

Realizing the Potential of iLabs in sub-Saharan Africa



Obafemi
Awolowo
University

Kick-Off/Steering Committee Meeting



Makerere University, Kampala (Uganda)

June 24, 2005



University of Dar es Salaam



MAKERERE UNIVERSITY

Carnegie Corporation of New York

Meeting Schedule

- 8:30-9:15 AM - informal breakfast
- 9:15-9:30 AM – introduction by Dr. Lugujo
- 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 UDASM 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)



Polymer crystallization
(Chem. E., deployed 2003)



Shake table (Civil Eng.,
deployed 2004)



Microelectronics device characterization
(EECS, deployed 1998)



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 [Main Page](#) | [Load another experiment](#) Signed in by **Developer**

Floor Accelerations | Transfer Functions | Table Displacement | Data Manager



Live Shake Table Lab
Design Studio Lab - CEE MIT

START

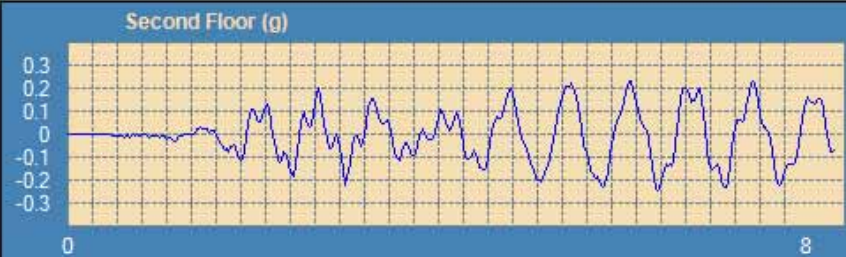
STOP

Lab Status
Exp Stopped

Experiment Name
Hachinohe - NS

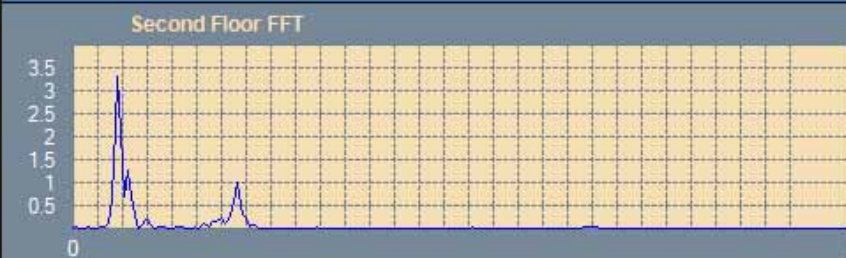
Date Created
7/7/2003 4:41:47 PM

Second Floor (g)



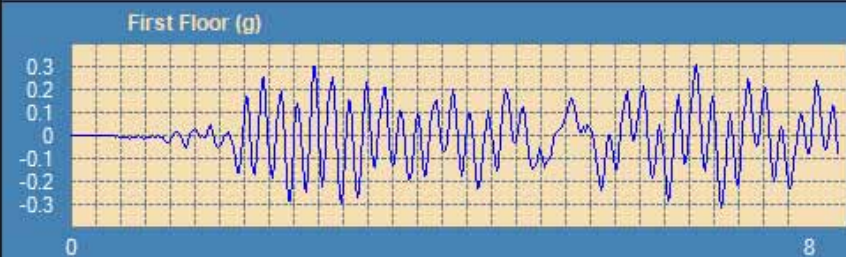
0 8

Second Floor FFT



0 24 Freq

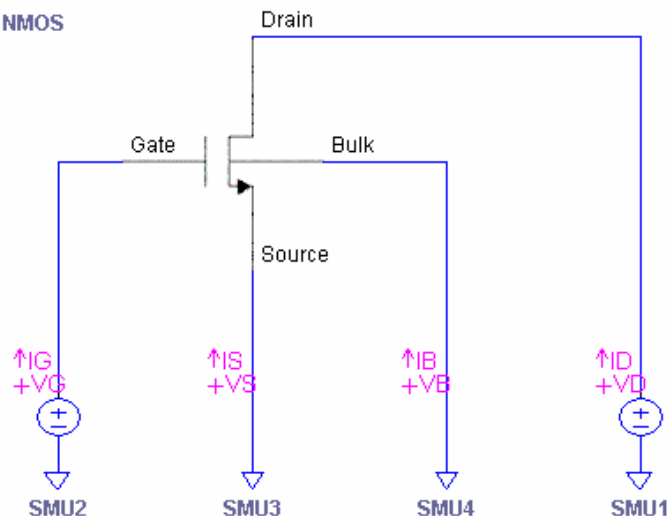
First Floor (g)



0 8

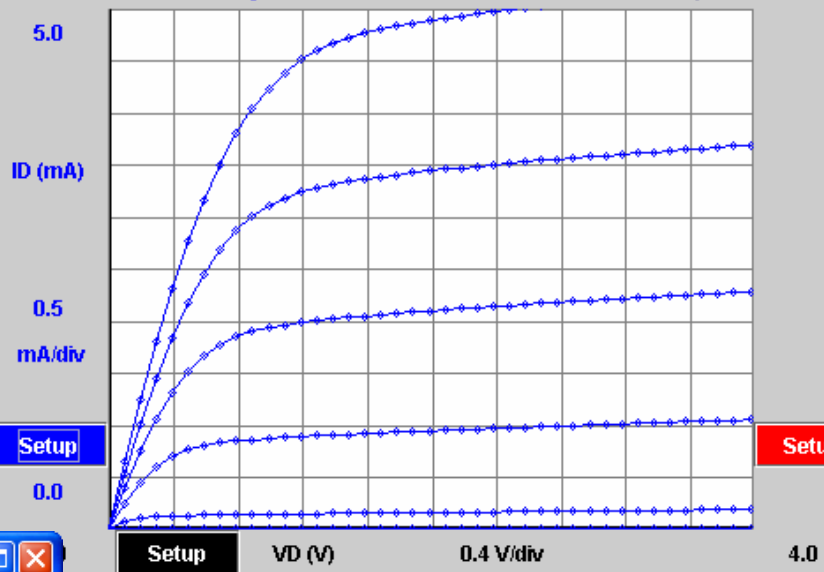
Select Plots

6.012 NMOS



MEASUREMENT RESULTS

x: 1.3736 V y1: 1.9965 mA Temp: 298.2 K



Java Applet Window

Load Setup...

Available Setups

- dummy
- PMOSoutput
- NMOSbackgate(linear)
- NMOSoutput**
- Resistor
- CNXTBJTCEoutput
- CNXTBJTqummel

Load Setup: NMOSoutput

OK

Cancel

Java Applet Window

SMU1 Input

VName	IName
VD	ID

Download Download
 Function: VAR1 Mode: V

 Variable Setup
 Scale: []
 Start: 0.0 [V]
 Stop: 4.0 [V]
 Step: 100.0
 Compliance: 100.0 [mA]
 Points: 41

OK Cancel

Java Applet Window

Data

```

T(K)=, +2.98164000E+02
VG, VD, ID
V, V, A
+0.000000E+000, +0.000000E+000, +2.000000E-014
+0.000000E+000, +1.000000E-001, +4.095000E-011
+0.000000E+000, +2.000000E-001, +7.008000E-011
+0.000000E+000, +3.000000E-001, +6.156000E-011
    
```

