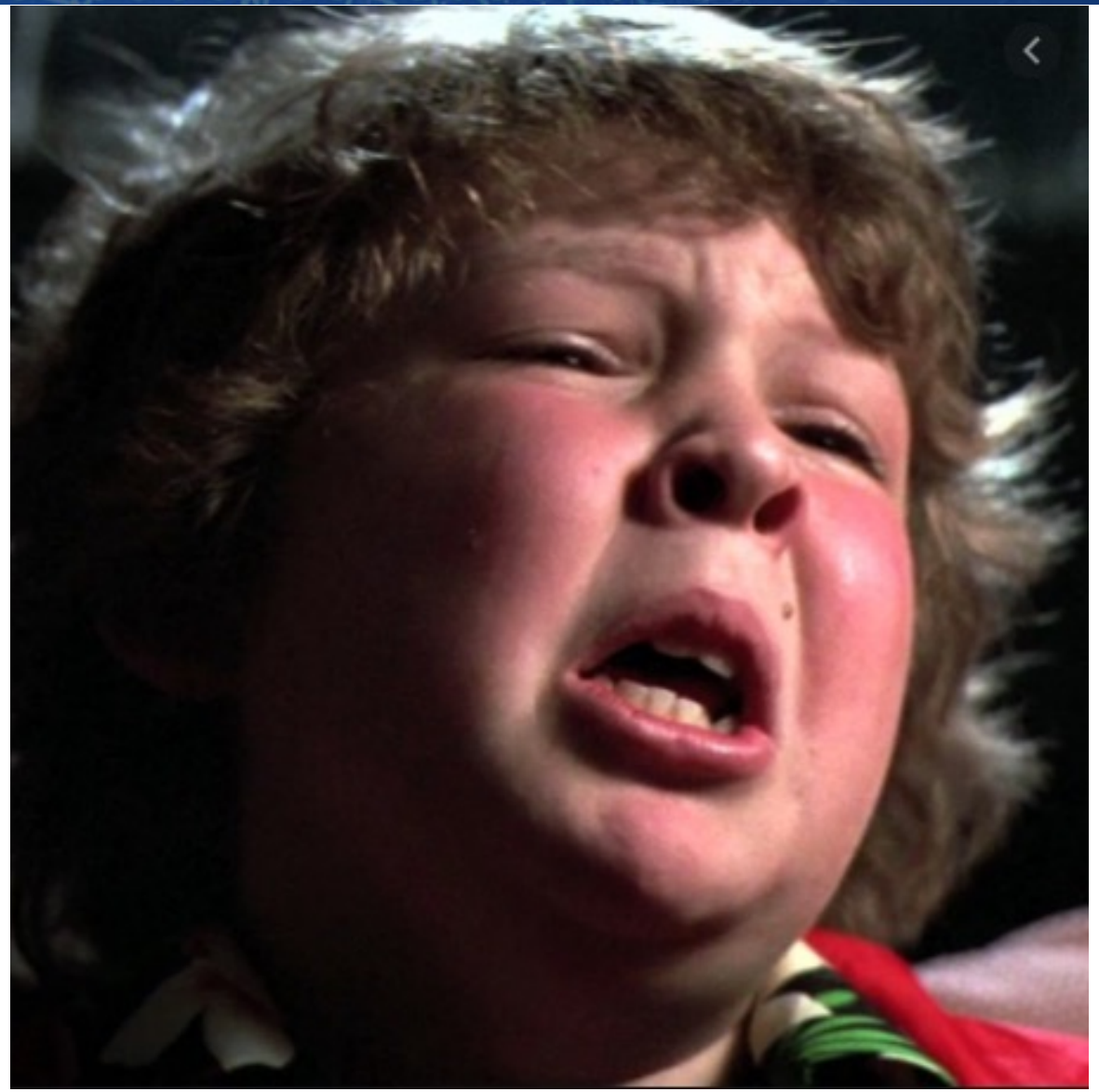
Re-use Vs. Creation

- Care should be taken to re-use where possible, particularly on verbs
- Multiple “passed” verbs, for instance, could cause poor results in visualizations
- Remember verb “display” allows more than one verb to **appear** the same
- Only re-use if the use case fits the verb, different extensions can be okay
- Only tag with the profile IF all rules are followed in a pattern (cmi5 “passed”)

Reuse

Cmi5 Confession

- cmi5 is not an xAPI Profile…it is more
- cmi5 does **contain** an xAPI Profile
- An xAPI Profile is just about the data
- Things like a “context template” are not normally a part of xAPI Profiles



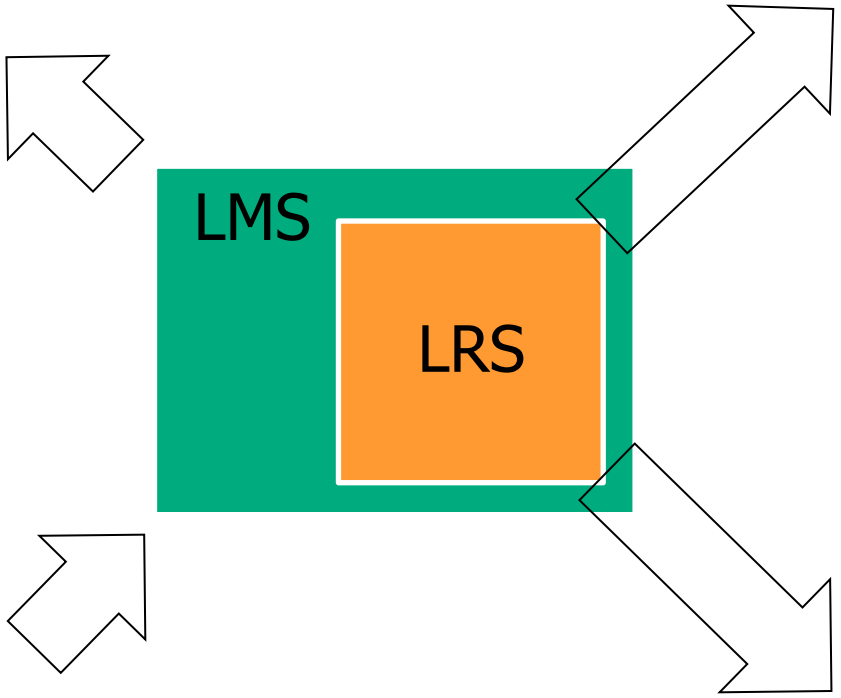
Expected Learning Outcome #4

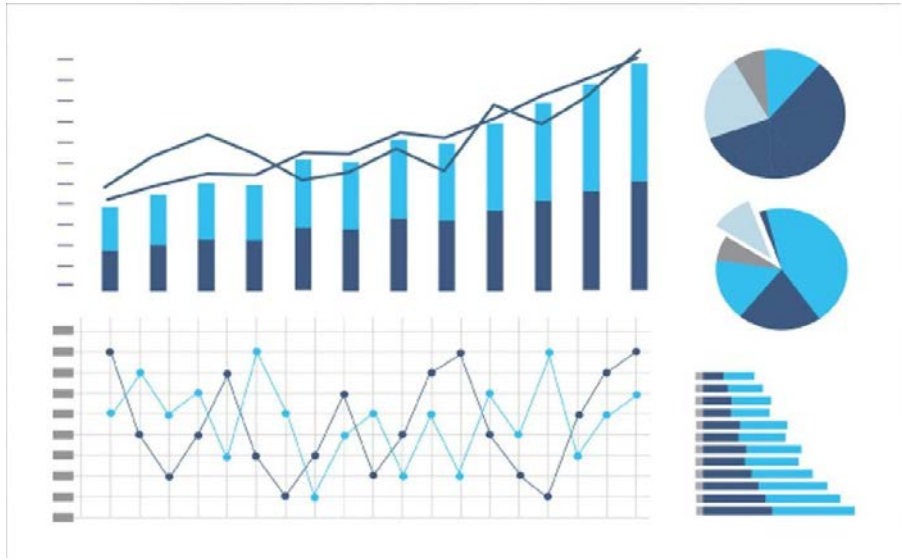
4

The learner will understand design principles around creation of cmi5 data and integration of other xAPI data into cmi5 solutions. The learner will be able to take the principles that cmi5 uses, along with xAPI application in this example, to create their own xAPI data to record learning and performance data of their choosing.

