iLabs:

Carrying out Experiments Through the Internet Across the Digital Divide

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LINC Symposium
MIT, October 28, 2005
Motivation to iLabs

- There is enormous educational value in hands-on laboratory experiences

- But, conventional labs...
  - ... are expensive and have complex logistics
  - ... can’t easily be shared

- iLabs (or “WebLabs”): real laboratories that are accessed through the Internet from anywhere at any time
iLabs at MIT

Dynamic signal analyzer
(EECS, deployed 2004)

Microelectronics device characterization
(EECS, deployed 1998)

Polymer crystallization
(Chem. E., deployed 2003)

Shake table (Civil Eng., deployed 2004)

Heat exchanger (Chem. E., deployed 2001)
Microelectronics device characterization:

- over 3000 student users (for credit) since 1998
The iLab Shared Architecture

- Client
- Campus network
- University Databases
- Service Broker
- Internet
- Lab Server
The iLab Vision

- Order of magnitude more lab experiences
- More lab time to users
- More sophisticated labs available
- Communities of scholars sharing
  - labs and
  - educational content
Unique Issues for iLabs in developing countries

- **Opportunities:**
  - Paucity of labs
  - Lots of young enthusiastic people
  - Great need for engineers

- **Challenges:**
  - Limited access to networked computers
  - Limited computer literacy
  - Severe bandwidth limitations
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

Bandwidth cost relative to GDP per capita w.r.t. to MIT: \(~10^4 X\)
No optical fiber links to East Africa, West Africa linked but no optical networks throughout country

- each country and each city is an island in the global Internet
- educational content cannot be disseminated from regional or national centers
Consequences for iLabs (and other rich educational resources)

• Need to deploy educational resources locally

• Technological solutions developed at MIT might not be effective in developing countries

• Pedagogy likely to be different in bandwidth starved situations

• Ultimate goal: home-grown iLabs. How do we support this?
iLab-Africa project

Goals:

- To deploy MIT's iLabs throughout curriculum in Africa
- To support new iLab development in Africa
- To create opportunities for internships for MIT and African students
- To create a scalable iLab research network in Africa

June 1, 2005 – May 31, 2007
iLabs in Africa: challenges and solutions

- client GUI’s are “fat”
- require complex plug-ins
- demanding on local resources
v. 6.1 graphical applet
• requires Java 1.4.2 plug-in
• 169 kbytes
• <download time> from OAU=79”

v. 6.1 classic applet
• Java 1.1 compatible (no plug-in)
• 94 kbytes
• <download time> from OAU=63”

Data courtesy of K. Ayodele (OAU)
iLabs in Africa: challenges and solutions

- client served from half a world away at MIT
- based on proprietary technology
Service Brokers installed at MUK, OAU and (soon) UDSM

<download time> at OAU: 22” (graphical), 17” (classic)
iLabs in Africa: challenges and solutions

- professional lab hardware prohibitively expensive
Investigating inexpensive hardware

- Agilent 4155 ~$40K
- NI Elvis ~$2K
- iLab Mini ~$40
iLabs in Africa: an avenue for a deeper engagement

MAKOCW: first OCW mirror site in Africa, now also at OAU, and soon at UDSM
Conclusions

- iLabs will enhance science and engineering education
- iLabs and their educational content will be broadly shared around the world
- iLabs provide a path for the developed world to support the educational objectives of the developing world
- Unique challenges to iLab technology and pedagogy in developing world
- iLabs Shared Architecture: scalable framework for iLabs, well suited to needs of developing world
“If You Can’t Come to the Lab… the Lab Will Come to You!”

(Earth at 89 GHz; courtesy of J. Grahn, Chalmers U.)