Tempus DesIRE
Spring School Ilmenau

FACHHOCHSCHULE KÄRNTEN

Center of Competence in Online Labs and Open Learning

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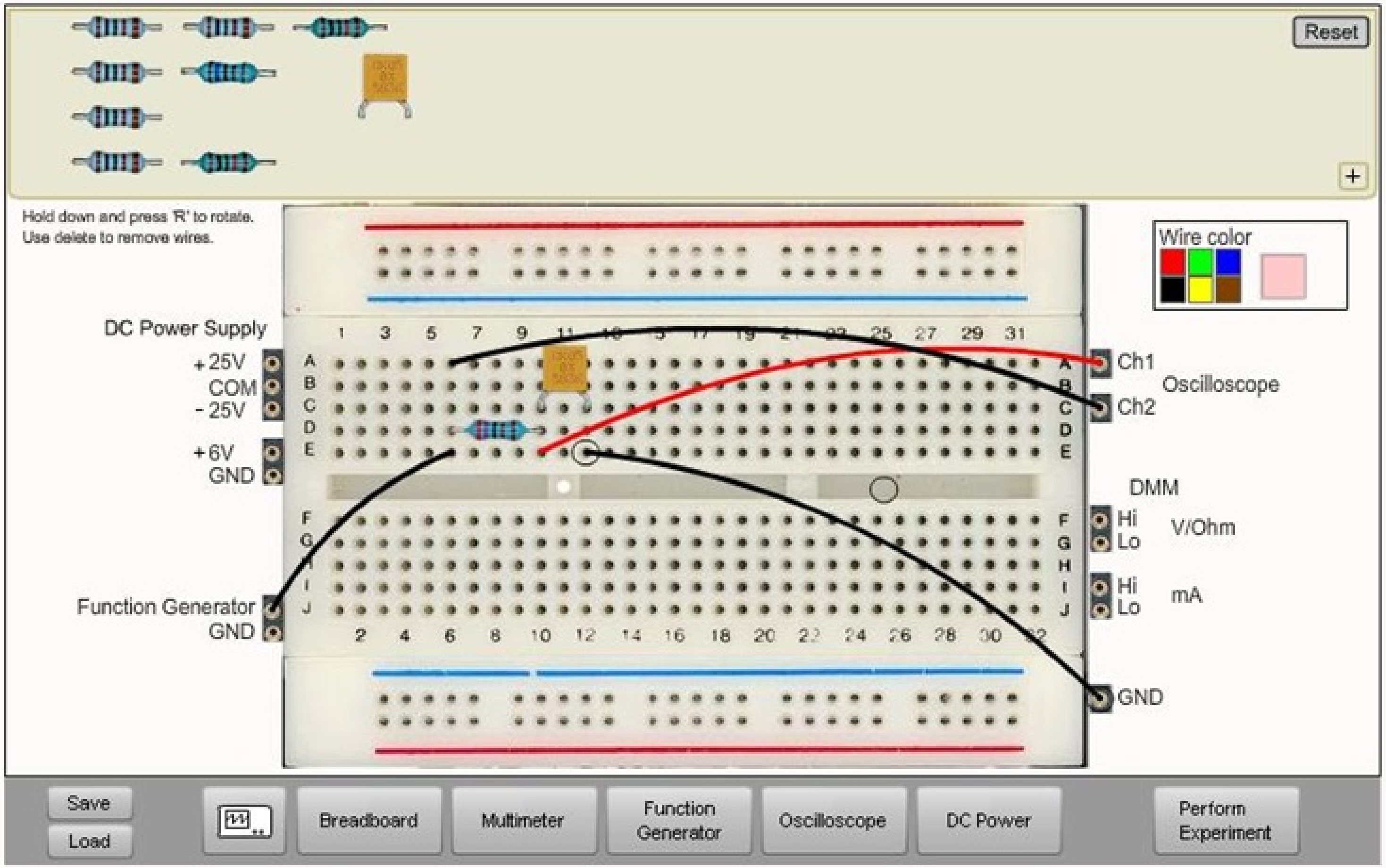
Examples and RLMS Analysis

Virtual Systems in Reality



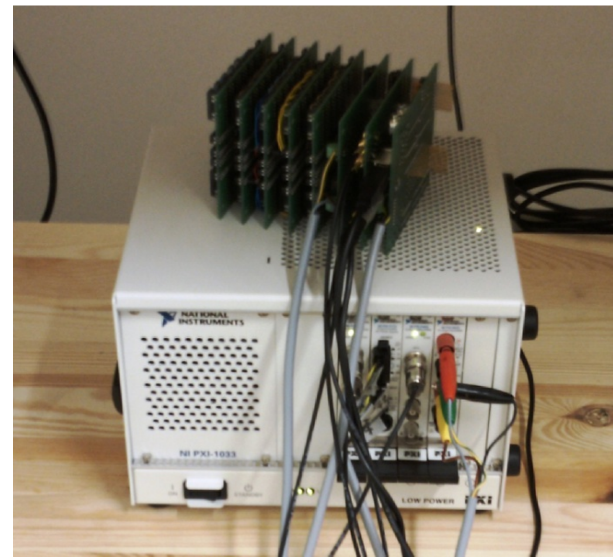
Developed by Blekinge Institute of Technology, Sweden

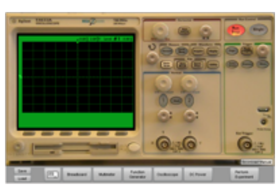
Virtual Systems in Reality

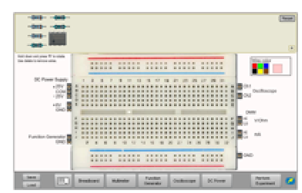
VISIR – Virtual Systems in Reality

The VISIR platform features an online workbench where users can perform electronics experiments. The Platform offers:

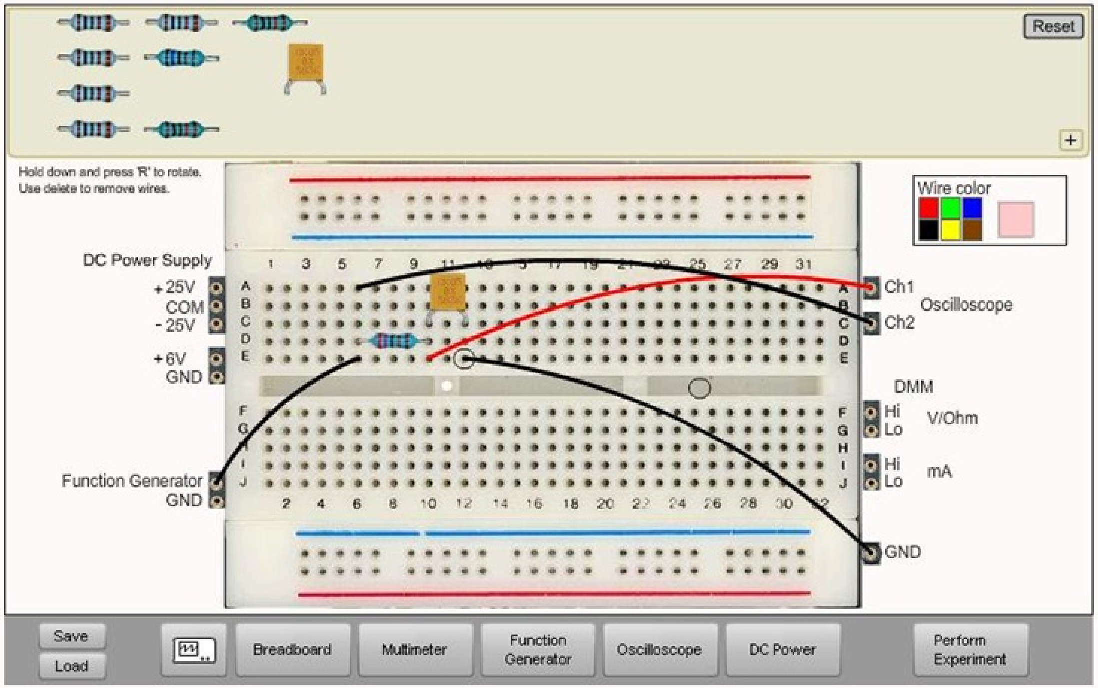
- Virtual Breadboard
- Oscilloscope
- Function Generator
- Digital Multimeter
- Power Supply







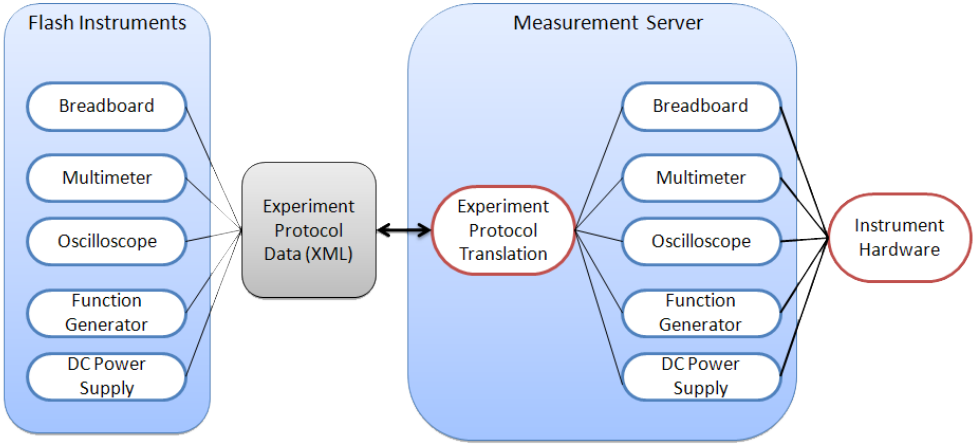
Virtual Systems in Reality



- Client delivered as flash application and/or HTML5+JS
- Very interactive, resembles real instruments
- Circuit designed in the virtual breadboard will be wired in the switching matrix.

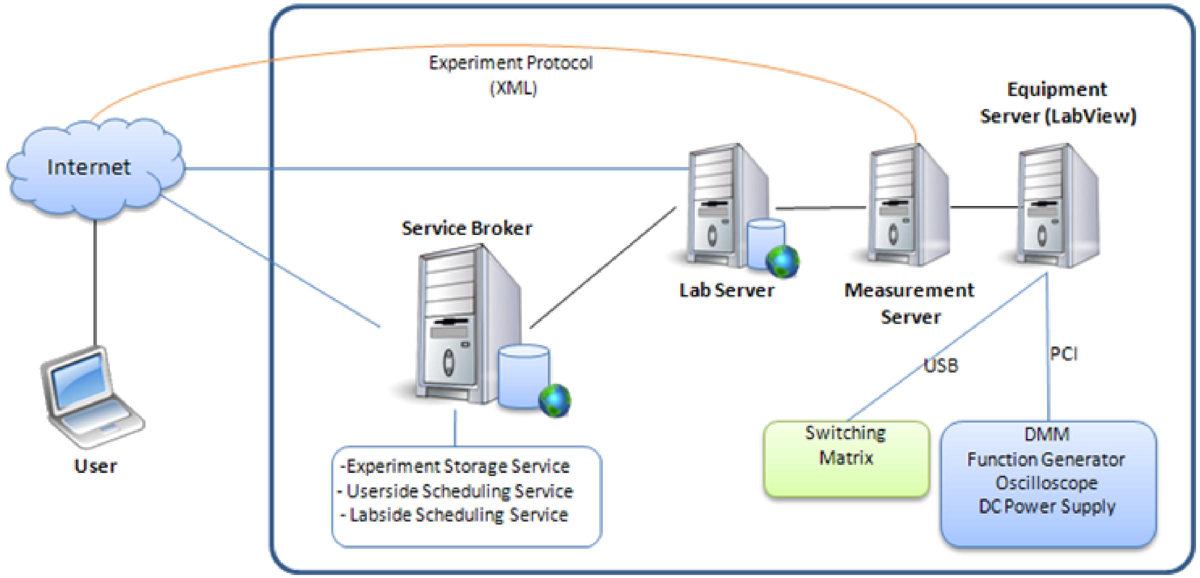
Virtual Systems in Reality

- A Lab Client that communicates with measurement server
- Measurement Server handles requests from clients and checks for the correctness of the parameters submitted by the client.
- Equipment server that works as a proxy translating commands received from the measurement server to hardware operations.
- A Web Application that handles the user management, lab session scheduling and maintenance and other functions specific for a lab experiment.