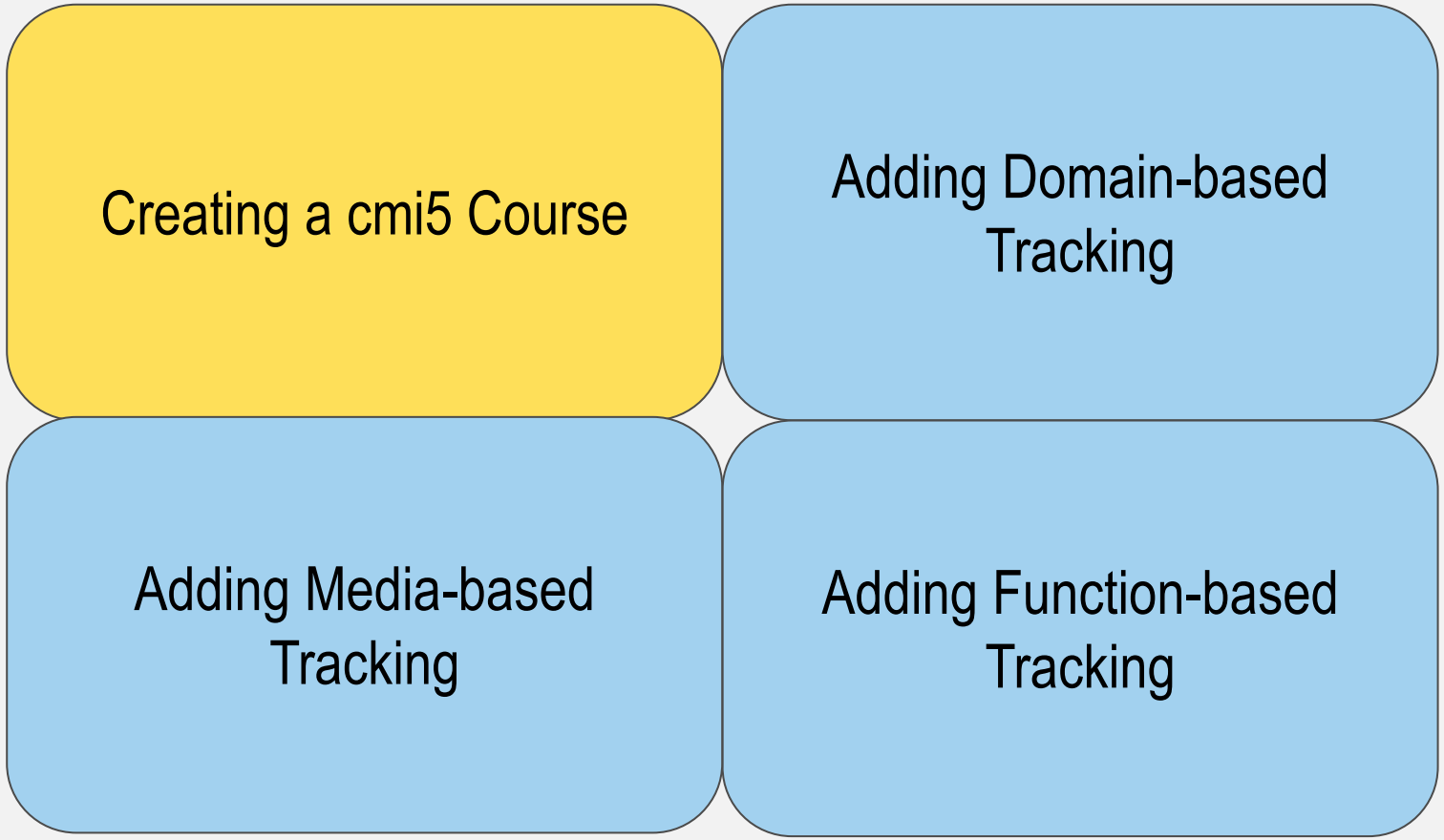
- This section will be based on instructional design decisions that must be made and will talk about xAPI data using the “lingo”, but not code.
- It will discuss how to add domain-based data, media-based data, and function-based data as a part of the overall cmi5/xAPI solution.

The Big Picture





cmi5 Expanded Content Creation

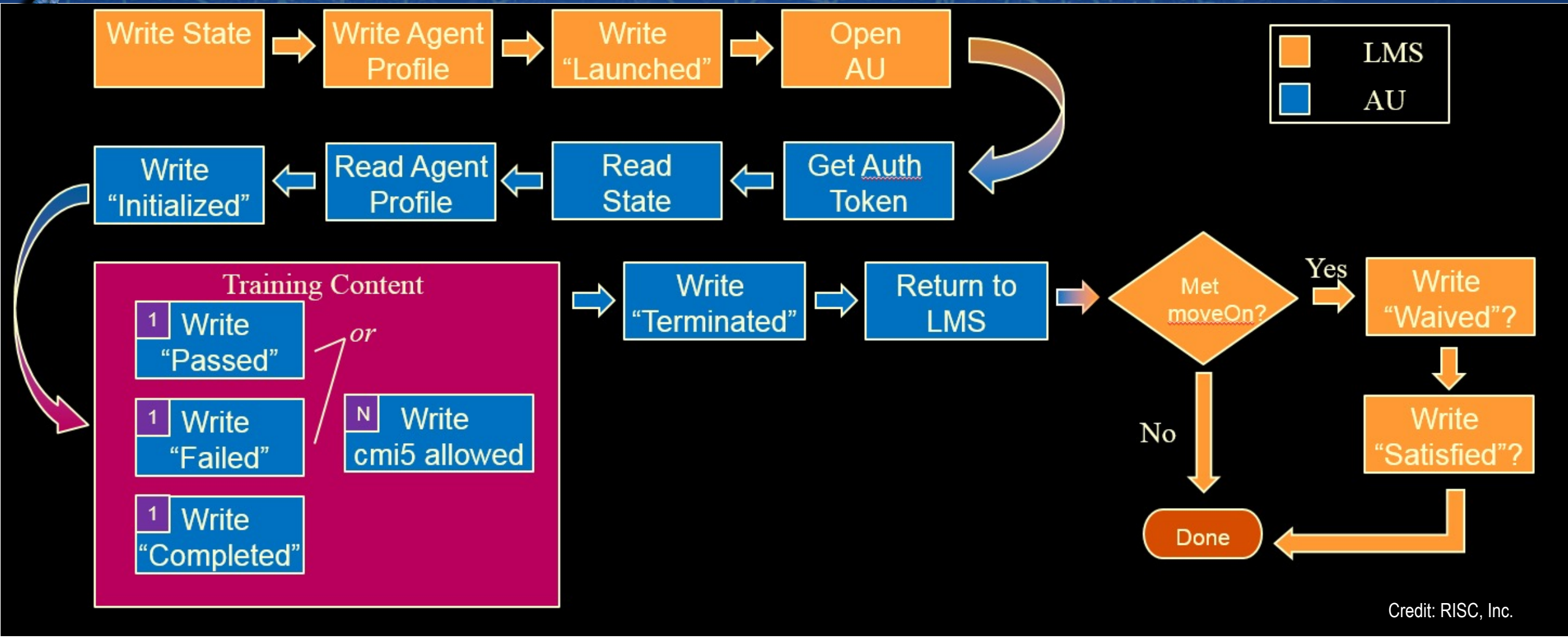


What is a "Course"?

Course Principles

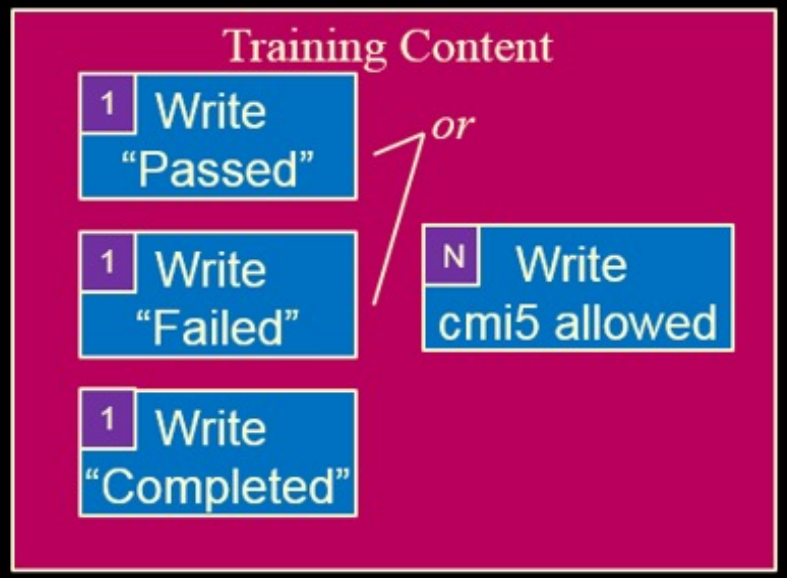
- Files consisting of or links to learning content assets
- Manifest (listing) of those files/links and their structure (as AUs/Blocks)
- Programming to connect to LMS / LRS
- Action: Import
- Action: Register
- Action: Step-Through – Track with Web Events
- Action: Complete, Possibly with Assessment
- Context: Running in an authenticated and authorized environment (LMS)

Course Data Flow



From our previous discussion, the flow of cmi5

Course Data Flow



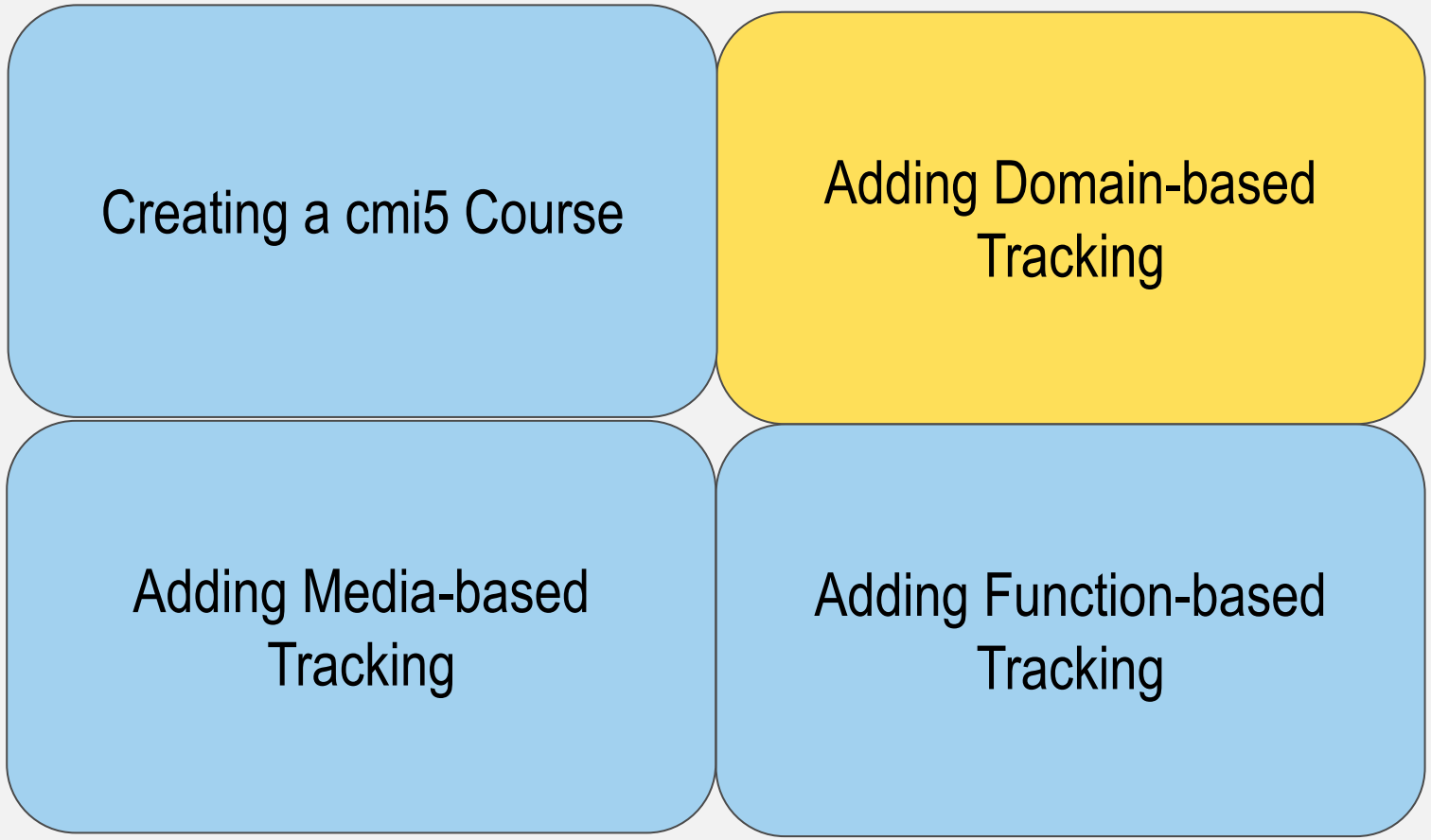
Not all of this is the responsibility of the course designer

