Comunidad de Madrid
www.madrid.org

eMadrid
www.emadridnet.org

Work in Progress on the Standardization of Online Laboratories for Education

eMadrid Session

www.emadridnet.org

26-Feb-2016 REV Conference, Madrid

Miguel R. Artacho
miguel@lsi.uned.es

GO-LAB
GLOBAL ONLINE SCIENCE LABS
INQUIRY LEARNING AT SCHOOL

UNED

REV International Conference
Remote Engineering & Virtual Instrumentation

IEEE SA P1876 Group

Networked Smart Learning Objects for Online Laboratories

Chair: Hamadou Saliah-Hassane

Draft Editors: Miguel Rodriguez Artacho, Denis Gillet, Hamadou Saliah-Hassane

https://ieee-sa.centraldesktop.com/1876public/

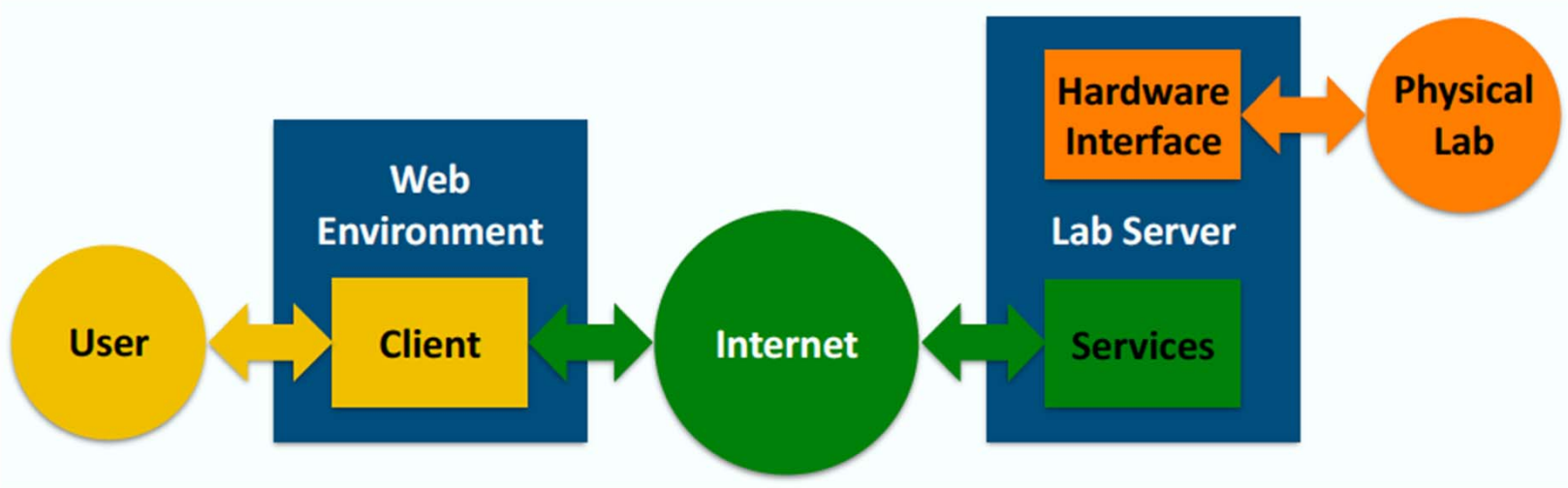
Scope


activity
aggregation
collaboration
communications
computers
context
design
environment
implement
interfaces
laboratories
learning
linking
mechanisms
methods
networks
objects
online
pedagogical
practical
remote
scenarios
smart
tools
work

