Realizing the Potential of iLabs in sub-Sahara Africa

Obafemi Awolowo University

Kick-Off/Steering Committee Meeting

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

University of Dar es Salaam

MAKERERE UNIVERSITY

Makerere University, Kampala (Uganda)
June 24, 2005

Carnegie Corporation of New York

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)

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

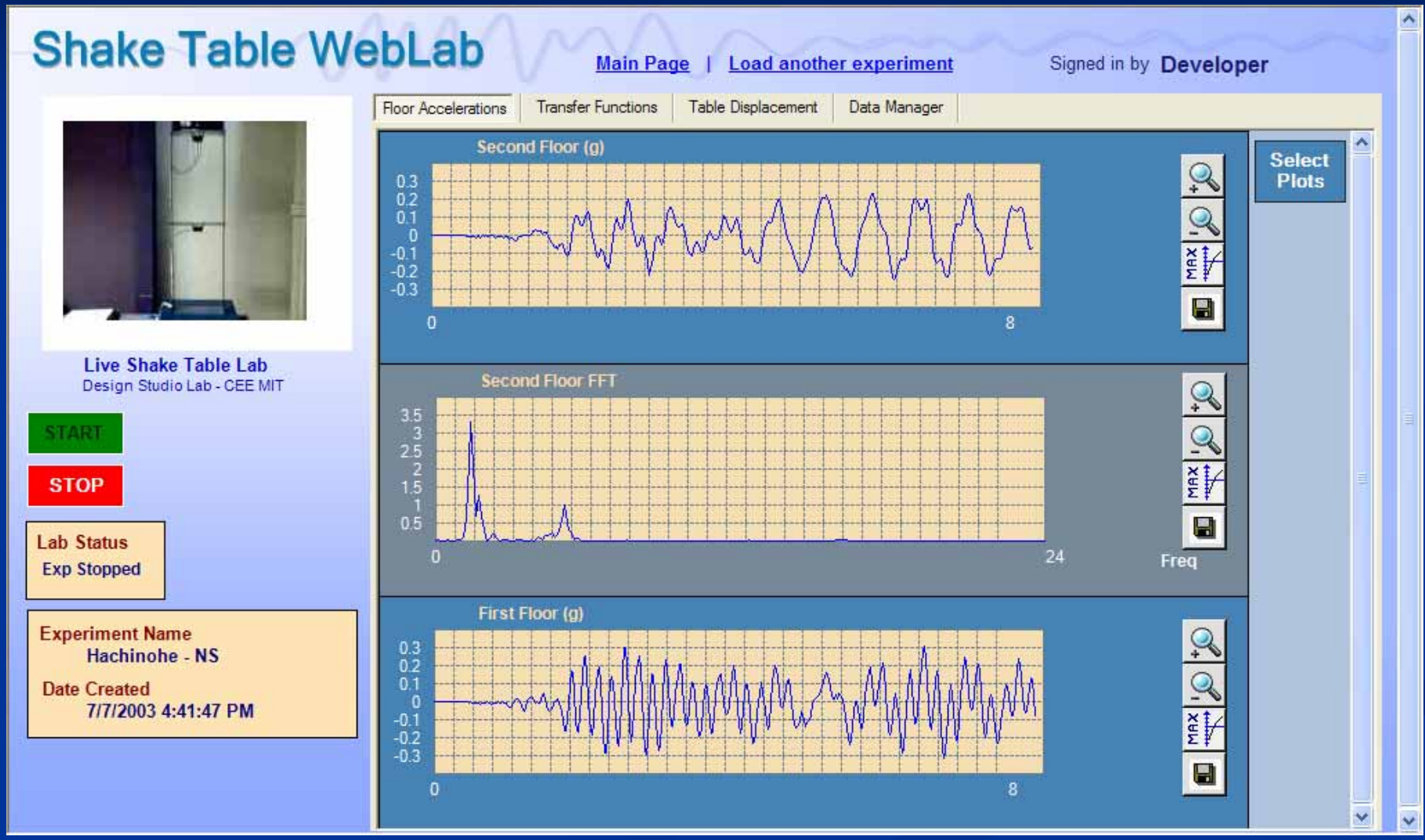
Goal:

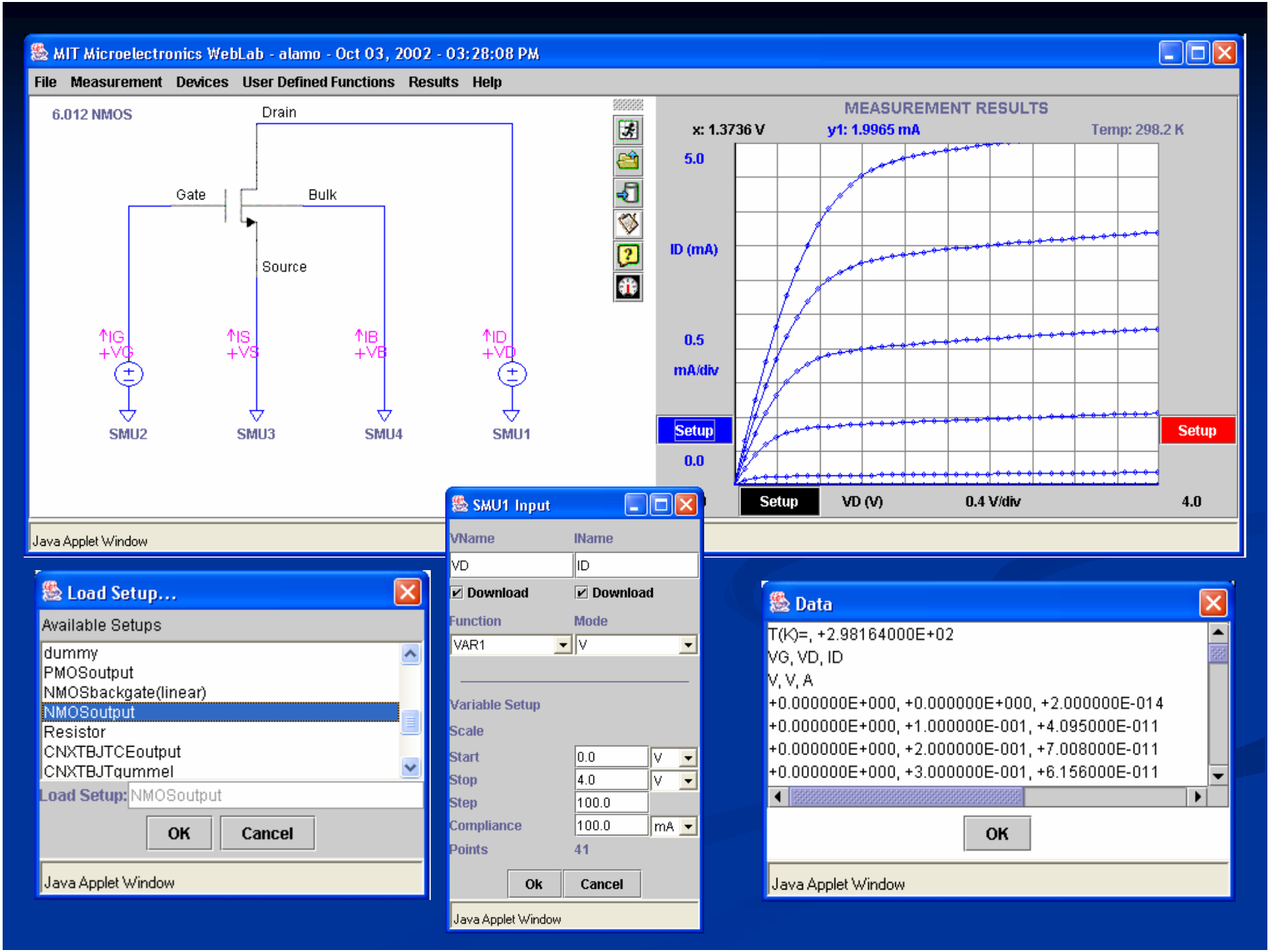
Study behavior of building model structure to ground vibration

Relevance:

Earthquake building engineering

Shake Table GUI

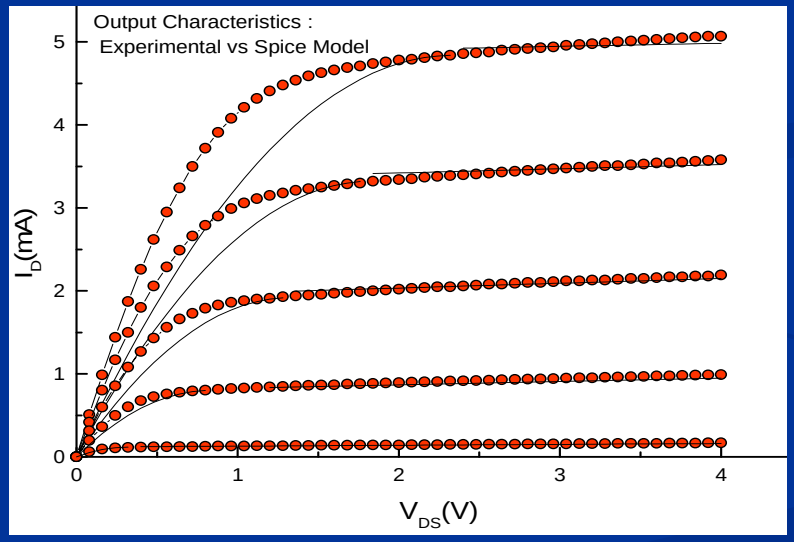



MIT Microelectronics WebLab - alamo - Oct 03, 2002 - 03:28:08 PM
File Measurement Devices User Defined Functions Results Help
6.012 NMOS
Drain
Gate
Bulk
Source
IG
+VG
IS
+VS
IB
+VB
ID
+VD
SMU2
SMU3
SMU4
SMU1
MEASUREMENT RESULTS
x: 1.3736 V
y1: 1.9965 mA
Temp: 298.2 K
5.0
ID (mA)
0.5
mA/div
Setup
0.0
Setup
Setup
VD (V)
0.4 V/div
4.0
Java Applet Window
SMU1 Input
VName
IName
VD
ID
Download
Download
Function
Mode
VAR1
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
Load Setup...
Available Setups
dummy
PMOSoutput
NMOSbackgate(linear)
NMOSoutput
Resistor
CNXTBJTCEoutput
CNXTBJTgummel
Load Setup: NMOSoutput
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

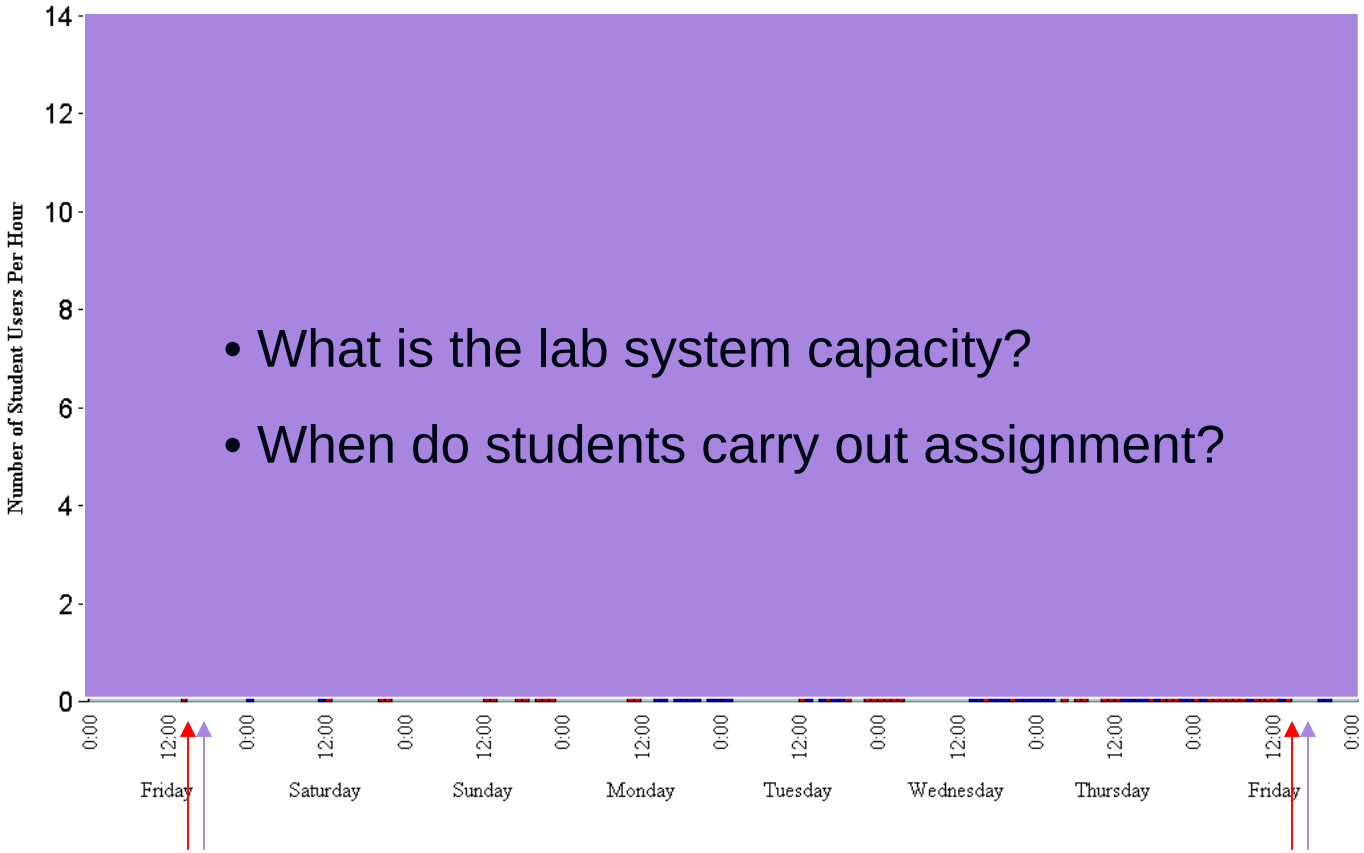
Transistor characterization project:

- 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)

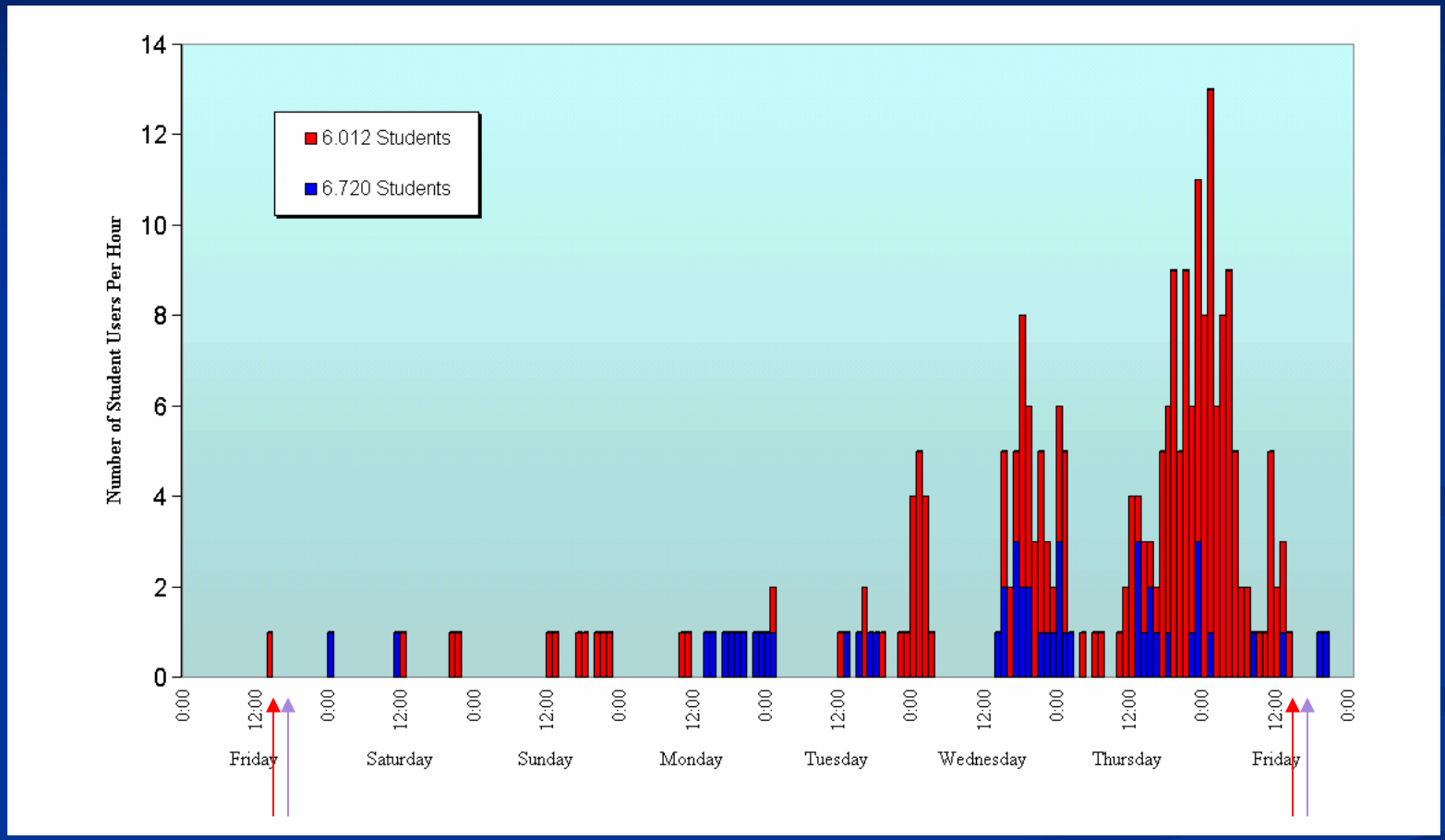
4PM: 6.720J/3.43J exercise out (25 students)

