Center of Competence in Online Laboratories and Open Learning

GEDC 2013 CHICAGO Global Engineering Deans Council Conference

Chicago 2013 | October 20-22

Global Engineering Deans Council Conference 2013

"Online Digital Education and Transformed Faculty Roles"

Online Engineering - A New Trend in the Work of Engineers and in Engineering Education

Michael E. Auer

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Online Engineering

can be defined as

- a **combination of engineering and telematics**, where specific engineering activities like programming, designing, controlling, measuring, sensoring, maintenance etc. are provided in an interactive manner over a distributed network (Internet, intranet etc.)
- a special network technology with **remote and virtual labs as a core**

Grid Technologies are of high interest for Online Engineering.

Applications in virtual learning environments and in industries.

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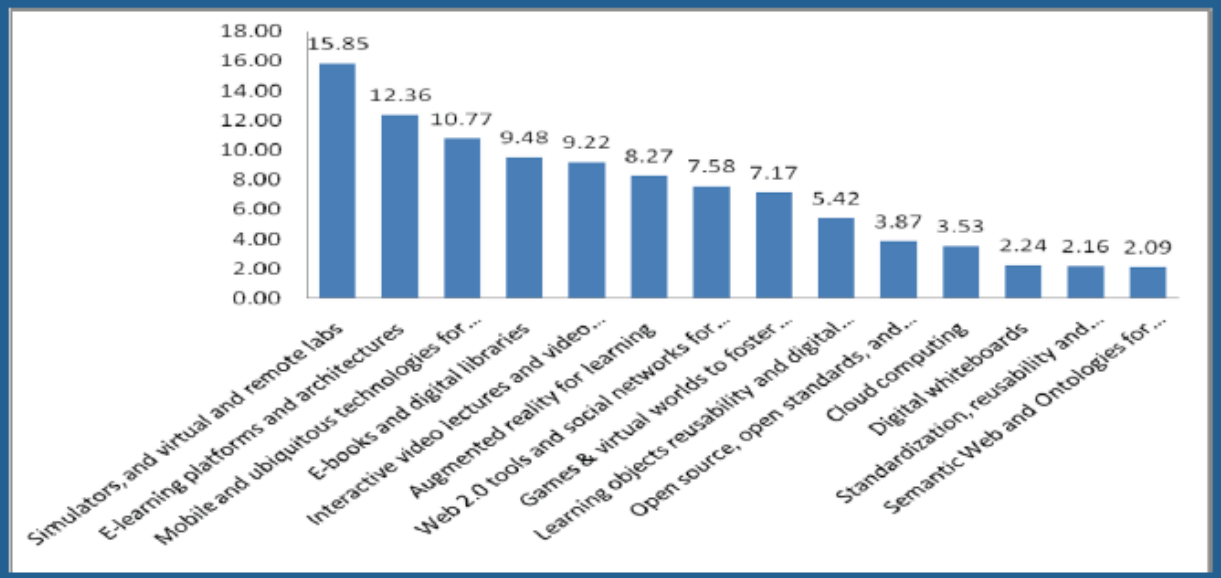
ICT in Engineering Education Survey

http://www.engineeringeducationreport.com



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Reasons for Online Engineering

- the growing complexity of engineering tasks,
- the increasingly specialized and expensive equipment, software tools and simulators required,
- the decreasing innovation cycles,
- the necessary use of expensive equipment and software tools/ simulators in short time projects,
- the application of high tech equipment required in SMEs,
- the need of highly qualified staff to control new equipment,
- the demands of globalization and division of labor.

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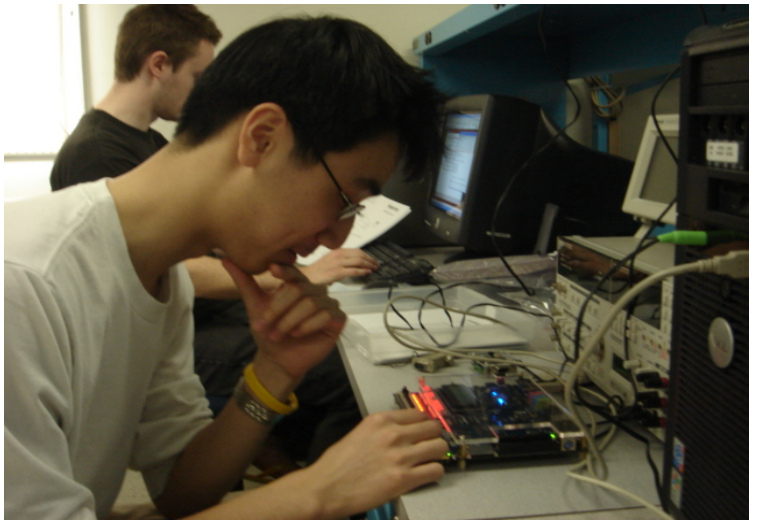
Motivation for Online Labs

- There is enormous educational value in hands-on laboratory experiences
- But, conventional labs…
  - … are expensive and have complex logistics
  - … can't easily be shared
  - … are often outdated
- Remote Labs:

  Real laboratories that are accessed through the Internet from anywhere at any time



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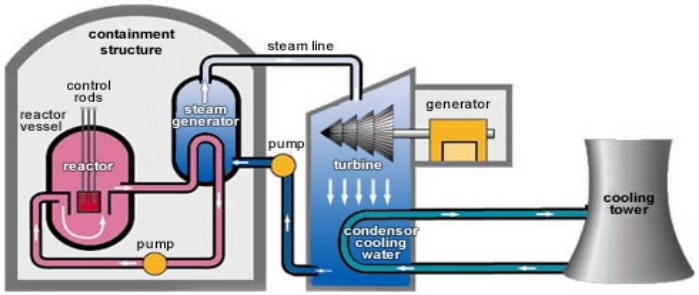
Online Labs: The Opportunities

- Order of magnitude:
  - more laboratories available to our students
- Unique labs:
  - Unusual locations, expensive equipment, rare materials



- Richer pedagogical experiences:
  - More lab time to students
  - Interfaces to lab integrating graphing, simulations, collaboration, tutoring
- Worldwide communities of scholars created around labs sharing content