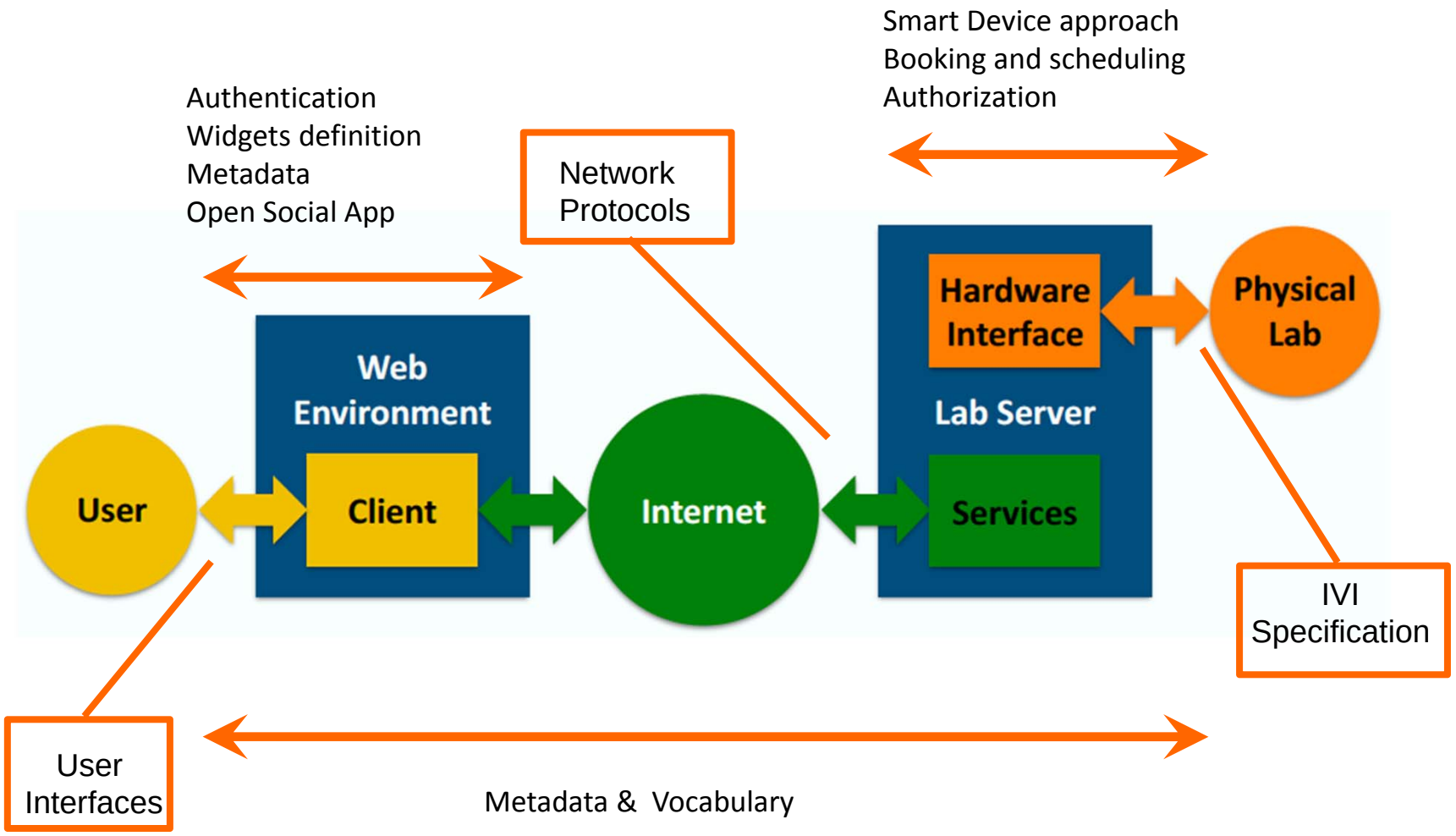
Content

- Context
- Normative references
- Definitions
- Standardization levels and information
- Metadata
- Learner experience and outcomes

