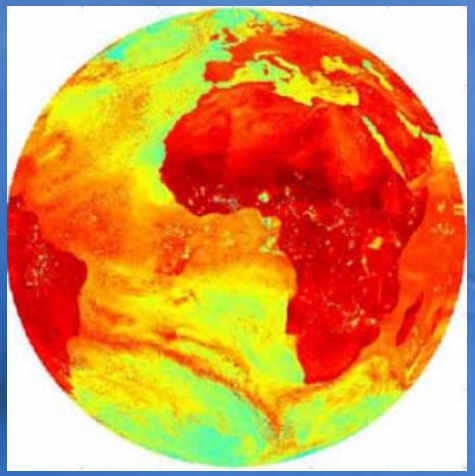
MIT iLabs:

Towards a Community of Internet Accessible Laboratories



Phillip D. Long, Ph.D.
MIT

Mark Schulz, Ph.D.
University of Queensland

Open Educational Resources for Network-enabled education
August 18-19, 2006, Hotel Taj Ambassador, New Delhi
Sponsored by: National Knowledge Commission

Contents

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

- iCampus - context
- Motivation
- iLabs at MIT
- The iLab Architecture
- Unique issues for iLabs in the developing world
- iLabs at UQ
- Opportunities for partnership

What is iCampus?

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

- iCampus is an MIT research program to enhance university education through information technology
  - Established in 1999 with funding from Microsoft Research
- 2000 – 2004: Focus on impact at MIT
  - Sponsored projects involving over 400 MIT faculty, staff, and researchers
  - Has affected nearly 100 subjects with a combined enrollment of over 5,000 students per year
- 2004-2006: Focus on global dissemination

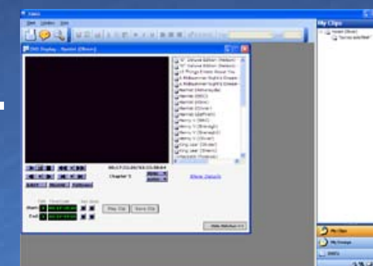
iCampus
the MIT-Microsoft Alliance

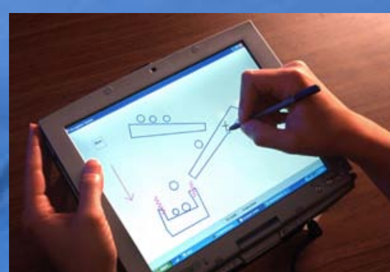
QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

xMAS : Cross Media

Annotation System)

Understanding





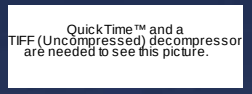
iCampus
the MIT-Microsoft Alliance

Motivation to iLabs

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

- 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: real laboratories that are accessed through the Internet from anywhere at any time potentially by large numbers of students

Goals of iLab project at MIT



- To leverage the pedagogical potential of iLabs in science & engineering education

- To develop a scalable framework to:
  - Ease the development of new iLabs
  - Facilitate iLab management
  - Enable worldwide sharing of iLabs

iCampus
the MIT-Microsoft Alliance

iLabs at MIT

Dynamic signal analyzer *(EECS, deployed 2004)*

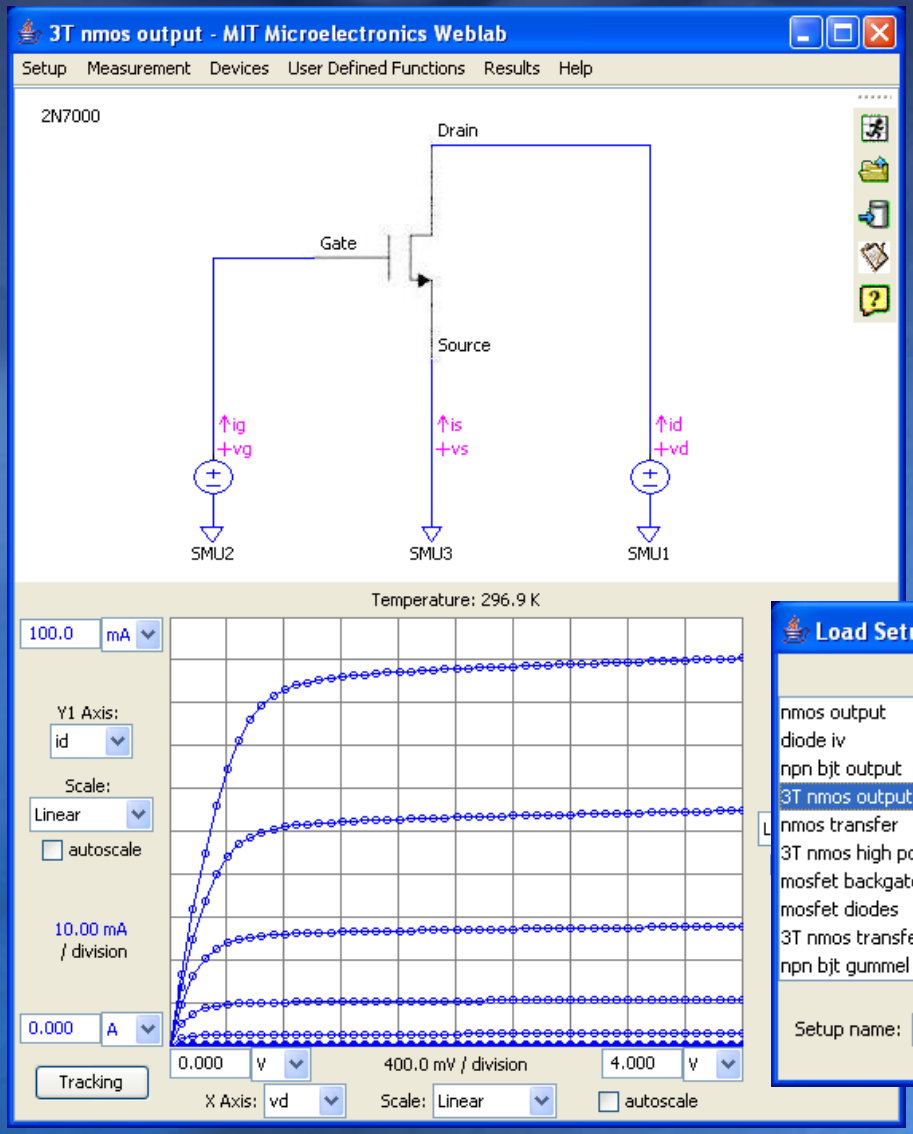
Polymer crystallization *(Chem. E., deployed 2003)*

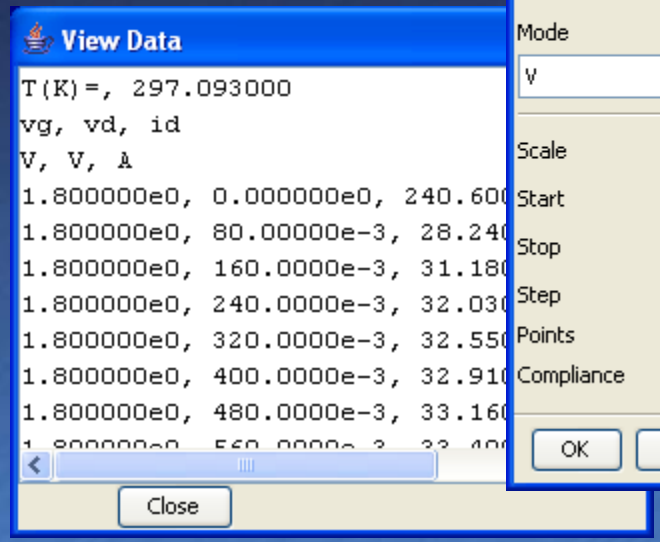
Shake table *(Civil Eng., deployed 2004)*