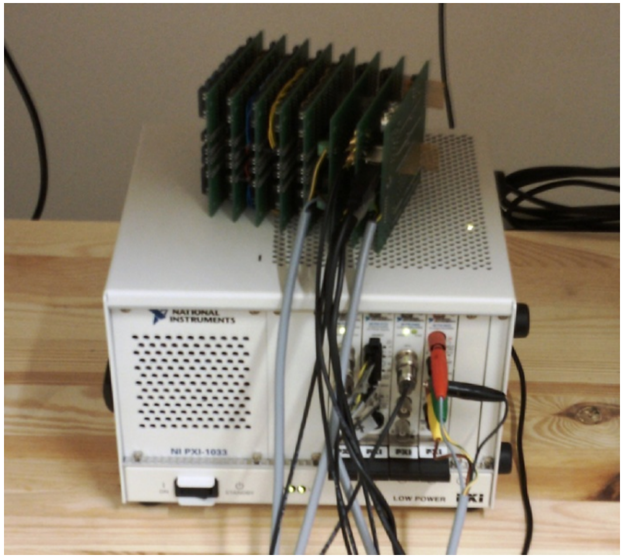
- VISIR offers a very modular platform

Virtual Systems in Reality



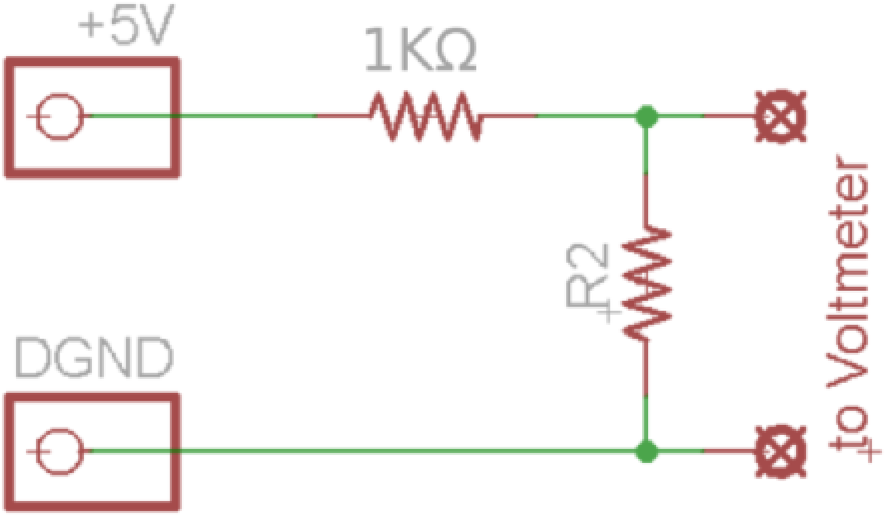
- User reserves a time slot and redeems a reservation
- User launches the lab and is redirected to the lab client
- Service broker forwards the credentials to the Lab Server
- Lab Server uses the credentials to validate the ticket and check if user is authorized to carry out experiments
- Lab Server launches the client and forwards a coupon ID (BTH)
- Measurement server uses the coupon ID to authenticate the client (BTH)

