OAU ilab:
Experience and Plans

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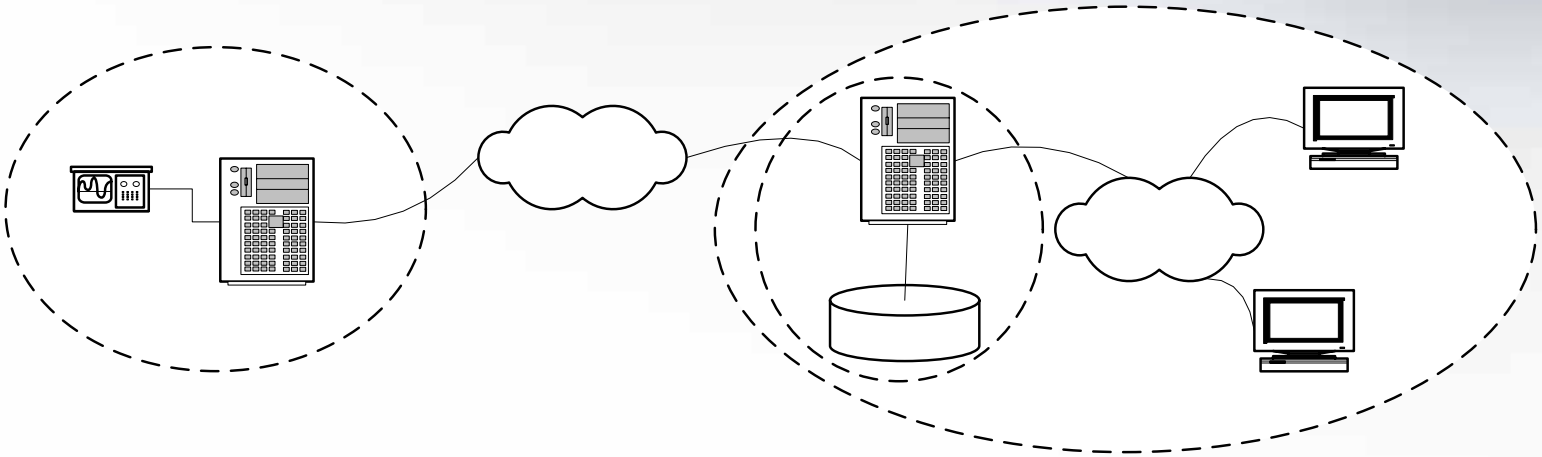
What is ilab?

- **A new platform** in the emerging field of Virtual Laboratories.
- **An online laboratory** that can deliver many of the educational benefits of hands-on experimentation (Del Alamo, 2005)
- **An architecture developed at MIT** and being shared with African collaborators among others.

What is ilab?(cont'd)



The Topology of the MIT iLab Batched Experiment Architecture.

The OAU approach to Ilab

Our ilab program has three prongs

- **Utilization for curriculum development**

  - Leveraging on the proven viability of the platform to improve our curriculum vis-à-vis experiments.

- **Contribution to iLab architecture development**

  - our efforts should lead to the emergence of a hybrid that would take into account peculiarities of the Nigerian/African learning process.

- **Popularization of the platform**

  - It is almost certain that standards will emerge in the field of virtual instrumentation with time.
  - We believe that the MIT architecture is very viable, even if as in all designs is open to further development.
  - There are benefits to be derived from pushing for the MIT architecture to be a defacto industry standard.

Our Objectives

- **Contribute to iLab development**

  - To be able to make significant contributions to the WebLab architecture in 12 months. These contributions will include ability to handle new research thrusts as determined by the MIT WebLab and the African group.

- **Fruitful collaboration between staff and students in African Universities on one hand and MIT on the other**

- Meaningful collaboration and cooperation between the continent's higher institutions may offer the easiest path to mutual development.
- We intend to use the iLab initiative to develop such collaboration as well as explore other areas as they arise.

- **Ability to get more students perform more experiment**

- thereby making up for the present shortage of experimental set-ups in OAU.

Our Objectives (cont'd)

- **Enhancement of Curriculum development in OAU**

- **Manpower development**

- Positive interactions and skills enhancement through relevant ilab related hardware and software development.

Our plan

We propose the following stages

- **Hooking up OAU staff and students to the existing MIT Weblab** Microelectronics and other experiments. (May 2005 up).

