Realizing the Potential of iLabs in sub-Saharan Africa

Kick-Off/Steering Committee Meeting

Obafemi Awolowo University

Makerere University, Kampala (Uganda)
June 24, 2005
Meeting Schedule

- 8:30-9:15 AM - informal breakfast
- 9:15-9:30 AM – introduction by Dr. Lugujjo
- 9:30-10:30 AM - Overview of iLab and iLab-Africa projects by Prof. del Alamo
- 10:30-11 AM - break
- 11-12:00 AM - iLab Shared Architecture by Dr. Judson Harward (MIT)
- 12:00-12:30 PM - iLab-Africa personnel exchanges by Prof. B. Widdig (MIT)
- 12:30-2 PM – lunch
- 2-2:45 PM - iLab-Africa project at OAU by Prof. Kehinde
- 2:45-3:30 PM - iLab-Africa project at MUK by A. Lumu
- 3:30-4:15 PM - iLab-Africa project at UDSM by Prof. Nzali
- 4:15-4:50 PM - open discussion
- 4:50-5:00 PM – closing remarks
- 6:30-9 PM – dinner at Grand Imperial Hotel
Goals for Kick-Off Meeting

- Personal acquaintance of PIs and key participants
- Discuss and agree on goals, milestones, reporting, subcontracts, etc.
- Present initial project plans of each institution
- Discuss ways in which MIT can support projects
- Discuss logistics for student/staff exchanges
Project Overview
J. A. del Alamo. MIT

- The iLab project at MIT
  - Brief perspective
  - The iLab Shared Architecture
  - Futures
- iLabs-Africa project
  - Feasibility study + follow-on
  - iLabs-Africa project
  - MIT’s workplan
iLab Project at MIT

- Co-PI’s: Jesus del Alamo and Steven Lerman
- Chief Architect: Judson Harward

A brief chronology:
- 1998: Microelectronics Weblab 1.0
- 2000: iLab under iCampus
- 2002: Heat Exchanger Weblab (three more labs over next few years)
- 2003: iLab Shared Architecture
- 2004: First two labs developed under new architecture
- 2005: iLabs-Africa
iLabs at MIT

Dynamic signal analyzer (EECS, deployed 2004)

Shake table (Civil Eng., deployed 2004)

Microelectronics device characterization (EECS, deployed 1998)

Polymer crystallization (Chem. E., deployed 2003)

Heat exchanger (Chem. E., deployed 2001)
Motivation

- There is enormous educational value in hands-on laboratory experiences, but...

- ... conventional laboratories are expensive and have complex logistics:
  - Scheduling, equipment cost, lab space, lab staffing, training, safety

- ... conventional labs don’t scale well and can’t easily be shared
  - All institutions must own all labs
Shake Table

Goal:
Study behavior of building model structure to ground vibration

Relevance:
Earthquake building engineering
Shake Table GUI

Shake Table WebLab

- Second Floor (g)
- Second Floor FFT
- First Floor (g)

Live Shake Table Lab
Design Studio Lab - CEE MIT

- Live Shake Table Lab
- Design Studio Lab - CEE MIT

Experiment Name:
Hachinohe - NS

Date Created:
7/7/2003 4:41:47 PM
Typical Assignment

Transistor characterization project:

- Measure transistor characteristics
- Extract transistor parameters
- Compare measurements with class models

- Also, do whatever else you want with the transistor…
• What is the lab system capacity?
• When do students carry out assignment?