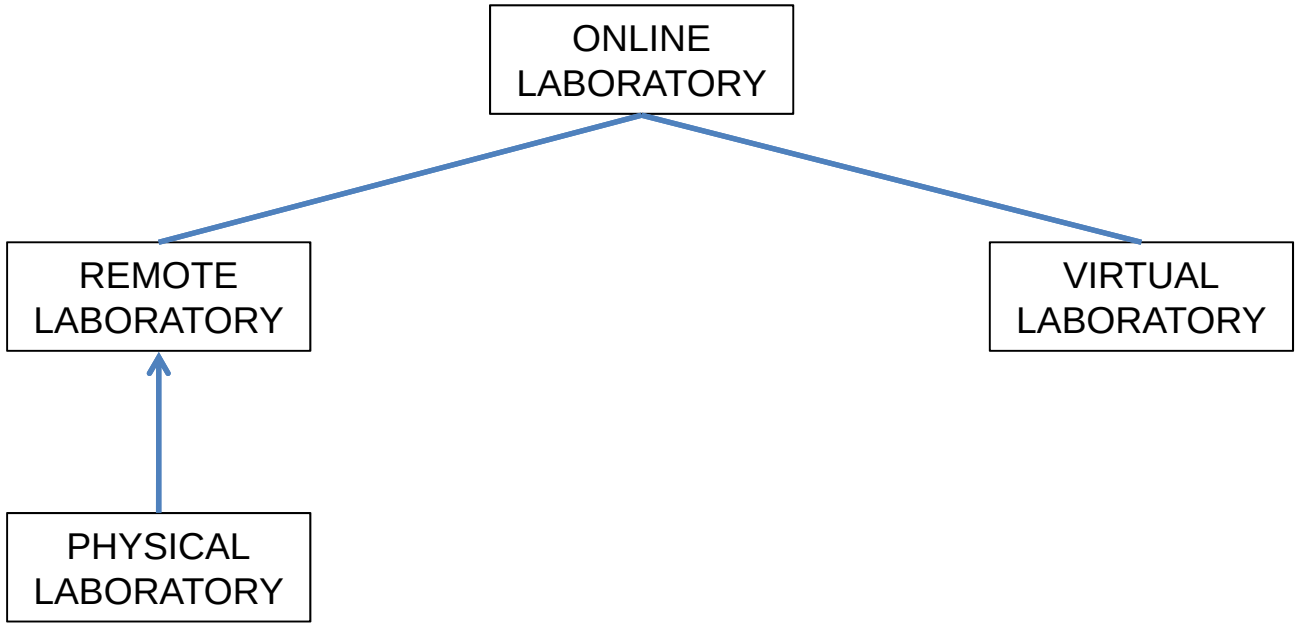
Online laboratories: context



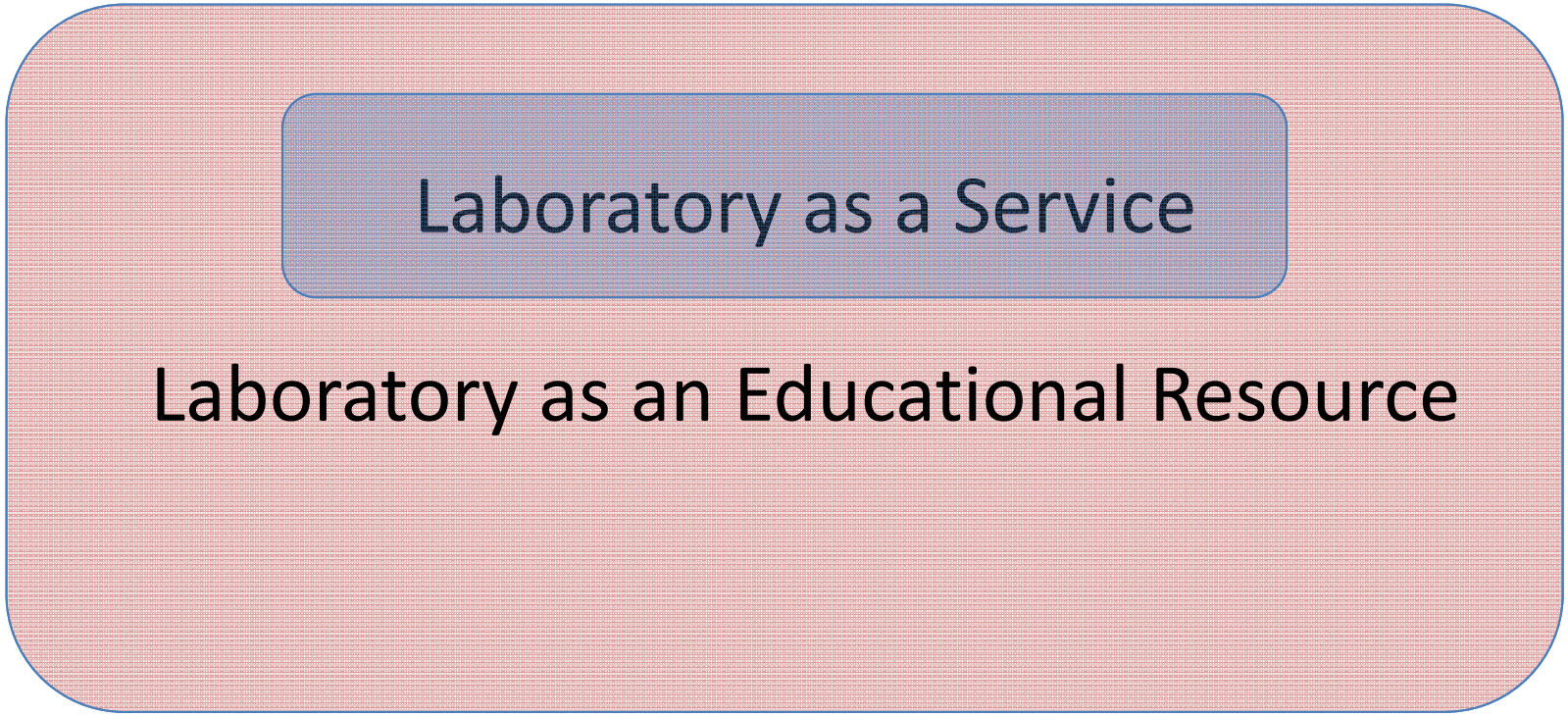
P1876

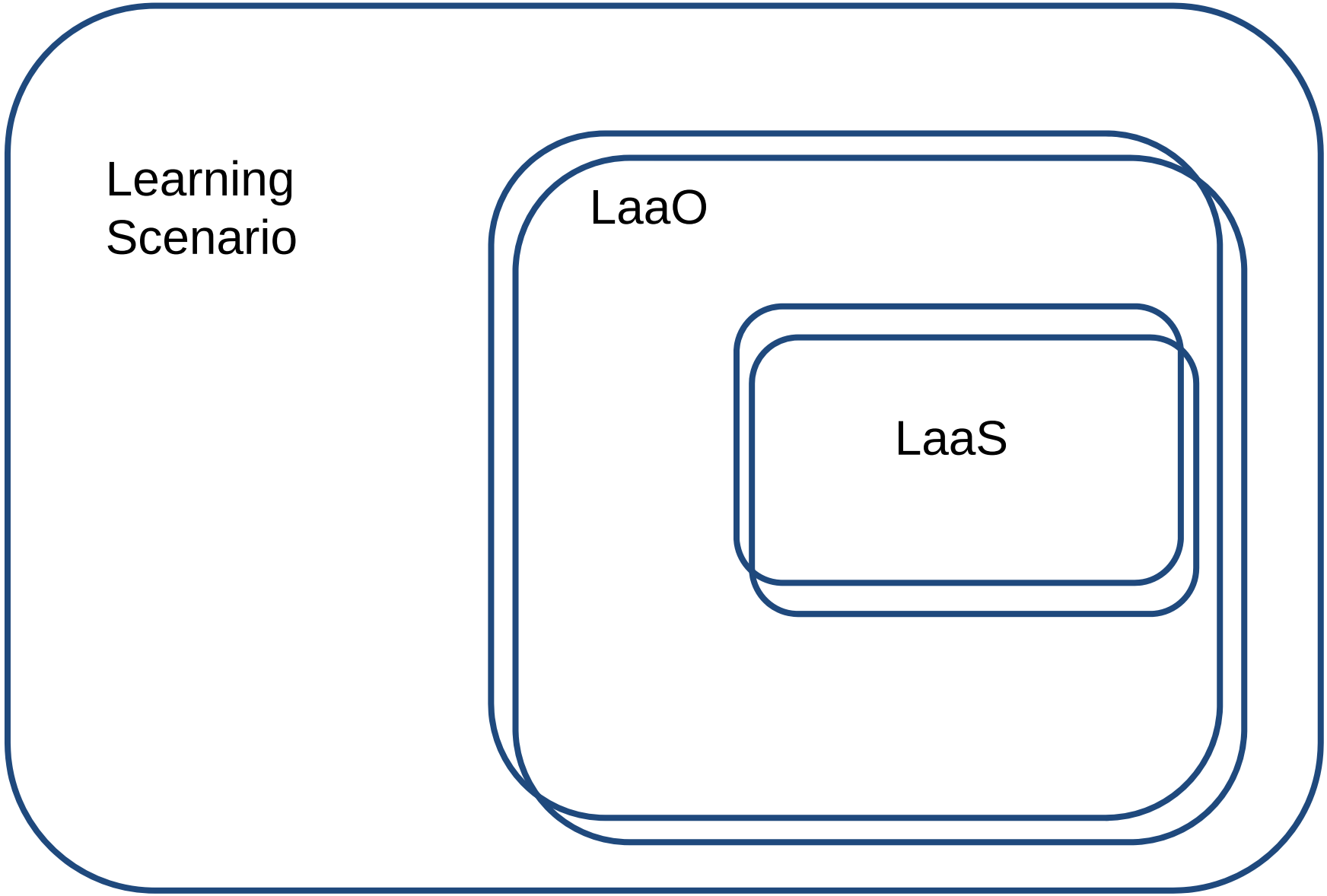

Smart Device approach
Booking and scheduling
Authorization
Authentication
Widgets definition
Metadata
Open Social App
Network Protocols
Hardware Interface
Physical Lab
Web Environment
Lab Server
User
Client
Internet
Services
IVI Specification
User Interfaces
Metadata & Vocabulary