[Oct. 13-20, 2000]

2PM: 6.012 exercise due

4PM: 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

4PM: 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)

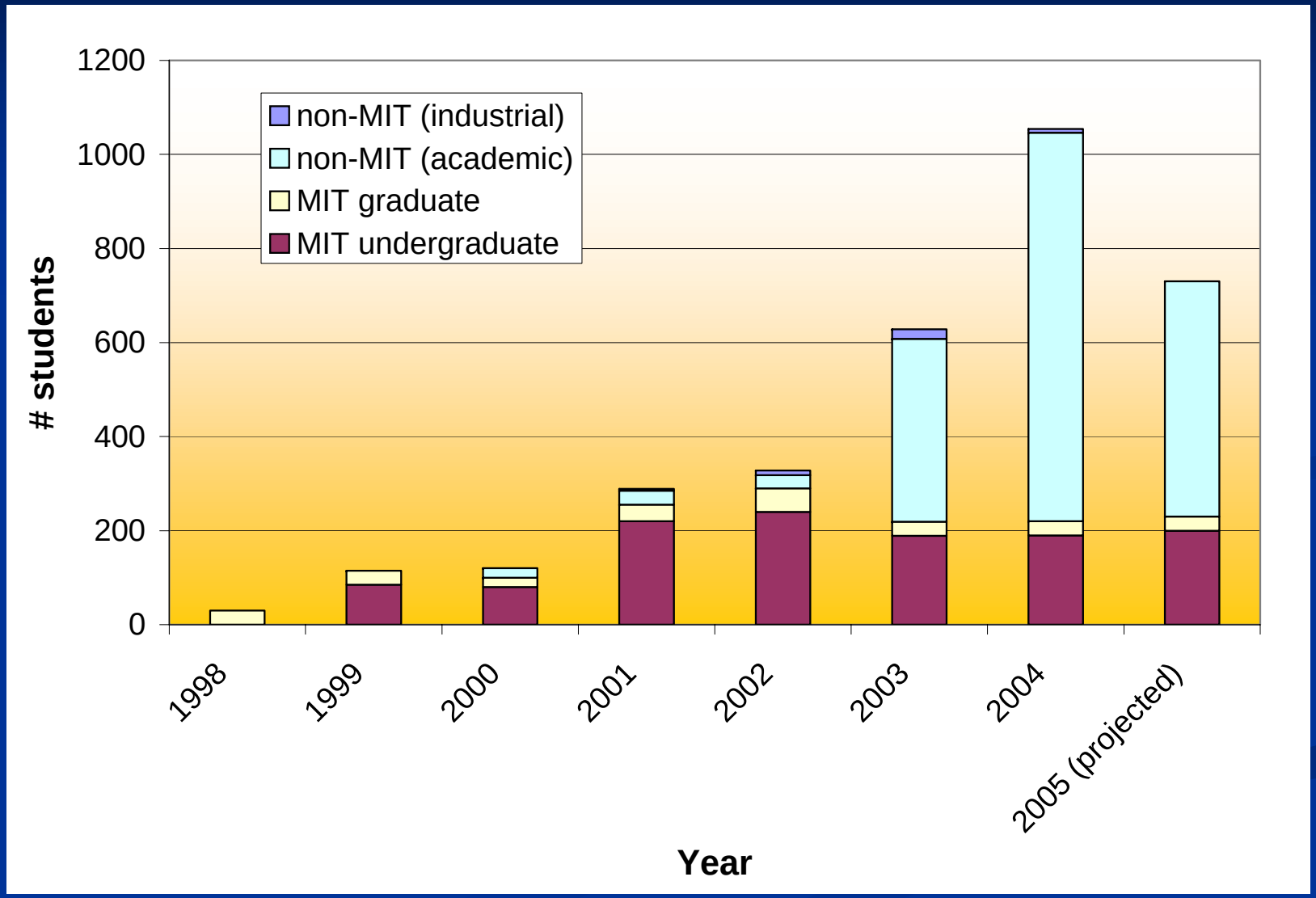
CCU Taipei (Taiwan), Fall 2004 (200 st/yr)

Makerere U. (Uganda), Fall 2004 (150 st/yr)

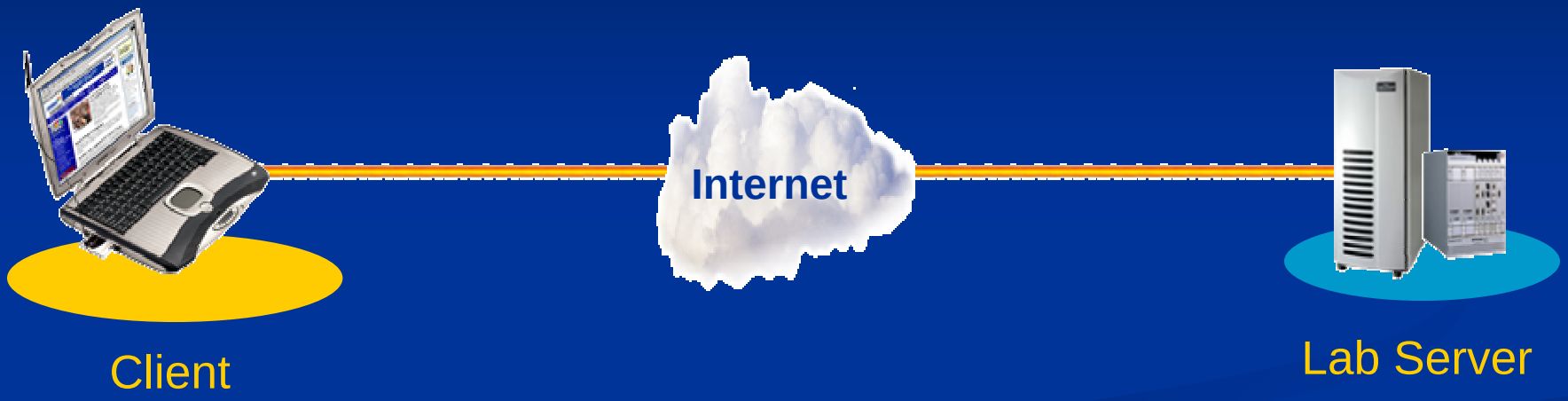
U. Parma (Italy), Spring 2005 (30 st/yr)