Demonstration

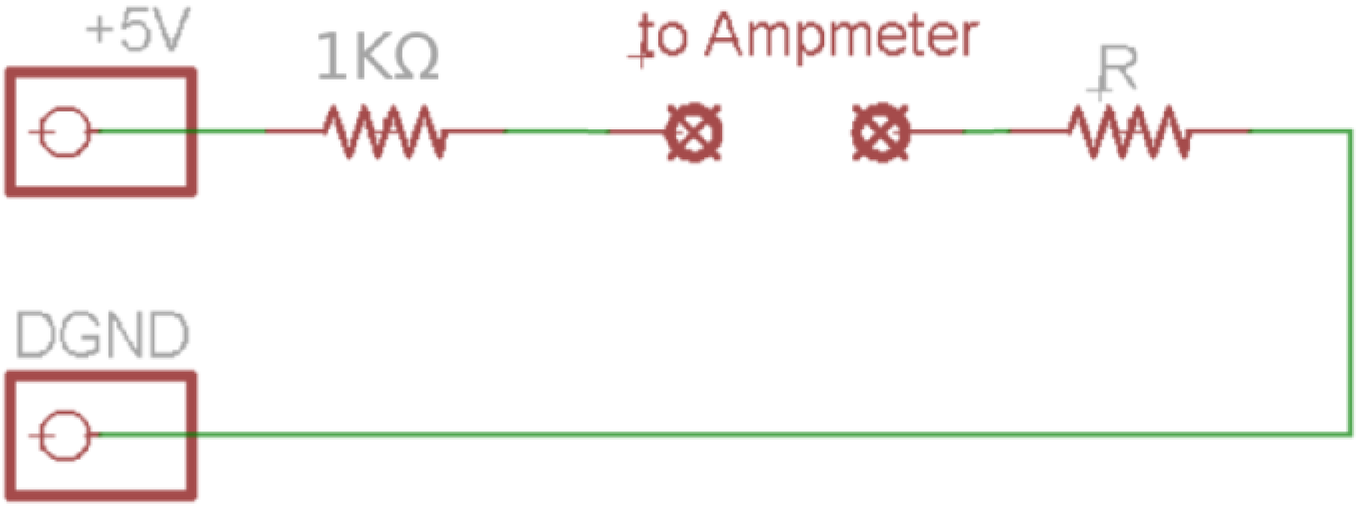


http://ilabs.cti.ac.at

Ex. 1: Voltage Divider

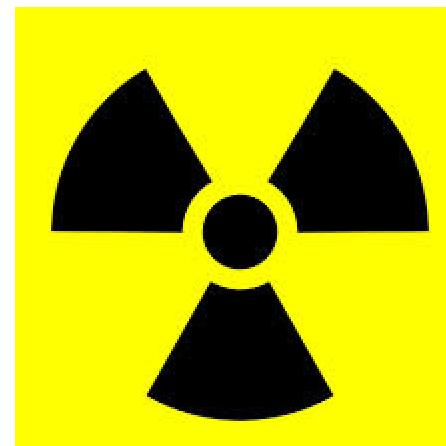


Ex. 2: Measuring the current



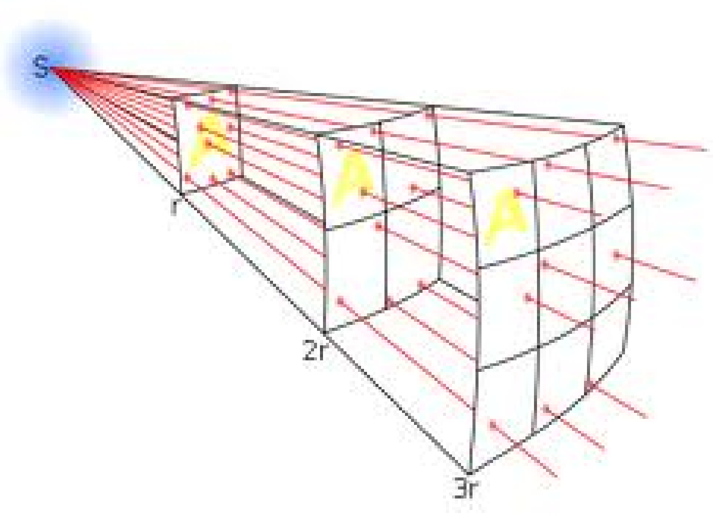
UQ Radioactivity Lab

- Developed and Deployed at the University of Queensland, Australia
- Two different Lab equipment setups: With and without absorbers