2PM: 6.012 exercise out (75 students)
4PM: 6.720J/3.43J exercise out (25 students)

[Oct. 13-20, 2000]

2PM: 6.012 exercise due
4PM: 6.720J/3.43J exercise due
System capacity: > 2,000 users/week, > 15,000 jobs/week

2PM: 6.012 exercise out (75 students)
4PM: 6.720J/3.43J exercise out (25 students)

[Oct. 13-20, 2000]

2PM: 6.012 exercise due
4PM: 6.720J/3.43J exercise due
Educational Experiments

MIT graduate and undergraduate courses since Fall 1998
NUS (Singapore), Fall 2000-03 (20-30 st/yr)
Chalmers U. (Sweden), Spring 2003-04 (350 st/yr)
NTU Athens (Greece), Spring 2004 (35 st/yr)
CCU Taipei (Taiwan), Fall 2004 (200 st/yr)
Makerere U. (Uganda), Fall 2004 (150 st/yr)
U. Parma (Italy), Spring 2005 (30 st/yr)
Over 3000 student users (for credit) since 1998
“Formal” use of WebLab

Year

# students

- non-MIT (industrial)
- non-MIT (academic)
- MIT graduate
- MIT undergraduate

1998 1999 2000 2001 2002 2003 2004 2005 (projected)
Early iLab Implementations

- **Lab developer** responsible for 100% of development
  - Long time to deployment
- **Lab owner** responsible for 100% of management
  - The lab itself
  - User accounts, data storage, authentication, security
- **Students** need multiple accounts to access multiple labs
The iLab Vision:
iLab Shared Architecture

- Client
- Campus network
- Service Broker
- University Databases
- Internet
- Lab Server

University Databases
The iLab Shared Architecture

- Many labs shared worldwide
- Some are unique (unreachable locations, rare materials)
- Many simple labs
The iLab Shared Architecture

- GUI to lab
- Students use lab at time and place of own choosing
- Integrates useful generic tools (graphing, numerical analysis, simulators)
- Allows for remote collaboration and tutoring
The iLab Architecture

- **Client**
- **Campus network**
- **Service Broker**
- **University Databases**
- **Internet**

- Serves GUI to Client
- Mediates between Client and Lab Server
- Performs generic functions: user management, data storage
- Single account access to many labs
- Managed by end user University
The iLab Architecture

- Service Broker acquires user data from University Databases
- User authentication through University IT infrastructure
The iLab Vision

- Order of magnitude more lab experiences
- More lab time to users
- More sophisticated labs available
- Communities of scholars created around iLabs sharing educational content
- Labs broadly shared across the world, including across the digital divide
iLab at MIT: futures

- iLab Shared Architecture for interactive experiments
  - Public release
  - Three labs to be ported over
- LabView integration with iLab
- Large iCampus dissemination project
- OpeniLabs.mit.edu
- Formulating model for continuation beyond iCampus (Dec. 2006)
In the spirit of MIT’s OpenCourseWare, explore the notion of a truly open iLab:

- Open access to Microelectronics WebLab to the world at large (more labs to follow)
- Nearly unrestricted use:
  - Access to 3 or 4 generic devices
- User accounts approved automatically
- Experimental set ups available
- Will connect lab to course content published in MIT’s OpenCourseWare
OpeniLabs Web site
iLabs in sub-Saharan Africa

Carnegie Feasibility Study 2003-2004

Goals:

- To assess the potential of iLabs to enrich university education in developing countries.
- To identify the barriers that prevent the realization of the potential of iLabs in developing countries.
Findings

- Good match in curriculum
  (Electrical Engineering and Physics)
- Paucity of labs
- World class and enthusiastic teaching staff
- Enthusiastic and entrepreneurial students
More findings

But…

- Limited access to networked computers
- Limited exposure to computers on part of students
- Severe bandwidth limitations
- Electrical power unstable
- Local networks fragile
Bandwidth limitations
(example: Makerere University, Kampala)

- Campus wide single-mode optical fiber (2 Gb/s)
- Satellite gateway to Internet (total bandwidth of Uganda = 25 Mb/s)
- Metropolitan network (total campus bandwidth = 2.5 Mb/s)
- Academic buildings networked at 10/100 Mb/s

Data corresponding to Spring 2004
### Bandwidth cost: MUK vs. MIT

<table>
<thead>
<tr>
<th></th>
<th>MUK</th>
<th>MIT</th>
<th>MUK/MIT ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>campus gateway (Mb/s)</td>
<td>2.5</td>
<td>~2,300</td>
<td>~10^{-3}</td>
</tr>
<tr>
<td>gateway cost ($ per month)</td>
<td>$28K</td>
<td>~$80K</td>
<td>~1/3</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>$1.2K</td>
<td>$36K</td>
<td>~0.03</td>
</tr>
</tbody>
</table>