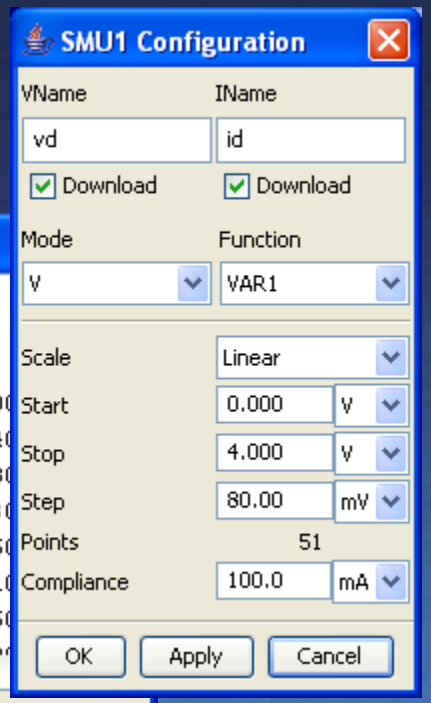
Microelectronics device characterization *(EECS, deployed 1998)*

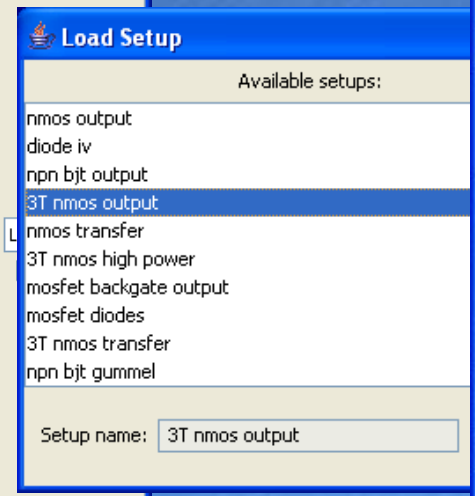
Heat exchanger *(Chem. E., deployed 2001)*

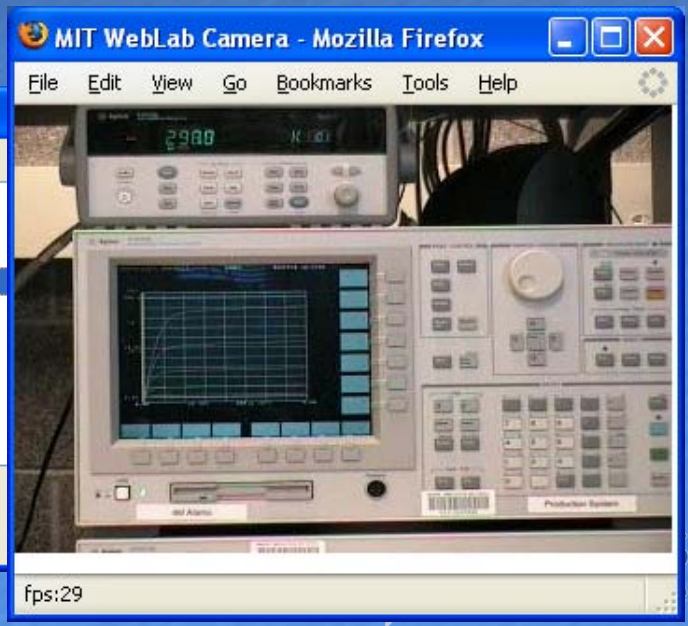
Microelectronics Device Characterization







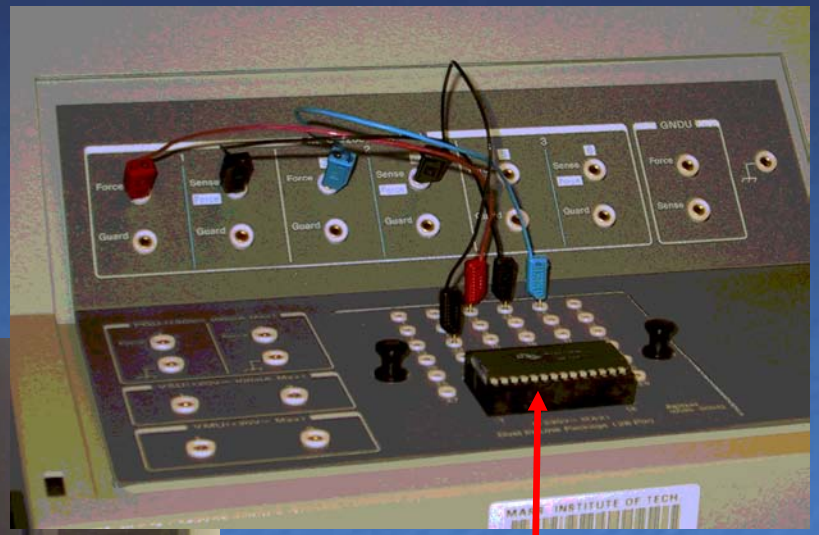


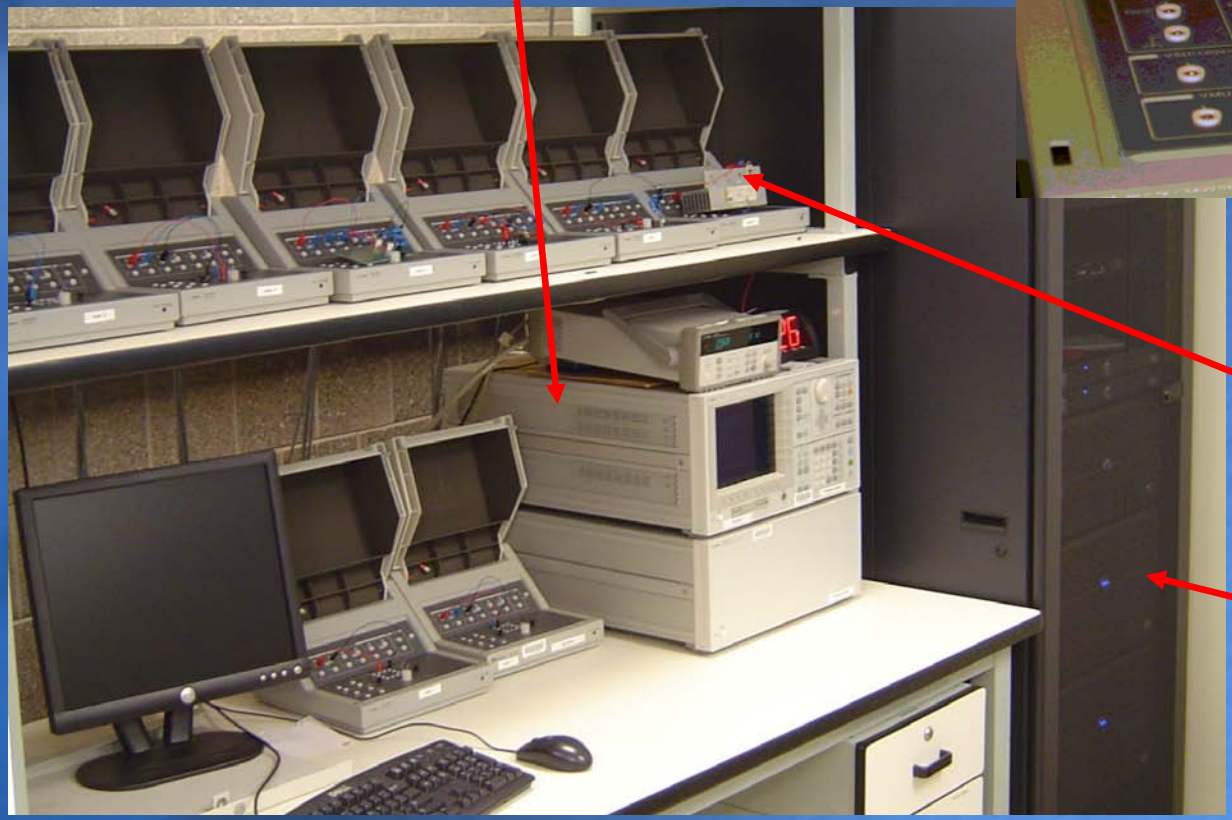


QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

Microelectronics Device Characterization

Semiconductor Parameter Analyzer, Switching Matrix (donation of Agilent Technologies)