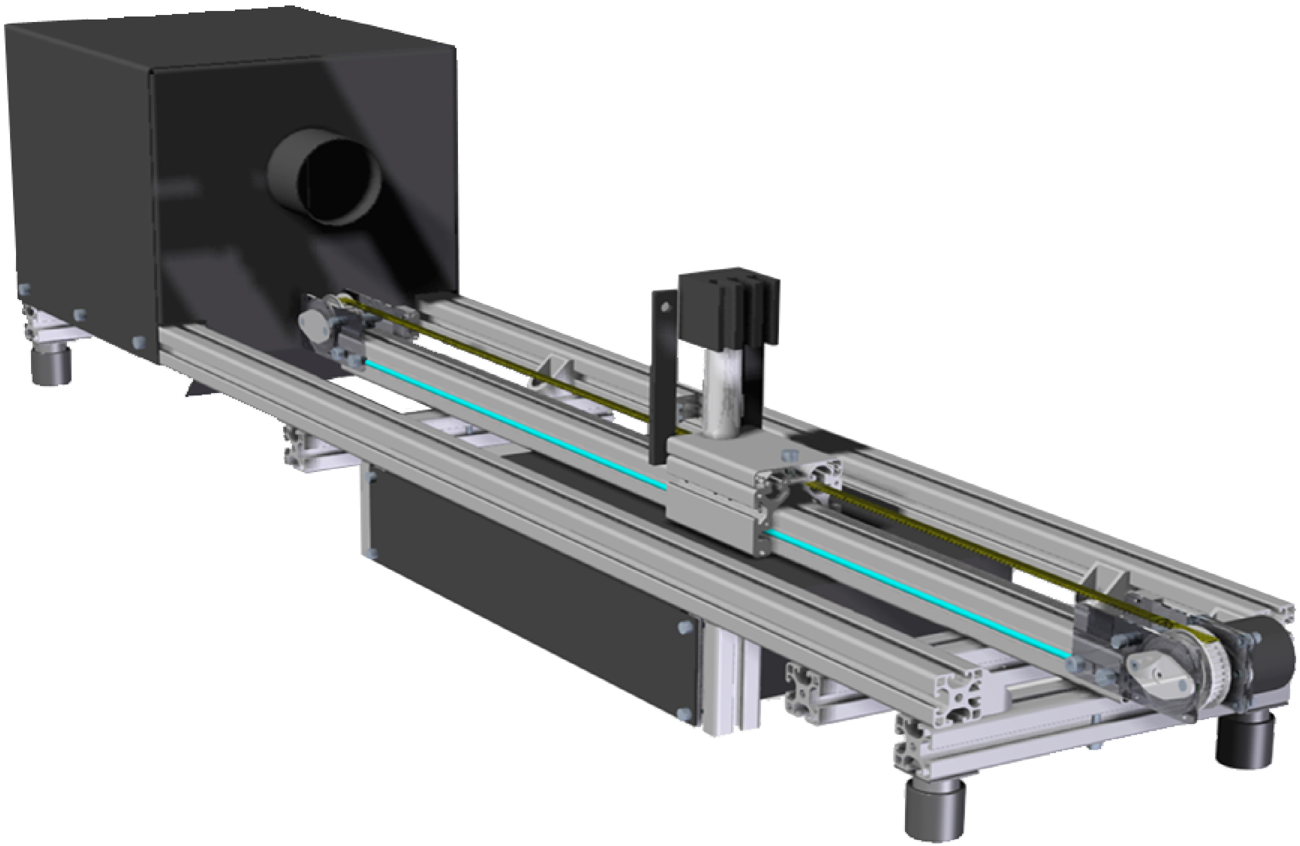


UQ Radioactivity Lab

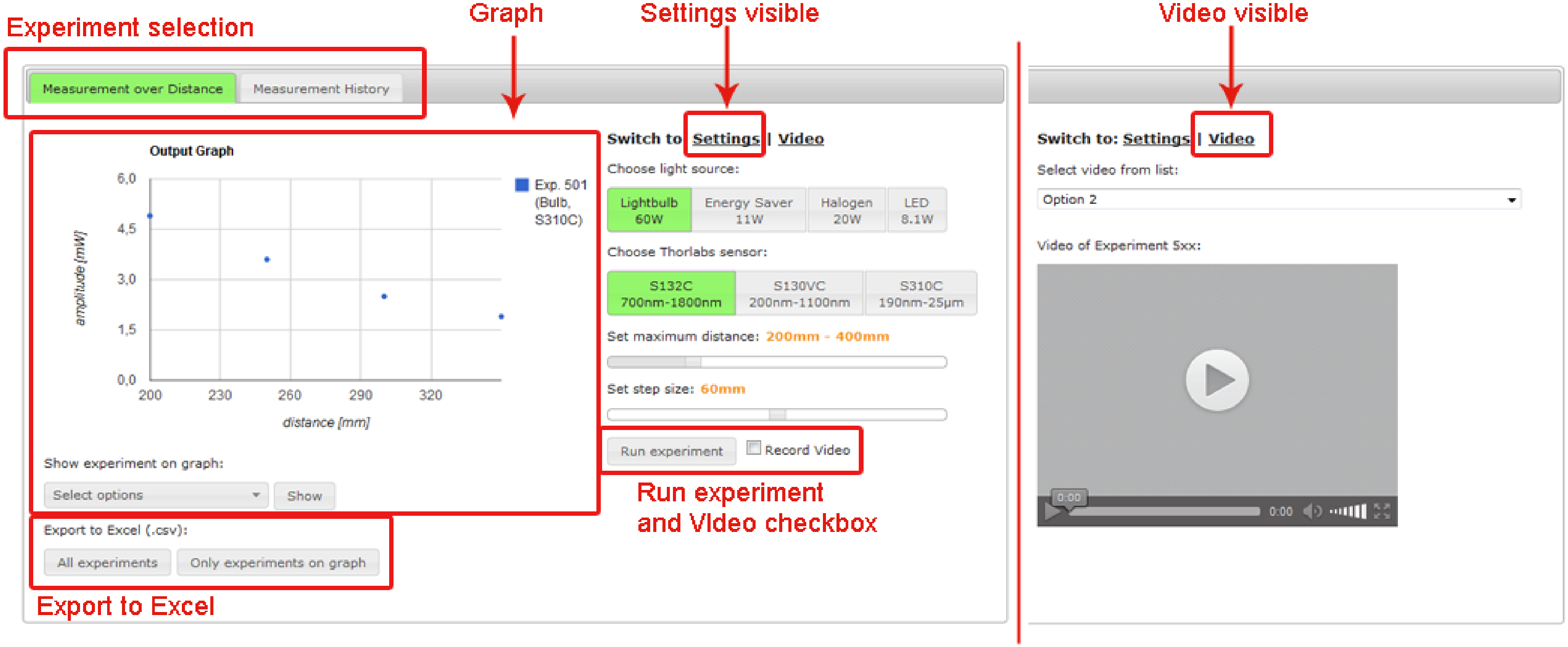
- The radioactivity lab has been used by thousands of kids from secondary schools in Australia, US and now Europe (through the Go-Lab Project)
- The lab is used to verify the inverse squared law



Blackbody Radiation Lab



Blackbody Radiation Lab

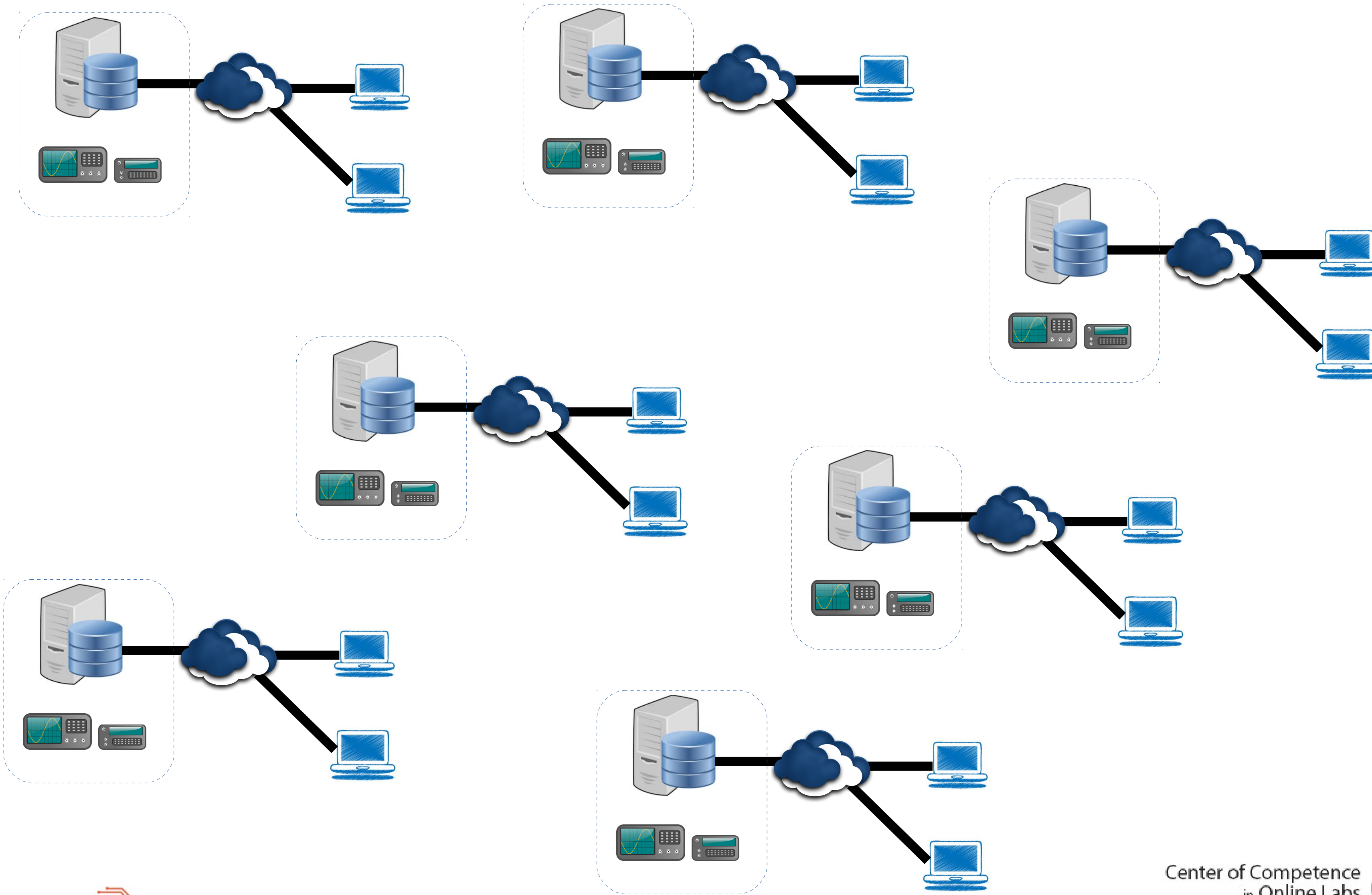


Main Problems Around RLMS, Online Lab Development and Deployment

The importance of sharing a software infrastructure

So that lab developers don't have to start fresh each time but can build upon a **stable foundation**;
So that students can have a consistent interface to multiple laboratories with **single sign-on**;
So that the infrastructure can **separate the task** of *providing the lab* from that of *managing students using the lab*.