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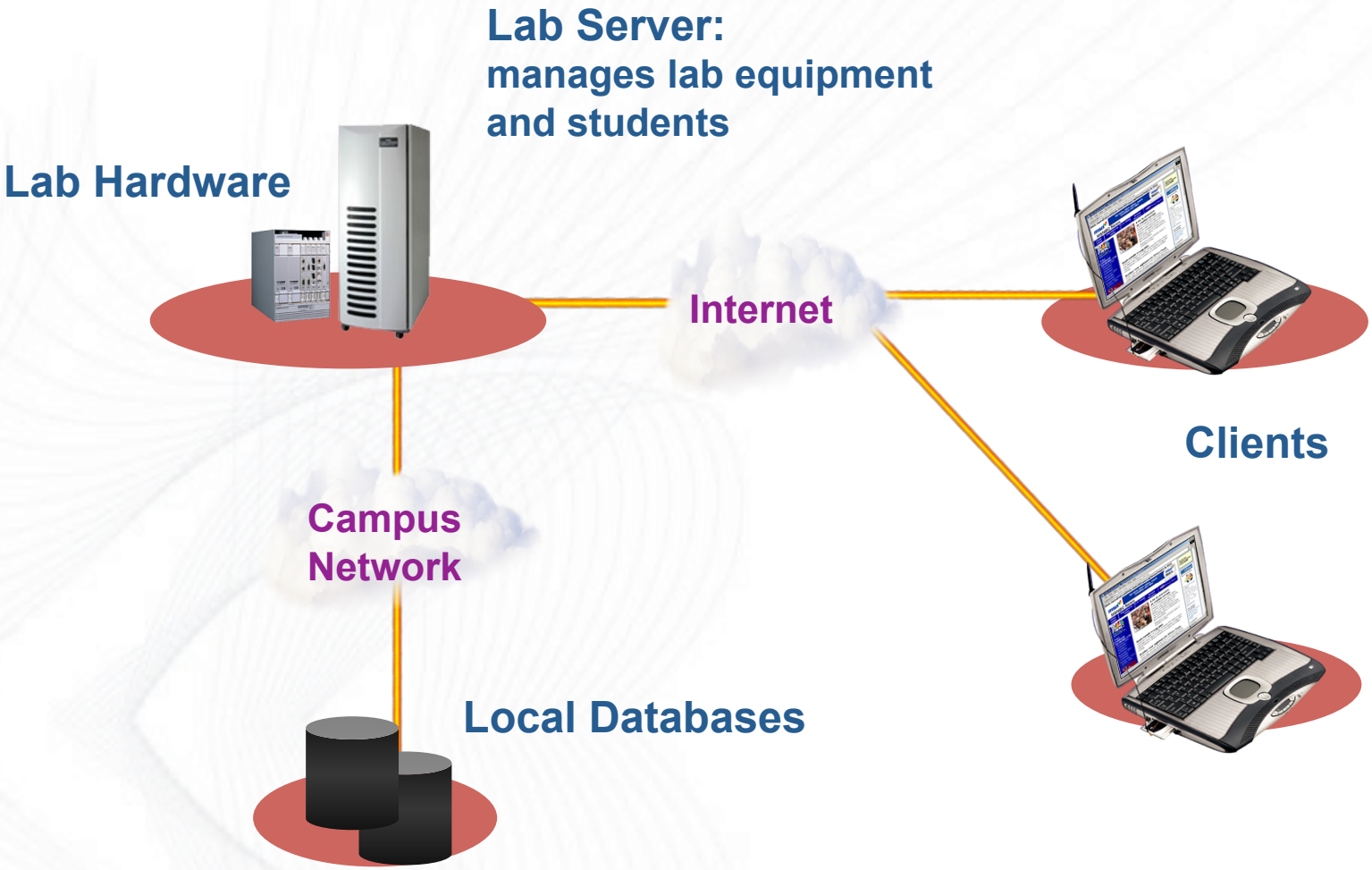
Typical Online Lab Architecture



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Current Trends in Online Labs

- Mobile
- Distributed
- Hybrid or mixed
- Game based
- MOOLs

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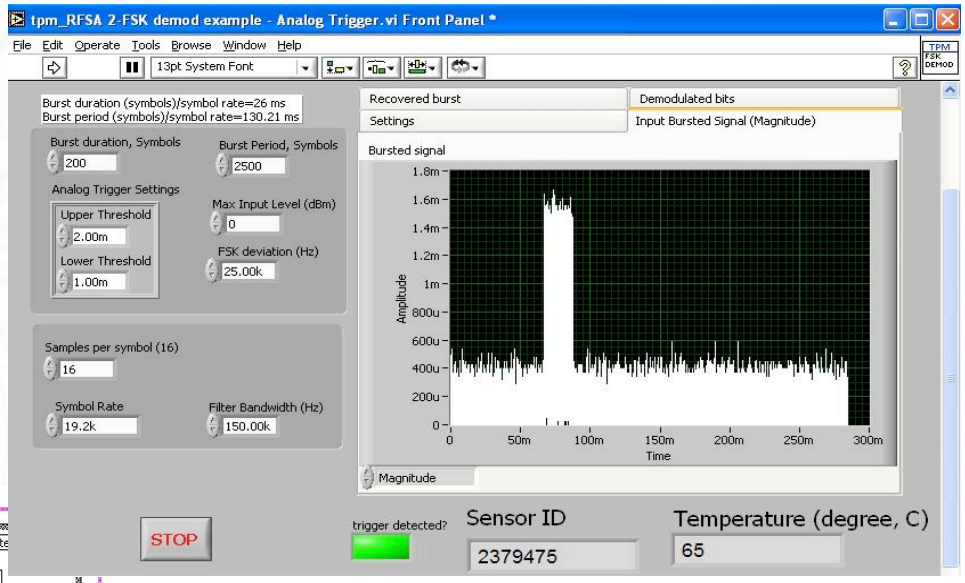
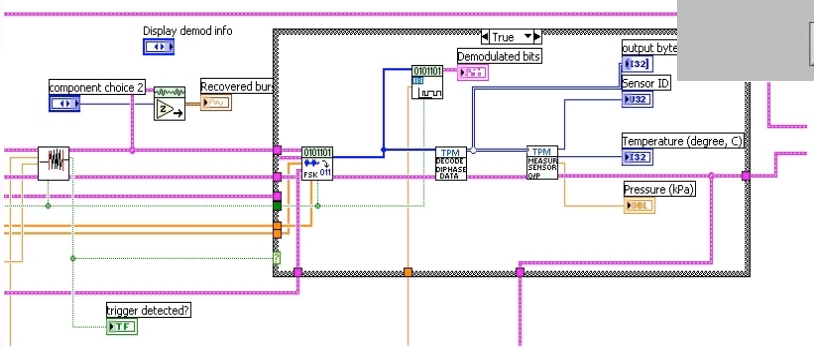
Mobile Experiment - Wireless Sensor