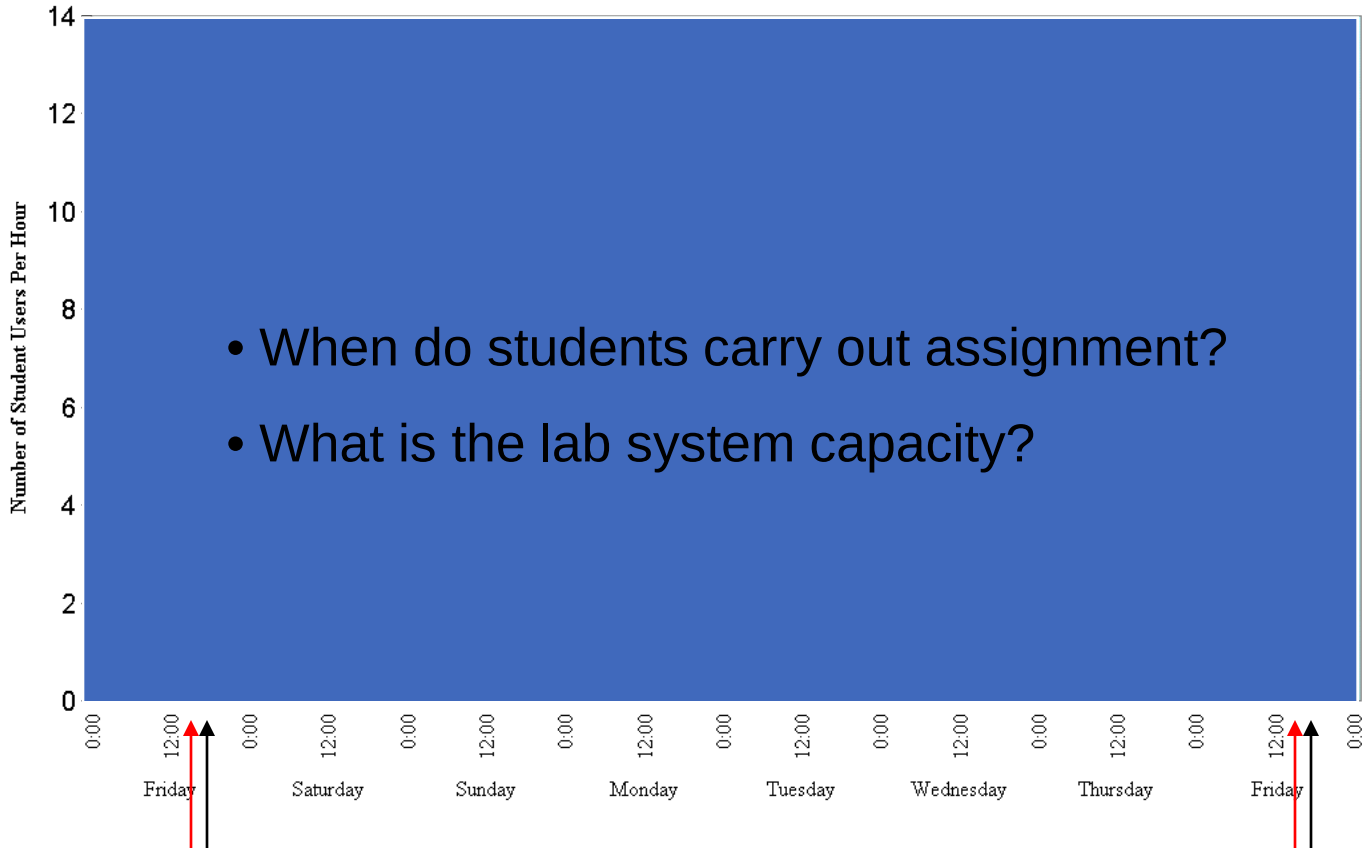
Device under test

Device test fixtures (donation of Agilent Technologies)

W2000 server (software donation of Microsoft)

Lab Capacity

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.



2PM: 6.012 exercise out (75 students)

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

[Oct. 13-20, 2000]