The big picture before RLMS (b.R)



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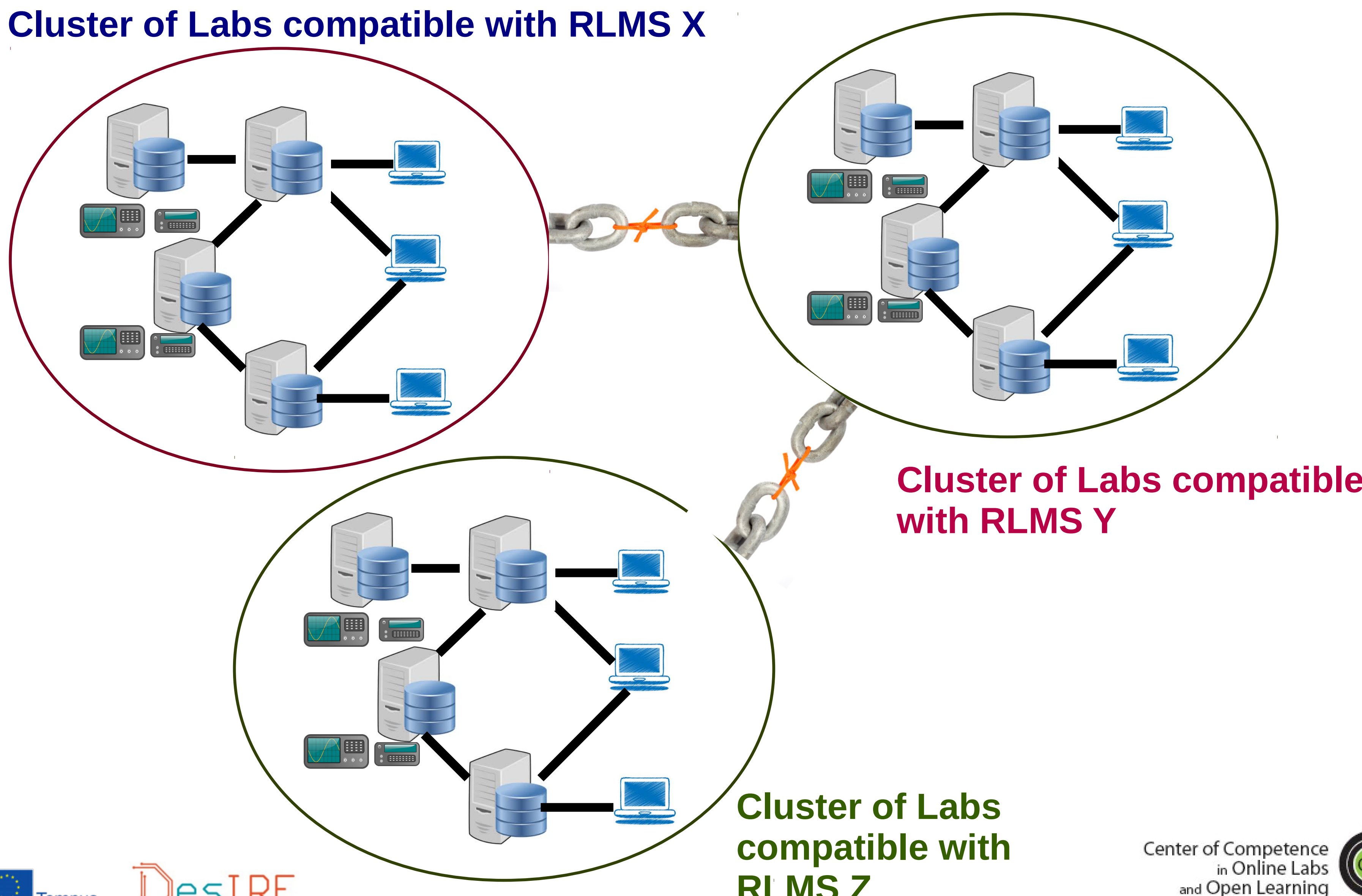
And now...



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Did RLMSs really solve this?

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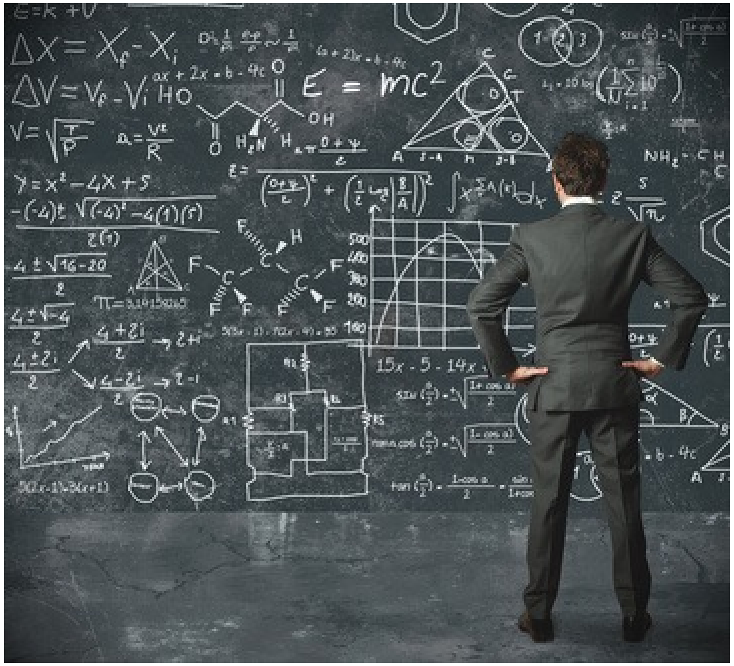
Skills

How challenging is it to develop and deploy an online laboratory?