Over 3000 student users (for credit) since 1998

“Formal” use of WebLab

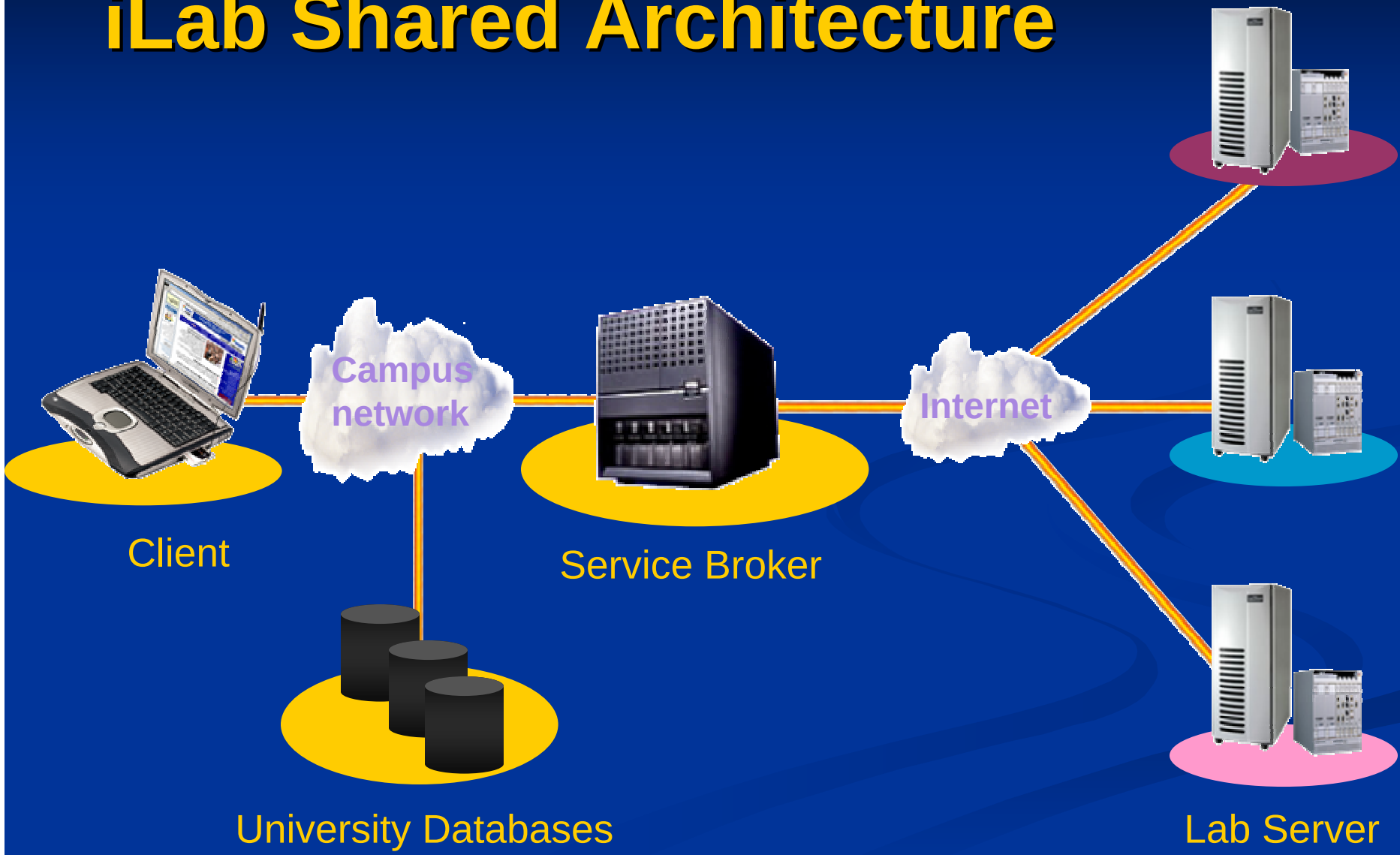


Early iLab Implementations



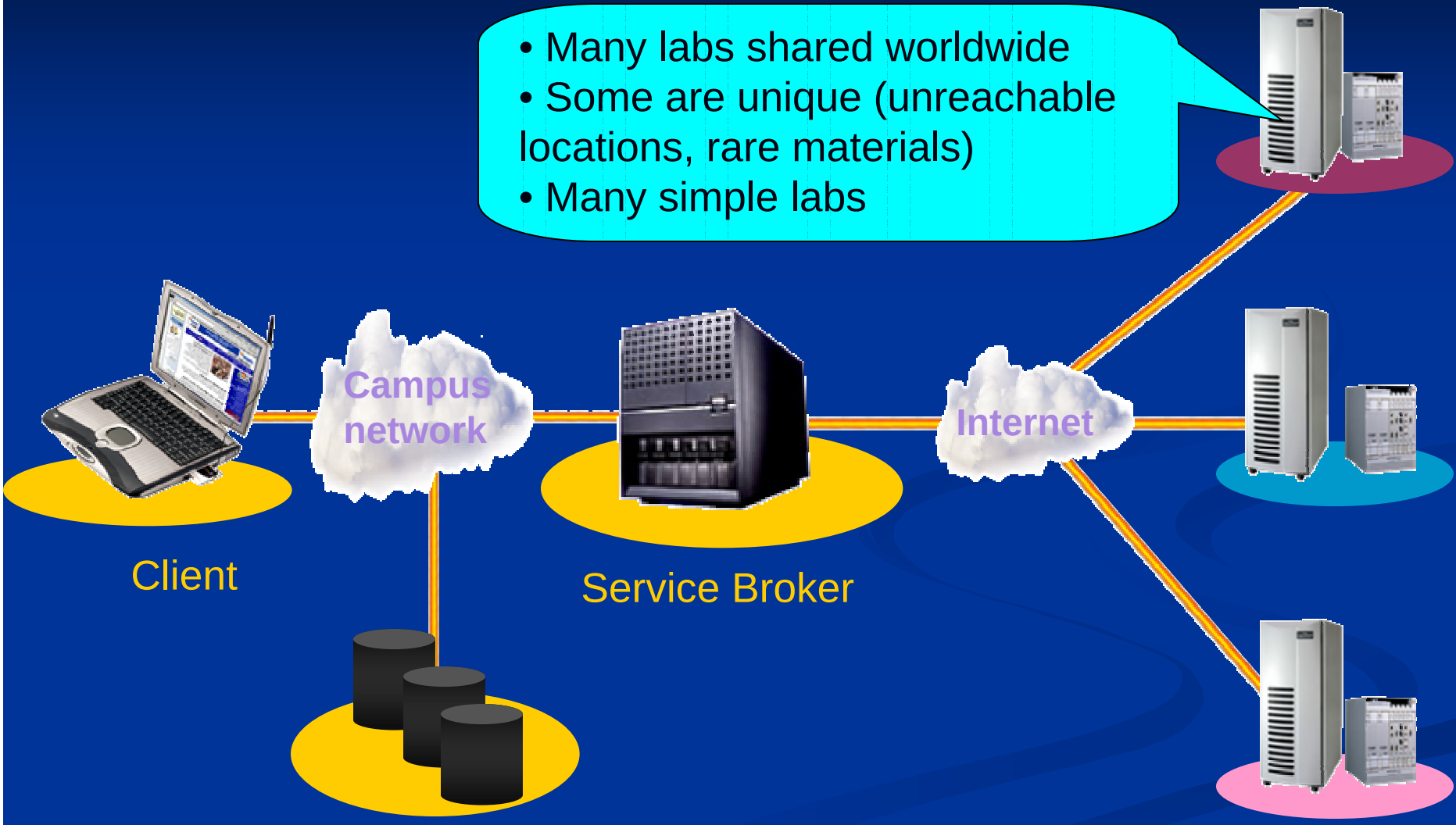
- **Lab developer** responsible for 100% of development
  - Long time to deployment
- **Lab owner** responsible for 100% of management
  - The lab itself
  - User accounts, data storage, authentication, security
- **Students** need multiple accounts to access multiple labs