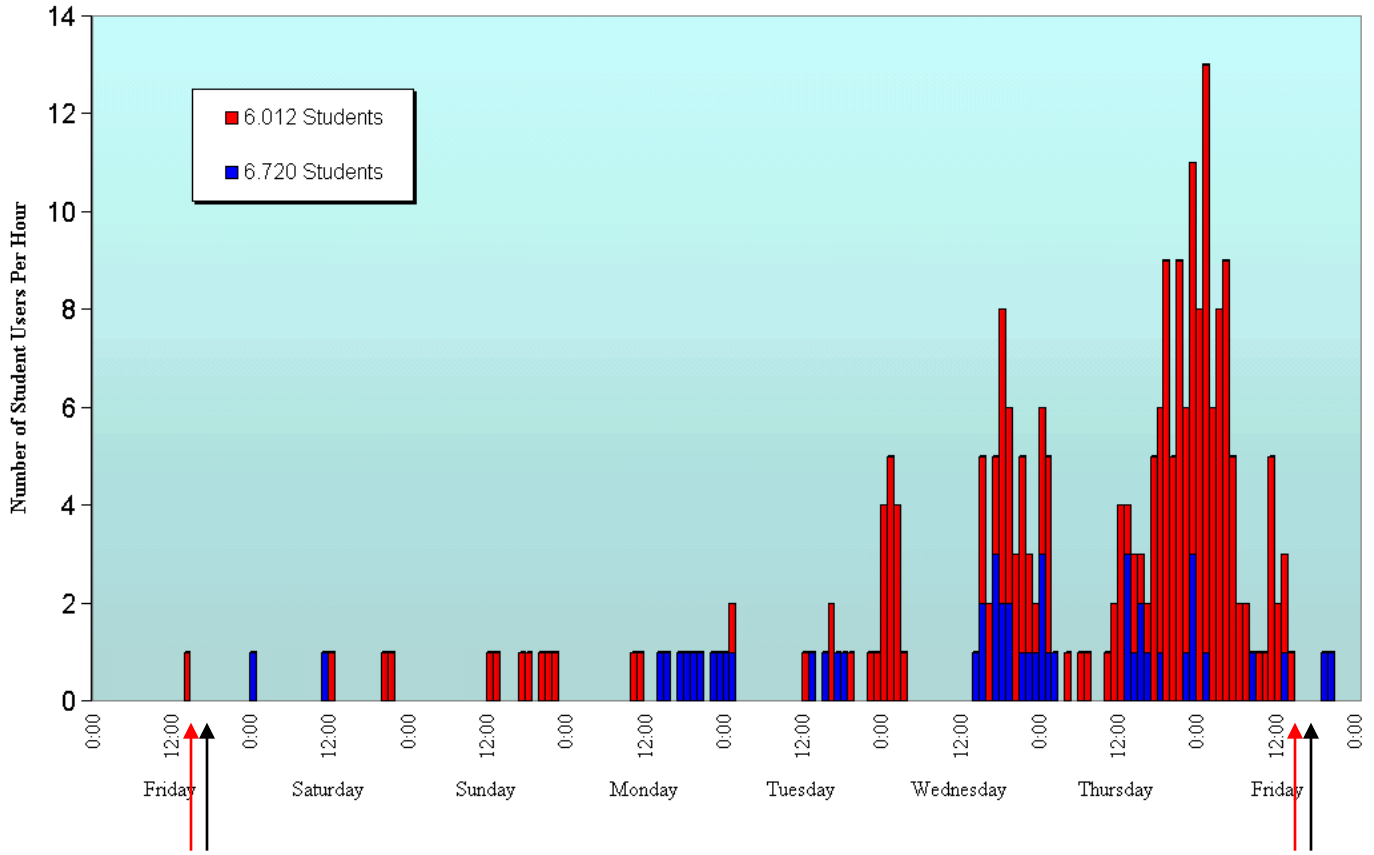
2PM: 6.012 exercise due

4PM: 6.720J/3.43J exercise due

iCampus
the MIT-Microsoft Alliance

Lab Capacity

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.



2PM: 6.012 exercise out (75 students)

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

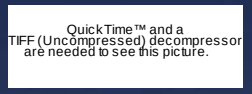
[Oct. 13-20, 2000]

2PM: 6.012 exercise due

4PM: 6.720J/3.43J exercise due

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

Typical Assignment:
Microelectronic Device Characterization Project



Four step process:

Using iLab GUI:

- Measure DC I-V device characteristics
- Graph results

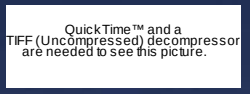
Download data to student's computer

Using MATLAB or EXCEL:

- Extract device parameters
- Construct model based on theory presented in class
- Compare with measurements, discuss

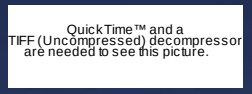
Freely explore other modes of operation…

Formal Assessment



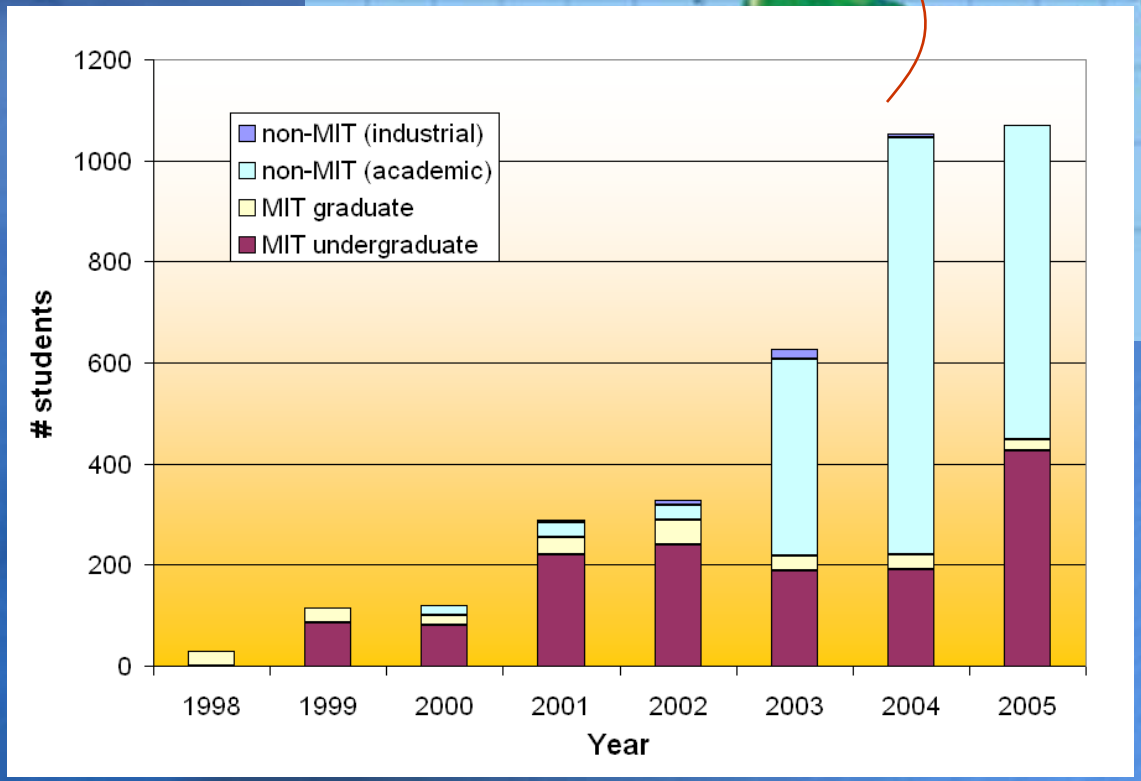
- Assessment performed in 6.012 in:
  - Spring 2005 (90 students)
  - Fall 2005 (65 students)
- Assessment through:
  - Individual student interviews (~20 students)
  - Quantitative surveys (~30-40 students)

What we've learned from μE ilab



- iLab experiences can significantly enhance learning
- For iLab educational experiences to be effective:
  - system has to work well, specially under peak load conditions!
  - system must allow free exploration and making many mistakes
  - clear documentation and tutorials are essential
- Several small assignments more effective than few large projects
- Students find difficulty in handling real-world data
  - offline, post-measurement portion of assignment critical to learning experience