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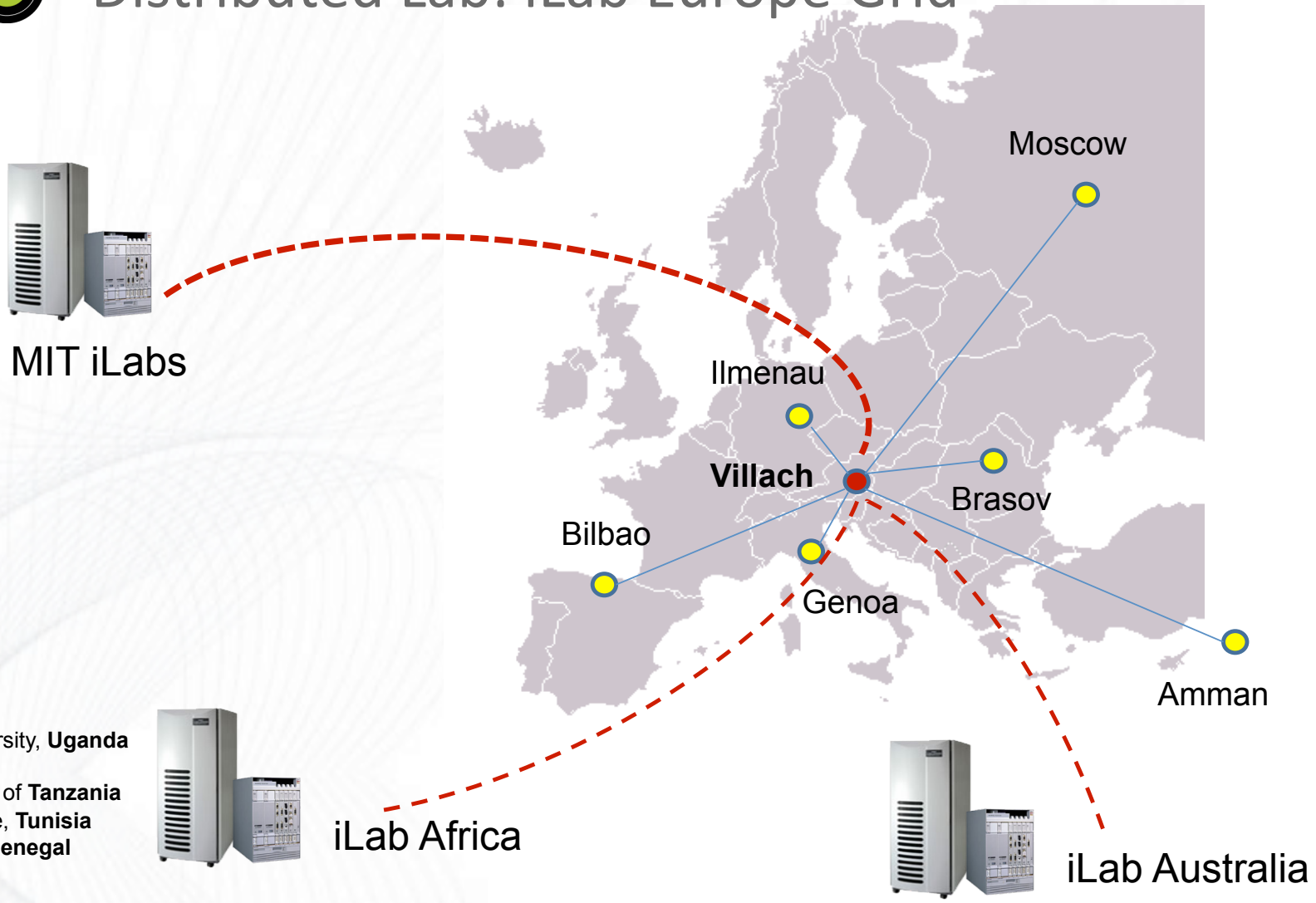
Distributed Lab: iLab Europe Grid



Makerere University, **Uganda**
OAU, **Nigeria**
Open University of **Tanzania**
Sciences Palace, **Tunisia**
Coders4Africa **Senegal**
…

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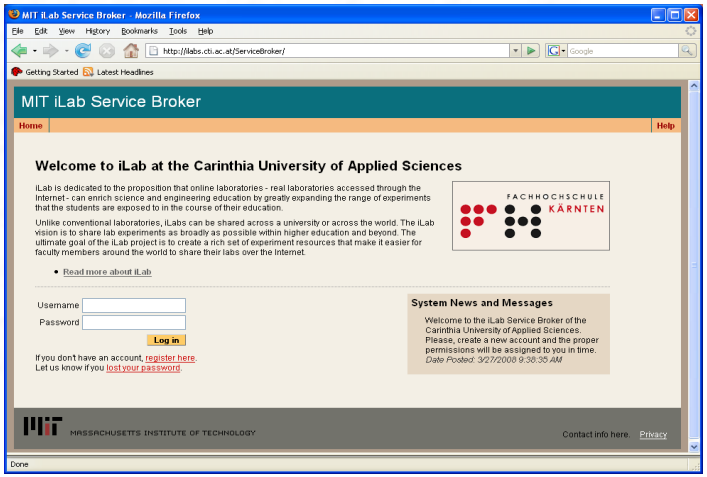
iLab Europe Broker Server

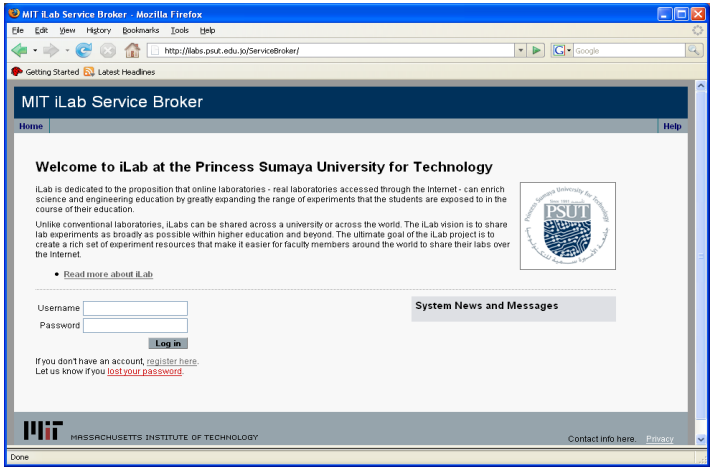
Nodes of the Online Lab Grid

- Villach, Austria
- Brasov, Romania
- Bilbao, Spain
- Amman, Jordan
- Ilmenau, Germany
- Genua, Italy
- Moscow, Russia