Typical tasks of a lab developer:

- Design Lab Clients
- Bound by Lab-specific UI requirements, RLMS API
- Design Lab Server
- Bound by lab instrumentation, desired functionality
- Design Client-Server communication framework

Specifically for ISA

- Implement the Web Services interface to communicate with the Service Broker
- Develop, deploy and consume SOAP Web Services
- Design Lab Server, queue experiments for execution
- Create/parse experiment specification (could be any format like XML, JSON, etc)
- Design Client-Server communication framework.

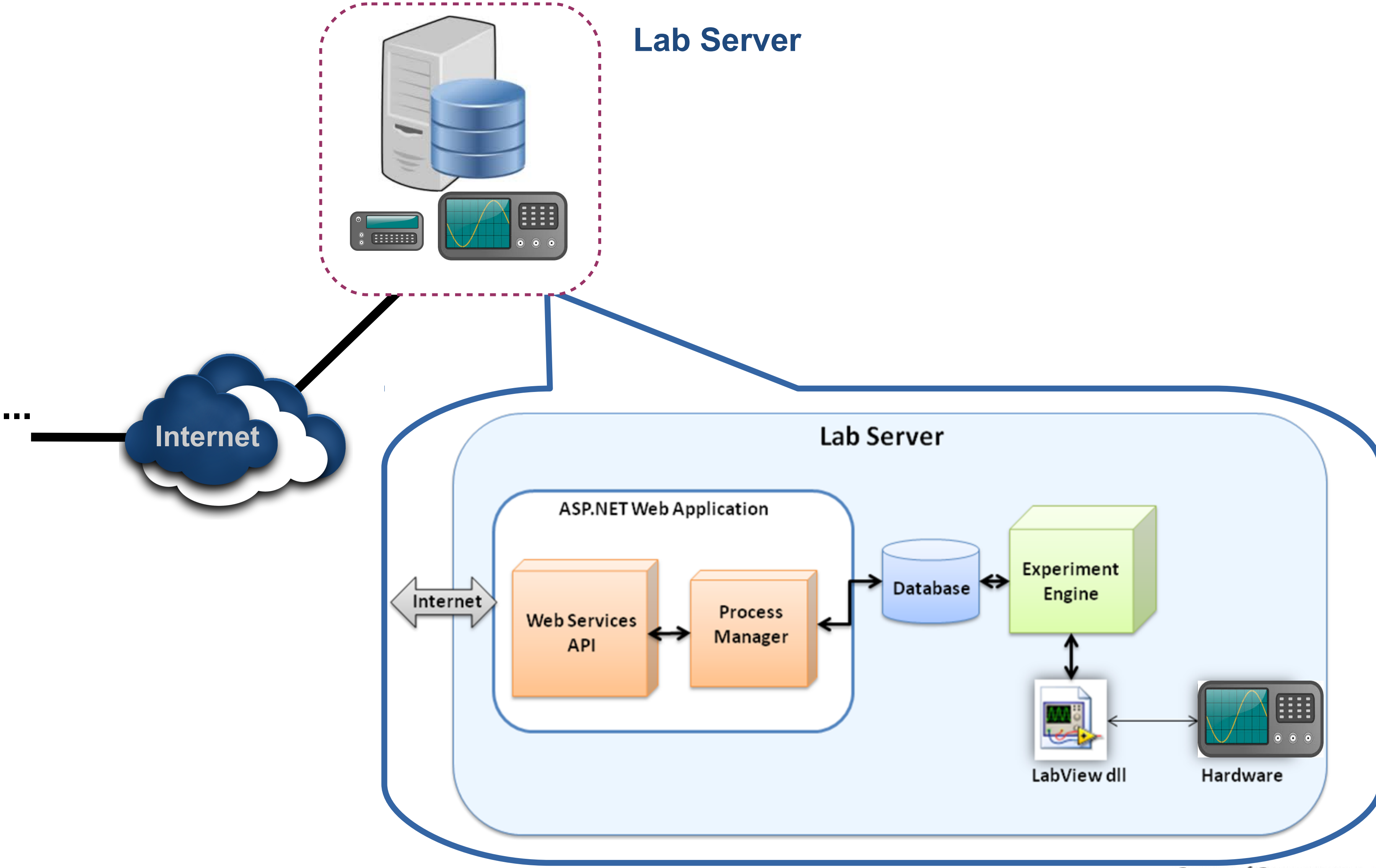
And more...

- Ensure proper **ICT infrastructure**
- Ensure proper system security
- Intense collaboration with institution’s IT department
- **Reachability:**
  - Lab must be reachable from external network
- **Security:**
  - Online lab should not be affected by firewall and network security policies
- Setup of the server environment respecting institution’s **network policies**

The starting point

"Deploying an online laboratory should be as simple as installing an application in your system"

