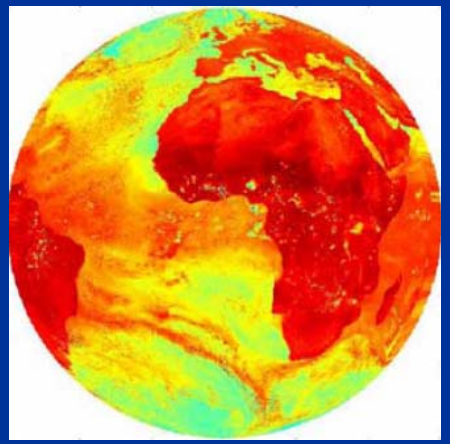
iLabs:

Carrying out Experiments Through the Internet Across the Digital Divide



Jesús del Alamo and Steven R. Lerman
MIT

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

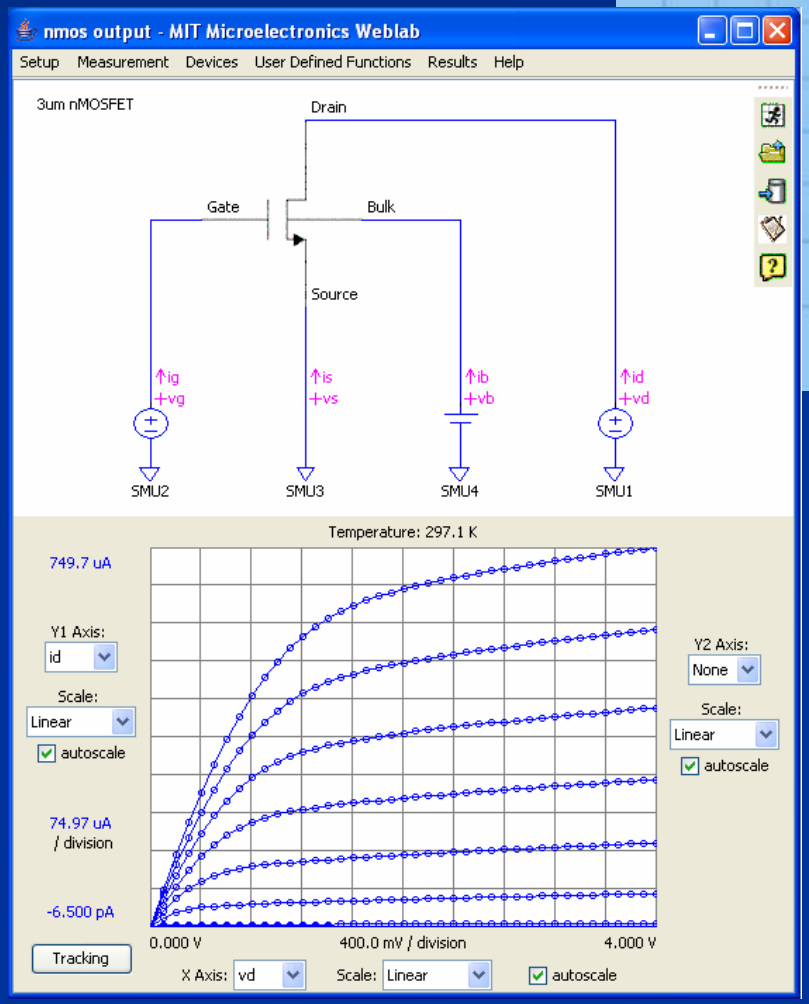
Dynamic signal analyzer
(EECS, deployed 2004)

Polymer crystallization
(Chem. E., deployed 2003)

Shake table *(Civil Eng., deployed 2004)*

Microelectronics device characterization
(EECS, deployed 1998)