Design Decisions

cmi5 Design Principles

- Focusing our efforts on what happens between the “Initialize” and “Terminate”
  - E.g. the content being displayed to the learner and being taken away
- cmi5 Authoring solutions would allow us to not have to figure out anything except the basics
- Determine pass/fail/completion criteria (cmi5 Defined)
  - Is completed viewing the last page? All of the pages?
  - Is there an assessment? If so, how is it scored and do we share out that score?

cmi5 Expanded Content Creation



Goals

Goal: A domain-specific course, rich in content topics and activities

- Now that we've designed the cmi5 portion, we have a traditional set of web-based assets
- Our course needs to have some "meat" – we will be taking on the domain of meal planning
- Topics will include
  - Diet Variance
  - Shopping
  - Meal Preparation
- Activities will include
  - Meal Tracking
  - Inventory Management

What Data Are We Interested In?

Content Design

- Basic web-based content should be covered by the previous template
- Subject matter/domain will not influence a new vocabulary without unique web events
- Knowledge assessment will be done independently from performance assessment on the activity

Activity Design

- Within a web interface, there will be an activity that brings two distinct principles that are covered in the content to life
- A subset of “The Fridge” that was discussed earlier, allowing effective inventory management.
- We will also use a scheduler to plan when particular people will be around for meals
- Could do many other things – recipes, portion sizes, etc.

Design Decisions

Domain Design Principles

- Without specific activities, tying domain-based tracking to content is difficult
  - Activities should be “task driven” – don’t force-fit xAPI or any technology
- It is key to understand if the activity has its own assessment component or not
- xAPI **can** be used to track individual data, but doesn’t have to
  - E.g. You don’t have to create Statements for each question and answer….but you can
- Some data is best left **inside** the course/application
  - E.g. If there is a complicated algorithm to determine portion size, the xAPI statement can just report out the size and not all of the math

What Data Are We Interested In?

In Thinking About the Data Design of the Activities:

- We need to define specific foods
- We need to define specific persons eating the meals
- We need to define the specific meals (lunch on Tuesday the 30th, for example)
- We need to know when a food leaves the fridge
- We need to determine when a food enters the fridge
- We need to determine when a person is added to a meal (for planning purposes)
- We need to determine when a person is removed from a meal
- We need to determine when a food is eaten (and its nutritional information)

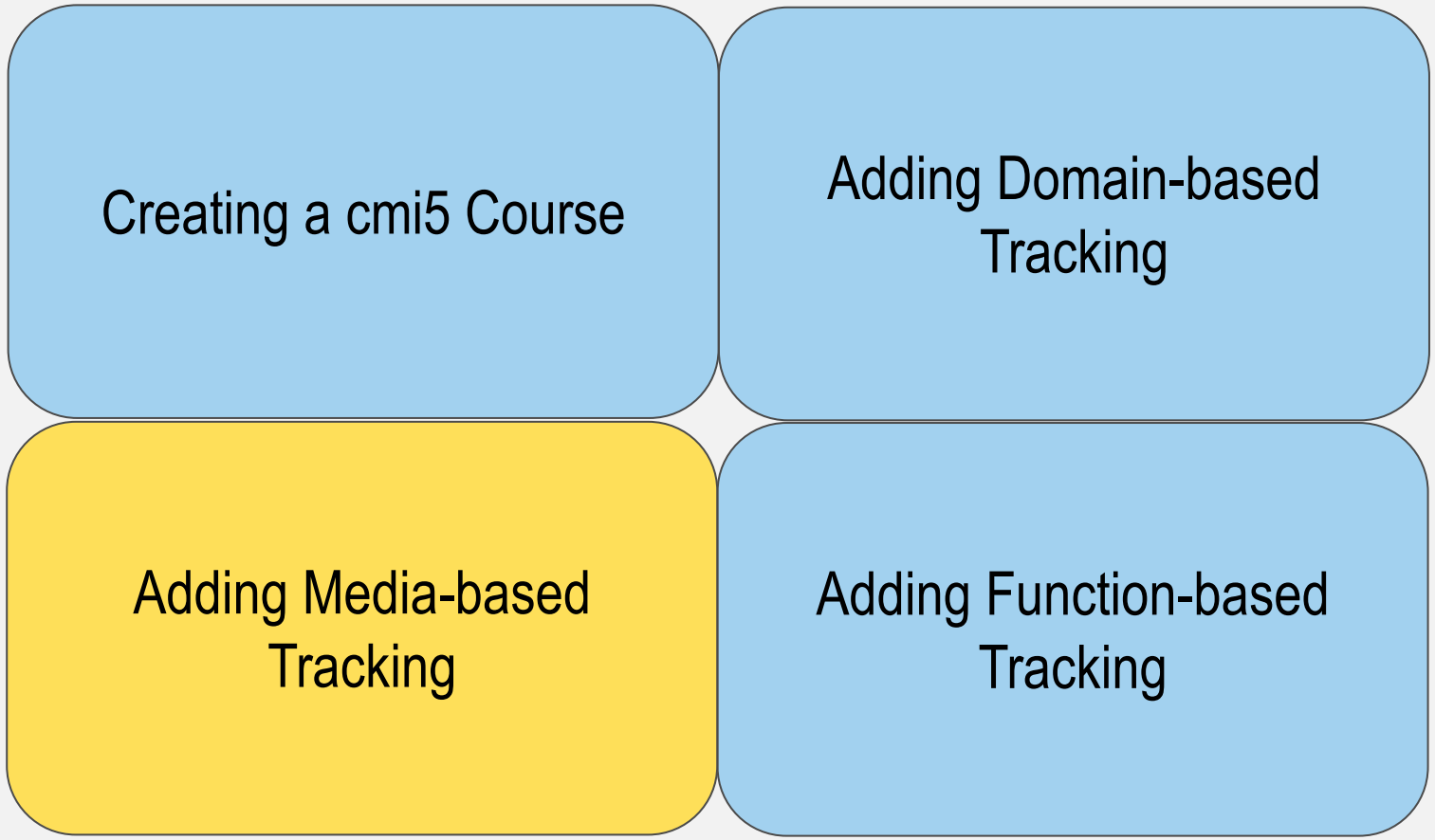
Conversation with the xAPI Developer

We need the following xAPI data defined:

- Objects for all foods in the supplied list
- Actors for all persons defined in the activity and the Fridge
- Activities for each meal of each day in the learning activity
- “Fridge <removed> Food” Statements when it occurs in the activity
- “Fridge <added> Food” Statements when it occurs in the activity
- “Actor <ate> Food” tracking calories as a result and the meal as context
- “Actor <was added to> Meal” Statements when it occurs in the activity
- “Actor <was removed from> Meal” Statements when it occurs in the activity

The developer should then do the legwork on the vocabularies and report back – It is not the designer’s job to determine if the “added” and “was added to” are the same verb

cmi5 Expanded Content Creation



Goals

Goal: Apply video tracking to our media assets

- With a solid course created, we can focus on some tracking that will allow monitoring of learner activity
- Seeing learner patterns allows us to effectively:
  - Ensure they are indeed completing the content
  - Learn where they may be struggling
  - Learn where our resources may require revisions (e.g. bad parts of the video)
  - Learn where supplemental material may be necessary (e.g. a new vocabulary term is brought up within the video)

What Data Are We Interested In?

Media-based xAPI Profiles

- Highly tied to media type, device type, or technology
- Still require corresponding “events”
- Others could include audio, simulation, augmented/virtual reality

Video Design

- Make the assumption that a video player is embedded and it has typical controls with it
- Videos are considered streamed assets – not necessarily a content medium
  - Some video formats allow more complex behavior such as clicking objects within them
- Determine which controls are going to be both important and available to tie to specific web events

Design Decisions

Media Design Principles – Lean on xAPI Profiles!

- Profiles that revolve around a media type or function often will have established practices within an xAPI Profile (https://liveaspankaj.gitbooks.io/xapi-video-profile/content/statement_data_model.html)
  - Narrative and technical formats/fields are important
- Learn the “lingo” of the design – “played”, “seeked”, “time from”, “time to”
  - This “lingo” is important because the developer can use the same resource as a code example!
- “Description” and “Usage” parts of a seemingly technical document provide both usage alignment and use case ideas
- Feel free to define use cases outside the xAPI Profile

What Data Are We Interested In?