The iLab Vision:
iLab Shared Architecture



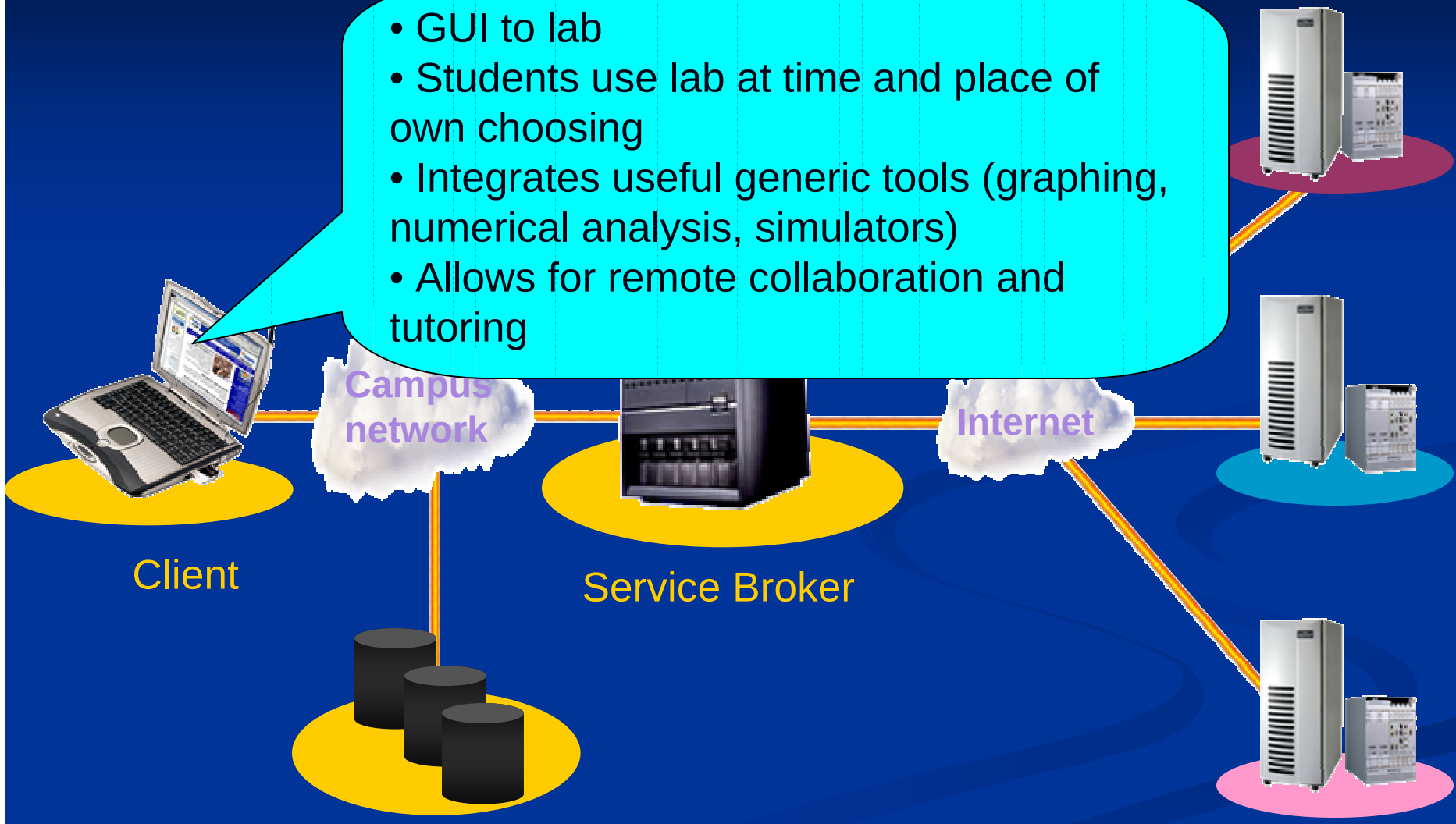
The iLab Shared Architecture

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

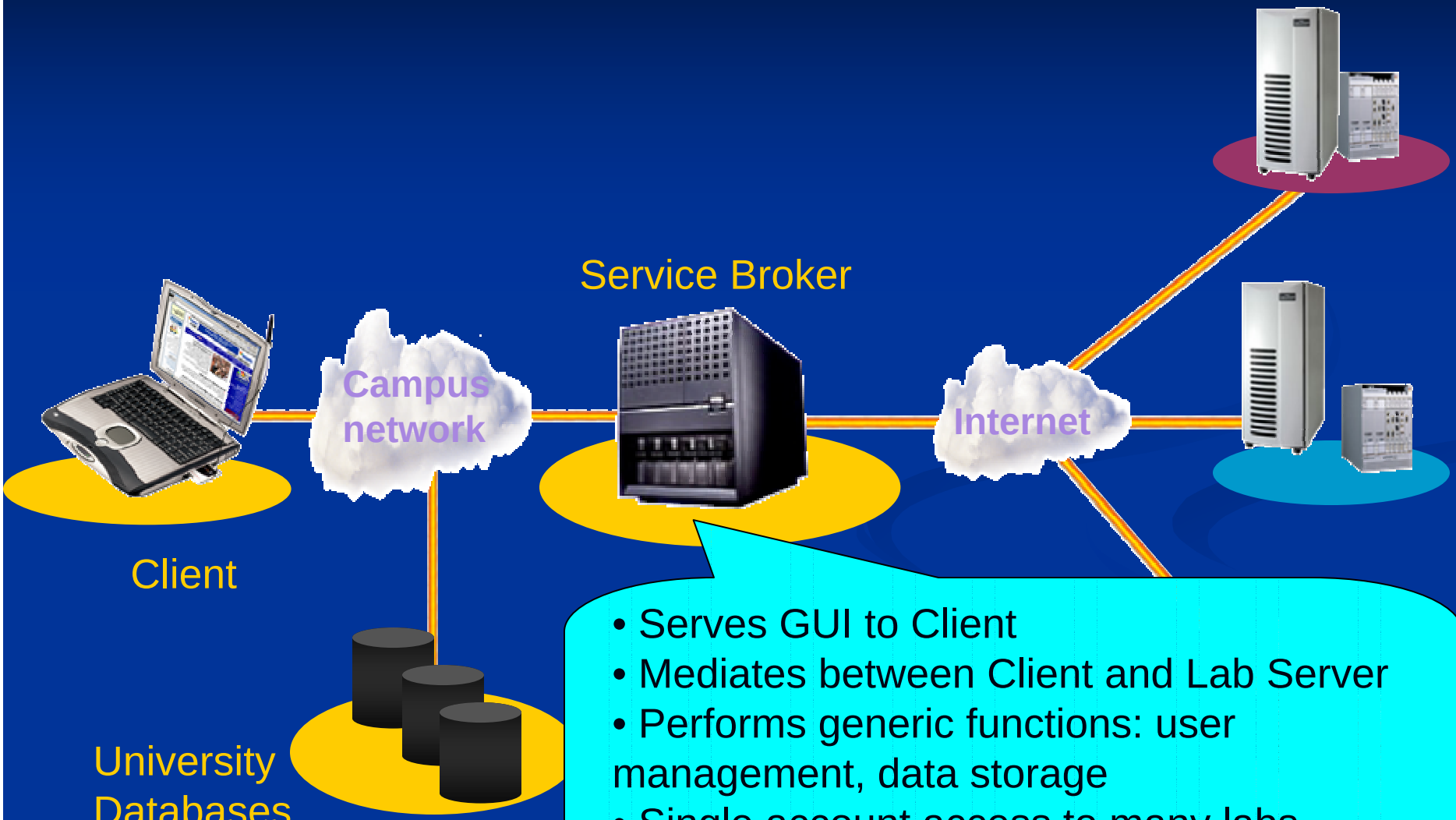


The iLab Shared Architecture

- 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