Lab Use

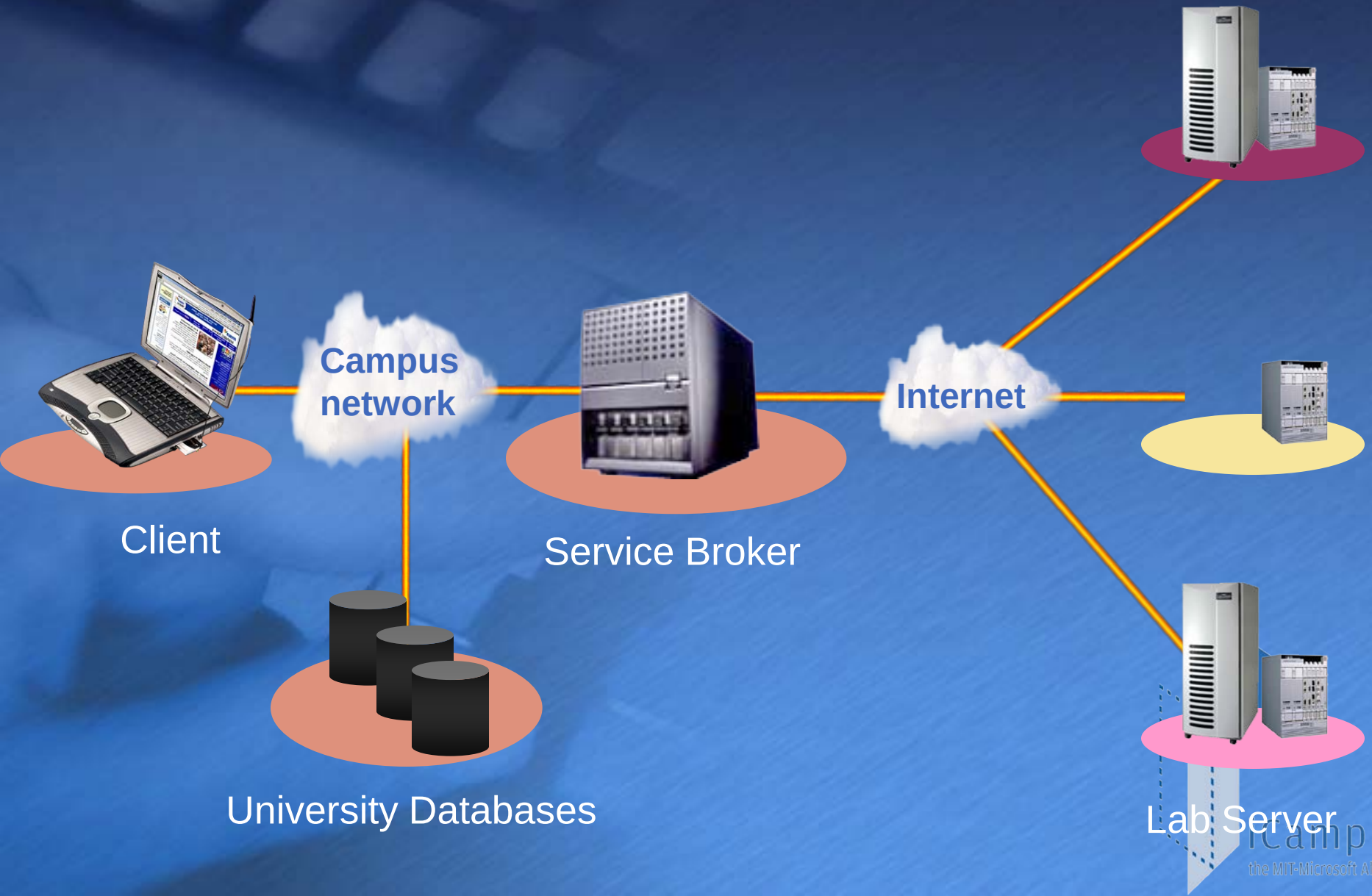


over 3600 student users (for credit) since 1998

iCampus
the MIT-Microsoft Alliance

The MIT iLab Architecture

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.



QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

Unique Issues for iLabs in developing countries

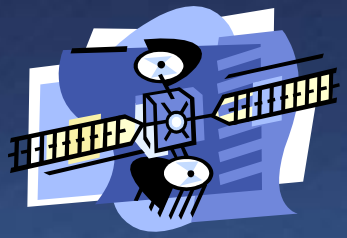
- **Opportunities:**
  - **Paucity of labs**
  - **Lots of young enthusiastic people**
  - **Great need for engineers**

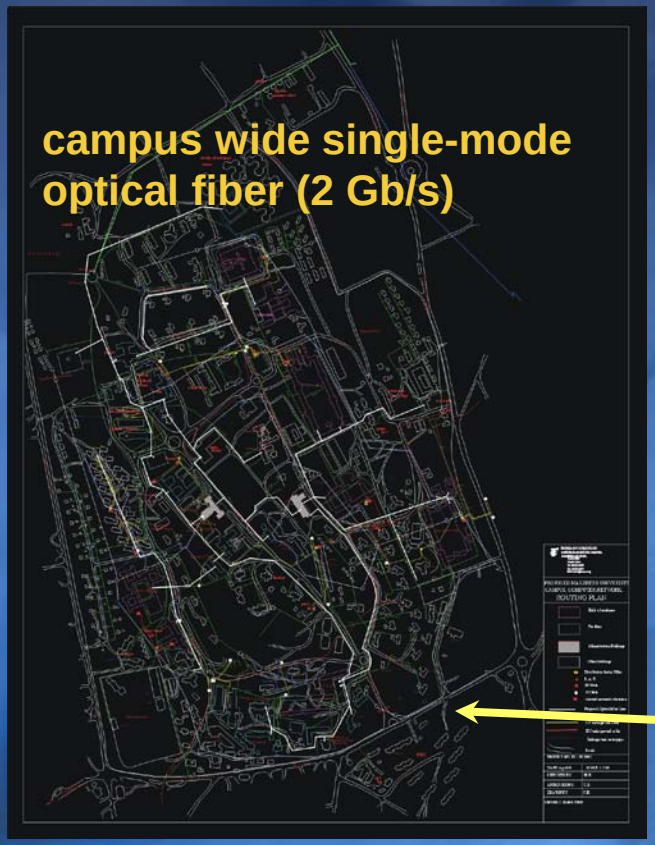
- **Challenges:**
  - **Limited access to networked computers**
  - **Limited computer literacy**
  - **Severe bandwidth limitations**

Bandwidth limitations

(example: Makerere University, Kampala)

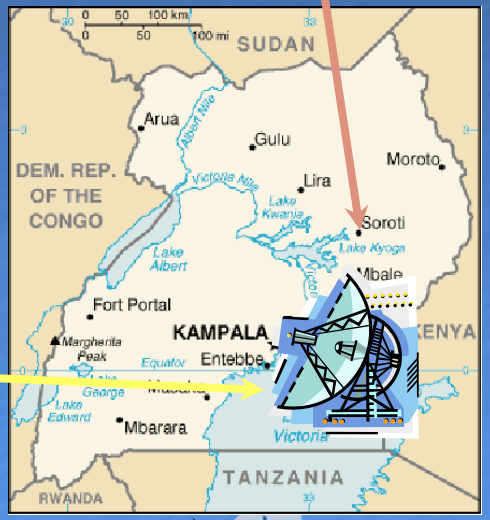
QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.





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

Figures for Spring 2004

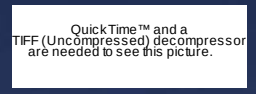
QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

Consequences for iLabs (and other rich educational resources)

- Need to deploy educational resources locally
- Solutions engineered in the developed world not necessarily effective in developing countries
- Pedagogy likely to be different in bandwidth starved situations
- Ultimate goal: “native” iLabs. How do we support this?