In Thinking About the Data Design of the Video:

- We want the video to be considered completed only when all parts have been watched
- We want to capture when the learner skips part of the video, which part, and how much
- We want to capture when the learner turns up the volume of the video
- We want to capture when the learner turns down the volume of the video
- We want to capture when the learner pauses the video
- We want to capture when the learner resumes the video and how long the time was between pausing and resuming
- We want to determine any parts of the video that are replayed

While "initialized" and "played" are critical parts of the video profile, we may leave that design detail out and expect our developer to bring that requirement to us.

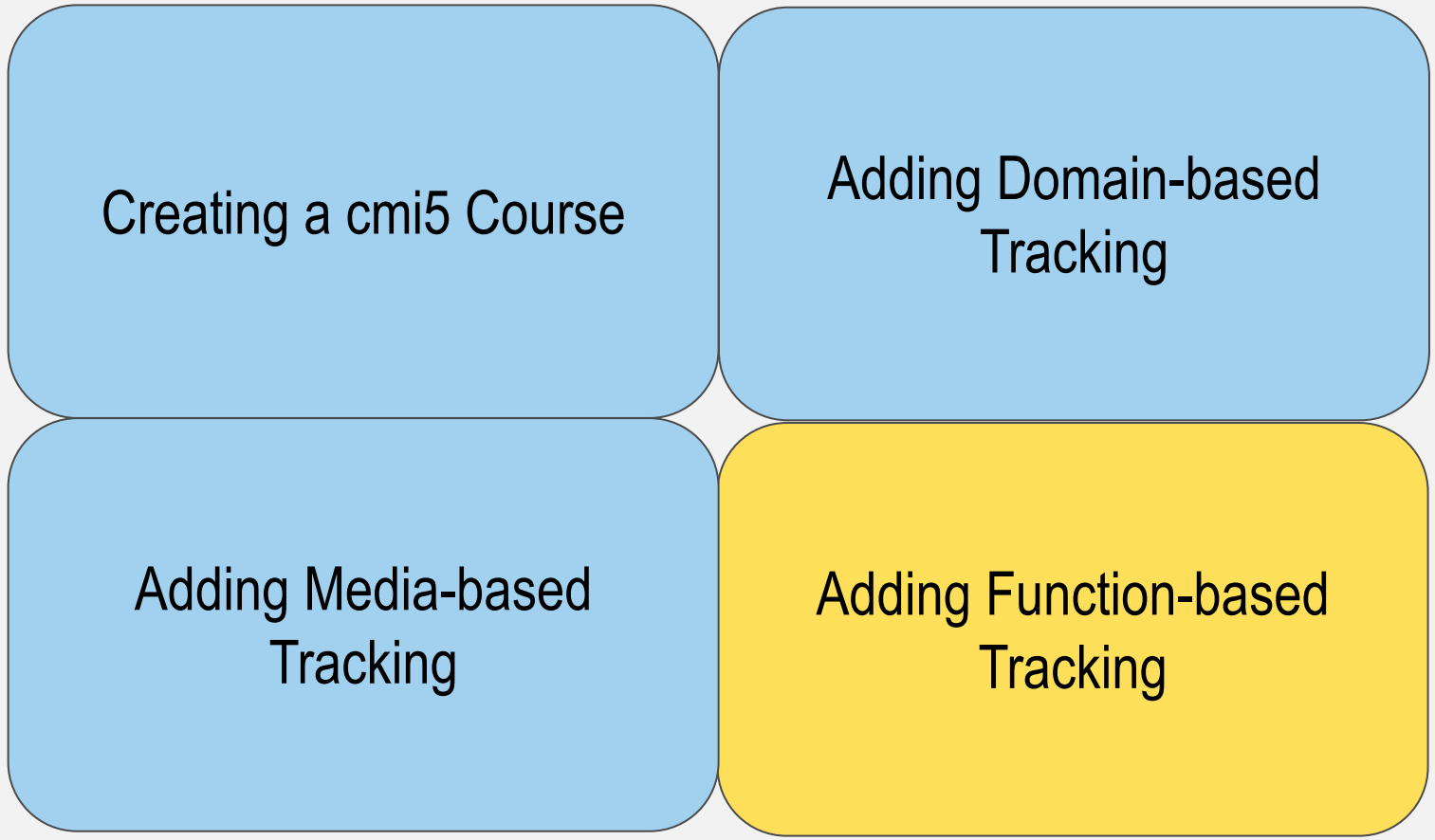
Conversation with the xAPI Developer

We need the following xAPI data defined:

- The Learner is the Actor
- The “played segments” and “progress” Extensions will be necessary
- Objects for each video asset will be necessary
- “Actor <completed> video” Statements when all segments are played
- “Actor <seeked> video” with the “time from” and “time to” Statements on relevant control
- “Actor <played> video” and “Actor <paused>” video” Statements at appropriate time
- “Actor <interacted> video” with context extension “volume” for both up and down
- Capture the “played segments” and “progress” as shown in the Video Profile

Developer Tip: All of these non-cmi5 Statements are “cmi5 allowed”, but in this case would also be tagged with a video profile context activity as well

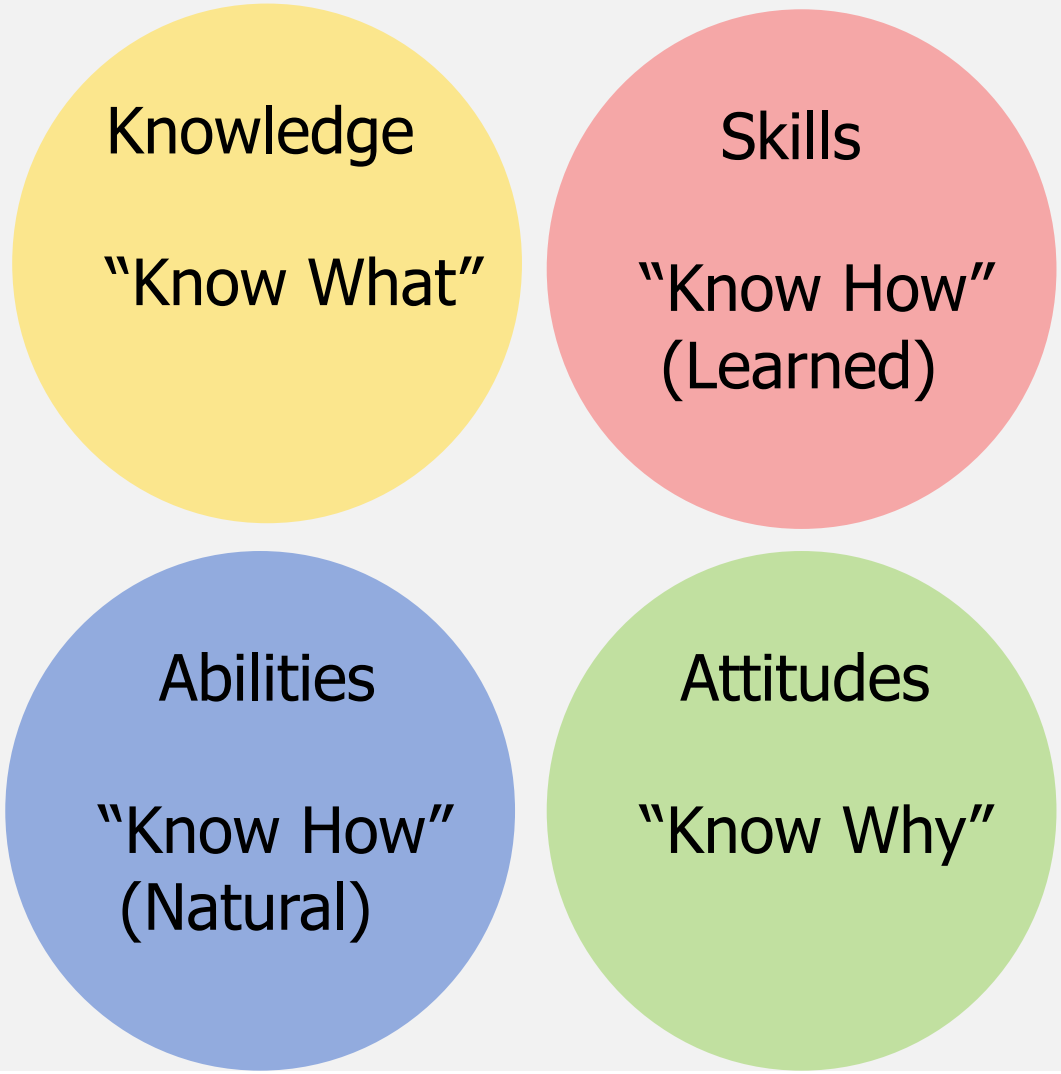
cmi5 Expanded Content Creation



Goals (Will create similar graphic that is cleaner)

Goal: Add Competencies to the Course

- We have a certificate as a goal, but we are going to add competencies
- The benefit of competencies is to store learner achievement for future credit
- Quick Definition of Terms
  - Competency - the set of skills and behaviors required in the performance of a task or activity
  - Credential – the earning of a competency by an individual as recognized by a certifying organization + “the admin stuff”
  - Certificate – the artifact of a credential that is owned by the earner



What Data Are We Interested In?

Competencies

- Competencies can be determined in many different ways
  - The course can “give out” competencies based on success either a cumulative assessment or on assessment sections
  - An evaluator can “give out” competencies based on performance evaluated either in real time or by using evidence of achievement
  - A determination of competence can be made based the weight of various assertions of competence across any number of sources
  - Luckily, these are all essentially set up the same way in xAPI

Credentials and Certificates

- An LMS could have a direct tie-in to award Credentials and Certificates based on the outcomes of earned competencies, which could be as simple as a single course

Design Decisions

Functional Design Information

- Profiles that revolve around a media type or function often will have established practices within an xAPI Profile, but this one does not…yet
- There is an ADL effort that deals with interoperability of competencies (https://cassproject.github.io/cass-editor/docs/guide/) which will be aligned to in this example, but only on the developer side
- Many competency-based decisions will happen well outside the course level, it will be up to the designer to understand possible constraints
  - One large one would be that it may be hard to design a course that responds to gained competence outside the course
  - As in other things with xAPI, if the course itself determines competence, it doesn't have to reveal all the algorithms or process

What Data Are We Interested In?