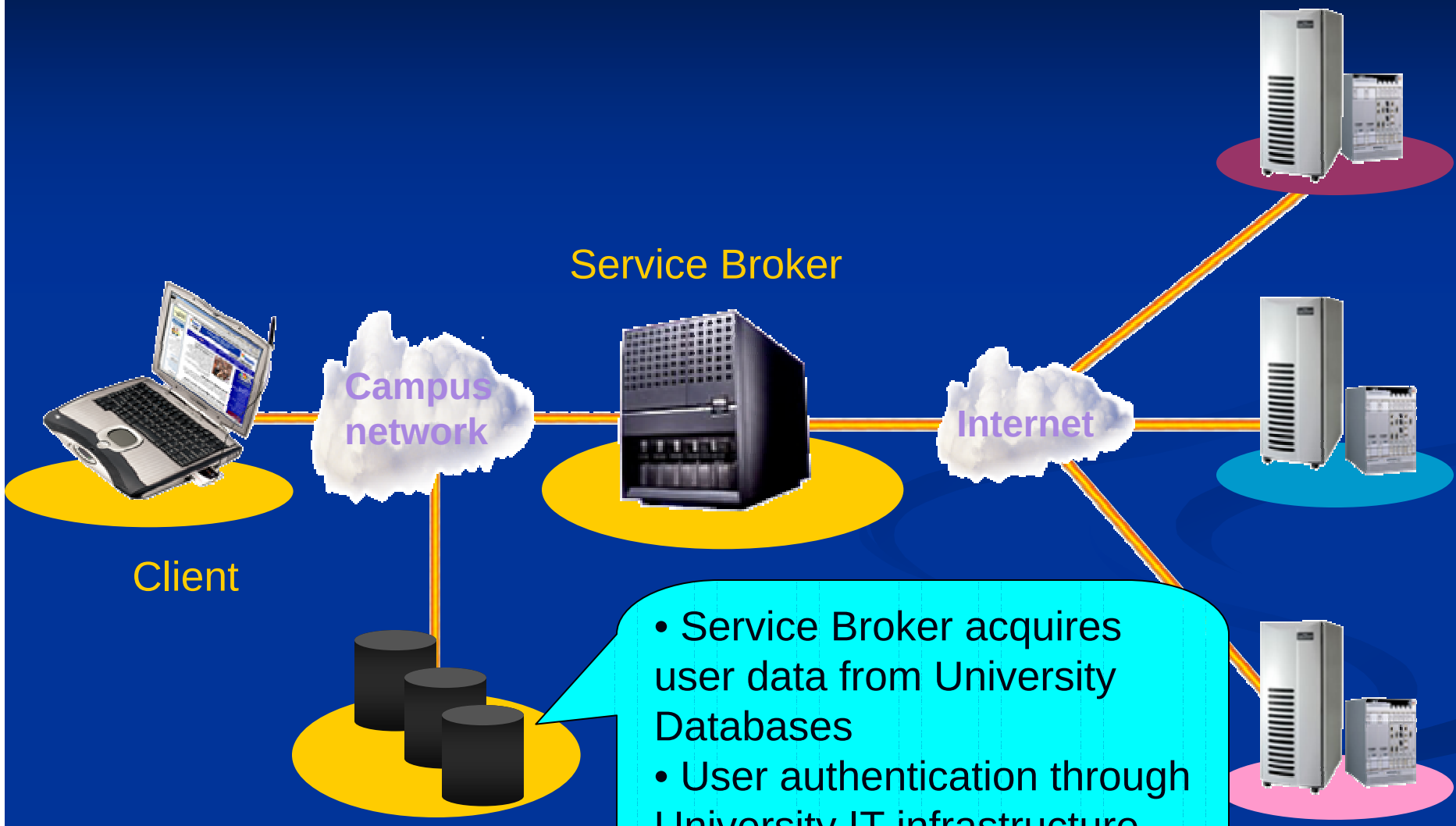


The iLab Architecture



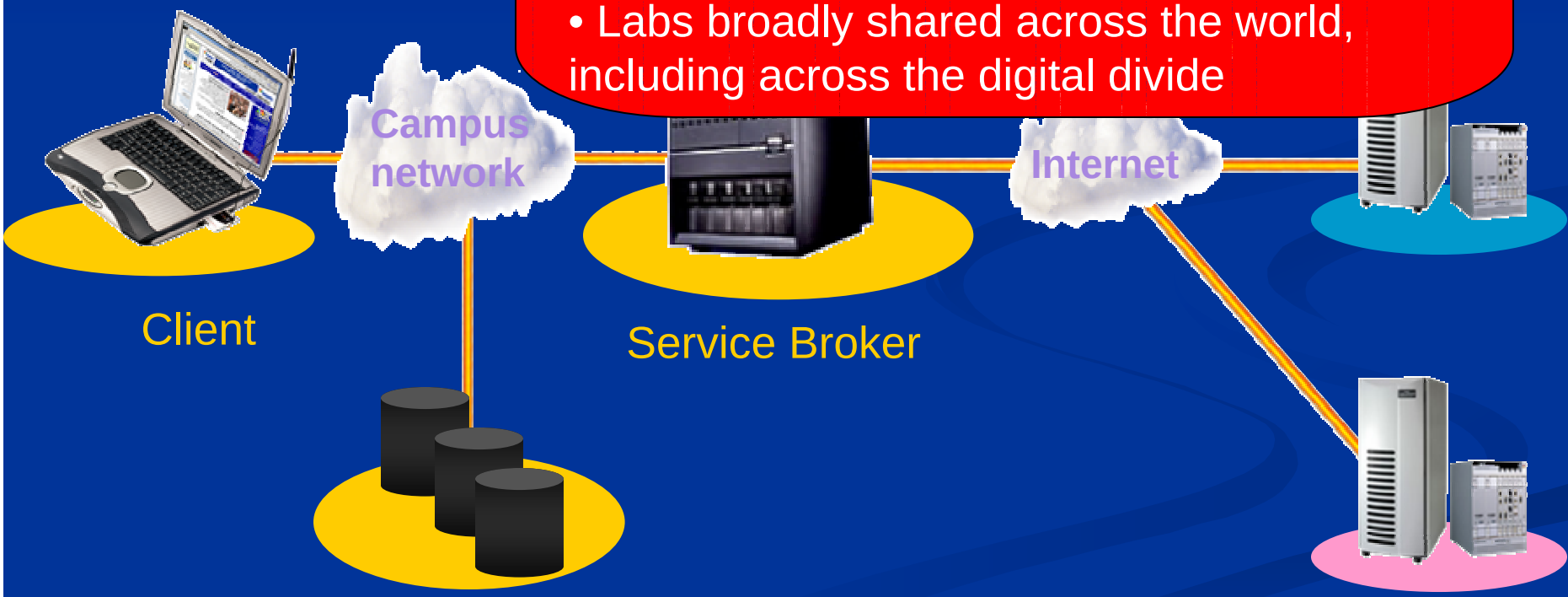
- Serves GUI to Client
- Mediates between Client and Lab Server
- Performs generic functions: user management, data storage
- Single account access to many labs
- Managed by end user University