iCampus
the MIT-Microsoft Alliance

An example: iLab-Africa project



Carnegie Corporation of New York

Makerere University

University of Dar es Salaam

Massachusetts Institute of Technology

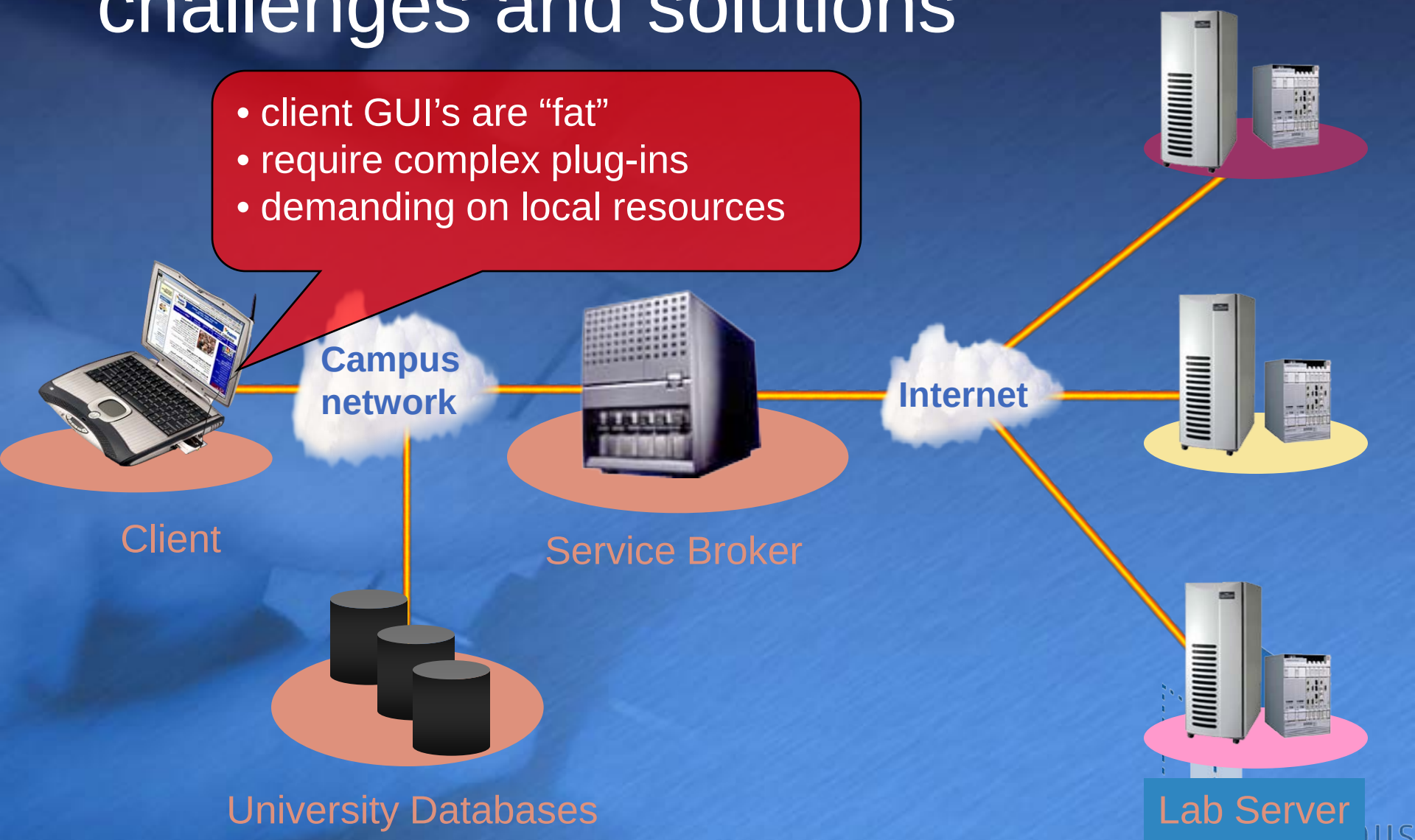
Obafemi Awolowo University

- **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

iCampus
the MIT-Microsoft Alliance

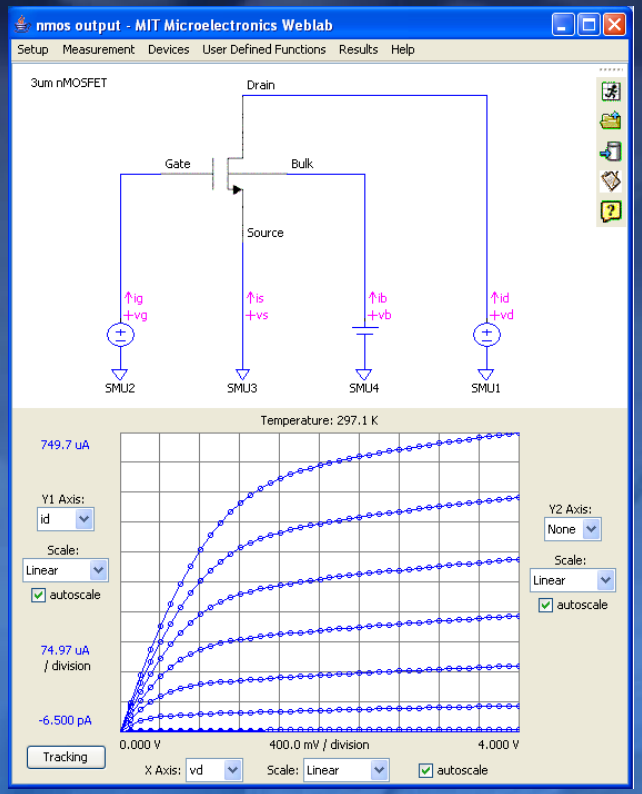
iLabs in Africa: challenges and solutions

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.



Partial Solution: “thin” clients

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

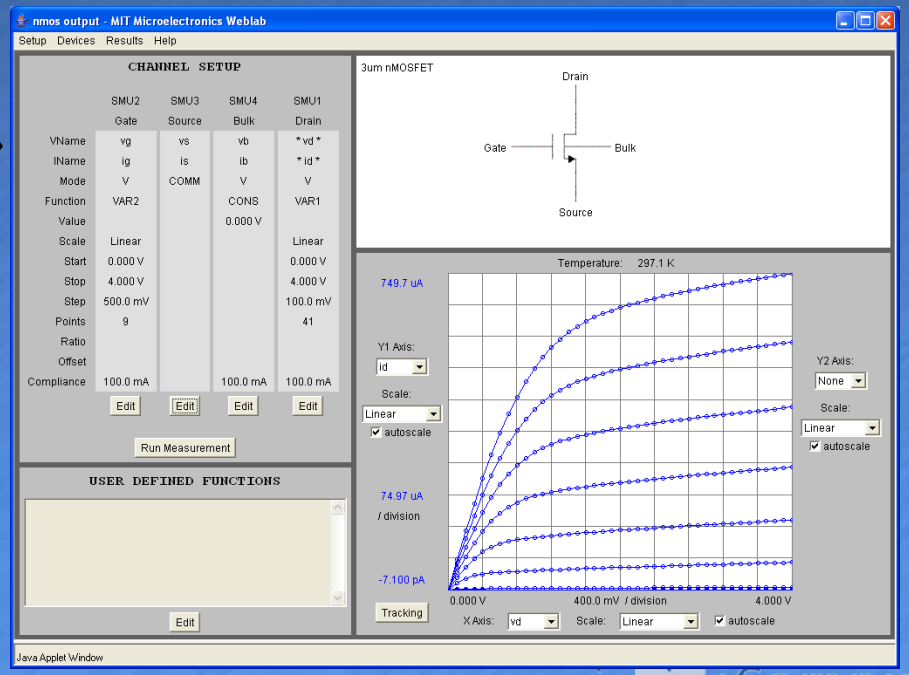


v. 6.1 graphical applet

- 169 kbytes
- <download time> from OAU=79”