In Thinking About the Competency approach:

- We want to provide specific competencies that are achieved by expressing a value of 1 (as in 100%)
  - This determination will be tied to performance on the activities and **not** the assessment
  - May have to revisit the idea of the activity being an assessed activities
- We want to tie the completion of content and the passing/failing of assessments to competencies
  - However, we won't declare competencies achieved in the course in this way
  - An external evaluation could be done on data such as these and issued outside the course

Conversation with the xAPI Developer

We need the following xAPI Data Defined:

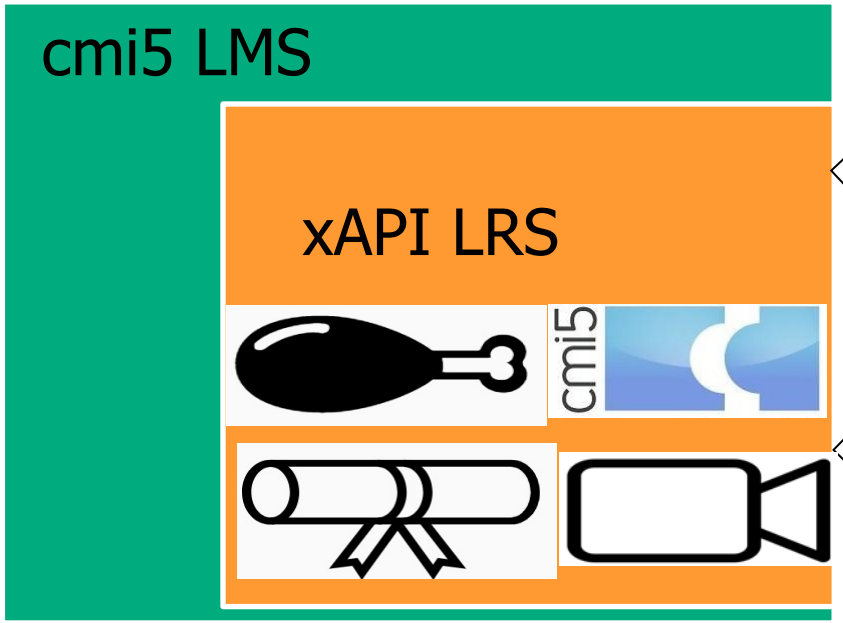
- The Learner is the Actor
- Objects for each Competency will be necessary
  - A Competency “Map” or Framework will be provided by the Designer
- Context Activities for each Competency will be necessary (the same id as the Object)
- Our Meal-Planning Activities may need to be updated to indicate assessment
- “Actor <achieved> Object (Competency) with Result “1” ” will be used when Meal-Planning Activities are successful
- In “Actor <completed> Activity”, “Actor <passed> Activity”, and “Actor <failed> Activity” Statements, the Context Activity for that Competency should be used

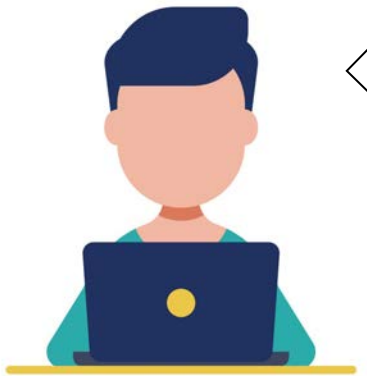
More for the xAPI Developer

The following is also useful for the xAPI Competency Developer :

- The CASS Project from ADL offers a way to implement competencies http://devs.cassproject.org/index.html?doc=1DZlrMrPd8Me2BsYHB0vUovtocWUMaj_VvKQD2_Ibb70#h.r5xxv2r1prwz that leverages xAPI.
- An example of how to look at a summary of achievement to see competency could function as follows: “Actor <asserted> Object (Competency) with Result “(0-1)” Authority *Credentialing Body* with StatementRef (Statement)”
  - Don’t worry if this doesn’t make sense to you yet
- The variety of implementation decisions available point to the strong need for an xAPI Profile in this area

Big Picture With cmi5/xAPI Data





Maybe We Did Use ADDIE…

ADDIE on Data

Analysis – We figured out what we want to track

Design – We figured out how to correlate it to events in our content

Development – We hand it off to a developer to code it in

Implementation – That coder connects the course to an LMS

Evaluation – We looked what the data is like in analytics and dashboards and we consider revisions

cmi5 Defined vs. cmi5 allowed (Revisited)

Profiles are “tagged” in xAPI within Context

The necessary cmi5 Statements are “cmi5 Defined”

The meal planning, video, and competency Statements are “cmi5 Allowed”

“cmi5 Allowed” Statements are tagged as such AND with the appropriate Profile

Expected Learning Outcome #5

5

The learner will understand the products and services available that integrate cmi5. This includes content authoring tools, LMS/LRSs, and utilities. The learner will understand evaluation criteria to distinguish conformant tools from non-conformant tools. The learner will be given information on available online documentation, code libraries, and documented best practices.

xAPI Profile Specification and Server

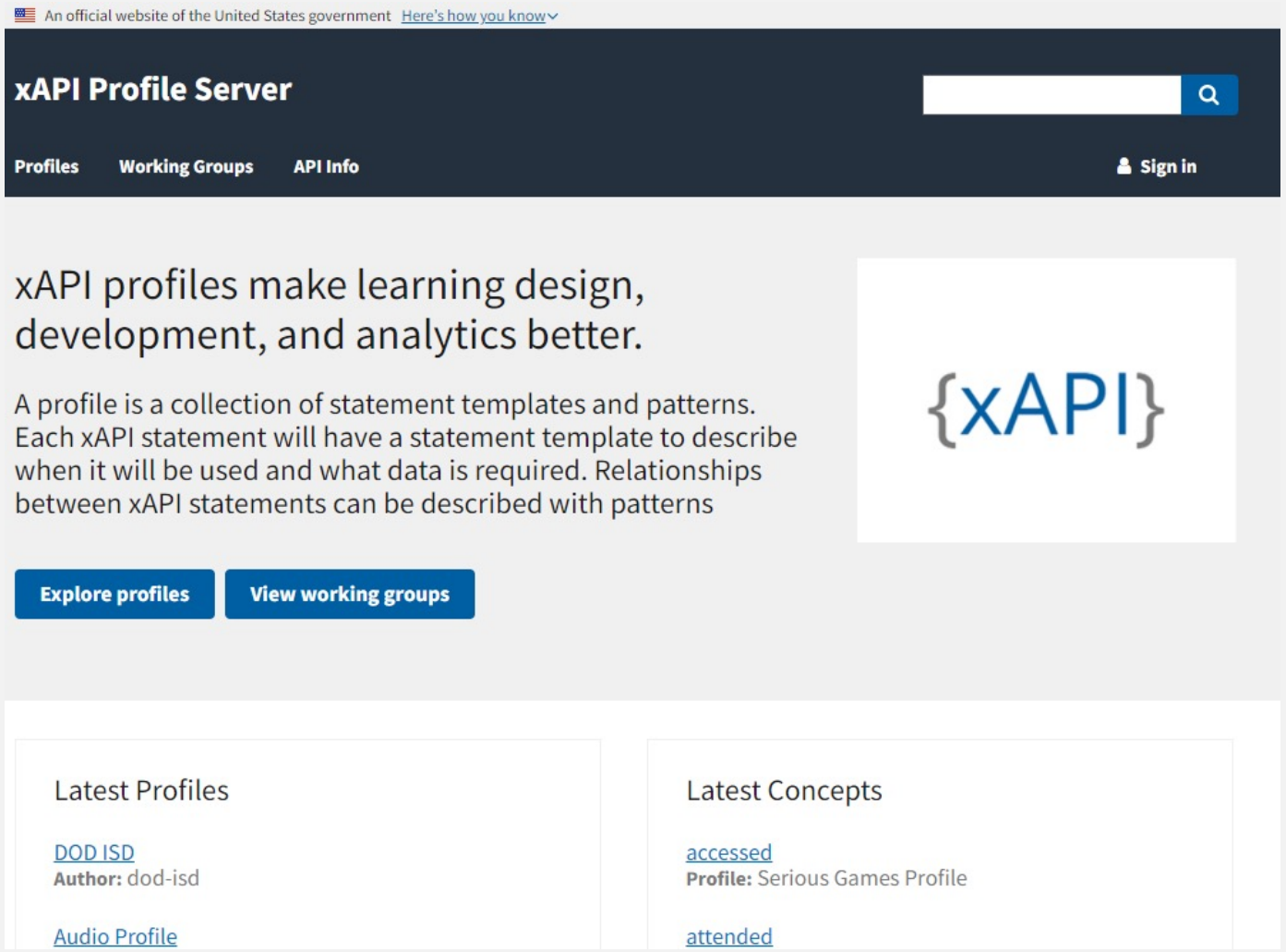
The xAPI Profile Specification

- Was created to provide uniformity to xAPI Profiles
- All the “blueprints” use the same way of structuring Statements and measuring their contents
- Allows validation through testing
  - Can Throw Out “Bad” Data