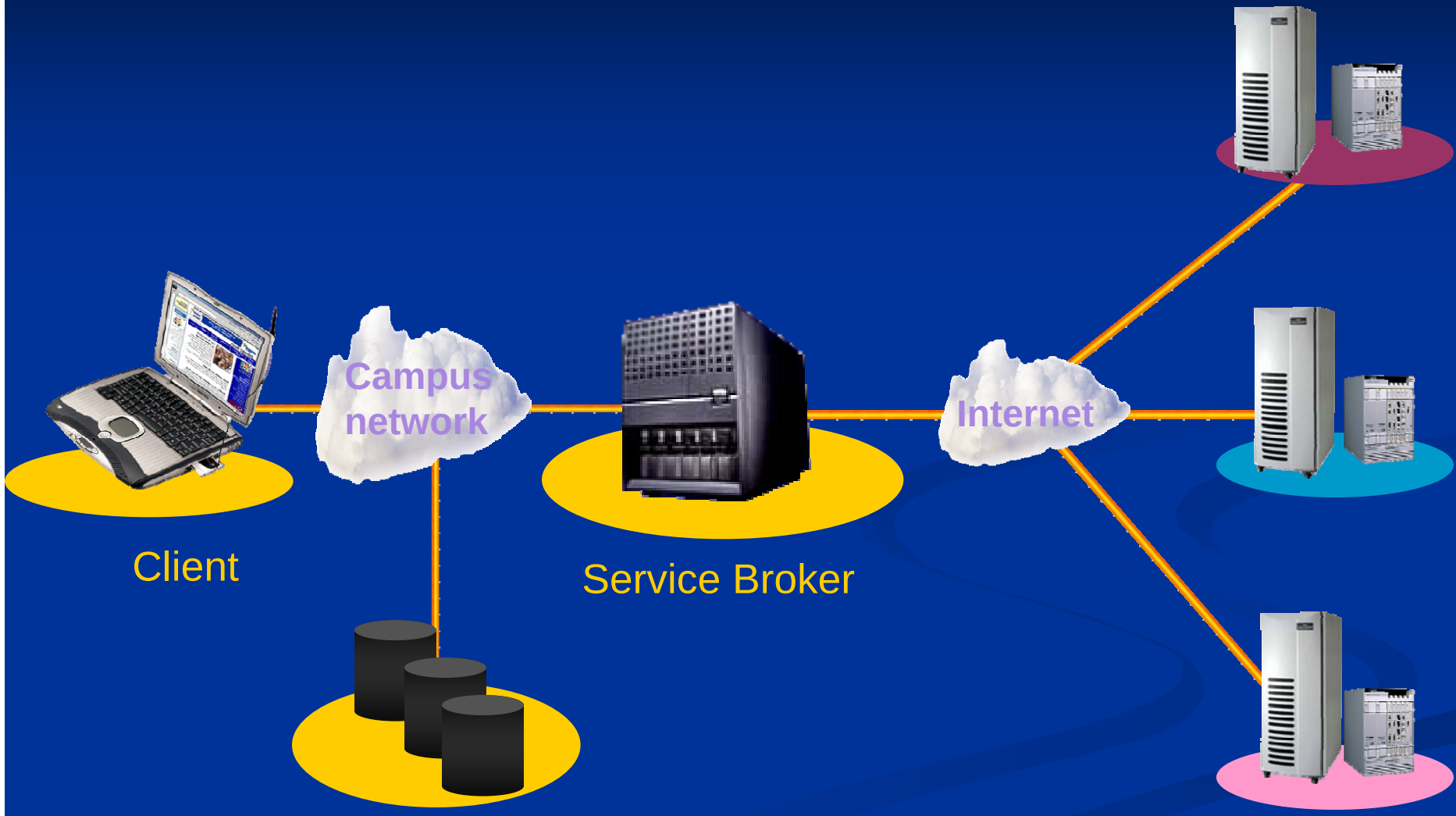
Heat exchanger *(Chem. E., deployed 2001)*



Microelectronics device characterization:

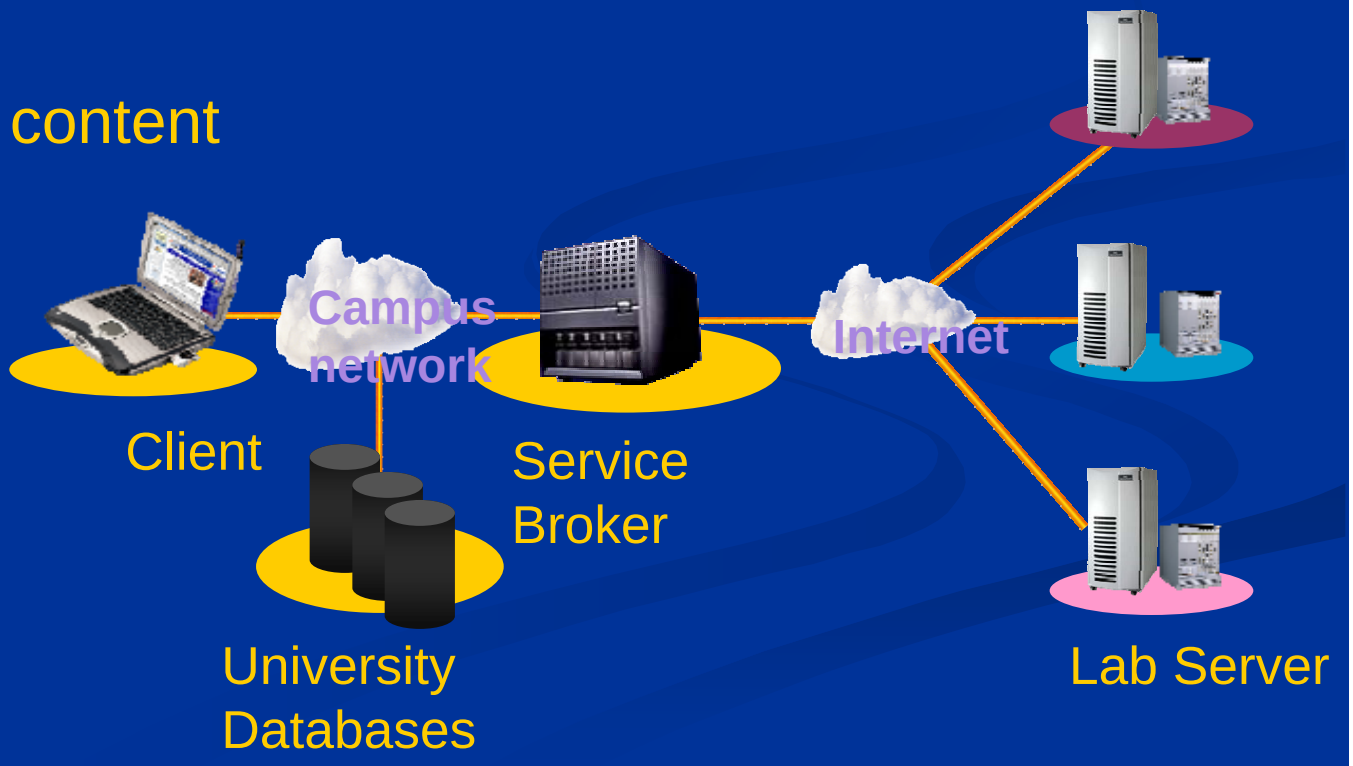
- over 3000 student users (for credit) since 1998