- **Duplication of MIT Weblab system :** We plan to duplicate the existing MIT setup. This would be studied in preparation for the next stage of adaptation in collaboration with MIT (if called for).

- **Adaptation of duplicated system**: next we plan to make modifications to the duplicated MIT set-up as called for either by peculiarities of the African environment/system or as a result of feedback from Users and Faculties.

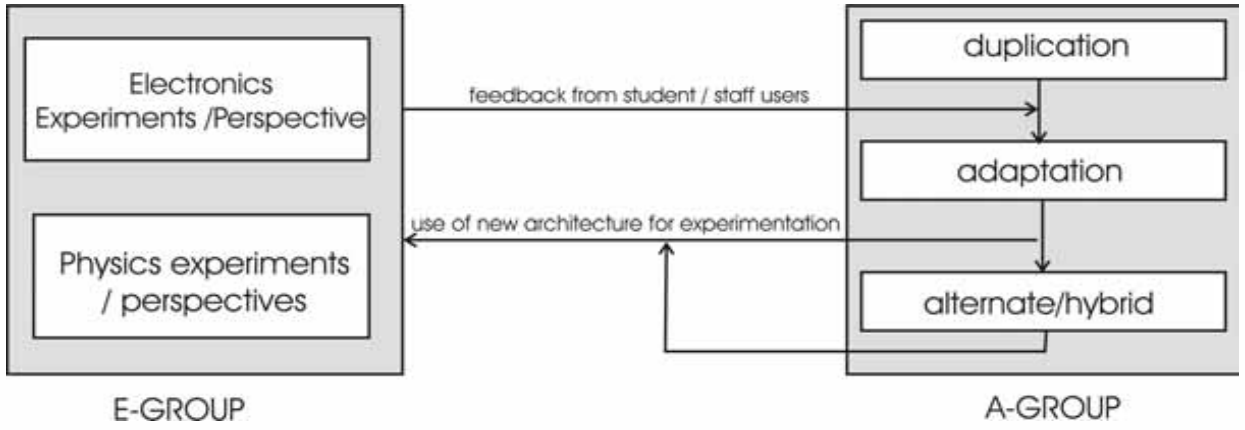
Implementation Details :Our Team

- **The Experimentation Subgroup (E-group)**

  - to utilize the existing MIT WebLab experiments and future OAU version for training students. Other experiments will be developed.

- **Architecture Subgroup (A-group)**

  - to implement the hardware/software needed to duplicate and adapt the MIT experimental setup, and eventually work together with MIT to develop an alternate/hybrid architecture (if called for).



OUR TEAM contd.

Separated into unit depending on applications

- **Physics** -headed by Prof. E. O. B. Ajayi
- **Electronics** - headed by Dr. O. Osasona
- **Hardware and Software Design group** -headed by Prof. L. O. Kehinde.
- **Chemical Engineering** -headed by Prof. O. Taiwo
- **Mechanical and Civil Engineering** - headed by Prof L. Adekoya

PRINCIPAL INVESTIGATOR- Engr. Professor. L. O. Kehinde

For better coordination,
Physics and Electronics are chosen as focus of Phase 1

The Chemical , Mechanical and Civil Engineering are in phase 2

Other fields will be added in the future as the needs arise.

Implementation vision and challenges.

- Our vision for this collaboration is that of a truly distributed virtual lab, where OAU develops N experiments, MUK develops X experiments and UDS develops Y. All experiments will then be pooled. Students of all universities needn't even to know exactly where the experiments they are doing are housed

- **Challenge of Experiment Development**

- the MIT architecture has wisely chosen to make the two tiers closest to the student (Client's browser and Service Broker) purely independent of experiment.

- The real work is integrating the hardware into the lab server module of the iLab system such that the low level GPIB (or appropriate) commands can be interfaced to the web services used by the service broker to set up experiments, fetch results etc.

- One other challenge is the Experimental hardware and interface design.