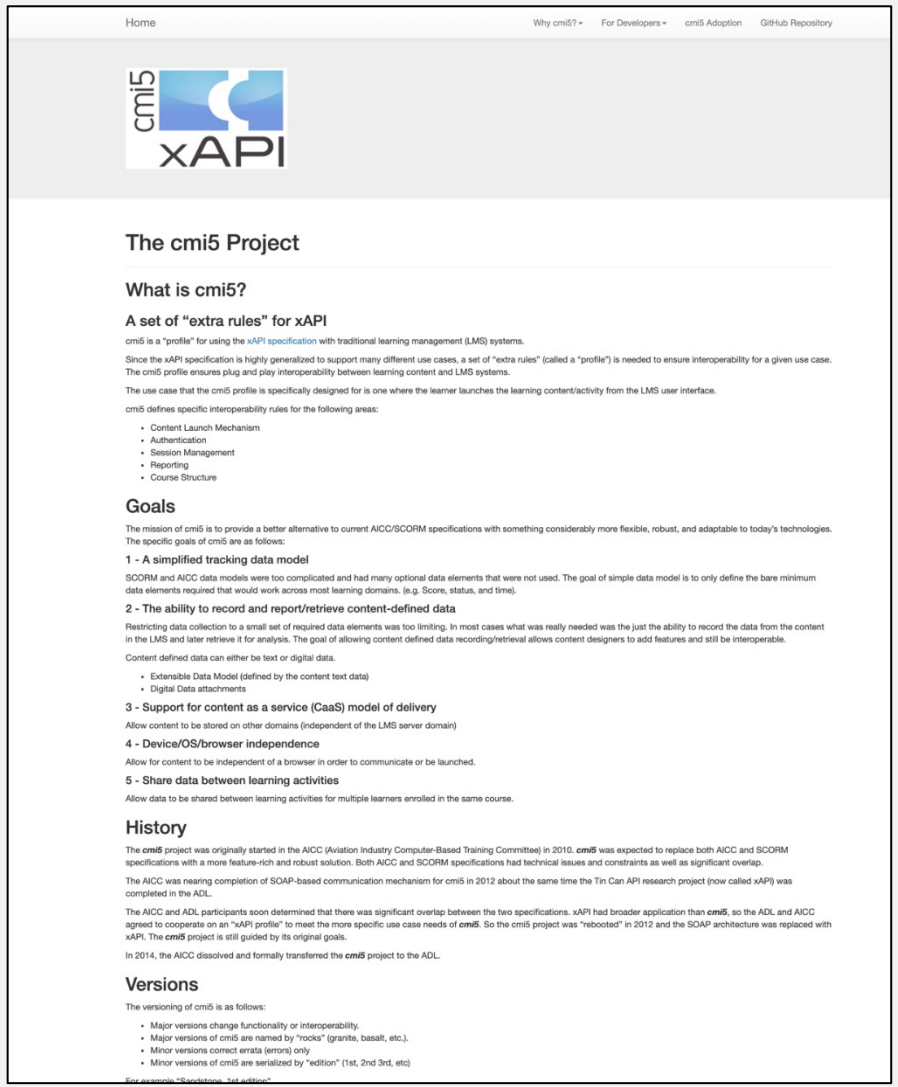
The xAPI Profile Server

- Strongly ties Profiles to Communities of Practice
- Publishing and Maintenance of xAPI Profiles
- Allows permission-based exploration of xAPI Profiles
- Validates a Profile is conformant to the xAPI Profile Specification

xAPI Profile Server



cmi5 Working Group



Home | Why cmi5? | For Developers | cmi5 Adoption | GitHub Repository

cmi5 xAPI

The cmi5 Project

What is cmi5?

A set of "extra rules" for xAPI

cmi5 is a "profile" for using the xAPI specification with traditional learning management (LMS) systems.

Since the xAPI specification is highly generalized to support many different use cases, a set of "extra rules" (called a "profile") is needed to ensure interoperability for a given use case. The cmi5 profile ensures plug and play interoperability between learning content and LMS systems.

The use case that the cmi5 profile is specifically designed for is one where the learner launches the learning content/activity from the LMS user interface.

cmi5 defines specific interoperability rules for the following areas:

- Content Launch Mechanism
- Authentication
- Session Management
- Reporting
- Course Structure

Goals

The mission of cmi5 is to provide a better alternative to current AICC/SCORM specifications with something considerably more flexible, robust, and adaptable to today's technologies. The specific goals of cmi5 are as follows:

1 - A simplified tracking data model

SCORM and AICC data models were too complicated and had many optional data elements that were not used. The goal of simple data model is to only define the bare minimum data elements required that would work across most learning domains. (e.g. Score, status, and time).

2 - The ability to record and report/retrieve content-defined data

Restricting data collection to a small set of required data elements was too limiting. In most cases what was really needed was the just the ability to record the data from the content in the LMS and later retrieve it for analysis. The goal of allowing content defined data recording/retrieval allows content designers to add features and still be interoperable.

Content defined data can either be text or digital data.

- Extensible Data Model (defined by the content text data)
- Digital Data attachments

3 - Support for content as a service (CaaS) model of delivery

Allow content to be stored on other domains (independent of the LMS server domain)

4 - Device/OS/browser independence

Allow for content to be independent of a browser in order to communicate or be launched.

5 - Share data between learning activities

Allow data to be shared between learning activities for multiple learners enrolled in the same course.

History

The ***cmi5*** project was originally started in the AICC (Aviation Industry Computer-Based Training Committee) in 2010. ***cmi5*** was expected to replace both AICC and SCORM specifications with a more feature-rich and robust solution. Both AICC and SCORM specifications had technical issues and constraints as well as significant overlap.

The AICC was nearing completion of SOAP-based communication mechanism for cmi5 in 2012 about the same time the Tin Can API research project (now called xAPI) was completed in the ADL.

The AICC and ADL participants soon determined that there was significant overlap between the two specifications. xAPI had broader application than ***cmi5***, so the ADL and AICC agreed to cooperate on an "xAPI profile" to meet the more specific use case needs of ***cmi5***. So the cmi5 project was "rebooted" in 2012 and the SOAP architecture was replaced with xAPI. The ***cmi5*** project is still guided by its original goals.

In 2014, the AICC dissolved and formally transferred the ***cmi5*** project to the ADL.

Versions

The versioning of cmi5 is as follows:

- Major versions change functionality or interoperability.
- Major versions of cmi5 are named by "rocks" (granite, basalt, etc.).
- Minor versions correct errata (errors) only
- Minor versions of cmi5 are serialized by "edition" (1st, 2nd 3rd, etc)

For example "Sandstone, 1st edition"

- Behind every profile is a unified and hard-working group
- cmi5 Working Group began BEFORE xAPI, with a completely independent organization
  - Considered WSDL and SOAP protocols (for any techies in the audience)
- Open, free, and unaffiliated
- Consider joining if interested (no experience required)
- Website: https://aicc.github.io/CMI-5_Spec_Current/
- Specification Document: https://github.com/AICC/CMI-5_Spec_Current
- Many Links to Articles on Website and in Bibliography

Buying a cmi5/xAPI Product

- Do NOT buy a product that simply claims xAPI Conformance
- Look for specifically cmi5 or named xAPI Profiles
- If an authoring tool, acquire sample output
  - Test with a known and trusted LMS/LRS
- If an LMS/LRS, ask to test with a sample course
  - Test with a known and trusted course
- Use the cmi5 Player, Test Suite, and Examples
  - ADL Project available late 2021!

Testing Criteria

Learning Record Store

- An LRS capability is NOT sufficient for cmi5 conformance, it must have additional capabilities found in an LMS
- Test an LRS as an LMS

Learning Management System

- Verify all nine types of cmi5 Statements work
- Verify all suspend/resume functionality works
- Verify all roll-up works
- Verify distributed learning content works
- Investigate through integrated dashboards, whenever possible

Testing Criteria (Cont.)

Authoring Tools

- An authoring tool's output is a Course including a Course Structure Format
- It will need to rely on a Learning Record Provider to create Statements
- Statements handed to the Learning Record Provider should be full
- Remember, not all cmi5 Statements are issued by the content
- Ensure that the authoring tool is EXTENSIBLE, much of the benefit of cmi5 is expanding into xAPI
- Authoring Tool Output and LMS Combinations CAN eliminate the need for an LRP, but is not guaranteed

ADL Efforts to Improve Acquisition

IEEE Standardization of cmi5

- Making it more enforceable

cmi5 Player Project

- Giving early adopters a platform to deploy authored courses

cmi5 Test Suite Project

- Allowing personal testing of content and systems (like SCORM)

All of these and Best Practice Guides and Templates!

- https://github.com/adlnet/CATAPULT

Tools At: https://github.com/adlnet/CATAPULT

README.md

Project CATAPULT

This repository contains the artifacts of ADL's Project CATAPULT. The resources here are intended to increase the adoption of cmi5 by providing resources and tools needed by developers, instructional designers, and procurement personnel.

Player

The `player/` houses the implementation of a prototype web service intended to be integrated into an LMS to provide the cmi5 launching system capabilities. It leverages an external LRS for xAPI requirement handling, but otherwise provides all validation, import, launch and other required functionality.

Content Test Suite

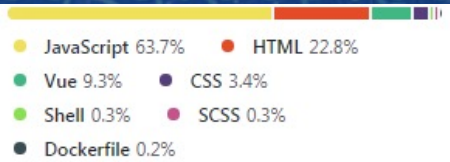
The `cts/` contains the implementation of a web service and web browser UI application that when used together enables end user testing of cmi5 packages. This application is targeted at instructional designers, content authoring tool developers, and learning content procurers. It also provides an example integration with the Player prototype.