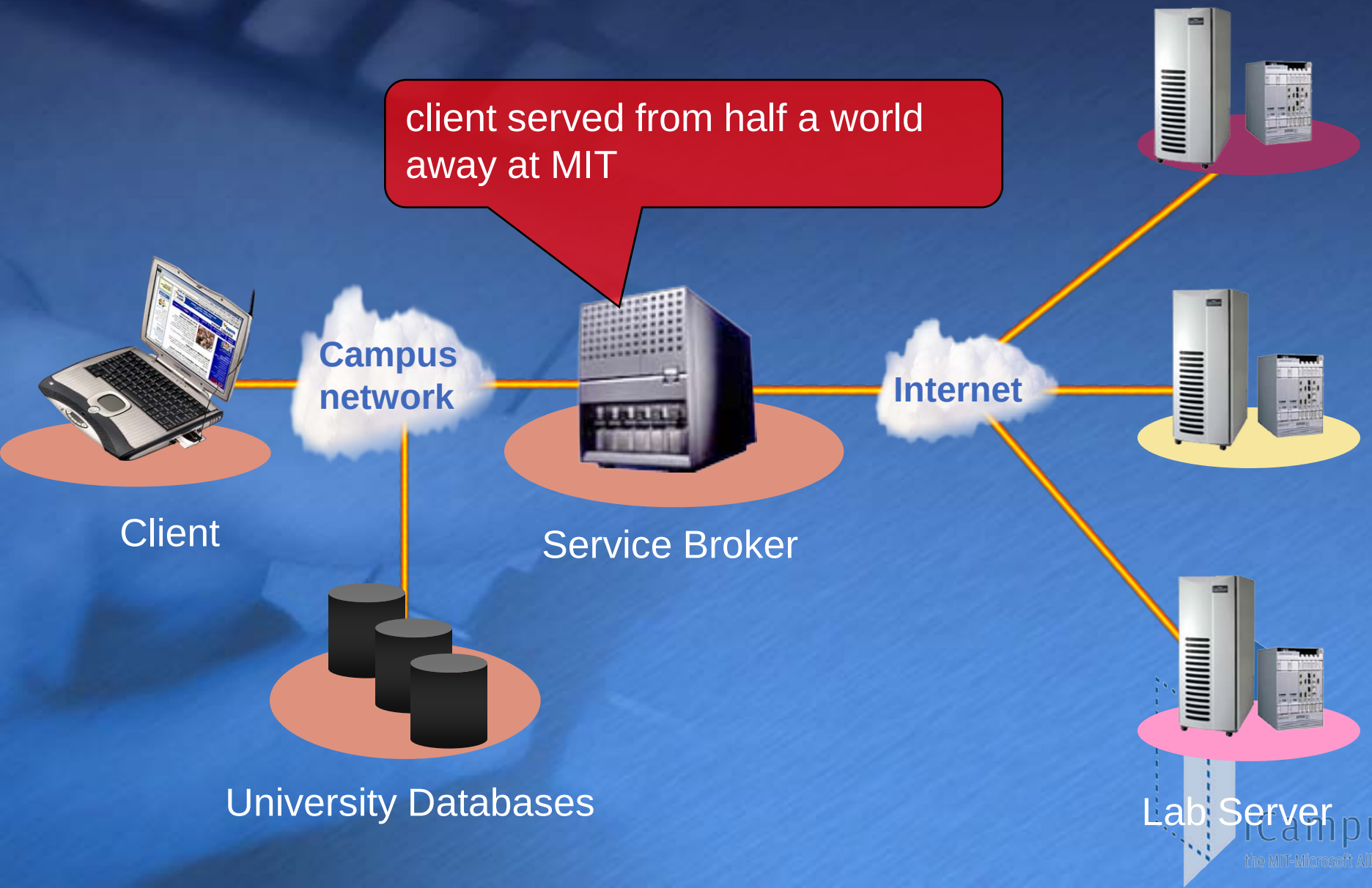
v. 6.1 classic applet)

- 94 kbytes
- <download time> from OAU=63”



Data courtesy of K. Ayodele (OAU)

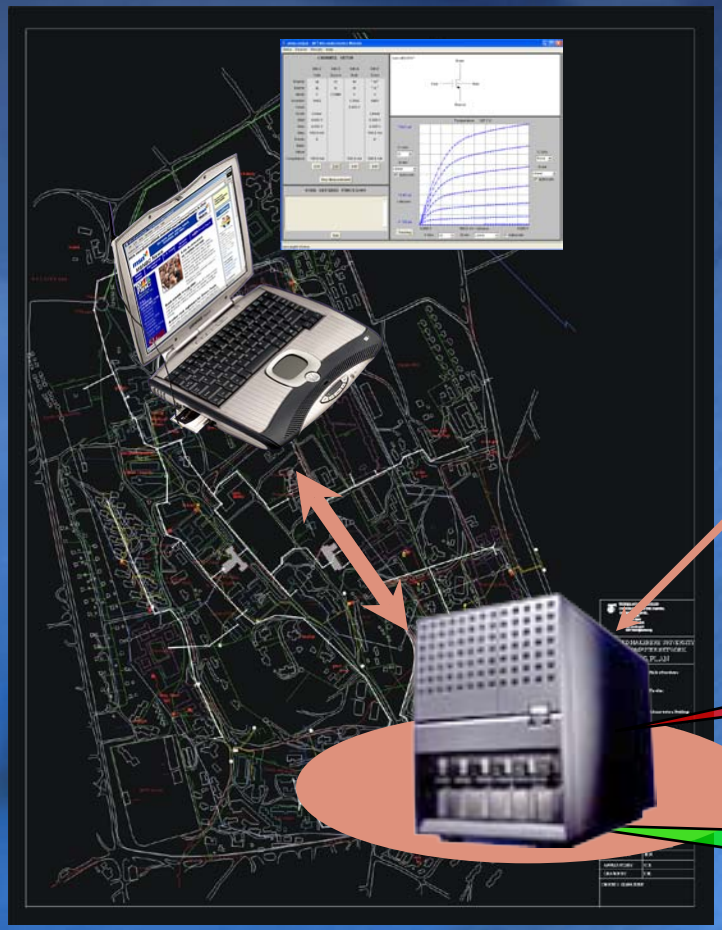
iLabs in Africa: challenges

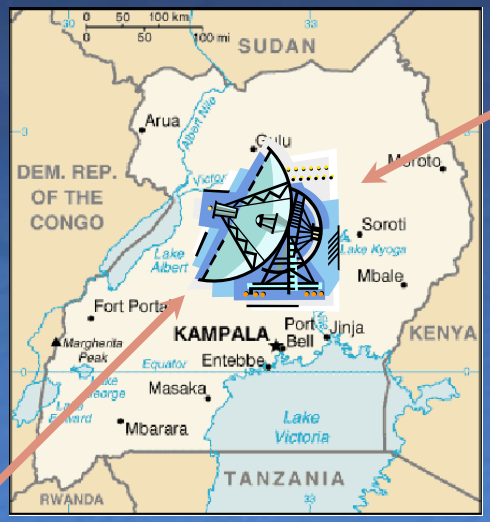


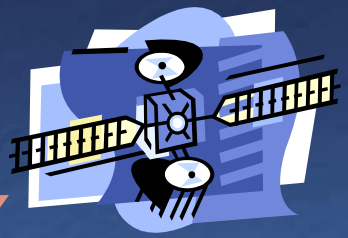
Solution: local Service Broker

Installed SBs at OAU, MUK and UDSM

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.