P1876

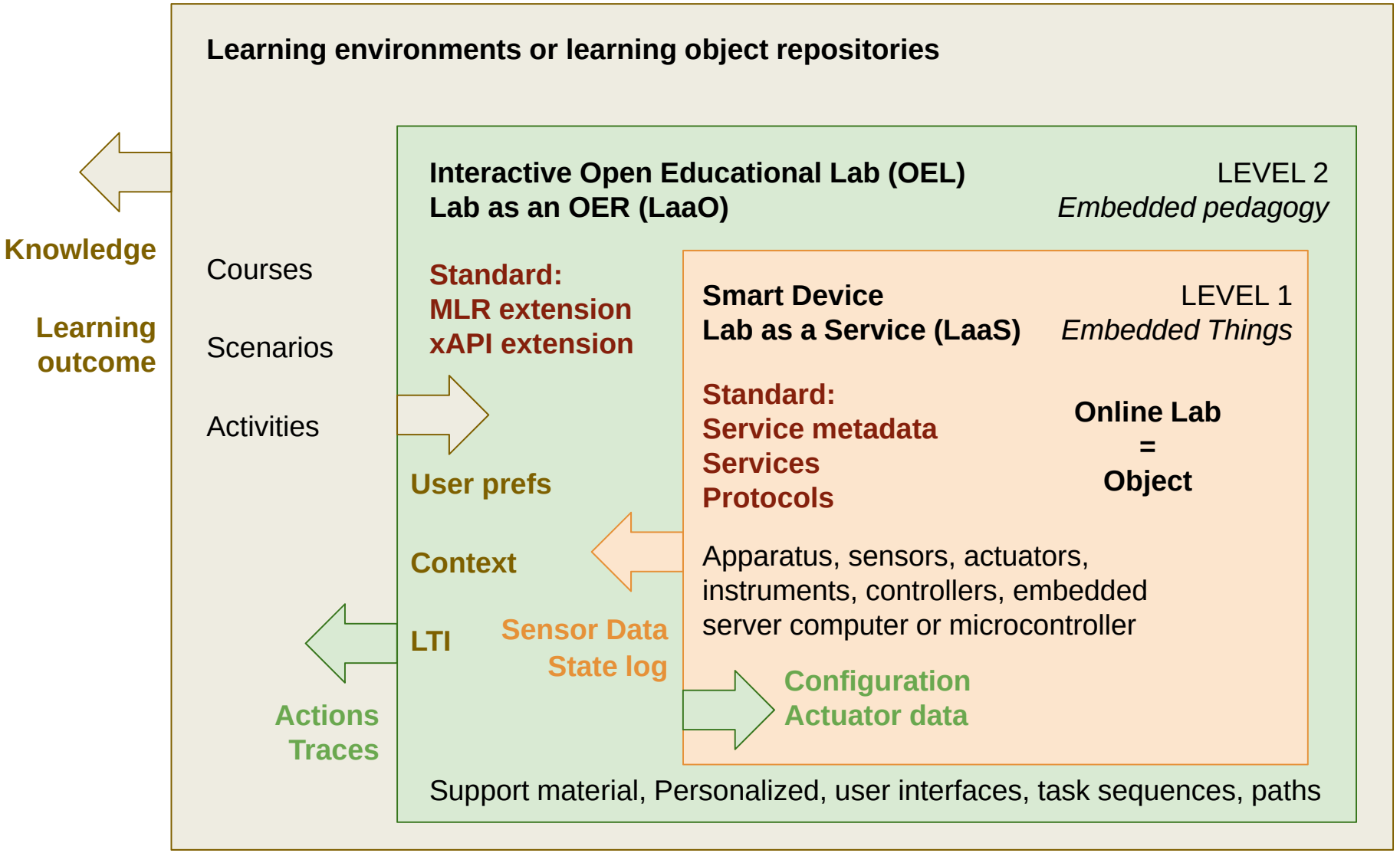

ONLINE LABORATORY
REMOTE LABORATORY
VIRTUAL LABORATORY
PHYSICAL LABORATORY

Educational Perspective




Learning
Scenario
LaaO
LaaS

Standardization Levels



P1876 Draft Sections

- Normative references
- Definitions
- Laboratory as a Service
  - Service Metadata
  - Service specification
- Laboratory as OER
  - Metadata:
    - Resource metadata --> MLR part 2
    - Interopetability metadata --> LTI
  - Outcomes: xAPI triplets – statements (LRS)
- Annexes: Service Bindings