Components of a Typical Batched Lab

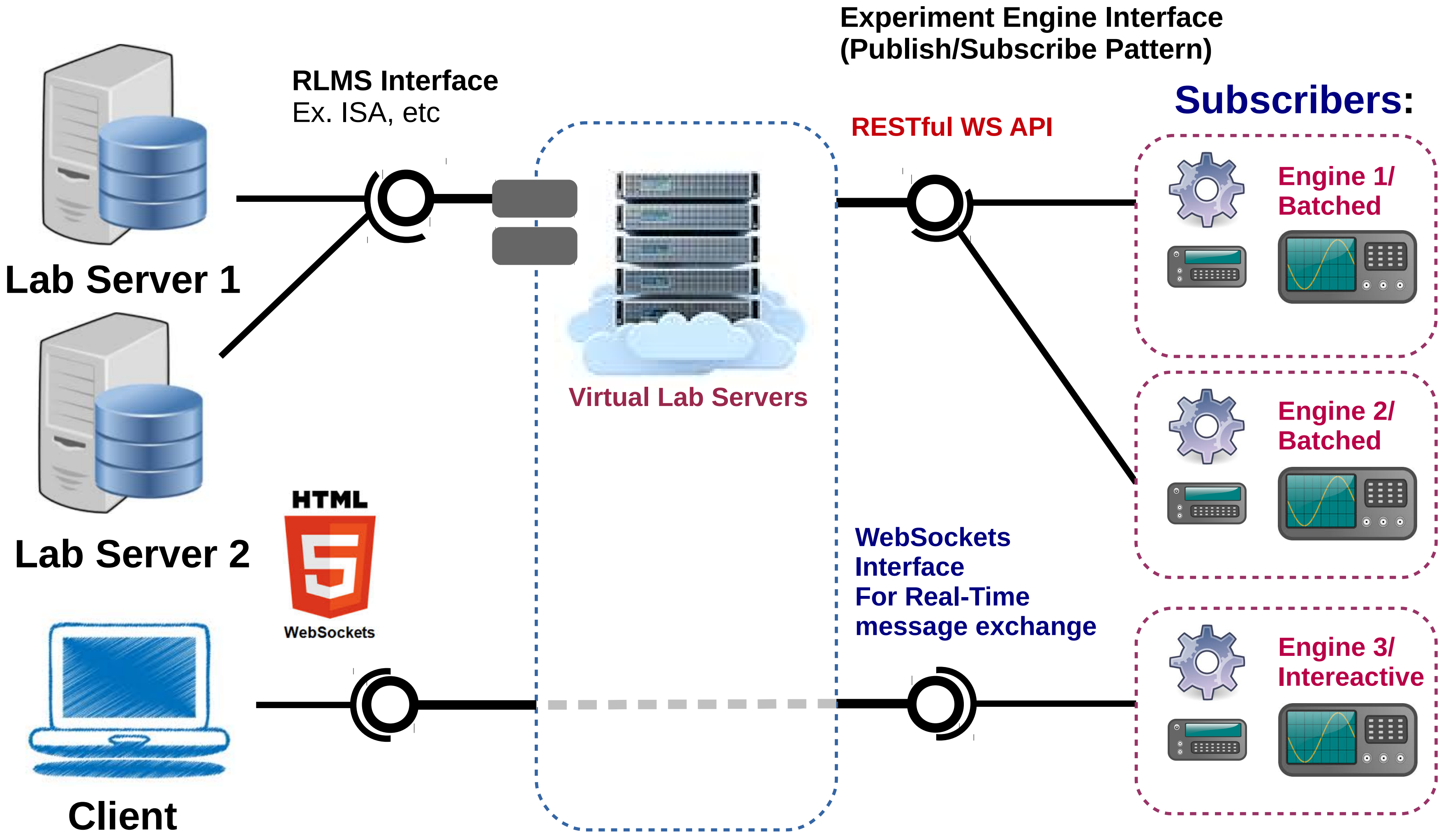


Lab Infrastructure as a Service

- Queuing mechanisms
- Scheduling mechanisms
- Integration with RLMS

- Pose zero or at least very few requirements for lab owner
- Do not require extra skills other than the knowledge in their domain of expertise

The Experiment *Dispatcher*



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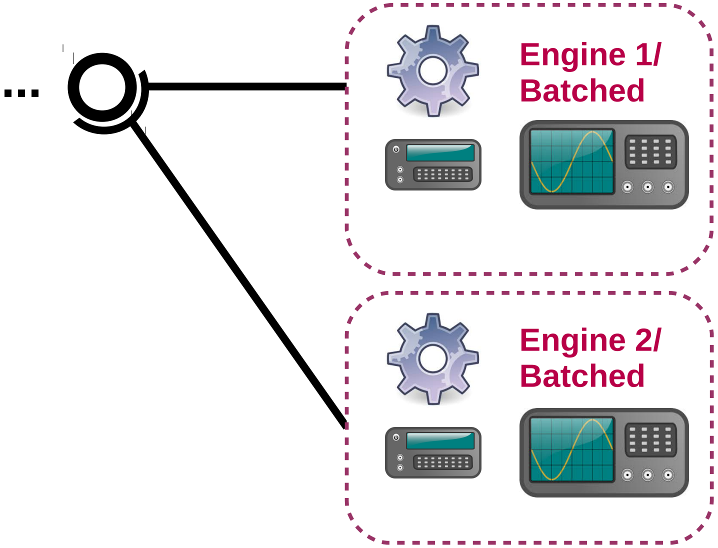
Experiment *Dispatcher*

- **Abstracts several aspects of Online Lab development and deployment:**
  - Integration with RLMS
  - Experiment Queuing
  - Lab Server setup: In the ***Cloud***
- **Publish/Subscribe** Pattern for experiment execution.
- Batched Labs: multiple subscribers are possible, what creates a built-in support for ***load balancing***
- Support for **interactive** (or synchronous) experiments by providing a virtual channel between lab server and client over WebSockets

Experiment *Engine*

Subscribers:



- **Subscribers** or Experiment Engines can be kept very simple and lightweight.
- Don't need to queue and store experiments, since this is done in the Cloud.
- Only task is to process experiments.
- Must subscribe for execution of experiments from one Lab Server.
- Communicate via a simple RESTful Web Services API.
- Checks for new experiments by polling via the REST WS API.
- Subscriber Engines are registered and receive an API key.

Experiment *Engine*

- Experiment Engine acts as a “*Client*” *by* subscribing for an experiment *type* or *class* published by a Lab Server.
- No need for complex server setup
- No extra requirements are posed in terms of network security policies
- Communication is done via HTTP and/or WebSockets, technologies widely supported
- Toolkits that implement the APIs will be offered ready to use (Ex.: LabView)

Global Initiatives and Projects

The Global Online Laboratory Consortium

GOLC

- to encourage and support the creation of new online labs and associated curricular materials;
- **to sponsor the design of an efficient mechanism for sharing, exchanging and trading access to online labs by creation of a global network of shareable experiments**
- to support communities of scholars created around online laboratories; and
- to lead the evolution of an architecture that enables the sharing of online labs by unified standards.
  - We need ..
  - Common terminology, common metadata schema, common APIs ..
  - An effective business model where different roles are taken into account

The Go-Lab Project

Global **O**nline Science **Lab**s for Inquiry Learning at School

Objective:

Supporting European wide federation and use of remote laboratories and virtual experimentations for learning and teaching purposes.

The Go-Lab project will open up remote science laboratories, their data archives, and virtual models ("virtual labs") for large-scale use in education. Go-Lab enables science inquiry-based learning that promotes acquisition of deep conceptual domain knowledge and inquiry skills and directs students to careers in science.

The OnlineLabs4All Project

OnlineLabs4All

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Thank you!