The iLab Architecture



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

iLabs in sub-Sahara 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

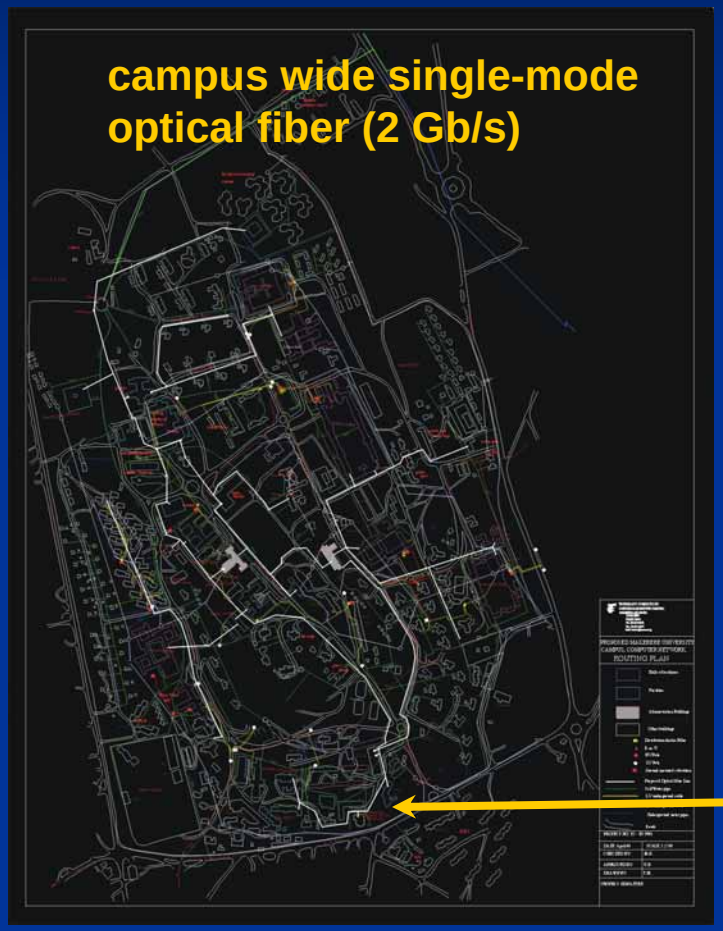
More findings

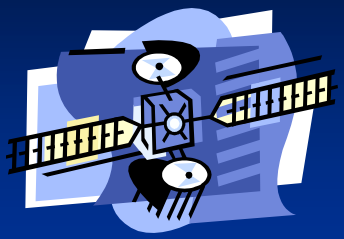
But…

- Limited access to networked computers
- Limited exposure to computers on part of students
- Severe bandwidth limitations
- Electrical power unstable
- Local networks fragile

Bandwidth limitations

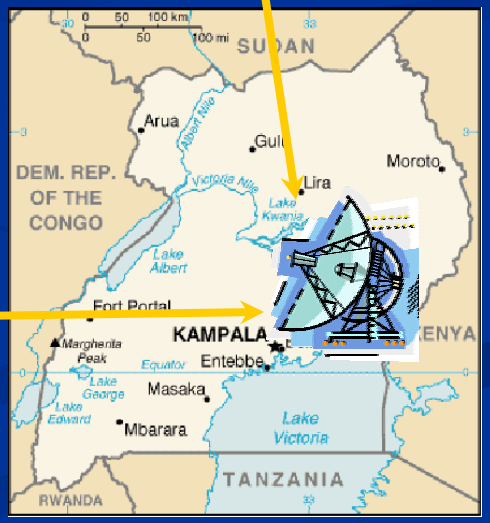
(example: Makerere University, Kampala)





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

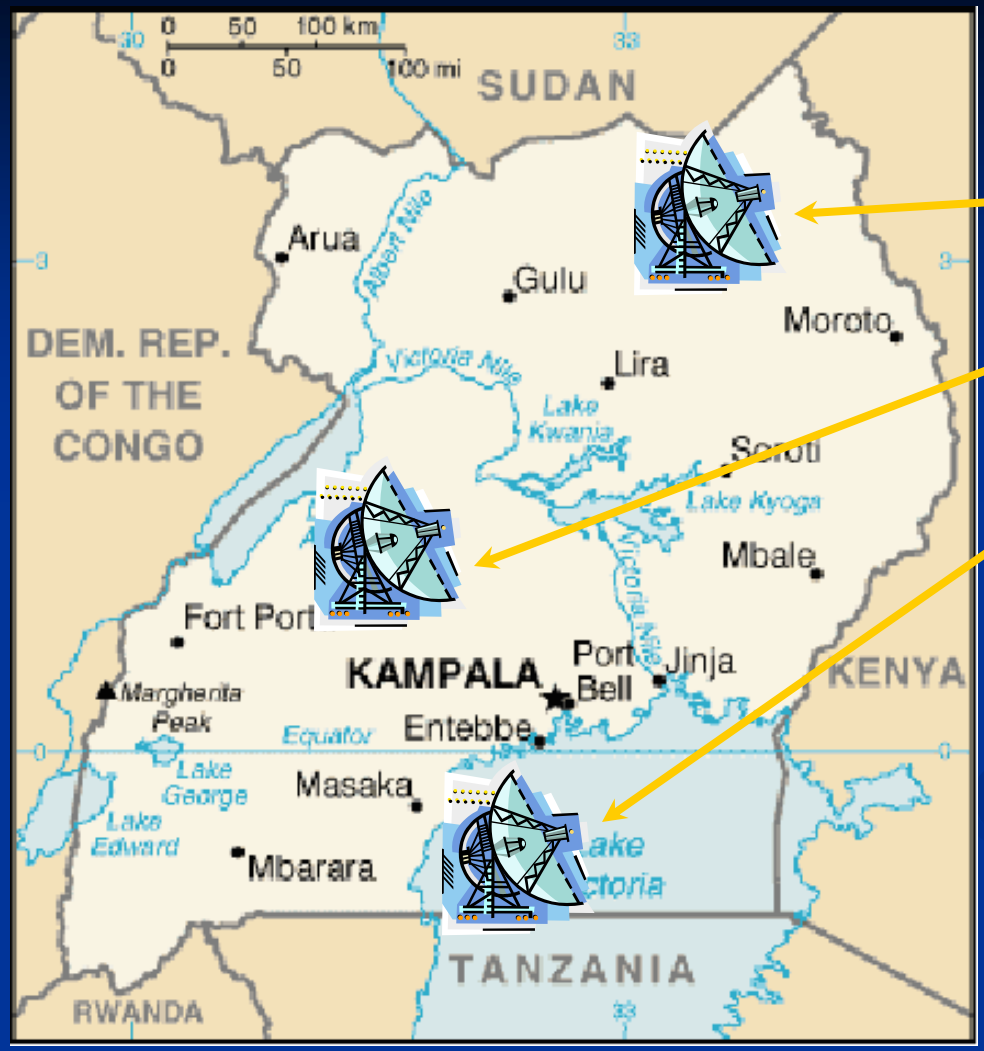
	MUK	MIT	MUK/MIT ratio
campus gateway (Mb/s)	2.5	~2,300	$\sim 10^{-3}$
gateway cost ($ per month)	$28K	~$80K	~1/3
GDP per capita	$1.2K	$36K	~0.03
bandwidth cost relative to per capita GDP			**$\sim 10^{4}$**

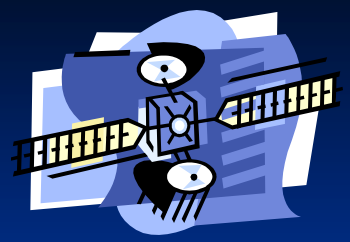
- Technological solutions developed at MIT might not be a good fit for developing countries
- Pedagogy likely to be different in bandwidth starved situations
- Need to deploy educational resources *locally*

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

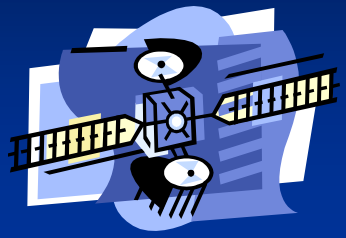
Lessons from Feasibility Study

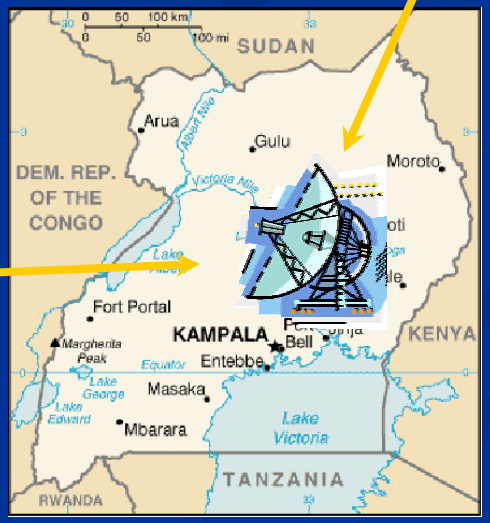
- Great potential for iLabs in Africa
- New technological approaches needed
- Must deploy educational resources locally
- Pedagogy needs to be investigated

Follow-on to Feasibility Study (2004-2005)