Nodes :

- are independent
- have an own user administration
- can use own labs and all labs from the grid





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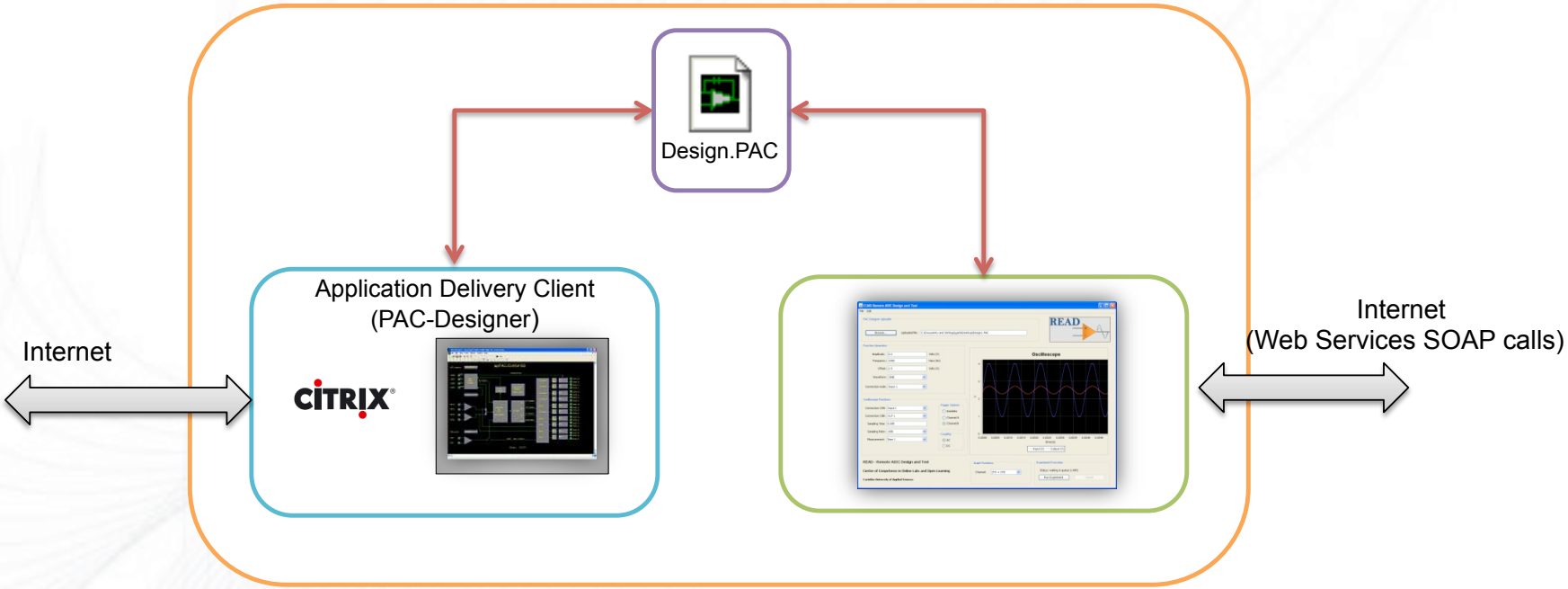
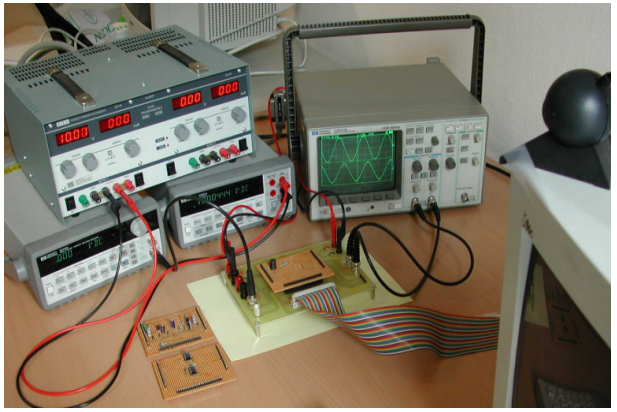
Hybrid Lab: Remote ASIC Design and Test



- Experiments with an analogue programmable device
- A hybrid laboratory, allowing the design, simulation and test of real devices.
- Completely integrated with the iLabs Shared Architecture