Normative References

- **IETF RFC 2396,** Uniform Resource Identifiers (URI): Generic Syntax.
- **ISO 639-1**, Code for the representation of names of languages—Part 1: Alpha-2 code.
- **ISO 639-2,** Codes for the representation of names of languages—Part 2: Alpha-3 code.
- **ISO 3166-1,** Codes for the representation of names of countries and their subdivisions—Part 1: Country codes.
- **ISO 8601:2000,** Data elements and interchange formats—Information interchange—Representation of dates and times.
- **ISO/IEC 646:199**1, Information technology—ISO 7-bit coded character set for information interchange.
- **ISO/IEC 10646-1,** Information technology—Universal Multiple-Octet Coded Character Set (UCS)—Part 1: Architecture and Basic Multilingual Plane.
- **ISO/IEC 11404:1996(E),** Information technology—Programming languages, their environments and system software interfaces—Language-independent datatypes.
- **ISO 15836:2009(E) --** Information and Documentation The Dublin Core Metadata Element
- ***W3C*** *Resource Description Framework (RDF) Revised Edition, available online at http://www.w3.org/TR/REC-rdf-syntax/*
- *The Singapore Framework for Dublin Core Application Proles, availableonline at http://dublincore.org/documents/singapore-framework/*
- ***DCMI*** *Description Set Profile Model. Working Draft, December 2007, availble online at: http://dublincore.org/architecturewiki/DescriptionSetProfile*
- ***IoT?***

Definitions

Online laboratory: Could be either a remote laboratory or a virtual laboratory which is accessible online. By nature, online laboratories are distributed as they are located and operated in different facilities (a remote lab is hosted by its owner and the server or the cluster running a virtual lab is hosted by its provider).

Remote laboratory: The remote laboratory is an apparatus and its instrumentation that can be accessed, monitored and controlled at distance. It typically includes the physical artefacts that exhibit the phenomena being explored, as well as the transducers, sensors, and actuators that allow interaction with those artefacts. A remote laboratory is located in a real facility (building). It is managed and offered by a provider (person, institution, organization or company).

Definitions

Virtual Laboratory: End-user interactive simulation software application to provide users with a learning activity otherwise unachievable on a local device. The simulation mimic the behaviors of an apparatus in various contexts of use and rely on its model defined at an appropriate level of abstraction. In general, interactive simulation, design, analysis and visualization go together. Virtual laboratory is executed on a physically server or cluster. It is managed and offered by a provider (person, institution, organization or company).

Definitions

Learning activity: A learning activity is a coherent set of tasks involving a learner or a group of learners and a set of online educational resources intended to result in learning outcomes. When the learning activity is carried out with an EOL, it is referred to as an Experiment. An experiment can be carried out in one or more learning sessions.

Mobile laboratory: Sensors can be hosted on vehicles (for pollution monitoring as example) and carried out by students when working in the field. In this case, the focus of the experiment is an environment rather than an apparatus. The corresponding mobile laboratory has not fixed IP address or location. It is rather the contextual data storage which can be considered as an online lab. It is referred as a mobile lab.

Laboratory as a Service (LaaS)

3.2 Metadata

- General information on the online lab, including its name, description or contact information.
- List of APIs to access the services (i.e., actuators service). The services themselves are described in Section 3.3.
- The authorization mechanisms, to allow access to the described services only by the granted users.
- The concurrent access mechanisms, to manage multiple access at the same time to the same resource

Laboratory as a Service (LaaS)

3.3 Services

- getSensorMetadata
- getSensorData
- getActuatorMetadata
- sendActuatorData
- getLoggingInfo
- getClients
- getModels

Laboratory as a Service (LaaS)

3.4 Functionalities

- Authentication functionality
- Self and known state functionality
- Security and local control
- Logging and alarms

3.5 Protocols

- HTTP (to get metadata)
- WebSocket (for interaction with the online lab)

AN EXAMPLE

client

smart device

Hey! What can you do?

http://serverIP/metadata

Here is what I do!

{ name…, "services": […], …}

services=[…]

Which sensors do you have?

{"method": "getSensorMetadata"}

These are my sensors:

{"method":"getSensorMetadata", "sensors": [

{ "sensorId": "disc pos", "values": [

{…"rangeMinimum": 0, "rangeMaximum": 10,…}],…}

sensors=[{
id:"disc pos",
min:0,
max:10}];

AN EXAMPLE CONTINUED

client

smart device

Which actuators do you have?