The iLab Shared Architecture



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

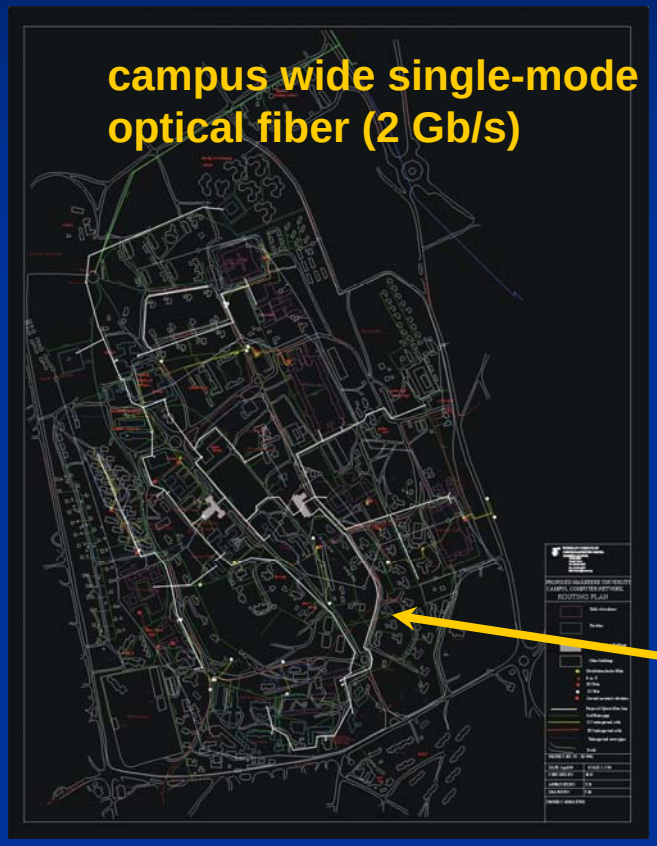


Unique Issues for iLabs in developing countries

- 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

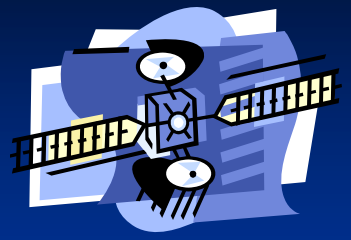
Bandwidth limitations

(example: Makerere University, Kampala)

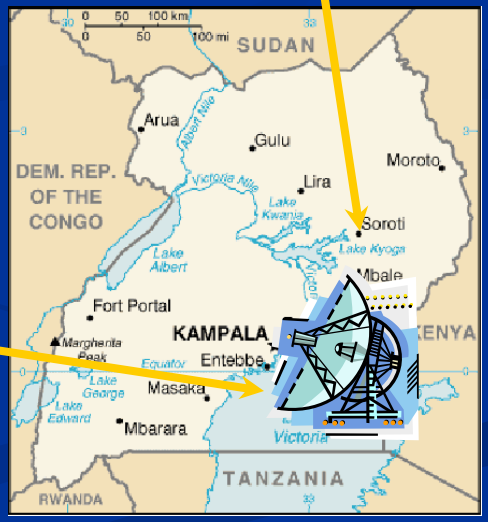


academic buildings networked at 10/100 Mb/s

metropolitan network (total campus bandwidth=2.5 Mb/s)



satellite gateway to Internet (total bandwidth of Uganda=25 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