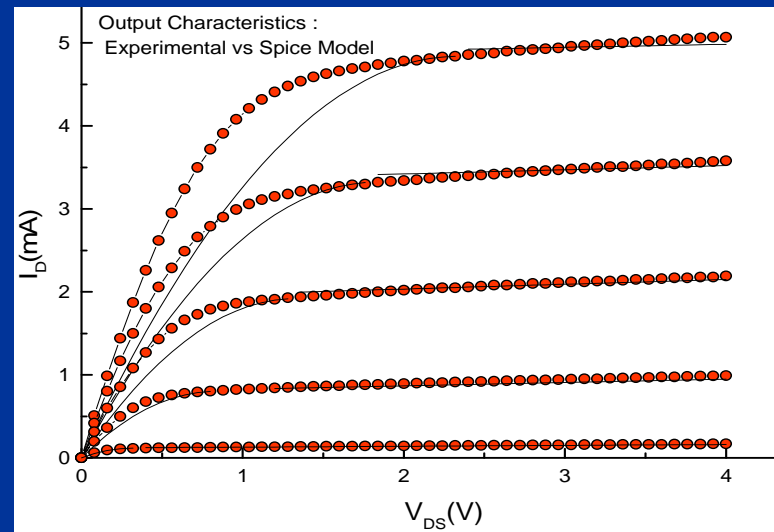
OK

Java Applet Window

Typical Assignment

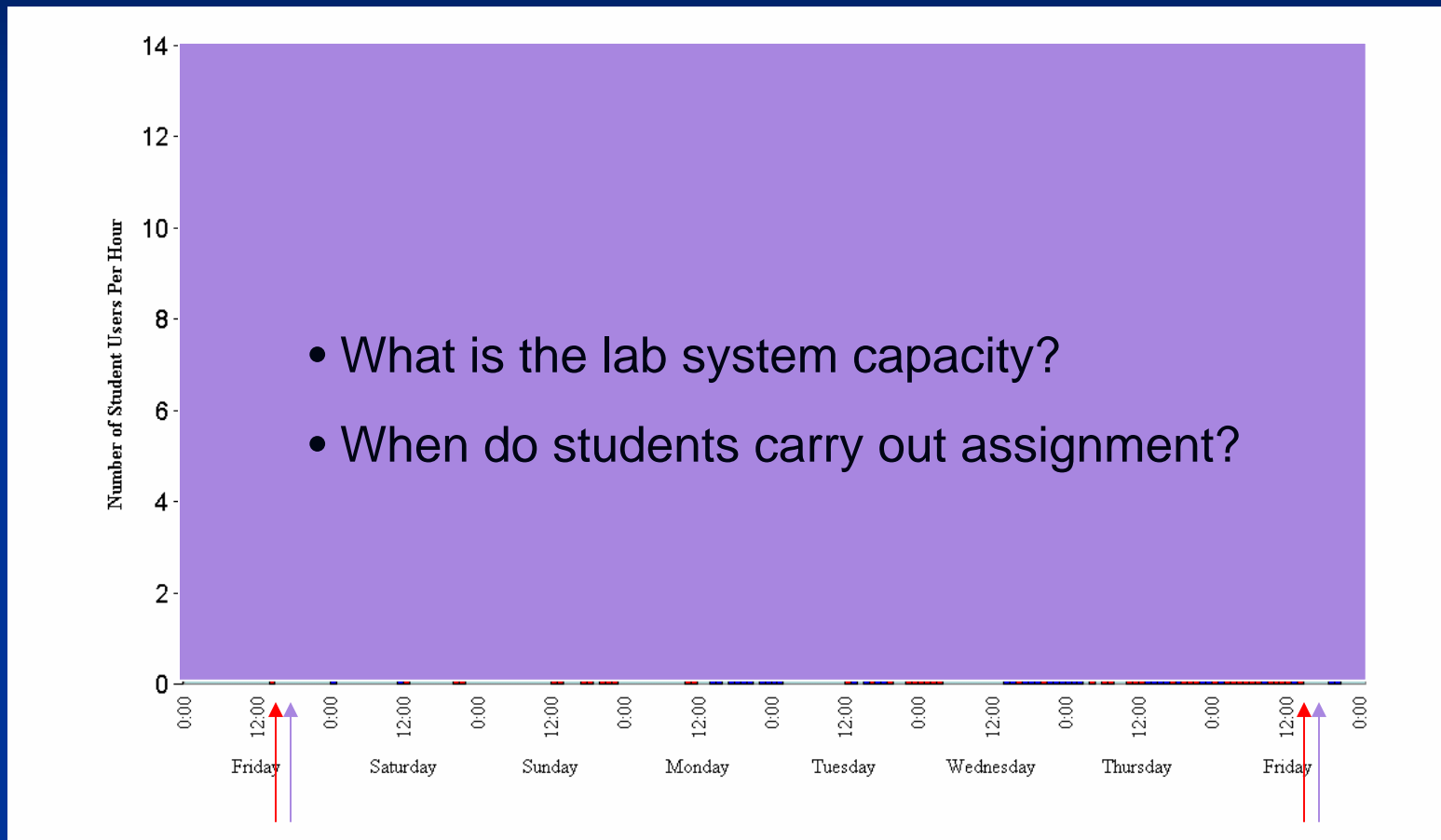
Transistor characterization project:

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



- Also, do whatever else you want with the transistor...

WebLab Capacity



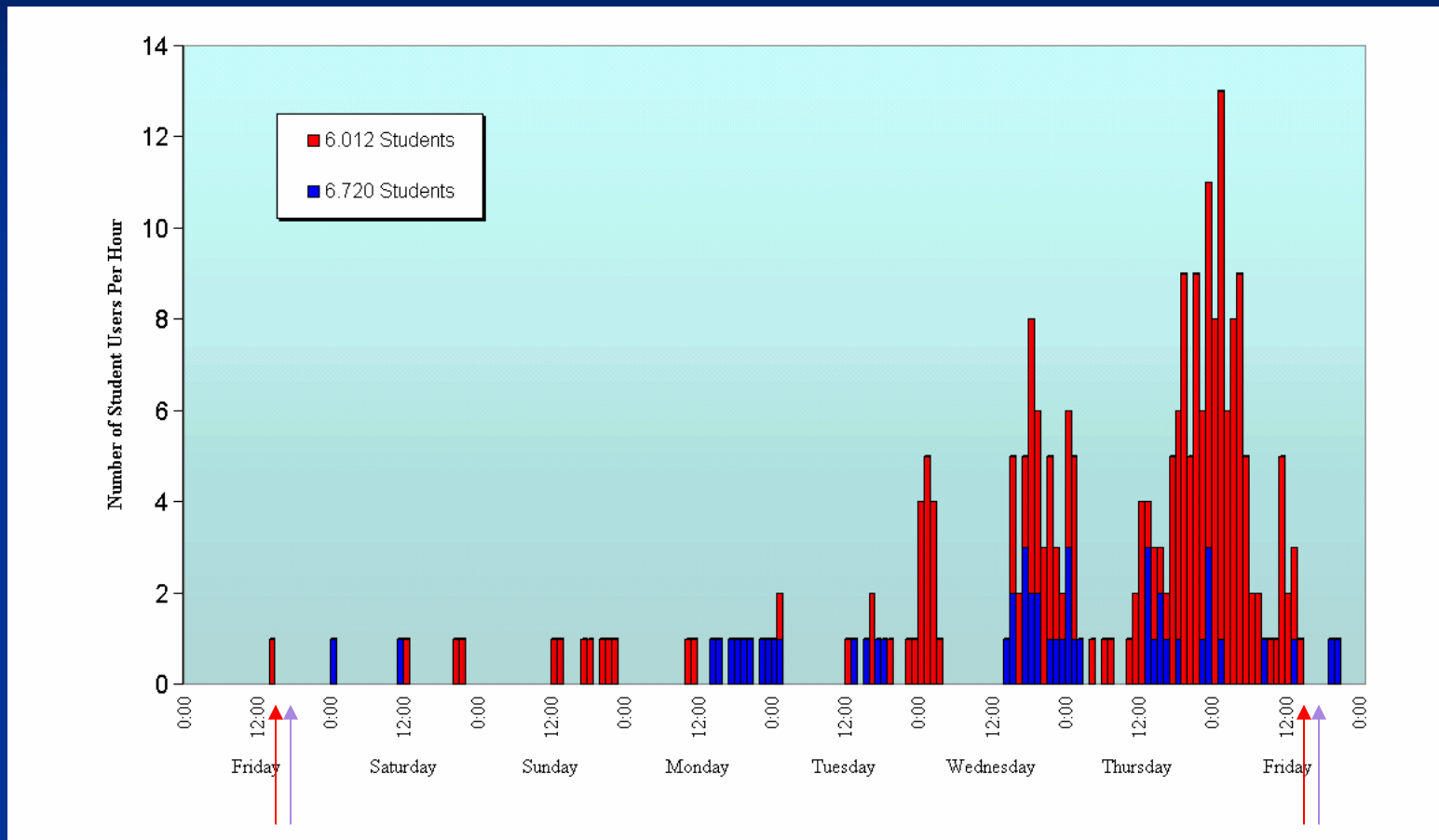
2PM: 6.012
exercise out
(75 students)

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

[Oct. 13-20, 2000]

2PM: 6.012 **4PM:**
exercise due **6.720J/3.43J**
exercise due

WebLab Capacity



2PM: 6.012
exercise out
(75 students)