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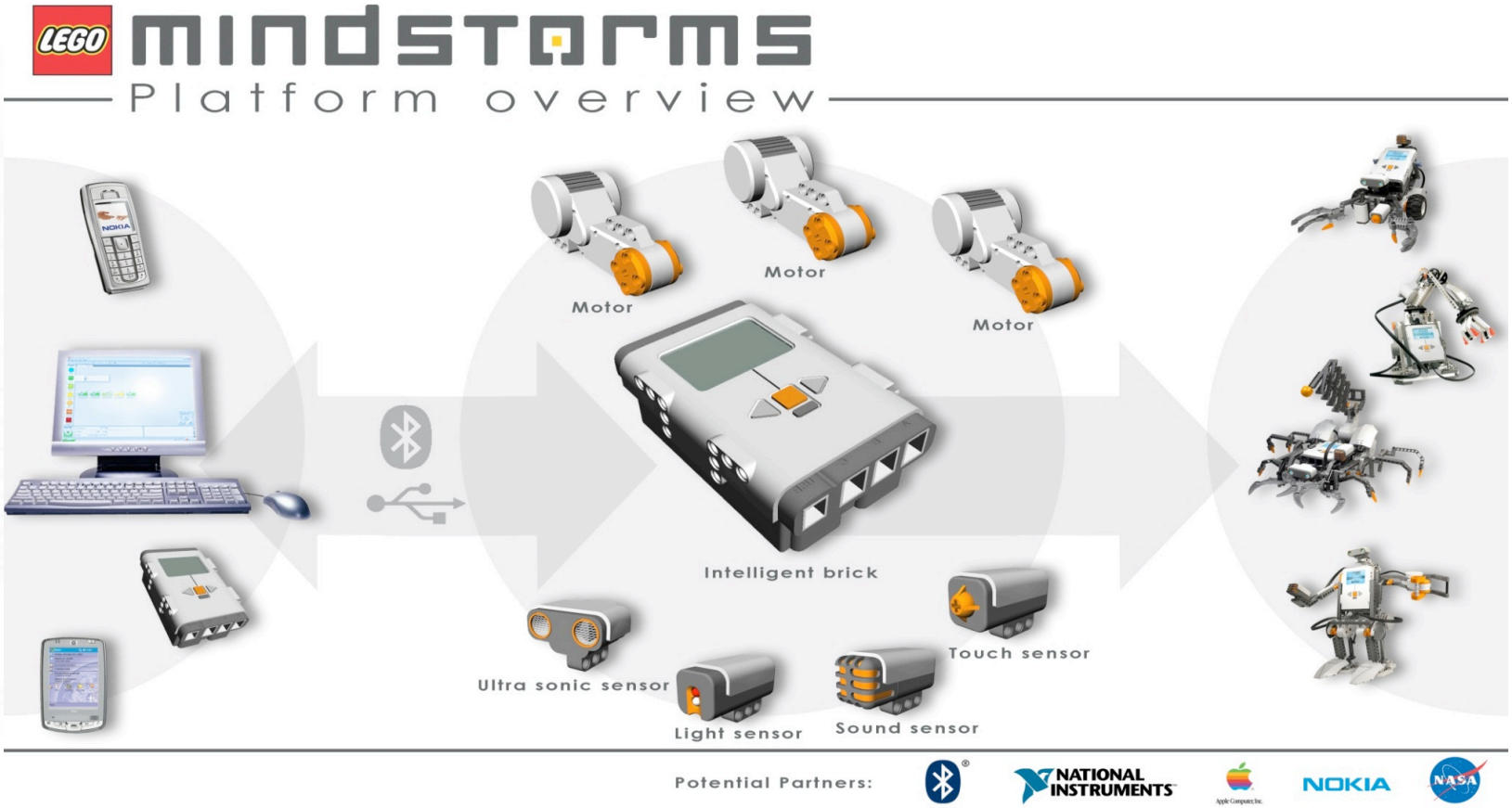
Game Based: LEGO Mindstorms



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Massive Open Online Labs (MOOLs)

- ***Coursera MOOC "Fundamentals of Electrical Engineering Laboratory"***
  each student is required to purchase a small electronics laboratory kit (US $200)

- **Go-Lab Project (**17 European Universities and Research Institutions)
  Mainly directed to secondary school level.
  A pilot with 400 schools in Europe is the main goal!

- **LabShare Project** (Australia)
  Large scale secondary school science laboratory: support is provided for all Australian secondary school year 8 science students to individually undertake a specific laboratory exercise involving radioactivity apparatus that would not normally be available to schools.
  (approximately 250,000 students)

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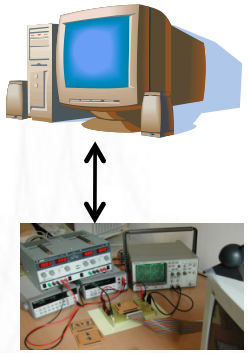
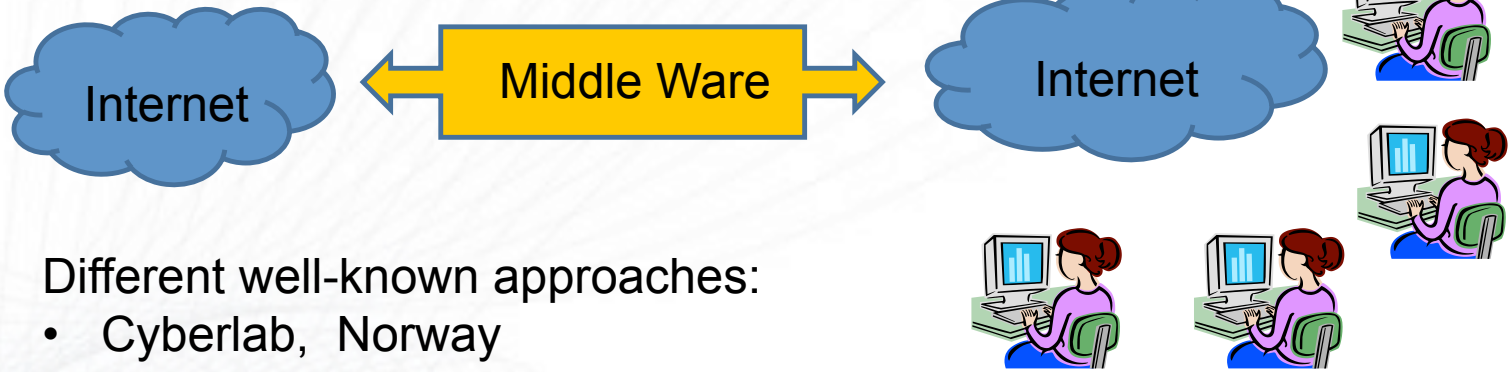
Main Problems

- Different implementation technologies of labs
- Different communication standards and data exchange protocolls
- Different User Interfaces and local requirements

- Different policies in handling user accounts, managing experiment data, ...
- Integration in existing teaching materials is difficult

Online Lab Middle Ware





Different well-known approaches:

- Cyberlab, Norway
- OCELOT, France
- ISA (iLab Shared Architecture), MIT USA
- LILA, Germany
- LabShare, UTS, Australia
- …

MIT's iLab Shared Architecture (ISA) seems to be best suited for a Global Online Laboratory Grid.