{“method”: “getActuatorMetadata”}

These are my actuators:

{“method”:“getActuatorMetadata”, “actuators”: [
{ ”actuatorId”: “motor”, …”values”: [
{…”rangeMinimum”: -5, ”rangeMaximum”: 5,…}]}

actuators=[{
id:“motor”,
min:-5,
max:5}];

Yay! I can make a UI!

Give me the current disc pos…

{“method”:“getSensorData”, “sensorId”: “disc pos”}

disc pos:

motor:

AN EXAMPLE CONTINUED

client

smart device

disc pos:
6.2
motor:
1

Here is the current position:
{"method":"getSensorData", "sensorId": "disc pos",
"data":[6.2], "lastMeasured":["18:28"]…}

disc pos:
7.1
motor:
1

Here is the current position:
{"method":"getSensorData", "sensorId": "disc pos",
"data":[7.1], "lastMeasured":["18:30"]…}

Set the motor to 3
{"authToken":"42FE36", method":"sendActuatorData",
"actuatorId": "motor",…"data":[3], …}

authenticate(42FE36)

YES!

set motor to 3

The Learning Object model and the Online Laboratories

- In the e-learning arena, online laboratories could be linked with the general concept of learning activity: “any activities of an individual organized with the intention to improve his/her knowledge, skills and competence”.
- There are standards and specifications that cover the interoperability of a subset of the following specific features of the LO:
  - Description and tagging: metadata.
  - Content structuring and packaging.
  - Communication.
  - Sequencing.
  - Learning tools and services interoperability.
  - LEARNING DESIGN

Metadata

- **Services (Operational)**
  Operational metadata for services and functionalities
- **Resources (Educational)**
  - Description
    Consider MLR as metadata schema --> + extensions
  - Interoperability
- **Outcomes**
  xAPI[1] LRS statements

Learner Experience

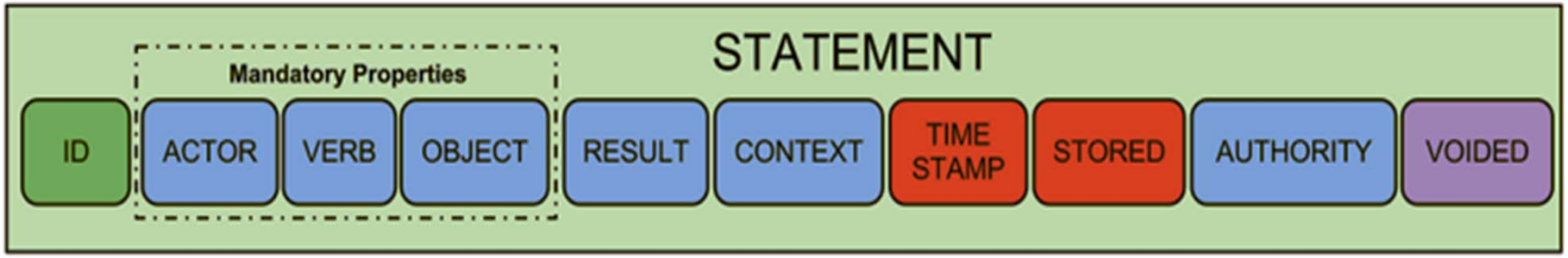
Learning activity described using ADL Training and Learning Architecture (TLA)

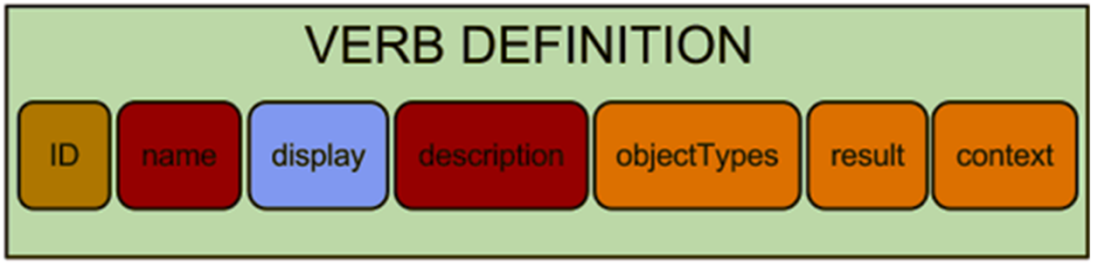
Student activity stored in LRS (Learning Record Store)

LRS and LMS communicate through API called eXperience API (xAPI)

LRS statements

I did THIS





Community of Practice

CoP responsibilities:

It is very important that such communities **share** best practices.
Define the identifiers (verbs, activity types, contextual relationships, extensions, etc.) to be used in their use cases.