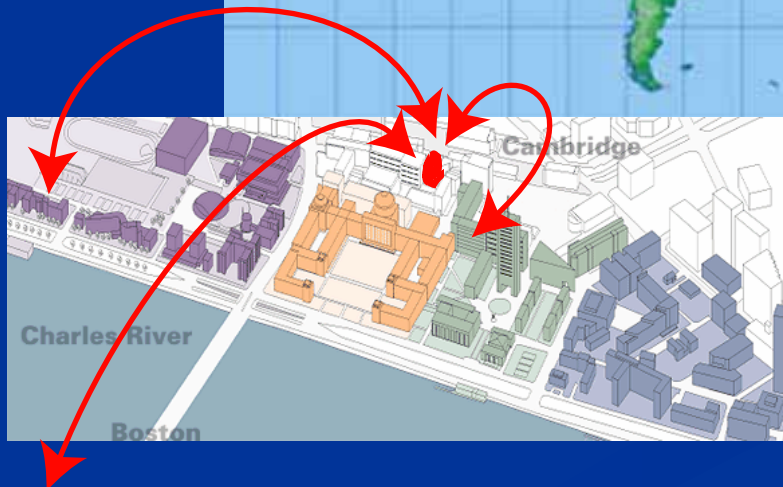
4PM:
6.720J/3.43J
exercise out
(25 students)

[Oct. 13-20, 2000]

2PM: 6.012
exercise due
6.720J/3.43J
exercise due

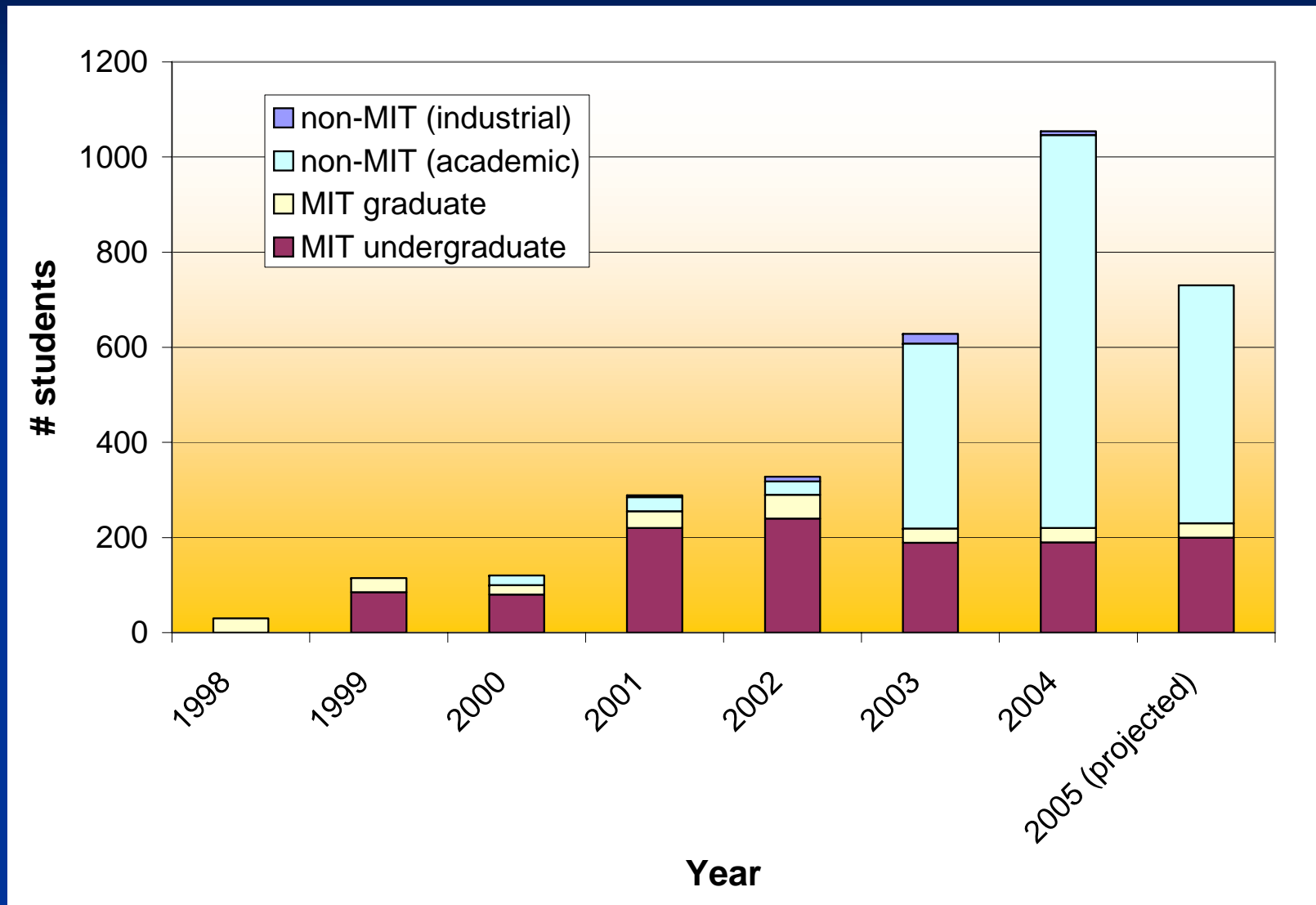
System capacity: > 2,000 users/week, > 15,000 jobs/week

Educational Experiments

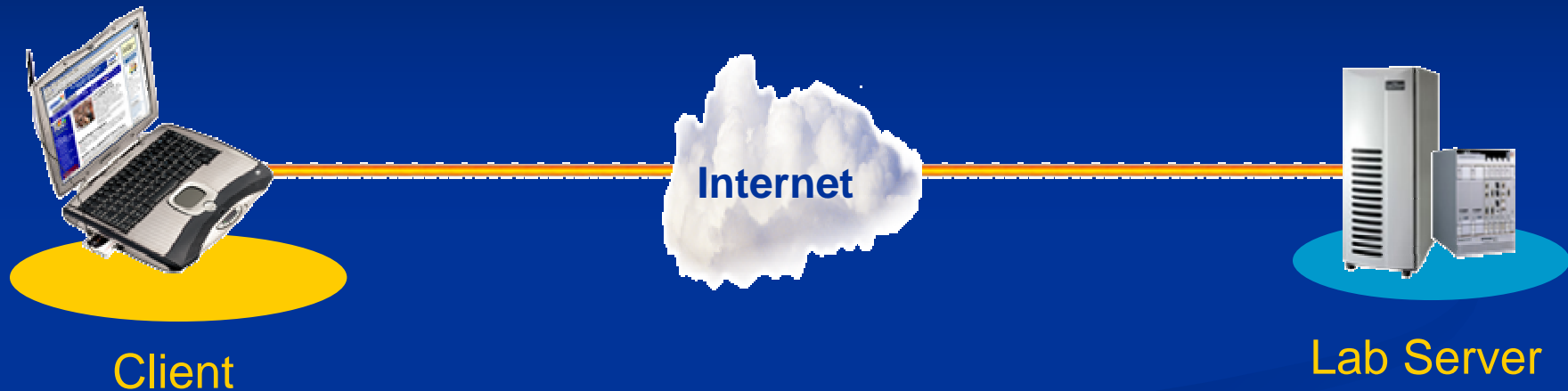


MIT graduate and undergraduate courses since Fall 1998
NUS (Singapore), Fall 2000-03 (20-30 st/yr)
Chalmers U. (Sweden), Spring 2003-04 (350 st/yr)
NTU Athens (Greece), Spring 2004 (35 st/yr)
CCU Taipei (Taiwan), Fall 2004 (200 st/yr)
Makerere U. (Uganda), Fall 2004 (150 st/yr)
U. Parma (Italy), Spring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