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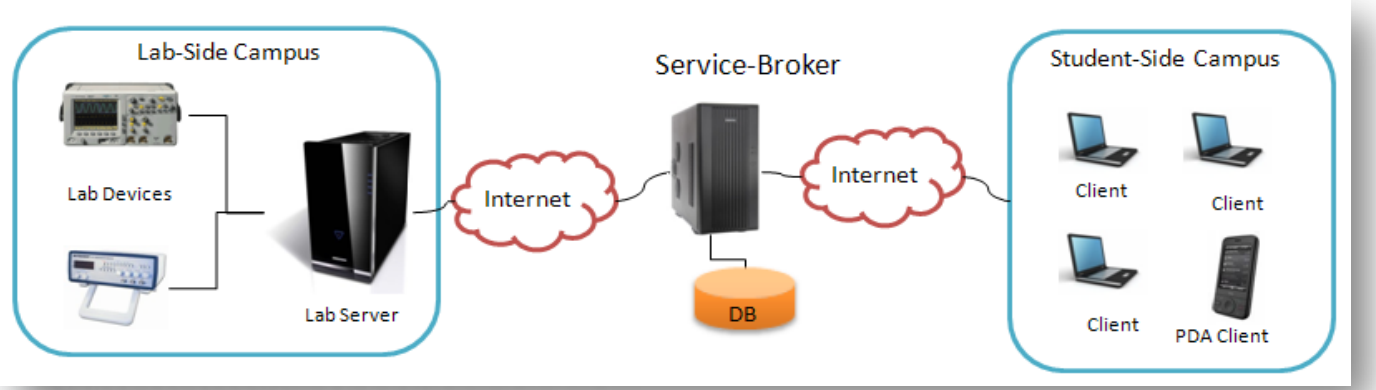
iLab Shared Architecture

- ISA – iLab Shared Architecture
  - A software architecture developed at MIT
  - Offers a common framework for sharing online labs
  - Provides an platform-independent API based Web services
  - Clear separation of holes (user management and experiment execution)
  - Supports batched and interactive experiments



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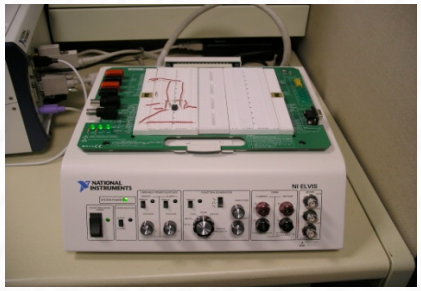
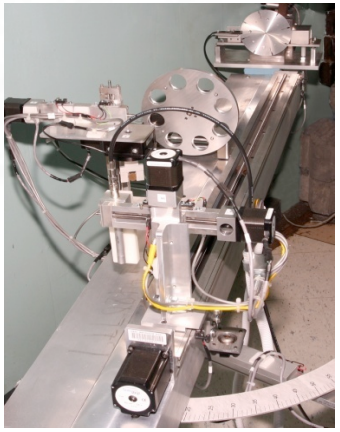
iLabs Around the World

Microelectronics Device Characterization

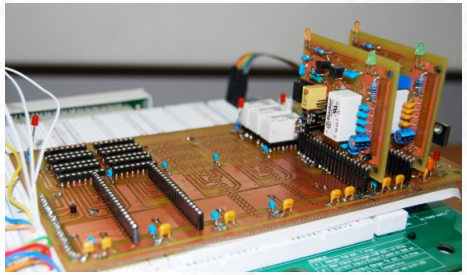


ELVIS

Dynamic Signal Analyzer

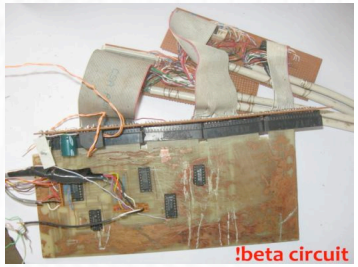


Neutron Spectrometer



OpAmp

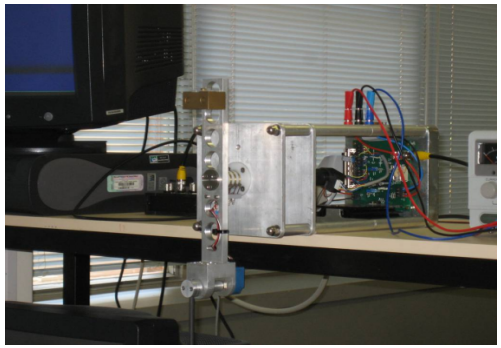
(CTI, Austria)



Logic Lab
(OAU, Nigeria)

Radioactivity

(UQ, Australia)



Inverted Pendulum

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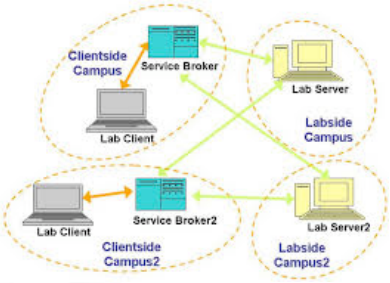
iLab Alliance



- Just founded by MIT, UQ, CTI (Developer Group)
- Provider Group: all existing iLab Broker Servers
- User Group open for all interested institutions and people

Main goal of the iLab- Alliance is to establish a global GRID of lab resources based on the iLab Shared Architecture and to connect as much as possible existing Labs/Experiments.

mit iCampus

The iLab-Alliance will

- encourage and supporting the creation of new online labs and curricular materials;
- design efficient mechanisms for sharing, exchanging and trading access to online labs;
- coordinate the further development and evolution of the iLab Architecture.

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Thank you!

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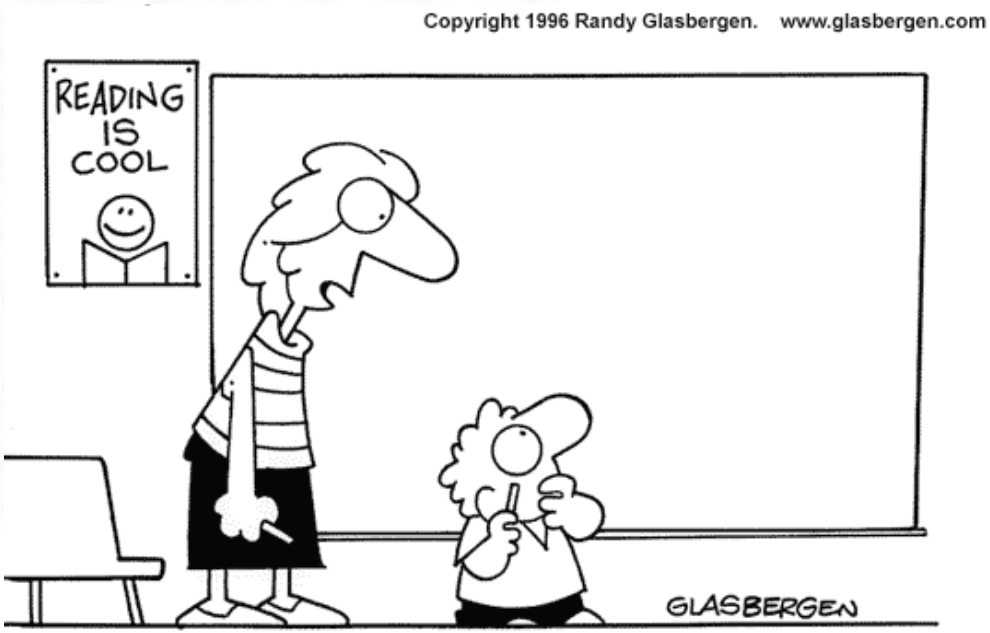
Michael E. Auer

CTI Carinthia Tech Institute
Villach, Austria

IGIP IAOE.