LMS Test Suite

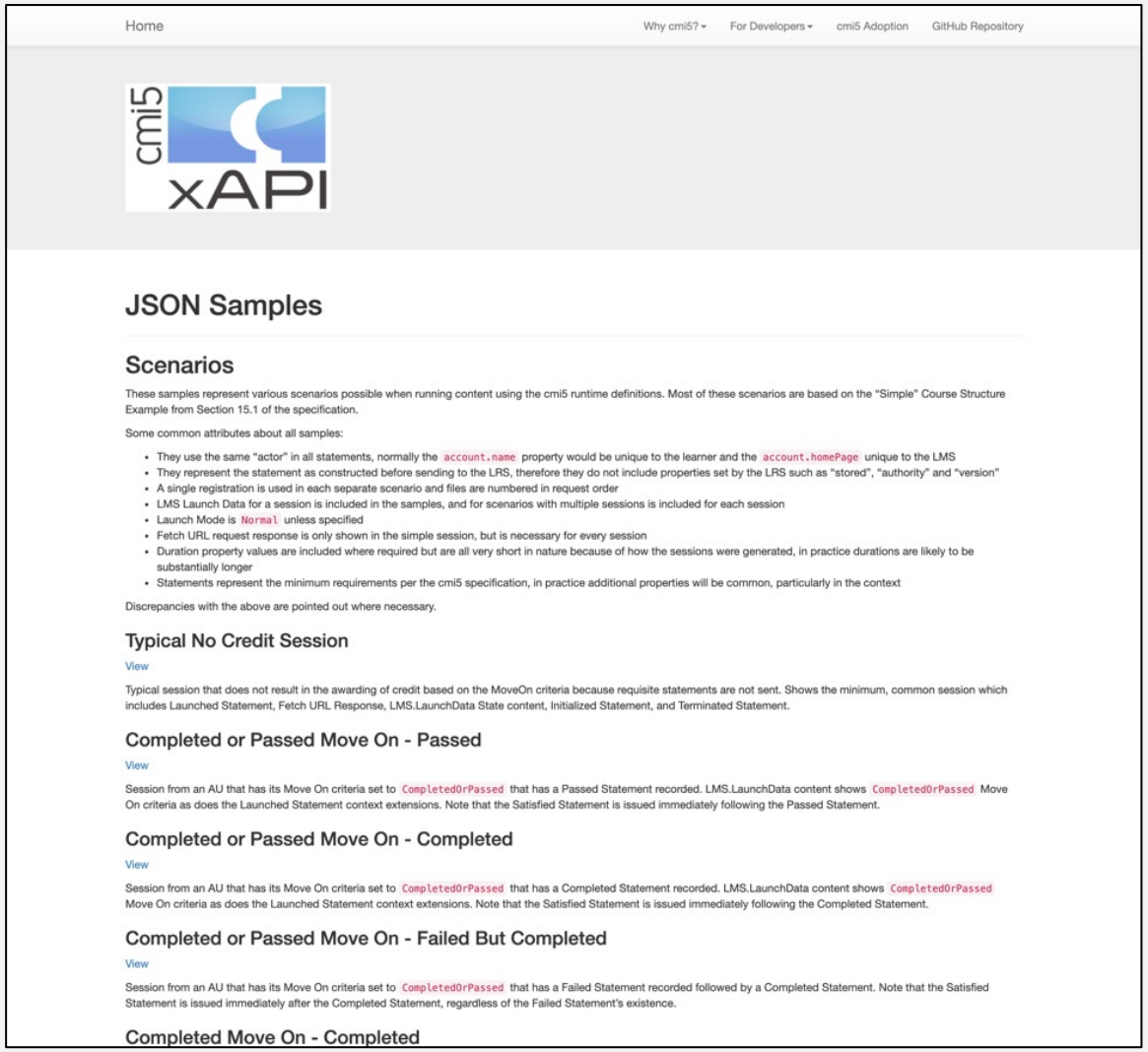
The `lts/` contains the implementation of a test suite used to validate the implementation of a cmi5 launching system within an LMS system. It contains a package library, manual test procedure document, and an automatable tool for LMS developers to use via their CI system.

Requirements

The artifact of `requirements/` is a JSON file that can be leveraged by systems to easily map from requirement identifiers to the specification language. It is made publicly available via npm's public registry.



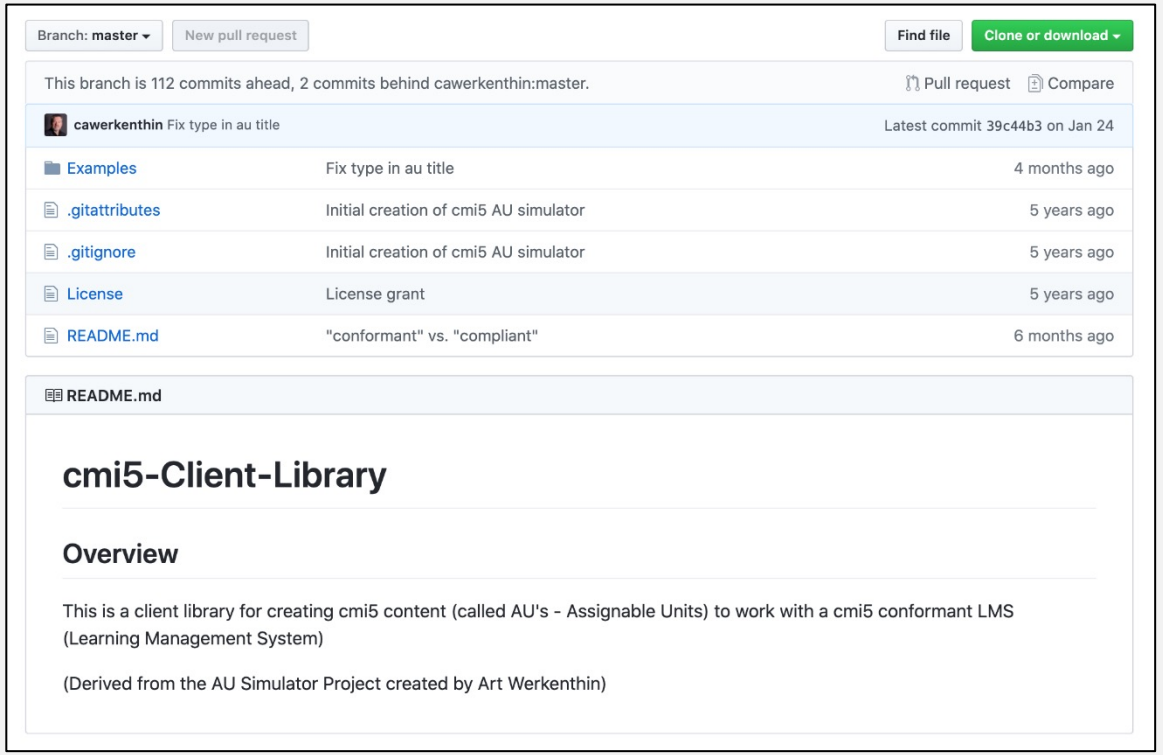
cmi5 Sample Statements



Full cmi5/xAPI Statements are available

- https://aicc.github.io/CMI-5_Spec_Current/samples/
- All necessary Statements for thirteen specific cmi5 scenarios
- Goes perfectly with the Workflow shown earlier
- Includes:
  - No Credit Sessions
  - Completed/Passed with MoveOn
  - Use of Mastery Score
  - Abandoned Sessions
  - Multiple Attempts
  - "cmi5 Allowed"

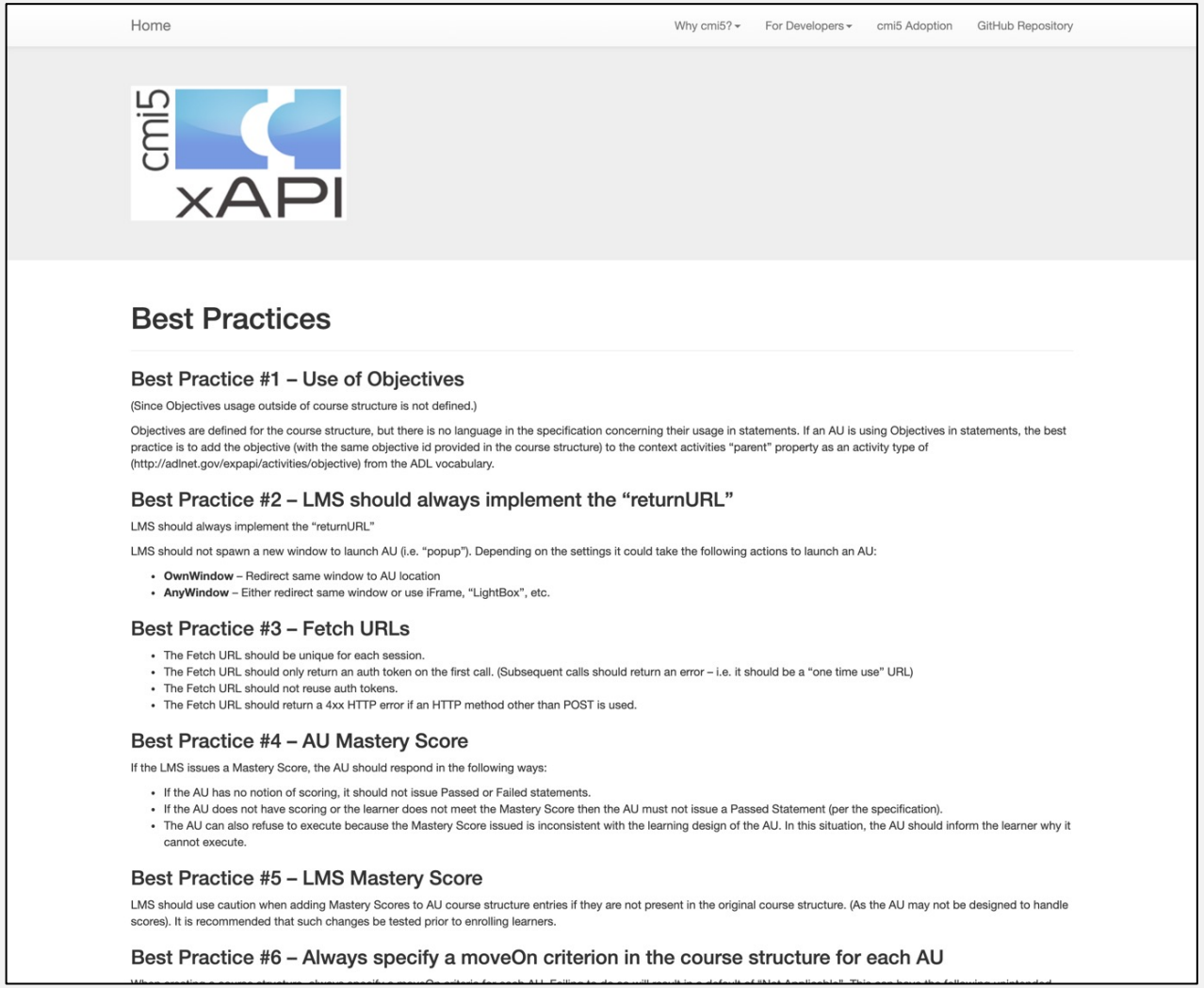
cmi5 Client (Content) Sample Code



Library of JavaScript Solutions

- https://github.com/adlnet/cmi5-Client-Library
- Includes Real Content, Code, and Scripts
- Verified by cmi5 Working Group