“Formal” use of WebLab

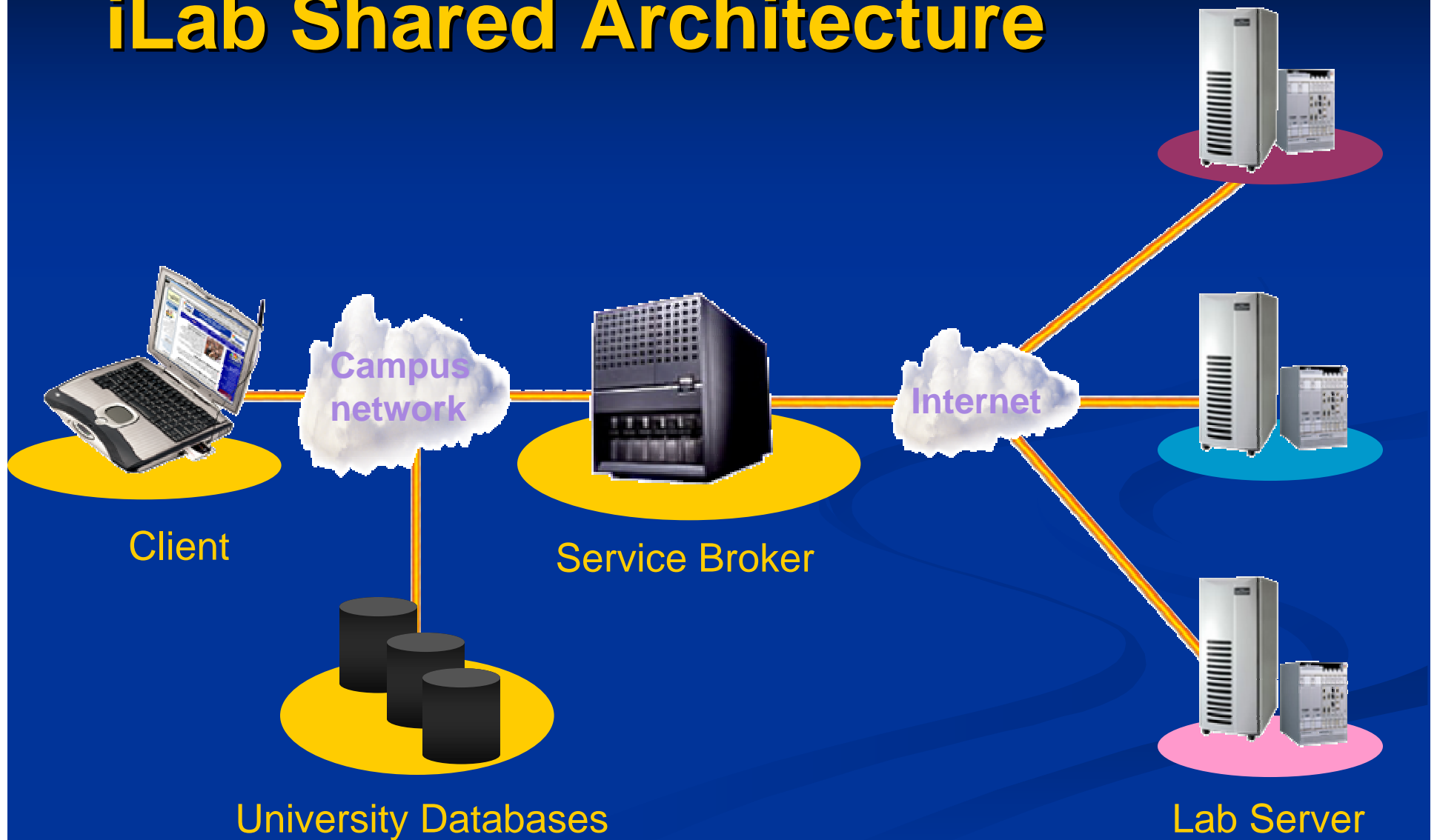


Early iLab Implementations



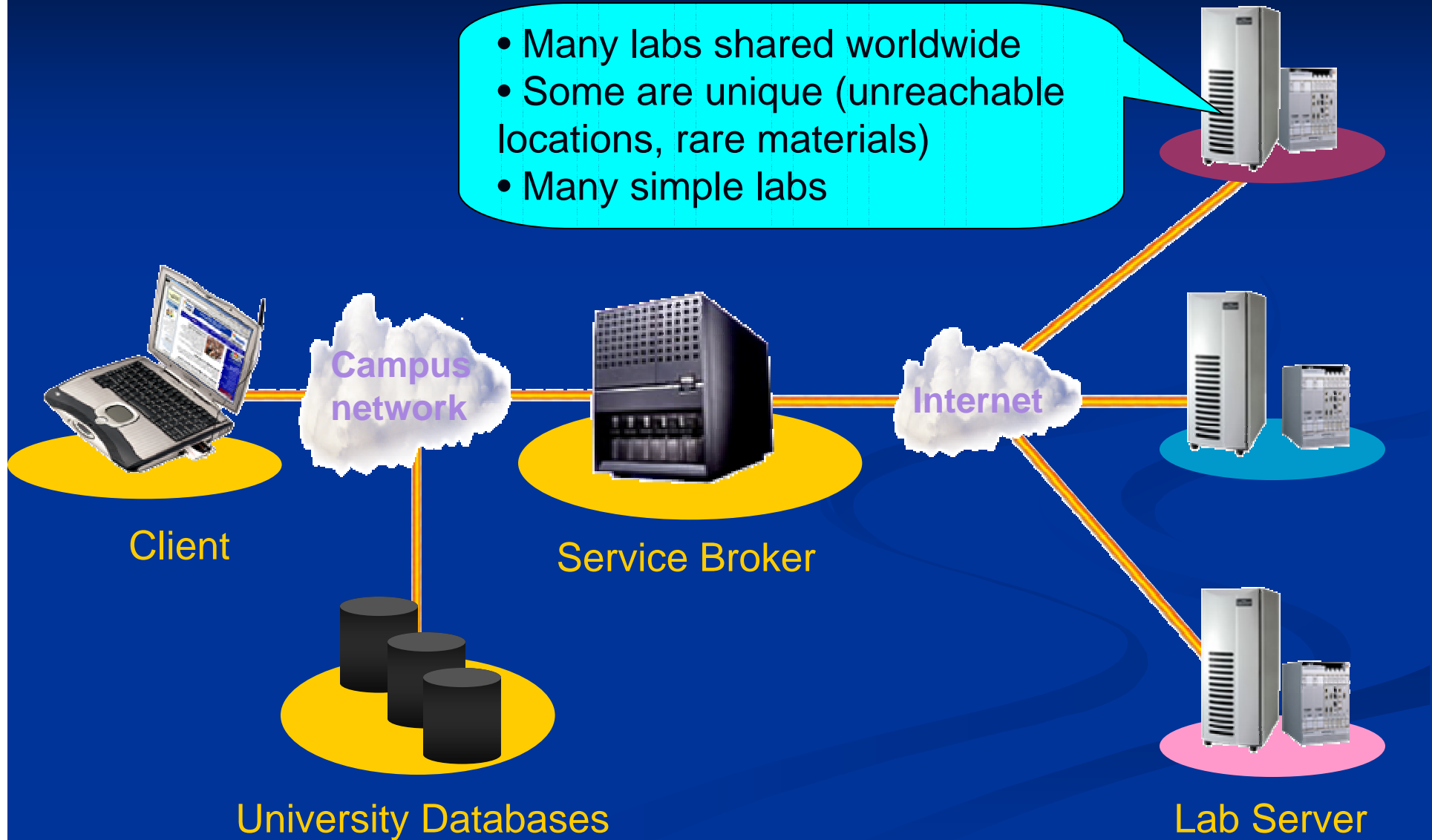
- **Lab developer** responsible for 100% of development
 - ❖ Long time to deployment
- **Lab owner** responsible for 100% of management
 - ❖ The lab itself
 - ❖ User accounts, data storage, authentication, security
- **Students** need multiple accounts to access multiple labs