"There aren't any icons to click. It's a chalk board."

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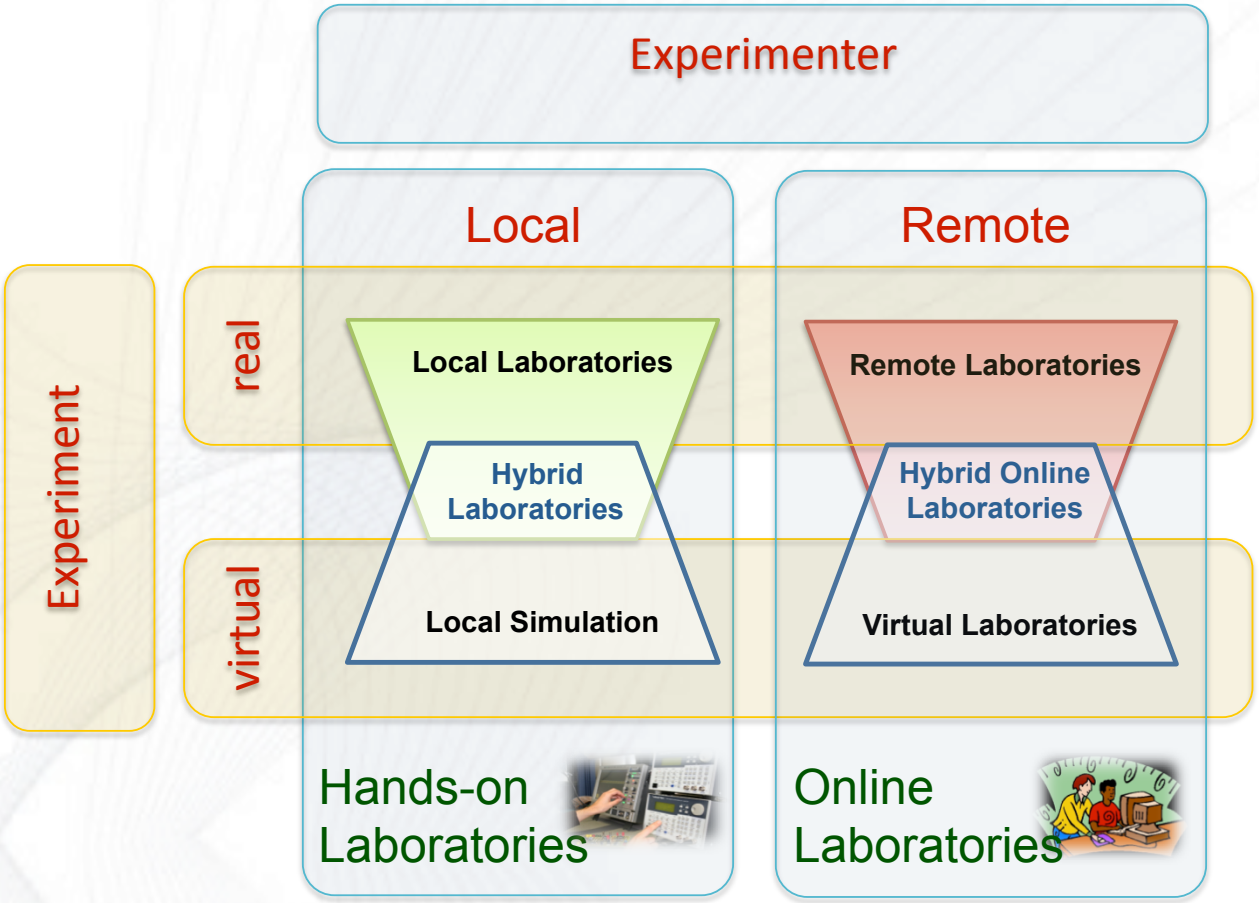
Types of Laboratories (1)



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Types of Laboratories (2)

In a **virtual (or computational) lab** each experiment is simulated by using software (e.g. LabVIEW, MATLAB, ORCAD, …). But computations and simulations often cannot capture the full range of experimental phenomena. Real-life effects are hard to model.

Benefits of virtual labs:

- cheaper
- more flexible
- trial-error-mode possible without damage of equipment
- multi-user operation
- easier to maintenance

In contrast the **remote lab** is designed to provide real-time experiments with hardware equipment and brings real-world learning experience to the classroom.

So-called **hybrid labs** combine the benefits of virtual and remote labs.

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Types of Experiments

Experiment visualization:

This service allows the student following on-line a lab activity determined by the course teacher. The student obtains the display on her/his computer of the desktop used by the teacher to control the measurement instruments involved in the experiment.

Experiment control:

This service allows the student to perform an experiment by controlling remotely one or more actual measurement instruments. The student can choose a specific experiment in a set of predefined ones and can run it only if the required instruments are currently.

Experiment creation:

This service allows the student to remotely create an experiment by interacting directly with the tools executed on the server(s) managing the instruments.

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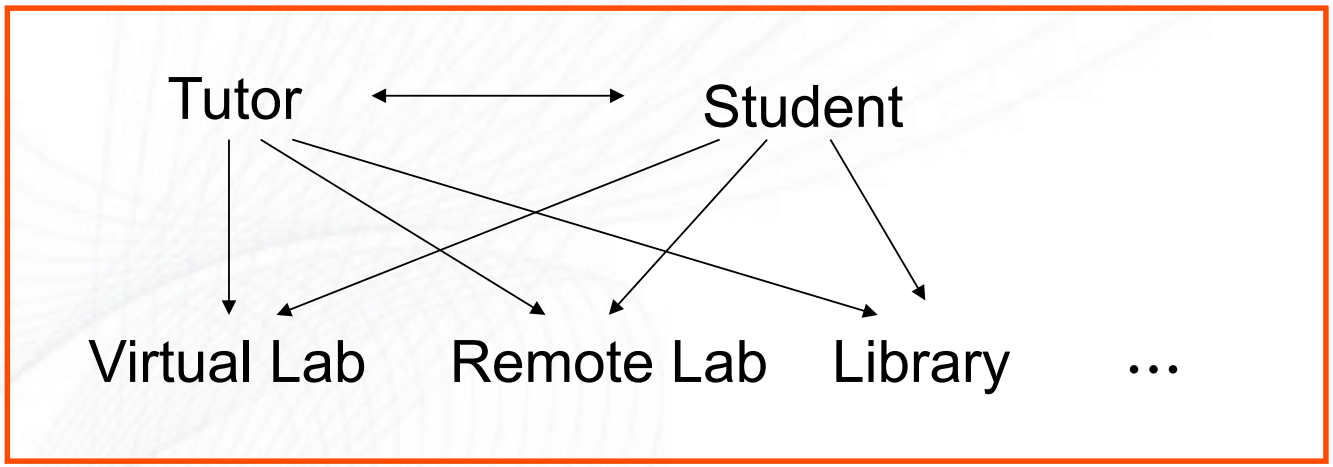
Distributed Lab