Carnegie Corporation of New York

MAKERERE UNIVERSITY

University of Dar es Salaam

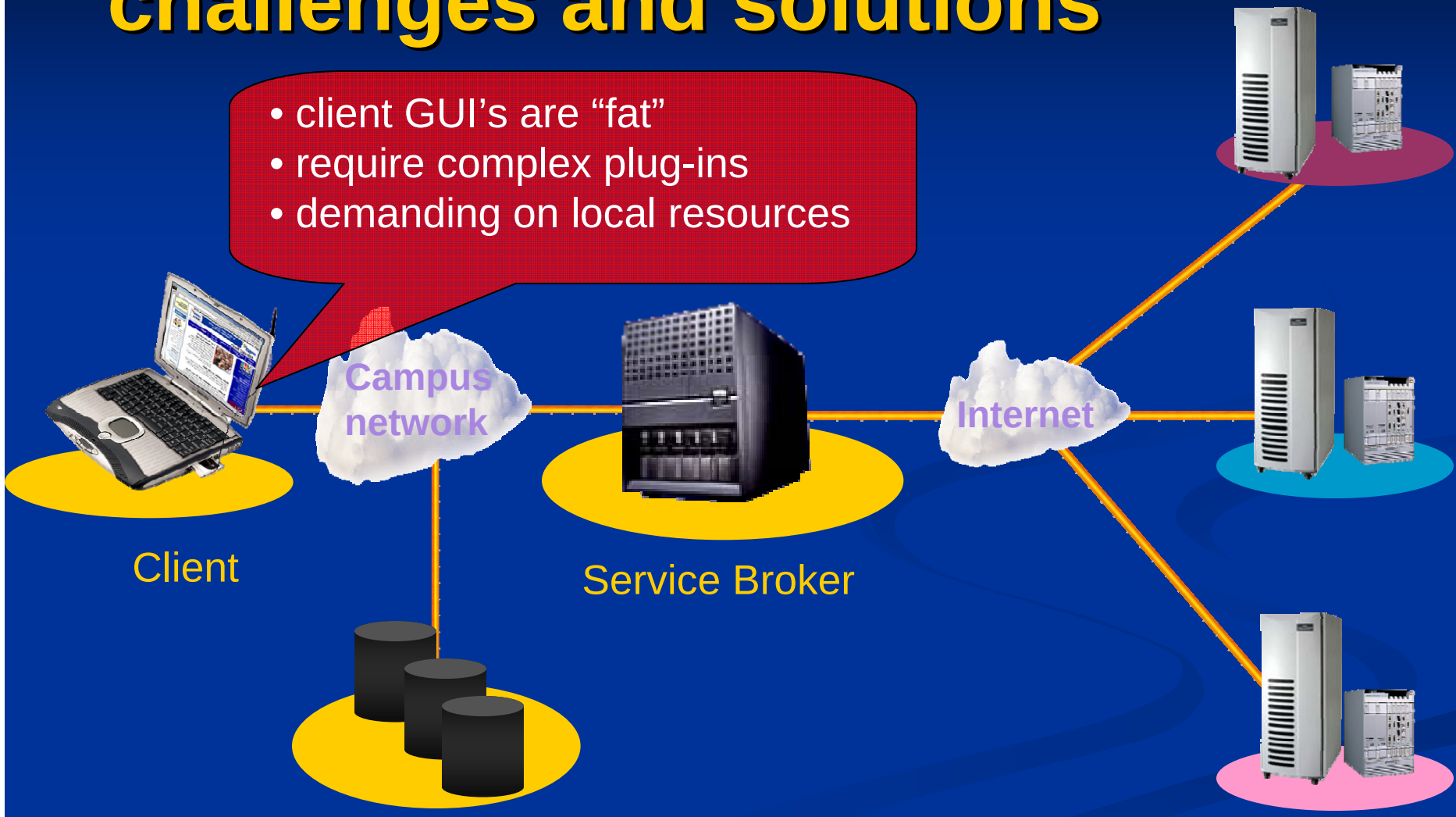
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