The iLab Vision: iLab Shared Architecture



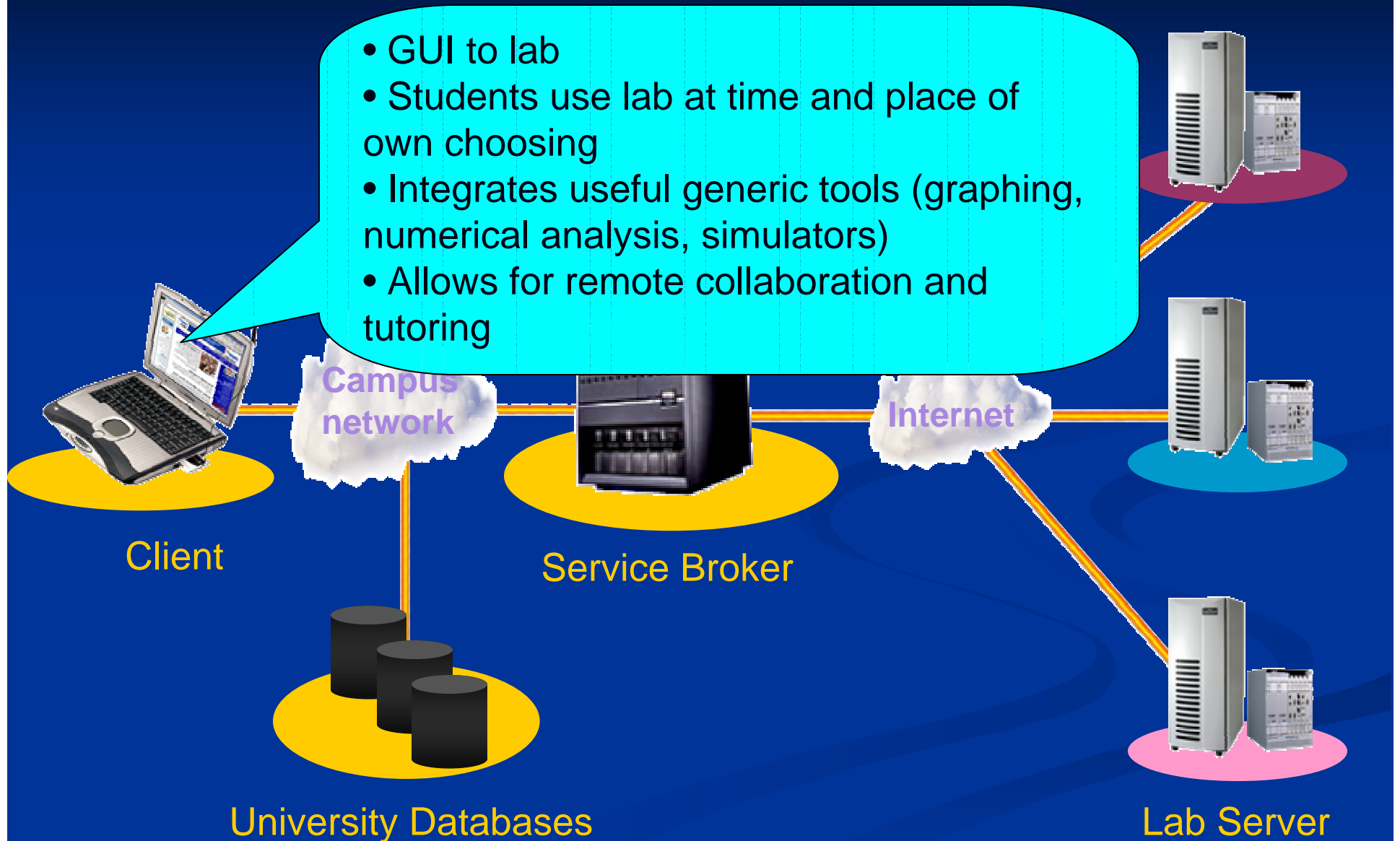
The iLab Shared Architecture

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

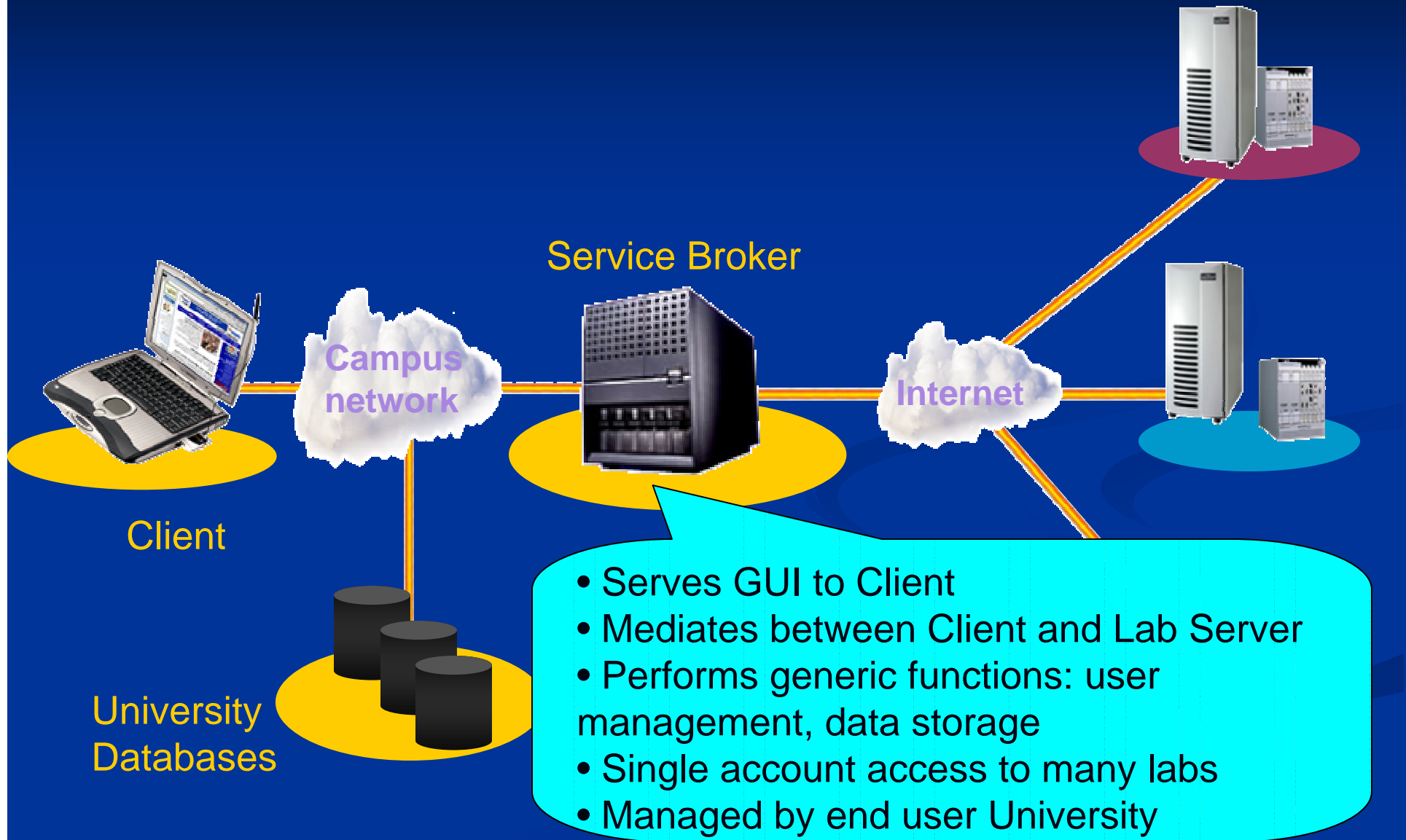


The iLab Shared Architecture

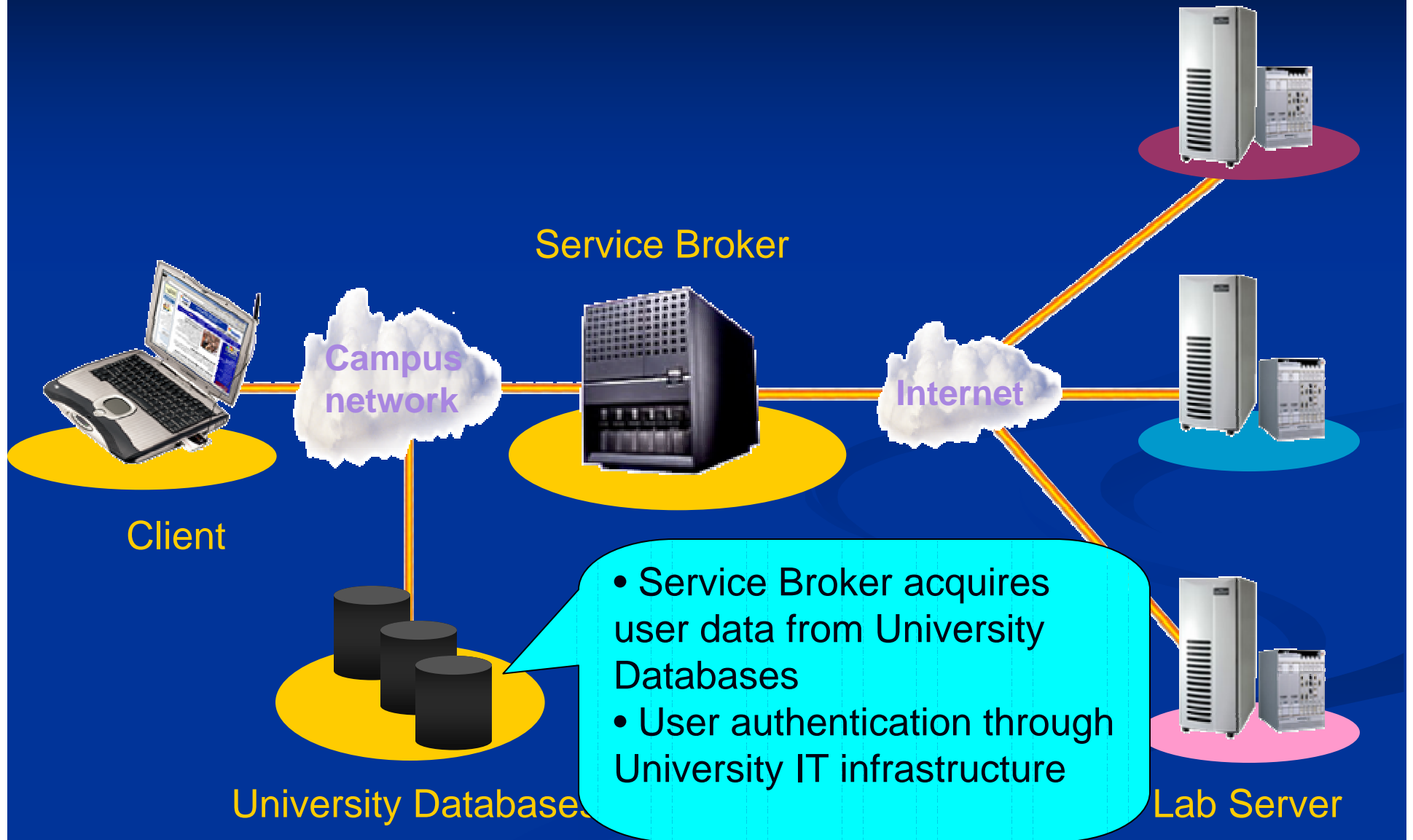
- GUI to lab
- Students use lab at time and place of own choosing
- Integrates useful generic tools (graphing, numerical analysis, simulators)
- Allows for remote collaboration and tutoring