Use of lab resources at different locations:



Laboratory Grid:

- No high performance computing
- Decentralized organization

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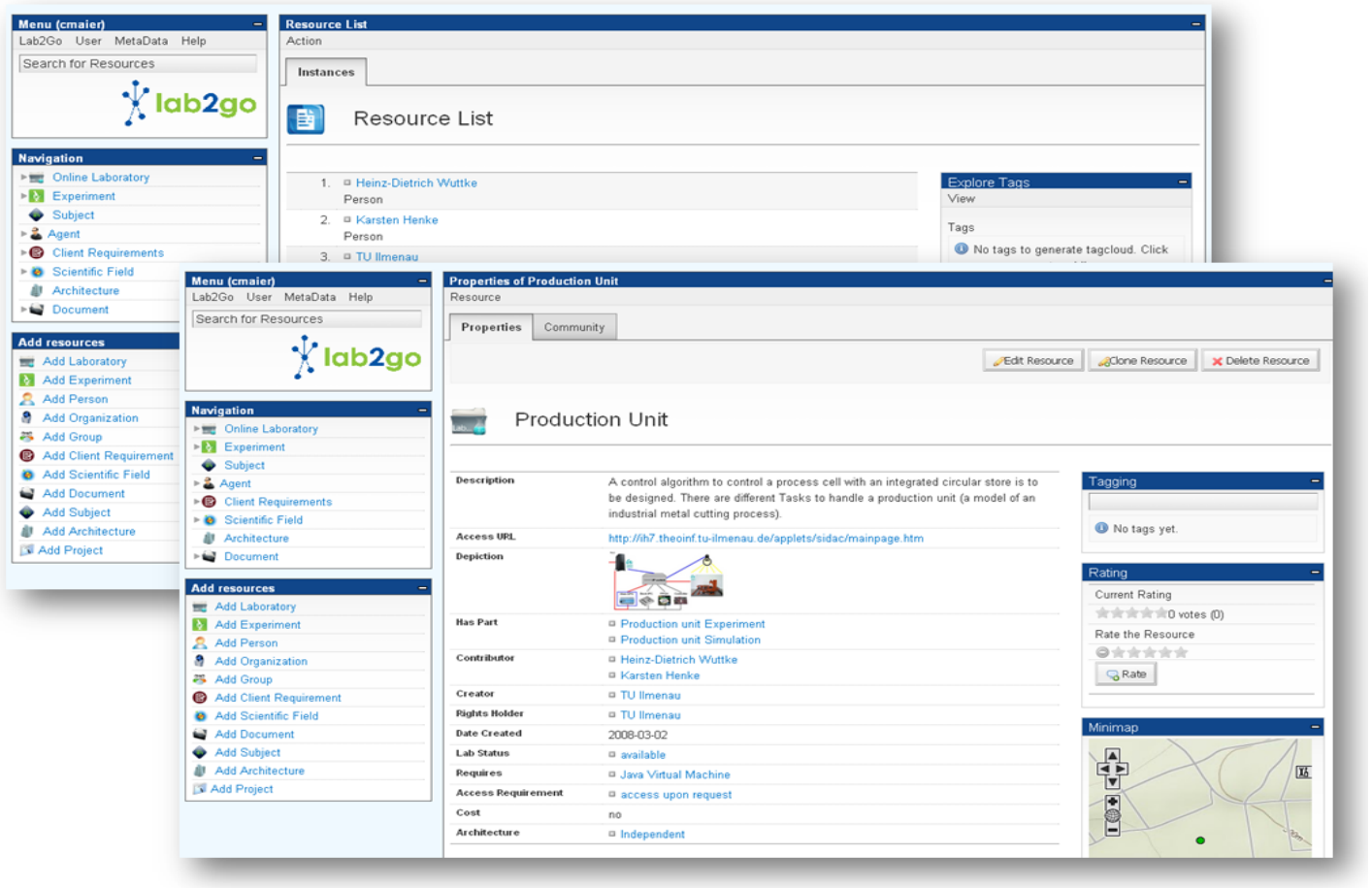
Semantic Online Lab Repository lab2go



www.lab2go.net

Global Online Laboratory Consortium (GOLC)

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Massachusetts Institute of Technology

19 June 2009, Boston MA, USA

Consortium Founder Meeting,
10 Universities, Microsoft, NI, IEEE EdSoc

25 June 2010, Villach, Austria

Establishment of GOLC as a non-profit association by Austrian law.

Founder:

- MIT Boston
- CTI Austria
- UQ, Australia

GOLC

www.golc-online.org

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iLab Europe Partners

- Carinthia University of Applied Sciences Villach, Austria
- Transylvania University of Brasov, Romania
- University of Deusto, Spain
- Technical University from Ilmenau, Germany
- University of Geneva, Italy
- Princess Sumaya University of Technology Amman, Jordan
- Technical University Moscow, Russia

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Suggestions

- Build up a **global grid** of Lab Broker Servers as a common infrastructure
- Organization of user support, further education, building of information pools, … (**dissemination** of the iLab idea)
- Dissemination and application of **standards** for online labs

Actions

- Establishment of a **SIG "Online Laboratories"** by using **GELCommunity.org** and workshops via IIDEA
- Publication of an article in one of the next **IFEES Newsletters**
- **Kick-of Meeting** of interested parties during EDUCON2013 in Berlin, 13-15 March 2013 in conjunction with an IIDEA WS
- Initialization of a **Public-Private-Partnership**

"Synergy from Classic and Future Engineering Education"