applet served from here

Instead of here

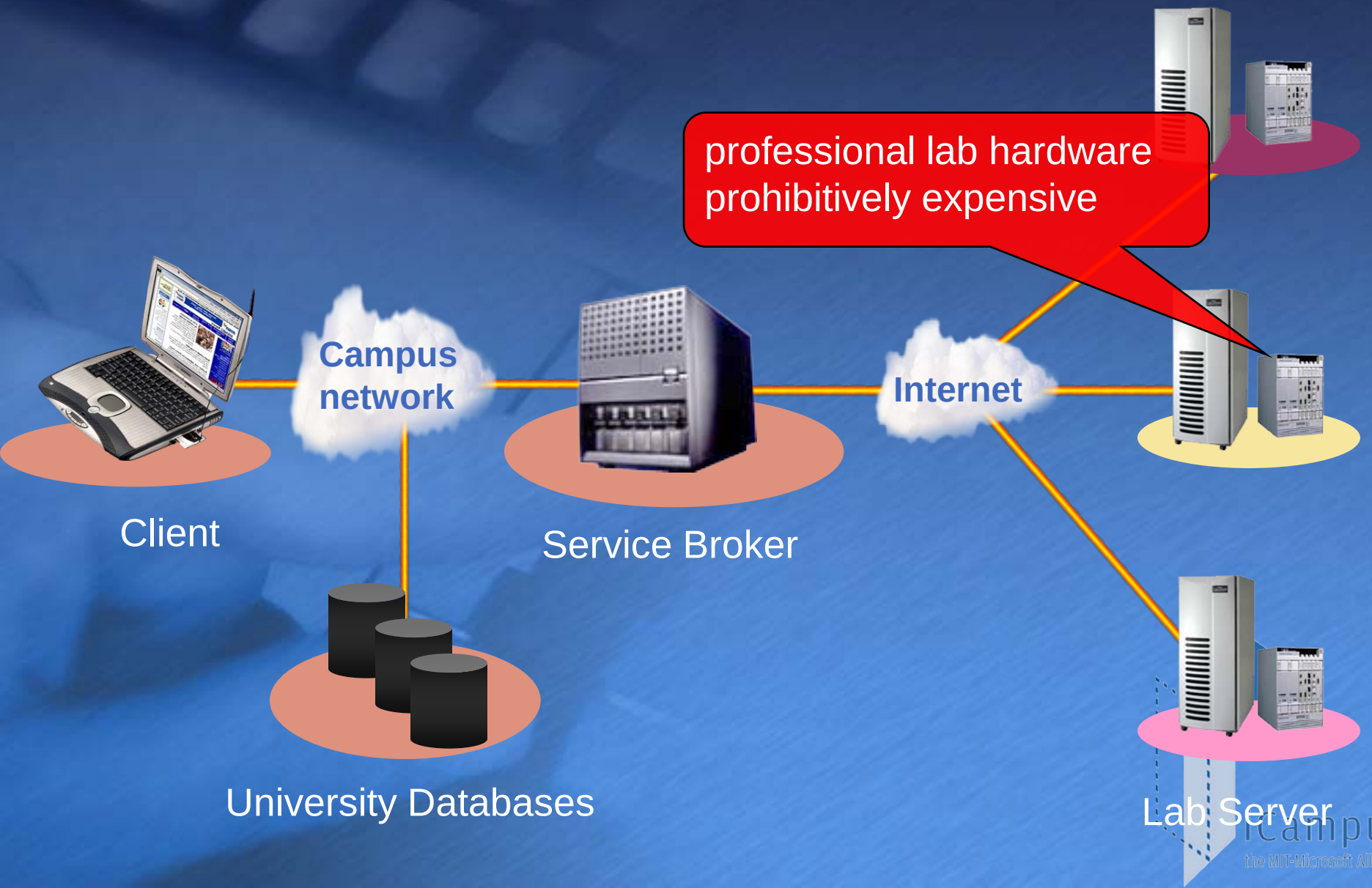
student data stored here

Instead of here

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

iCampus
the MIT-Microsoft Alliance

iLabs in Africa: challenges

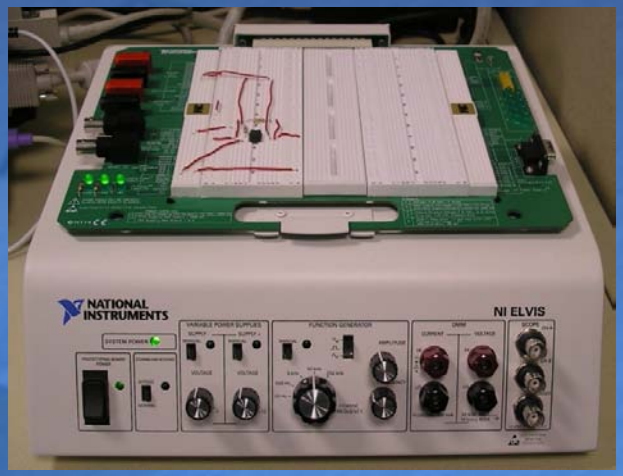


QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

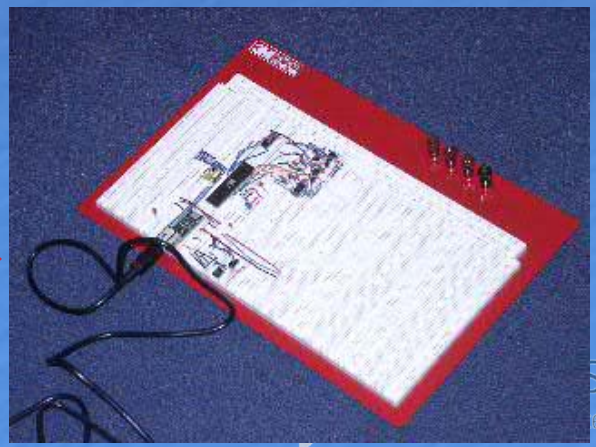
Solution: inexpensive hardware

Agilent 4155
~$50K

NI Elvis
~$2K



iLab Mini
~$40



QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

iLabs in Australia

iCampus
the MIT-Microsoft Alliance

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

Consequences for iLabs (and other rich educational resources)

- Need to deploy educational resources locally
- Solutions engineered in the developed world not necessarily effective in developing countries
- Pedagogy likely to be different in bandwidth starved situations
- Ultimate goal: “native” iLabs. How do we support this?

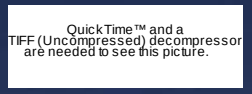
iCampus
the MIT-Microsoft Alliance

iLab: the Opportunities

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

- Order of magnitude more laboratories available to our students
- Unique labs:
  - Unusual locations, expensive equipment, rare materials
- Rich pedagogical experiences:
  - More lab time to students
  - GUI to lab integrating graphing, simulation, collaboration, tutoring
- Worldwide communities of scholars created around labs sharing content

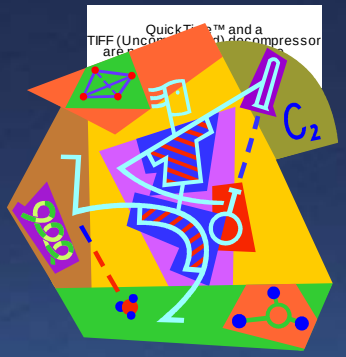
iLab: the Challenges



- Developing an iLab from scratch is a lot of work!
  - Great attention needed to user scalability
  - Needs to be done by domain specialist
- Managing a broadly shared iLab is also a lot of work!
  - Disincentive for owner to share lab
- Key challenge: iLab Scalability

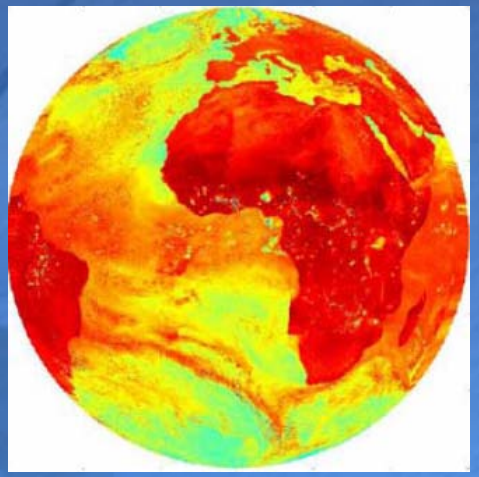
iCampus
the MIT-Microsoft Alliance

Conclusions



- iLabs can enhance science and engineering education in India as well as the rest of the world
- iLabs and their educational content can be broadly shared within India and around the world
- iLabs provide a path for the developed world to support education in the developing world
- iLabs Architecture is a scalable framework to support iLab dissemination around the world

“If You Can’t Come to the Lab… the Lab Will Come to You!”



longpd@mit.edu

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