The iLab Architecture

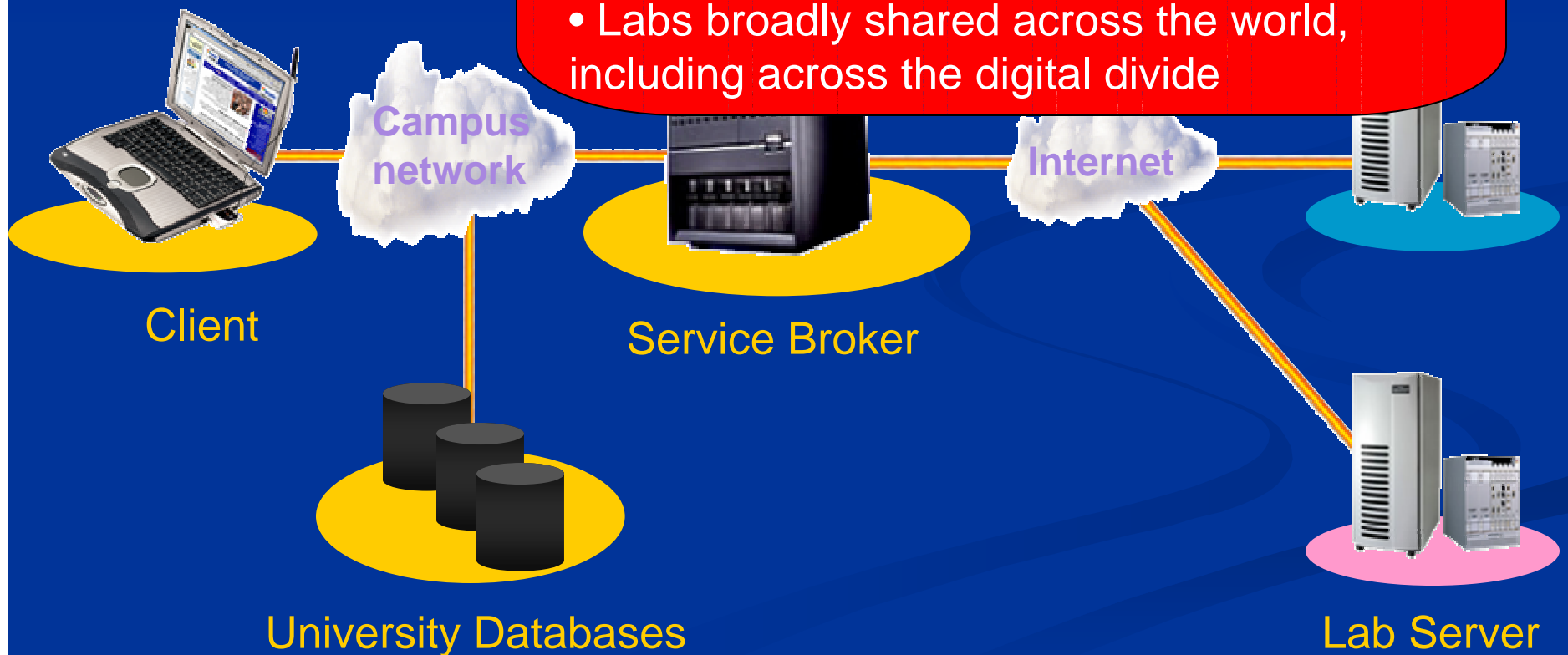


The iLab Architecture



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)

OpeniLabs.mit.edu

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

The screenshot shows the MIT Microelectronics WebLab website. At the top left is the iCampus logo. The main header reads "MIT Microelectronics WebLab". Below the header is a navigation bar with "Home" and "Help" links. The main content area starts with a "Welcome to the MIT Microelectronics WebLab" section, followed by introductory text about the system and its use. There are sections for "Using WebLab for self-study" and "Using WebLab for teaching a class". A "Log in" form is located on the left side, with fields for "Username" and "Password" and a "Log in" button. To the right of the form is a "System News and Messages" box containing a message about the default experiment setup and a date. At the bottom left is the MIT logo and the text "MASSACHUSETTS INSTITUTE OF TECHNOLOGY". At the bottom right are links for "Terms of Use" and "About iLabs".

MIT iCampus MIT Microelectronics WebLab

Home Help

Welcome to the MIT Microelectronics WebLab

WebLab is a system that allows you to operate a microelectronics device analyzer remotely over the web. It connects you to a laboratory equipment setup at M.I.T. that you can control, get data from, and use to understand how standard devices such as diodes and transistors work.

WebLab is a cornerstone of the iLabs project that has provided MIT students remote access to real laboratory experiments since the fall of 1998. Thirty-three classes with a total of over 3000 students in four continents, have successfully run experiments on the system. With support from the MIT iCampus initiative (funded by the Microsoft Corporation) we have made access to this equipment freely available to anyone who wants to experiment with it.

Using WebLab for self-study

iCampus maintains this public implementation of WebLab for individual self-study and trial use by faculty interested in this environment. Anyone is free to use the system for demonstration, evaluation and self-study. To register automatically for general use, [follow the link here](#).

Using WebLab for teaching a class

We are particularly interested in allowing faculty and students around the world make use of this experiment as part of a larger initiative to share access to lab experiment. If you are a professor and want to allow students in your classes to use this equipment, you can contact icampus@mit.edu and we can arrange for your students to be registered with us so that we can provide them with some help. If WebLab proves useful for your teaching, we encourage you and your institution to join the iCampus Affiliates program.

Send email to icampus@mit.edu to request a customized WebLab group for your class.

iCampus Affiliates Program

iCampus can provide only limited personal support for your teaching. However, we do offer a self-help learning community of students, teachers, and technologists who are using WebLab through the iCampus Affiliates program and related community of practice for WebLab at <http://icampus.mit.edu/ilabs>.

In addition, for those faculty interested in collaborating with MIT and other interested universities on implementing their own remotely operated experiments using the iLabs software architecture, additional support is available by becoming an iCampus Hub Affiliate. You can email longpd@mit.edu for further information about this program.

Explore MIT's Microelectronics WebLab

- Take [a simple tutorial](#) on how to use the Lab.
- Explore WebLab's available features by using [a more complex tutorial](#).
- Read [more about the iLabs Project](#).

Username

Password

Log in

If you don't have an account, [register here](#).
Let us know if you [lost your password](#).