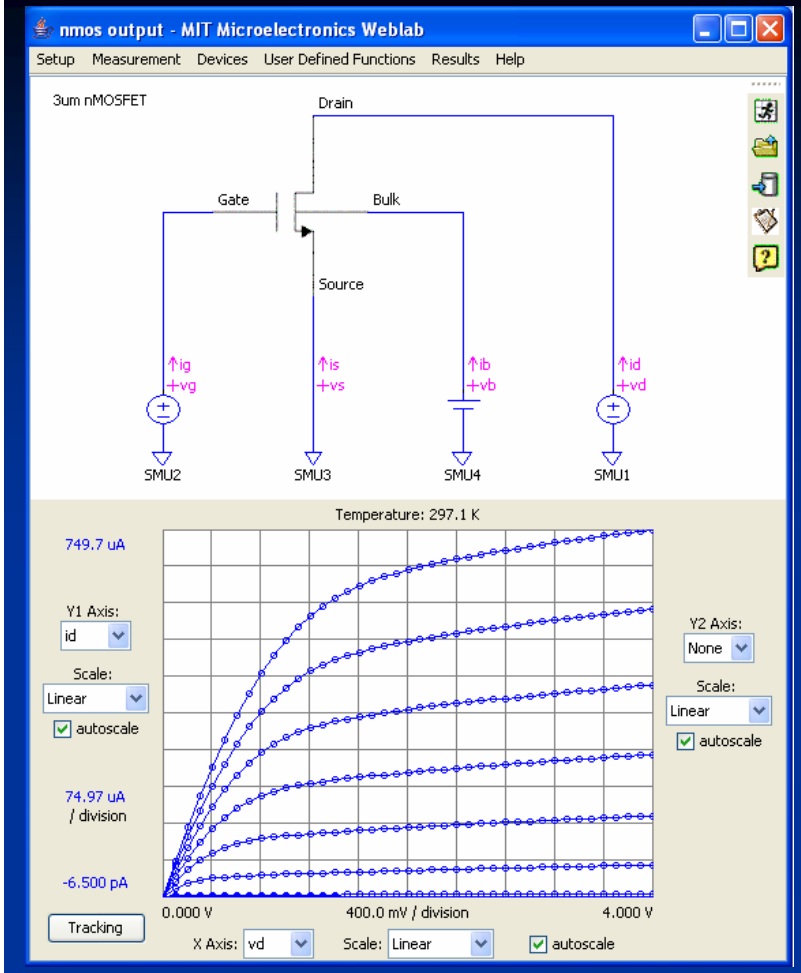
Obafemi Awolowo University

- 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

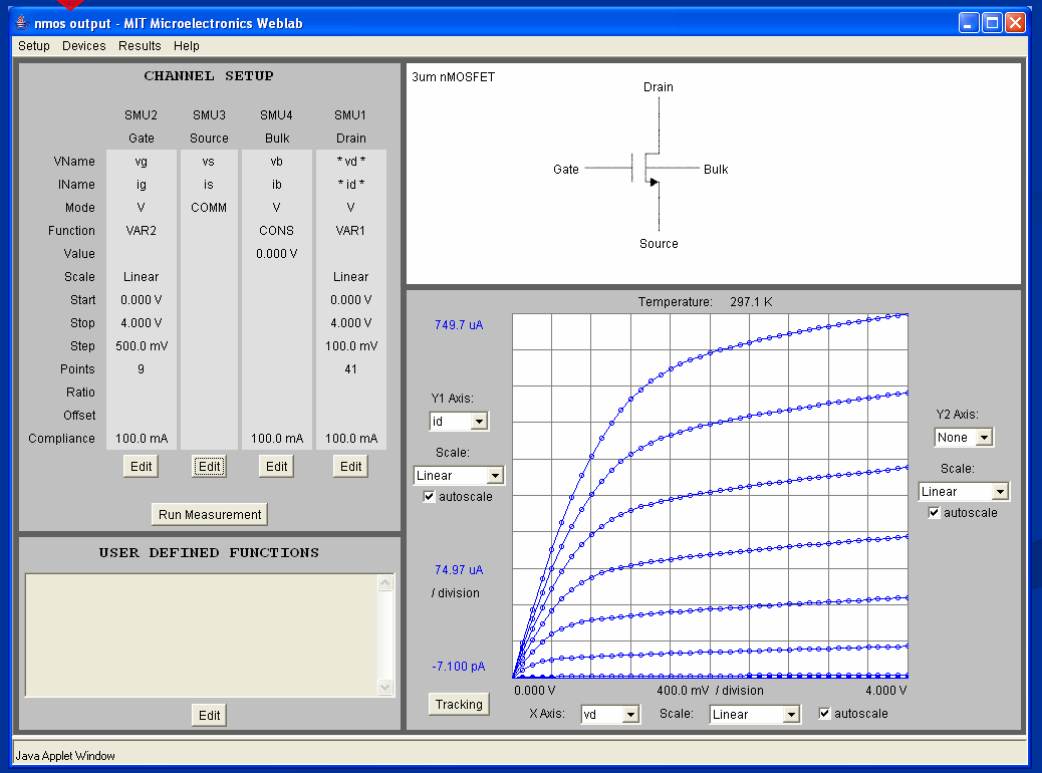
- client GUI's are "fat"
- require complex plug-ins
- demanding on local resources