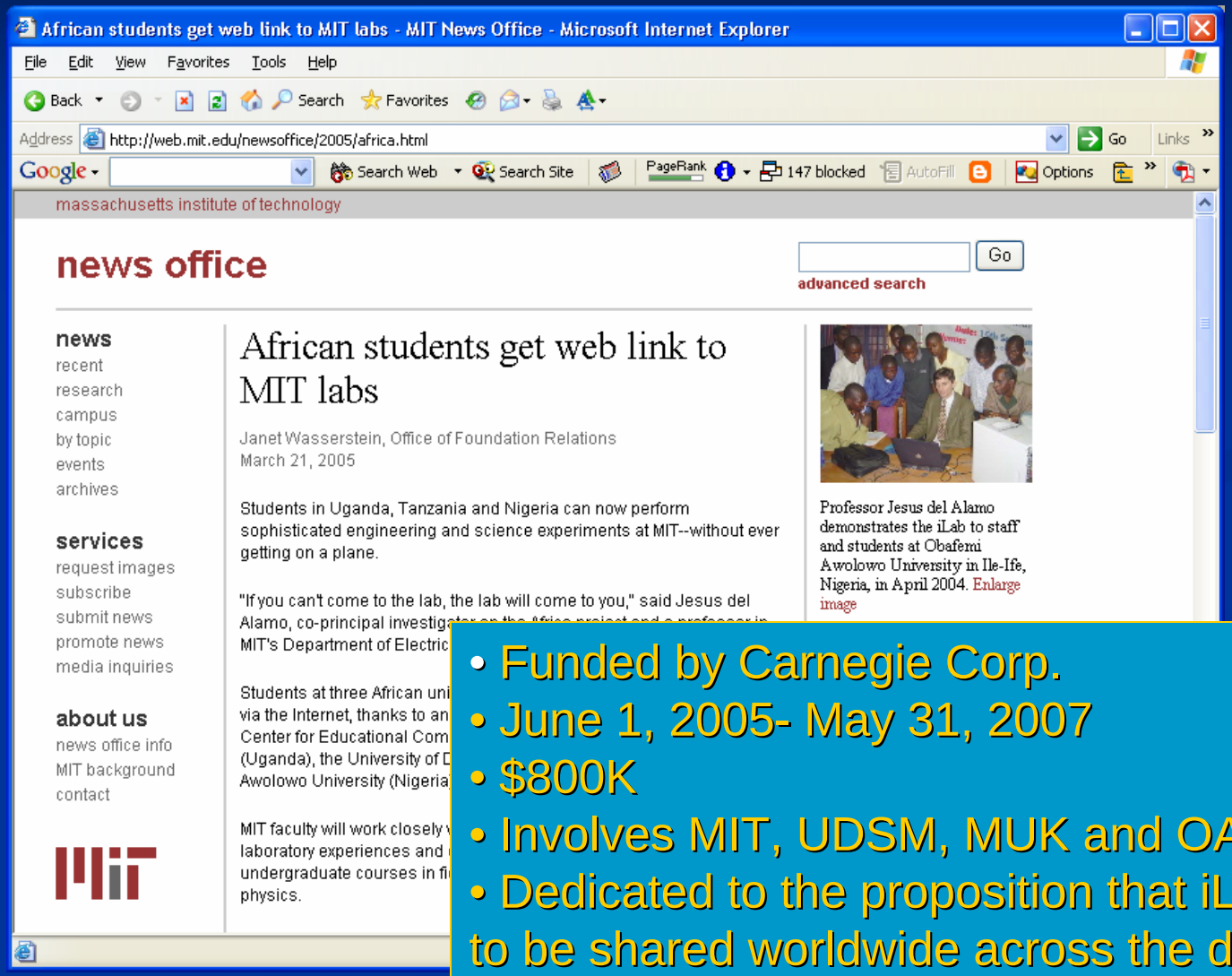
- Further explored issues with goal of formulating proposal for longer term action
- Hosted visits at MIT:
  - Albert Lumu (MUK) – Aug. 2004
  - Philip Jonah (OAU) – Jan. 2005
- Installed Service Broker in a laptop
  - Deployed at MUK (Fall 2004)
  - Deployed at OAU (Winter 2005)
- Submitted large proposal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

First iLab Service Broker outside MIT installed at Makerere University (Sept. ’04)





iLabs-Africa project

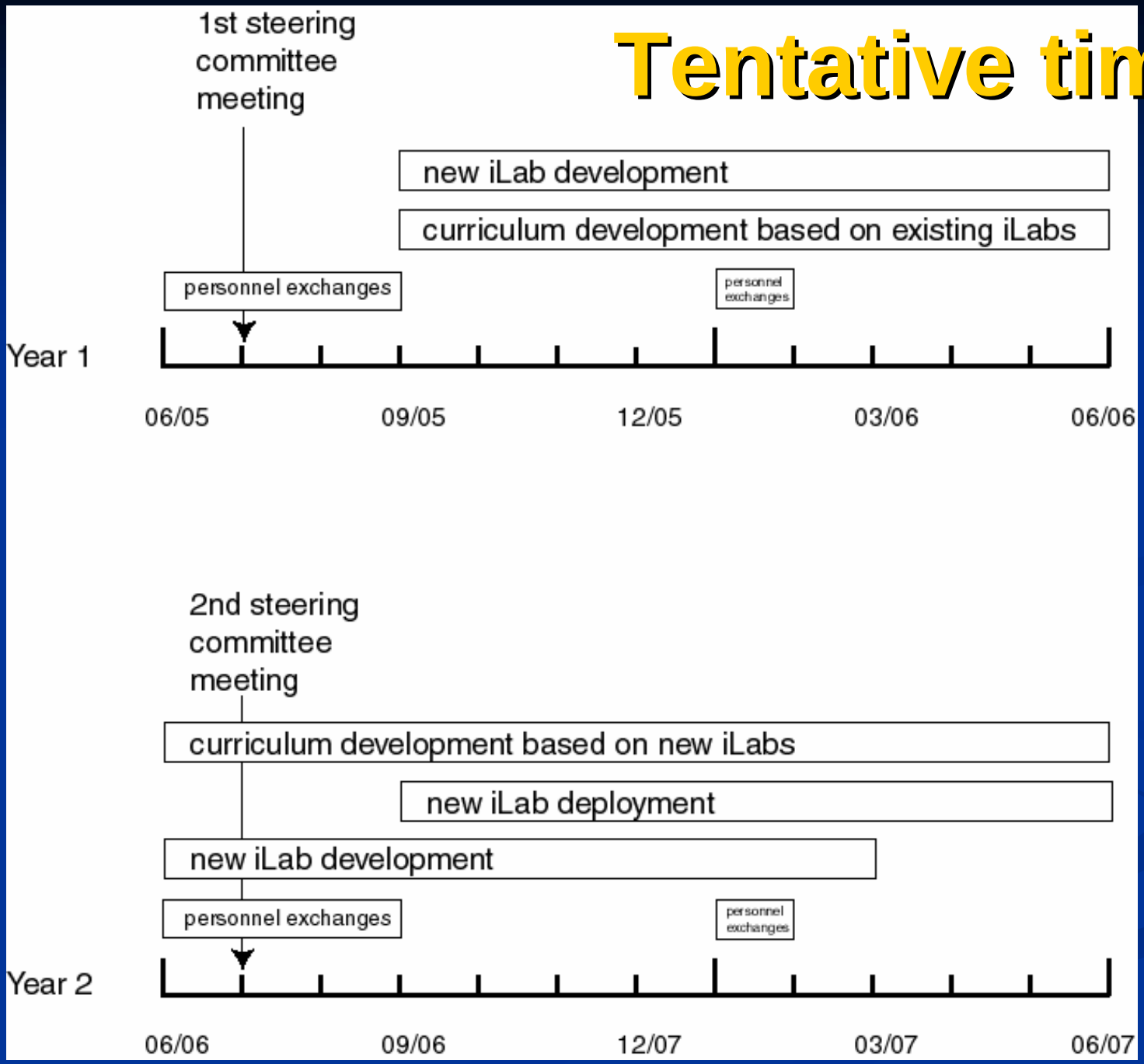


- Funded by Carnegie Corp.
- June 1, 2005- May 31, 2007
- $800K
- Involves MIT, UDSM, MUK and OAU
- Dedicated to the proposition that iLabs are meant to be shared worldwide across the digital divide

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-Sahara 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 allowes 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