Define these identifiers in a **profile/recipes**. This is a set of rules and/or vocabularies to be implemented in addition to xAPI for the particular use case being addressed.

Controlled Vocabularies

A controlled vocabulary is a restricted, agreed-on list of words or terms developed by a CoP and used for a specific domain of knowledge.

- Verb
- Activity id
- Activity type
- Extension key
- Attachment usage type

Controlled Vocabularies

Key aspects:

The **granularity** with which we subdivide the activity space matters very little for the simple act of recording statements, but is extremely important to be able to later derive meaning from a set of statements for reporting or other types of use.

It is important to **define relationships** between activities. In the examples, a “larger” activity was subdivided into smaller activities, which forms a parent/child relationship. It is important to think through how activities can be **grouped** to realize better reporting and decision making later in the process.

Controlled Vocabularies

For the structure of metadata about Activity ids:

Property	Type	Description	Req
name	Language Map	The human readable/visual name of the Activity	Recommended
description	Language Map	A description of the Activity	Recommended
type	IRI	The type of Activity.	Recommended
moreInfo	IRL	Resolves to a document with human-readable information about the Activity, which could include a way to launch the activity.	Optional
Interaction properties, See: SCORM style cmi.interactions			
extensions	Object	A map of other properties as needed (see: Extensions)	Optional

Controlled Vocabularies

For the structure of hosted metadata about all other identifiers:

Property	Type	Description	Req
name	Language Map	The human readable/visual name. For Verbs, this is equivalent to the Display property in a statement.	Optional
description	Language Map	description	Optional

Online Labs

Actor – User in the system

Verbs – Vocabulary list

Activity

Two Activity types:

Label	Description	ID (IRI)
sensor	The sensor is the building blocks of a remote laboratory rig, and represents the components, which can be monitored. It will typically include the physical or virtual artefacts that capture the phenomena being explored.	http://IEEE-SA-P1876.com/expapi/activityType/sensor
actuator	The actuator is the building blocks of a remote laboratory rig, and represents the components, which can be controlled monitored. It will typically include the physical or virtual artefacts that capture the phenomena being explored.	http://IEEE-SA-P1876.com/expapi/activityType/actuator

Result

- Store the action performed on an actuator or the result
- SCORM Interaction “like” + extensions

Verb List

General verbs:

Started, attempted, experienced…

Specific Verbs:

Turned on, turned off, rotated, measured, recorded, wired, heat, increased...

Example Verb “Rotated“

Property	Value	Type
Id	http://IEEE-SA-P1876.com/expapi/verbs/experienced	String
Name	Rotate – to rotate an actuator certain degrees	String
Display	{ "en-US" : "rotated"}	Object
description	Turn an actuator on an axis certain degrees.	String
objectTypes	Actor (actuator)	String[]
Result	Extension	String[]
Context	No recommendations	String[]

Case Study

Eolic Lab (http://uned.esy.es/eolic)
@ UNED DIEEC Dept www.ieec.uned.es

Actuators:
Fan (engine) 0 – 168 W
Wing Rotator (engine) -150 – 150
Battery – act as actuator, because the student can decide to use a percentage of the load.

Sensors:
Battery – act as a sensor, the percentage of the battery loaded by fan

Next Steps

- Communication with ADL/TIC CAN

form: http://tincanapi.com/contact-us
From: http://adlnet.gov/contact-adl/

- Increase verbs and activities => more case studies
  Pool of statements, verbs, activities…

- Get feedback to improve the definitions

Next Steps

- Recipes (profiles)

Recipes are a strategy to help systems more effectively use the data in xAPI statements. XAPI has a structured but incredibly open way of dealing with data. This is its greatest strength and weakness. You can do anything you need to do with it, and you can make a big mess of the data in the process.

- Semantics

Semantic interoperability is needed to automatically interpret the information exchanged meaningfully and accurately in order to produce useful and consistent results.

- MLR metadata

Acknowledgements

Work in Progress on the Standardization of Online Laboratories for Education

eMadrid Session

www.emadridnet.org

26-Nov-2015 REV Conference, Madrid

Miguel R. Artacho
miguel@lsi.uned.es

Thanks!