System News and Messages

The Microelectronics WebLab is available with a default experiment setup.
Dyle Pooled: 3/8/2005 3:17:57 PM

MIT MASSACHUSETTS INSTITUTE OF TECHNOLOGY

[Terms of Use](#) [About iLabs](#)

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

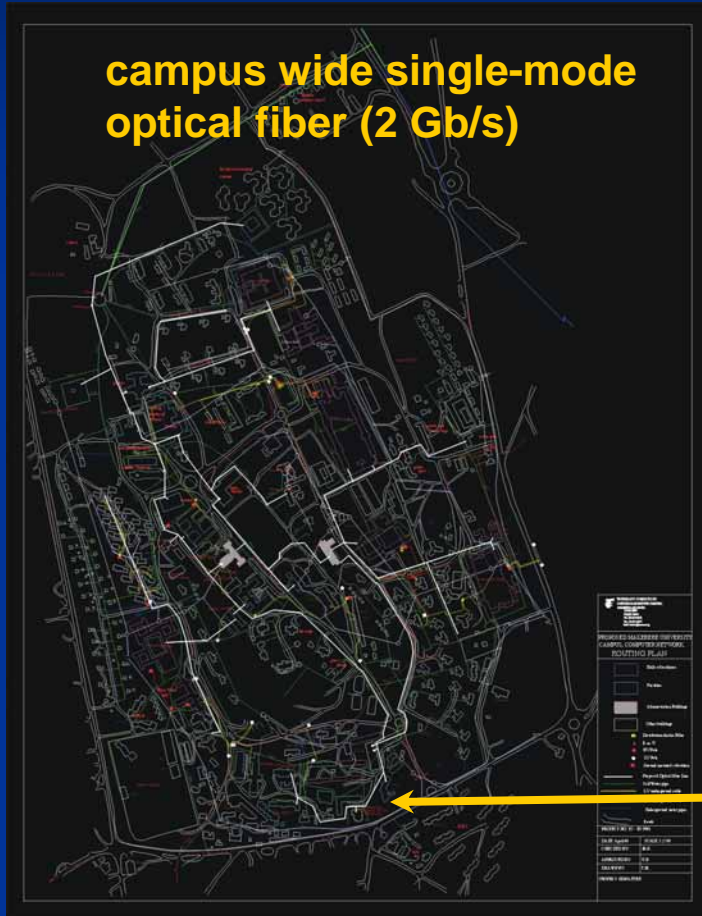
But...

- 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)



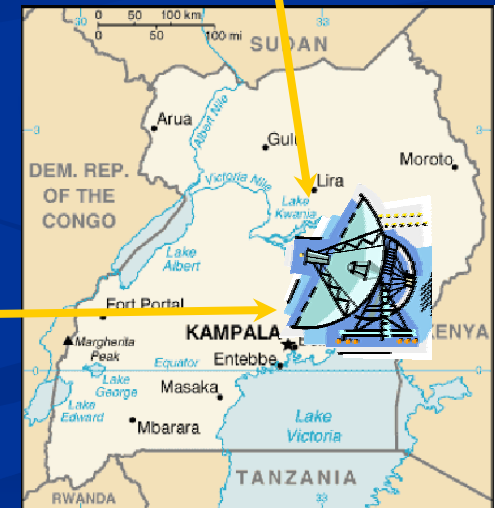
academic buildings networked at 10/100 Mb/s

data corresponding to Spring 2004

satellite gateway to Internet (total bandwidth of Uganda=25 Mb/s)



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



Bandwidth cost: MUK vs. MIT

	MUK	MIT	MUK/MIT ratio
campus gateway (Mb/s)	2.5	~2,300	$\sim 10^{-3}$
gateway cost (\$ per month)	\$28K	~\$80K	~1/3
GDP per capita	\$1.2K	\$36K	~0.03
bandwidth cost relative to per capita GDP			$\sim 10^4$

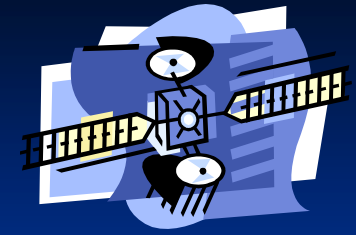
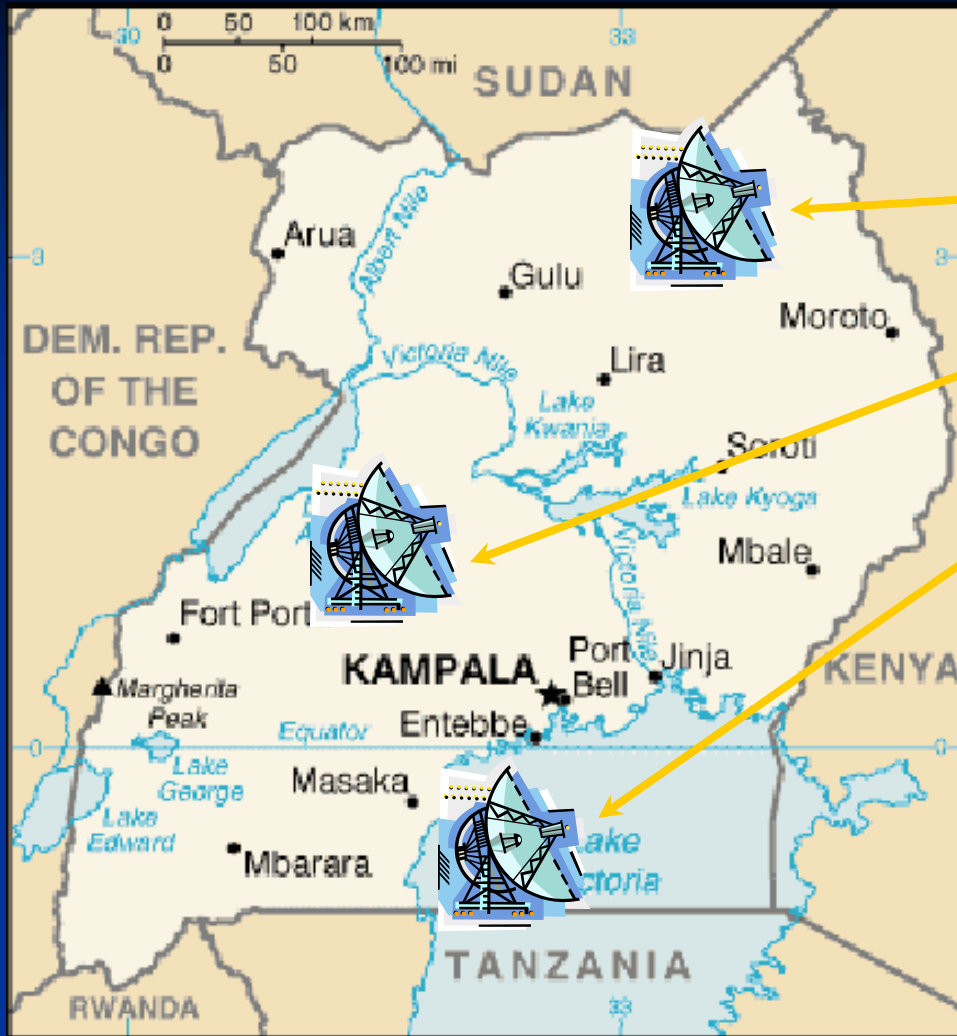
- Technological solutions developed at MIT might not be a good fit for developing countries
- Pedagogy likely to be different in bandwidth starved situations
- Need to deploy educational resources *locally*

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

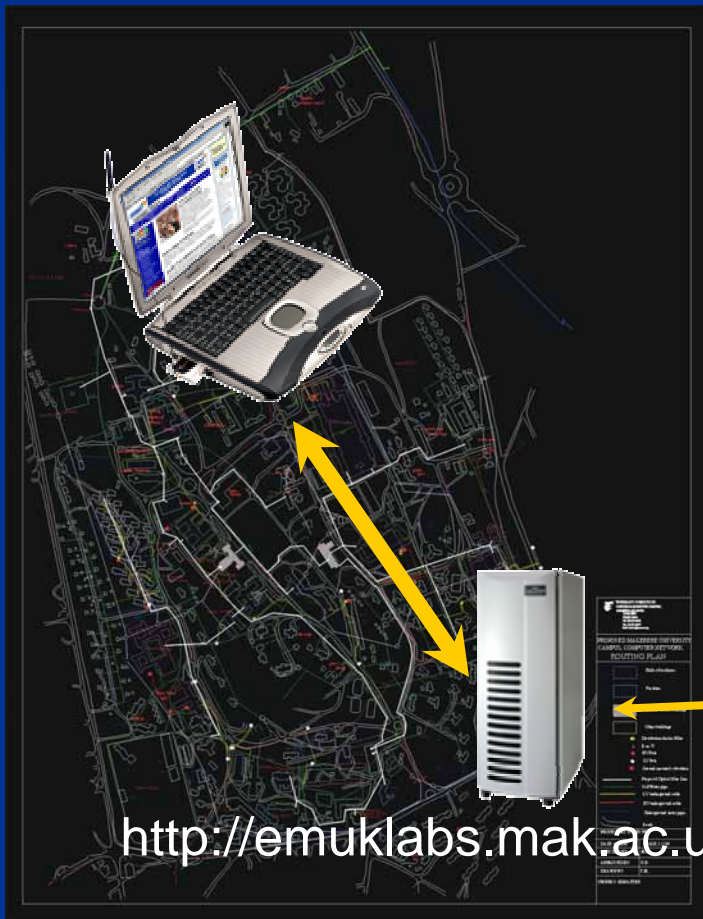
Lessons from Feasibility Study

- Great potential for iLabs in Africa
- New technological approaches needed
- Must deploy educational resources locally
- Pedagogy needs to be investigated