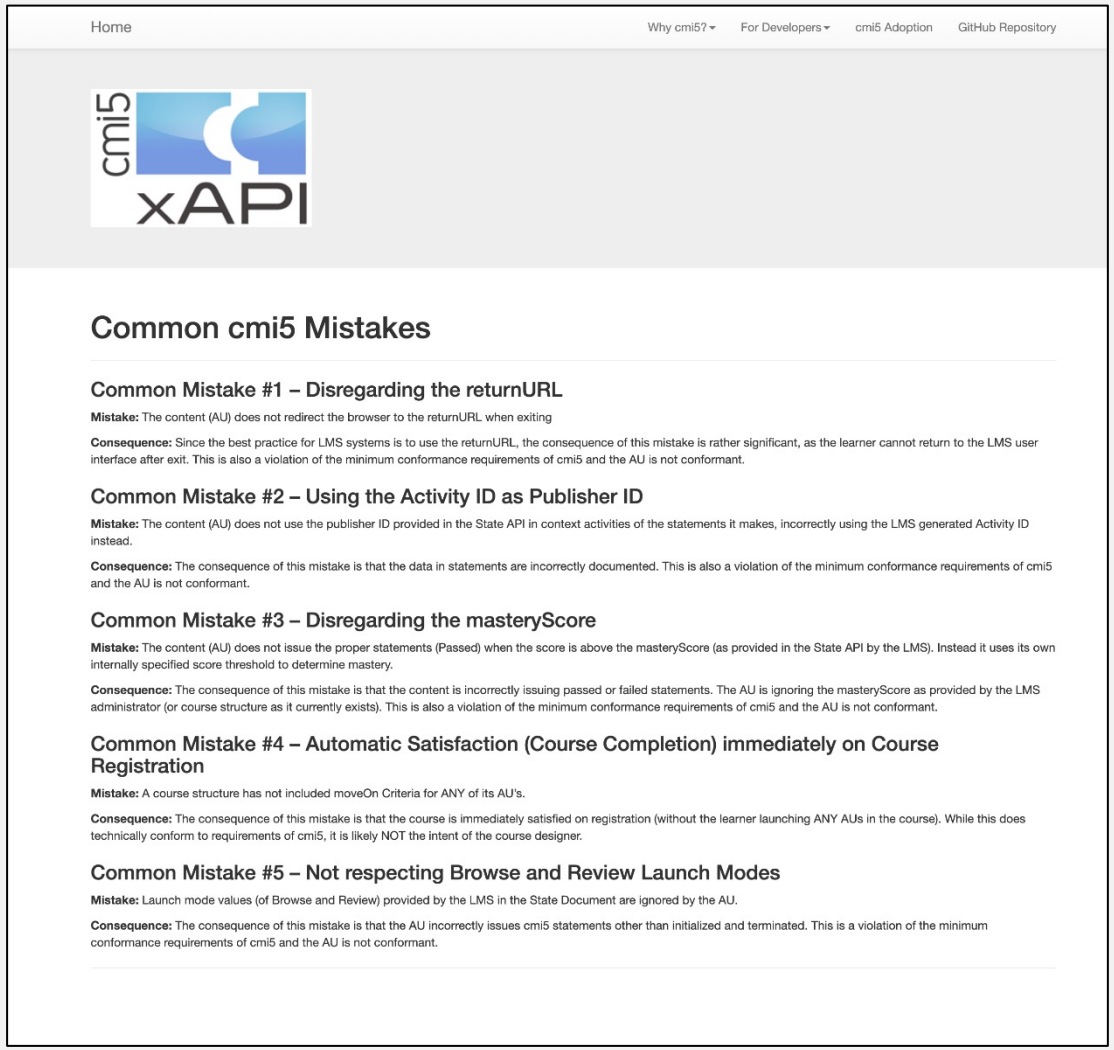
cmi5 Best Practices



Best Practices

- https://aicc.github.io/CMI-5_Spec_Current/best_practices/
- Discusses many of the tougher to implement parts of cmi5
- Includes Advanced Topics such as:
  - The Authentication "Handoff"
  - Mastery Score
  - Mobile
  - Objectives
  - Error Handling

cmi5 Worst Practices



Worst Practices

- https://aicc.github.io/CMI-5_Spec_Current/mistakes/
- Discusses many of the pitfalls and early mistakes of adopters
- Doesn't include things like "don't use the same id for every activity"
- Includes Advanced Topics such as:
  - Activity vs. Publisher Id
  - Mastery Score
  - Registration
  - Launch Modes
  - Error Handling

cmi5 Adopters

Results of All cmi5 Conformant LMSs Shown Below:

cmi5 Adopters

cmi5 Working Group maintains a list of adopters (see Bibliography)

- Unbiased

Content Authoring Products

- Articulate Global, Inc. - Storyline 360 (Content Authoring Tool)
- Growth Engineering - Genie Game-based Authoring Tool
- iSpring Solutions iSpring Suite (Content Authoring Tool)
- Rustici Software SCORM Driver (Content Authoring Middleware)
- Trivantis Lectora Publisher (eLearning Content Authoring Tool)
- Trivantis CenarioVR (VR Content Authoring Tool)
- xAPI.js – cmi5 Profile Library

cmi5 Adopters (Cont.)

LMS Products

- Epignosis, LLC - Talent LMS
- Grassblade xAPI Companion (Add-on for WordPress)
- RISC Inc. Virtual Training Assistant™ (LMS)
- Rustici Software SCORM Engine (LMS Middleware)
- Rustici Software SCORM Cloud (LMS/LRS)
- WP Courseware Learning Management System (Via Grassblade Integration)

Thank You to the chi3 Working Group! (Will be Updated to reflect current membership and meeting link)

Chair:

- Bill McDonald (and a thank you to Amazon for loaning us Bill every week)

Current Participants (Thank you to all past participants too):

- Alan Mustafa, Alessio Breviglieri, Allyssa Thompson, Andy Johnson, Art Werkenthin, Ben Clark, Bill McDonald, Brandon Billings, Brian Duck, Brian Miller, Carsten König, Chetan Sachdev, Choompol Boonmee, Chris Horan, Chris Mangoine, Christopher Thompson, Christopher Krepich, Cole Tinney, Cristina Boyer, David Pesce, David Mallette, David Wang, Dennis Hall, Derek Redmond, Devlin Peck, Eilieen Quenin, Florian Tolk, Geir Fuhre Pettersen, George Vilches, Henry Ryng, Jack Bowden, Jason Haag, Jason Woodford, Jim Broadwell, Ketan Patel, Kevin Owens, Laurie Johnson, Marco Dal Colle, Marcus Birtwhistle, Matty Kahler, Megan Bowe, Michael Pack, Michelle Goodson, Mike Hernandez, Moges Kelklie, Nabin Test, Peter Hawkins, Prathiba Prathapan, Richard Shipmon, Robert Verner, Russ Engoran, Scott Powers, Seli Agbolosu-Amison, Shakhriyor Khudoyberdiev, Simon Hsu, Sriraman Raman, Stuart Simon, Tammy Rutherford, Thomas Turrell-Croft, Tim Edwards, Tracy Cowan, Udith Dilshan, Vijay Mandava, Vpad Dots, Willem Kupper, Yifei Dong, Yihua Liu

Join Us:

- https://attendee.gotowebinar.com/register/4876843550305432332

ADL Efforts to Improve Acquisition

IEEE Standardization of cmi5

- Making it more enforceable

cmi5 Player Project

- Giving early adopters a platform to deploy authored courses

cmi5 Test Suite Project

- Allowing personal testing of content and systems (similar to the SCORM Test Suite)

cmi5 Course Templates

- Free templates with xAPI Statements from cmi5, video profile, etc.

The Learner Now (Hopefully)

- Is able to describe xAPI Concepts and how they relate to cmi5
- Understands the use cases of cmi5 and its value to enable other xAPI solutions
- Is able to describe xAPI Profiles and their critical role in interoperability
- Is able to design learning resources using xAPI, xAPI Profiles, within a cmi5 framework
- Understands available cmi5 resources and whether products are cmi5 compliant or not

Bibliography

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- IEEE 9274.1.1_2021_D1 – TBD (as in, will populate before final)
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- cmi5 Working Group Page – https://aicc.github.io/CMI-5_Spec_Current/
- cmi5 Content Player, Test Suite, and Templates – TBD
- cmi5 Adopters List (ADL) - TBD
- SCORM vs. cmi5 Comparison (by cmi5 Working Group) - http://aicc.github.io/CMI-5_Spec_Current/SCORM/
- cmi5 as SCORM Replacement Article - http://risc-inc.com/next-generation-scorm-cmi5/

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- cmi5 Best Practices - https://aicc.github.io/CMI-5_Spec_Current/best_practices/
- cmi5 Worst Practices - https://aicc.github.io/CMI-5_Spec_Current/mistakes/
- cmi5 Code Library - https://aicc.github.io/CMI-5_Spec_Current/client/
- cmi5 Sample Statements - https://aicc.github.io/CMI-5_Spec_Current/samples/
- SCORM to xAPI Wrapper - https://github.com/adlnet/SCORM-to-xAPI-Wrapper
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Questions?

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