**bandwidth cost relative to per capita GDP** ~10^4

- Technological solutions developed at MIT might not be a good fit for developing countries
- Pedagogy likely to be different in bandwidth starved situations
- Need to deploy educational resources *locally*

Data corresponding to Spring 2004
No optical fiber links to East Africa, West Africa linked but fiber landing in Lagos not active (?):

- each country is an island in the global Internet
- cannot have *regional* center to disseminate educational resources
No optical fiber links across country:

- each city is an island in the global Internet
- cannot have *national* center to disseminate educational resources
Lessons from Feasibility Study

- Great potential for iLabs in Africa
- New technological approaches needed
- Must deploy educational resources locally
- Pedagogy needs to be investigated
Follow-on to Feasibility Study (2004-2005)

- Further explored issues with goal of formulating proposal for longer term action
- Hosted visits at MIT:
  - Albert Lumu (MUK) – Aug. 2004
  - Philip Jonah (OAU) – Jan. 2005
- Installed Service Broker in a laptop
  - Deployed at MUK (Fall 2004)
  - Deployed at OAU (Winter 2005)
- Submitted large proposal to Carnegie
First iLab Service Broker outside MIT installed at Makerere University (Sept. ’04)

http://emuklabs.mak.ac.ug
iLabs-Africa project

- Funded by Carnegie Corp.
- June 1, 2005- May 31, 2007
- $800K
- Involves MIT, UDSM, MUK and OAU
- Dedicated to the proposition that iLabs are meant to be shared worldwide across the digital divide
iLabs-Africa project

Goals:
- To deploy MIT's iLabs throughout curriculum in Africa
  - Adapt MIT’s content, develop new content
- To support new iLab development in Africa
- To create opportunities for internships for MIT and African students and staff
- To create a scalable iLab research network in sub-Saharan Africa
Tentative timeline

Year 1

1st steering committee meeting

- New iLab development
- Curriculum development based on existing iLabs

- Personnel exchanges

Year 2

2nd steering committee meeting

- Curriculum development based on new iLabs
- New iLab deployment

- Personnel exchanges
MIT’s work:

1. Curriculum

- Available MIT iLabs:
  - Microelectronics WebLab (now)
  - Dynamic Signal Analyzer WebLab (Fall 2005)
  - Heat Exchanger (2005?), pending more experiments
  - Polymer Crystallization Experiment (?): need to do experiments

- Educational materials:
  - Revise/develop documentation about microelectronics weblab
  - Revise/develop educational content for microelectronics weblab; write solutions
    - basic electronics circuits course (6.002)
    - mid-level devices and circuits course (6.012)
  - Develop documentation and content for dynamic signal analyzer weblab
  - Create website to host all materials
MIT’s work:
2. iLab Development

- Microelectronics WebLab:
  - Install high-power unit for power electronics courses
  - Develop new “nimble” client
  - Expose Service Broker functionality that allows data storage

- Dynamic Signal Analyzer:
  - Work on unique issues for usage from Africa

- Support iLab development in Africa
MIT’s work:
3. Student/Staff Exchanges

- Send MIT students to join iLabs teams in Africa
  - Summer or January
  - 2 per institution per year
  - Students have prior experience in iLab project at MIT
  - Students have prior education/awareness on Africa

- Host African students/staff at MIT
  - 2 per institution per year
  - To join iLab project in most suitable capacity
  - Best in a coordinated fashion
iLabs in Africa: an avenue for a deeper engagement

MAKOCW: first OpenCourseWare mirror site in Africa
Discussion topics

- Bureaucratics: workplans and subcontracts
- Technical
- How can MIT support your project?
- Problems? Concerns?
- …
“If You Can’t Come to the Lab… the Lab Will Come to You!”