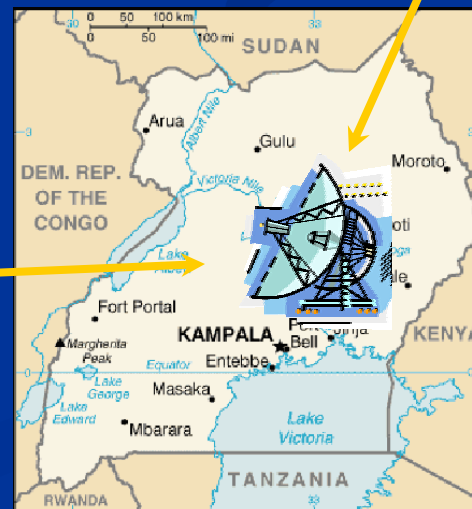
Follow-on to Feasibility Study (2004-2005)

- 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

news office

news
recent
research
campus
by topic
events
archives

services
request images
subscribe
submit news
promote news
media inquiries

about us
news office info
MIT background
contact

African students get web link to MIT labs

Janet Wasserstein, Office of Foundation Relations
March 21, 2005

Students in Uganda, Tanzania and Nigeria can now perform sophisticated engineering and science experiments at MIT--without ever getting on a plane.

"If you can't come to the lab, the lab will come to you," said Jesus del Alamo, co-principal investigator on the iLab project and a professor in MIT's Department of Electric

Students at three African uni via the Internet, thanks to an Center for Educational Com (Uganda), the University of D Awolowo University (Nigeria

MIT faculty will work closely y laboratory experiences and undergraduate courses in fi physics.

Professor Jesus del Alamo demonstrates the iLab to staff and students at Obafemi Awolowo University in Ile-Ife, Nigeria, in April 2004. [Enlarge image](#)

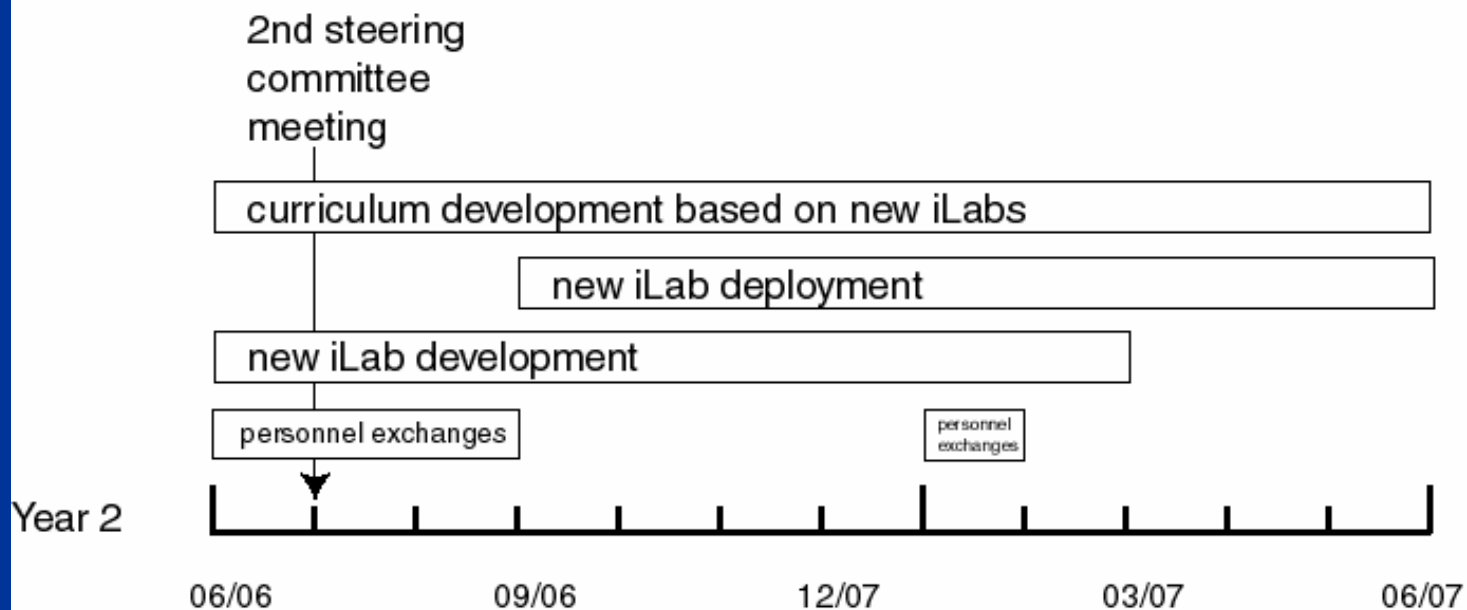
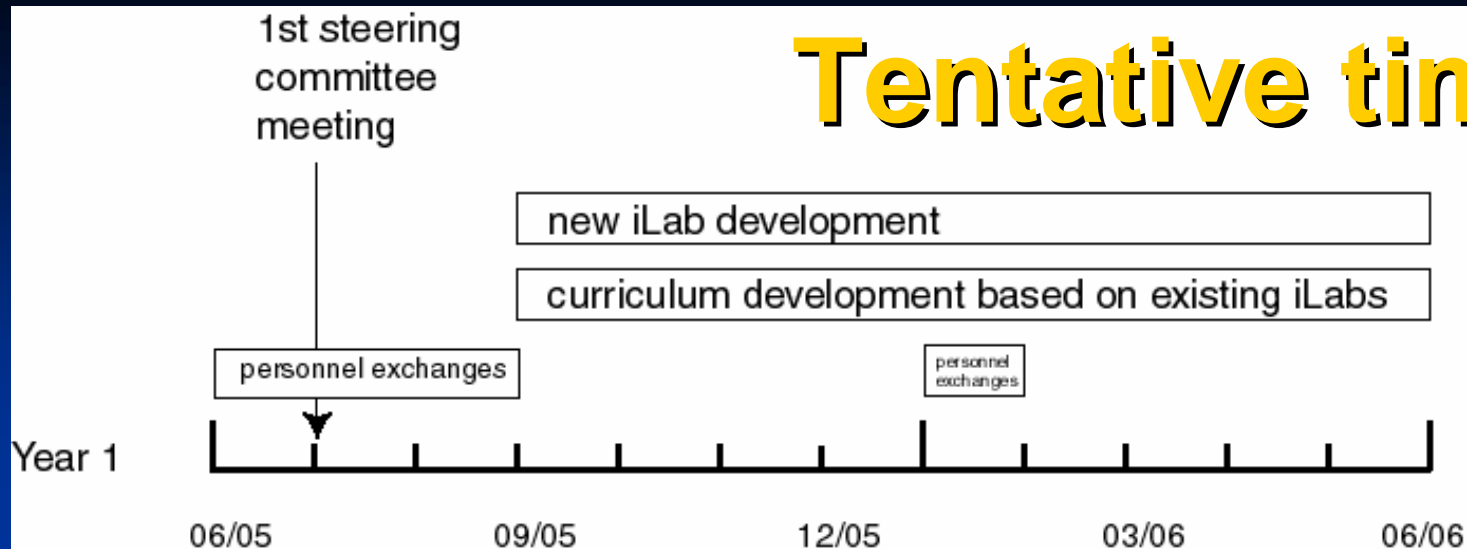
- Funded by Carnegie Corp.
- June 1, 2005- May 31, 2007
- \$800K
- Involves MIT, UDSM, MUK and OAU
- Dedicated to the proposition that iLabs are meant to be shared worldwide across the digital divide

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



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!”**



iLab