v. 6.1 graphical applet

- requires Java 1.4.2 plug-in
- 169 kbytes
- <download time> from OAU=79”



v. 6.1 classic applet

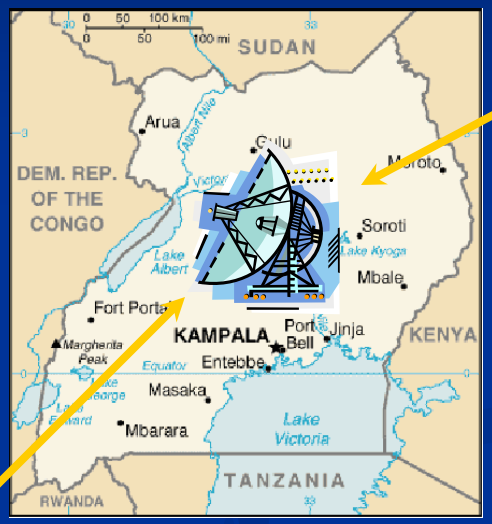
- Java 1.1 compatible (no plug-in)
- 94 kbytes
- <download time> from OAU=63”

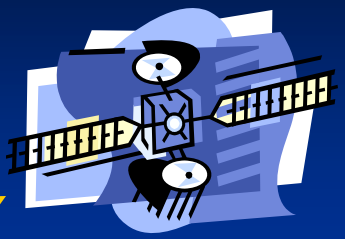
Data courtesy of K. Ayodele (OAU)

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





applet served from here

student data stored here

Instead of here

Instead of here

<download time> at OAU: 22” (graphical), 17” (classic)

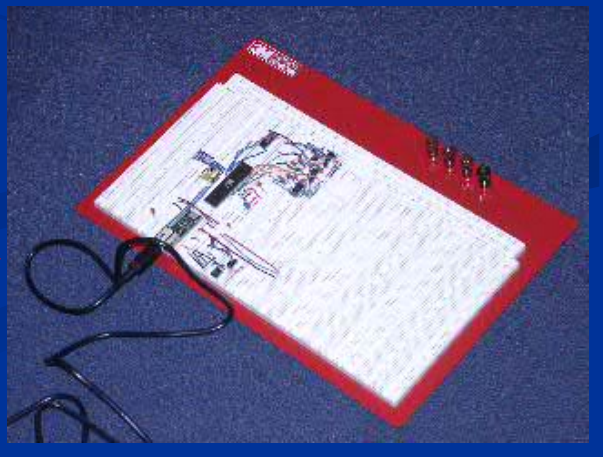
iLabs in Africa: challenges and solutions

Investigating inexpensive hardware

Agilent 4155
~$40K

NI Elvis
~$2K

iLab Mini
~$40



iLabs in Africa:

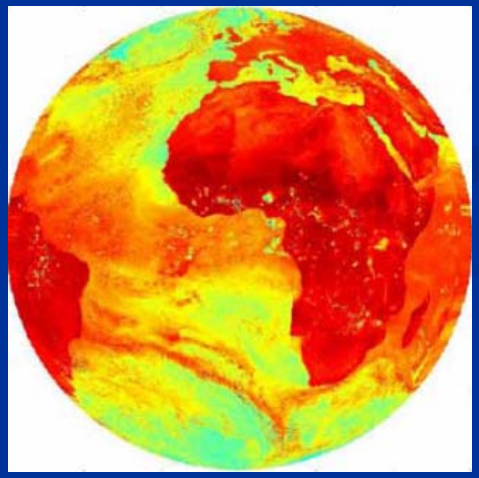
an avenue for a deeper engagement

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.)