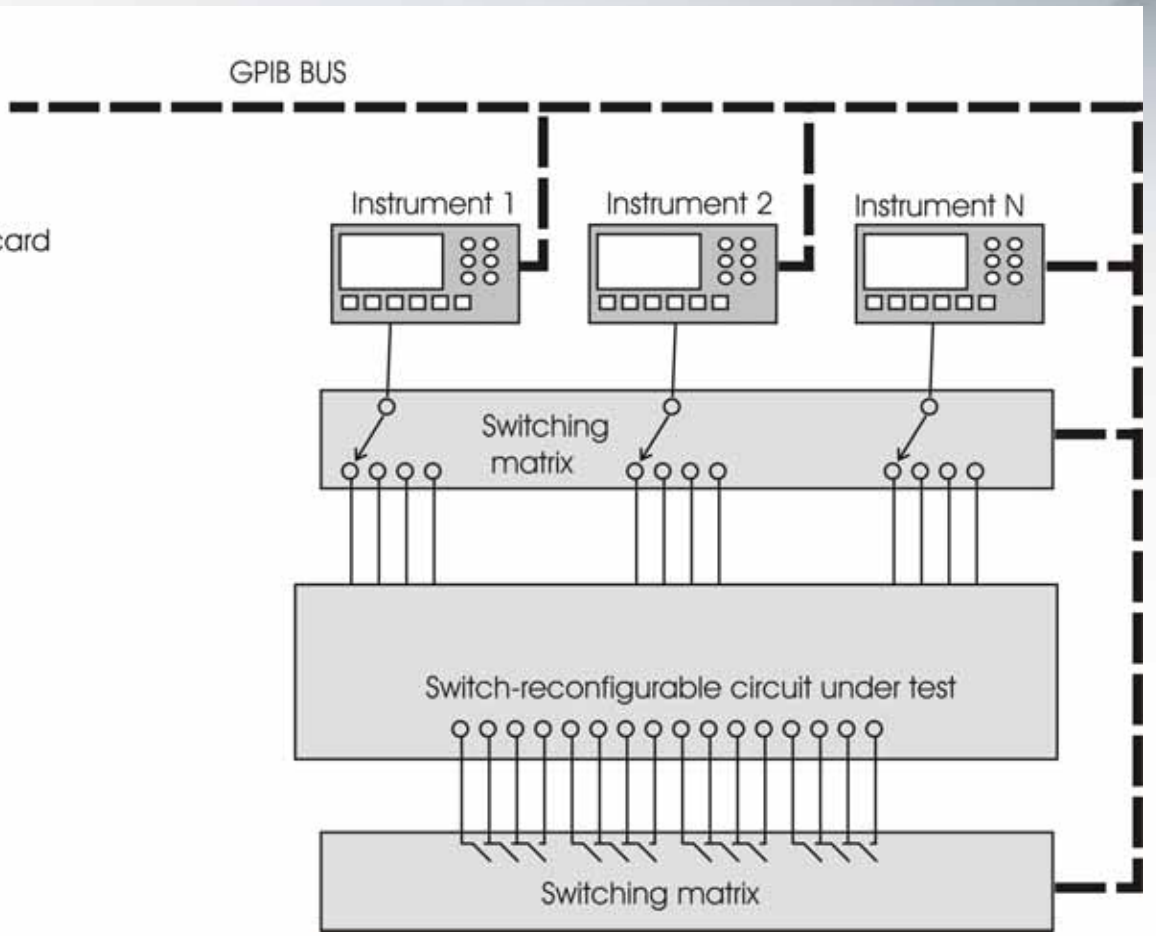
A generic experiment

- **Why the iLab architecture can handle virtually any experiment**

- Every experiment simply consists of electrical components connectible in a finite number of states
- The various connections can be achieved by using switches in a switch matrix
- The switches in turn should be controllable via software. The preferred means is by using GPIB-compatible devices
- Instruments can be used to measure the state/level/variations in any parameter of interest
- For a purely automated system, the terminals of such instruments must be passed through software controllable switches so the point in the hardware that they are used to monitor can be varied

A generic experiment (cont'd)

GPIB controller card



A generic experiment: remarks

- Although one bank of switches in the previous diagram was shown as a multiplexer, it is still preferable to think of all switching as being done via a switch matrix.
- The GPIB bus is used to setup the experiment (Application Program Interface, API calls from the service broker to the Server get translated to appropriate low level GPIB command to the switch matrix to take on an appropriate configuration of switches).
- Part of the switch matrix is used to multiplex instrument terminals to various parts of the circuit.
- This brings the requirement that all switch matrix used must be instrumentation-grade, that will not introduce errors into the setup.

Remarks (cont'd)

- **Possible interface Connectivity:**
  - USB
  - Ethernet
  - Firewire
  - GPIB
  - RS 232
  - PCI
  - And a mix of any of the above interfaces

- Choice of GPIB because it is the single most widely supported instrument connectivity standard, more functional than RS232 and with adequate data throughput.

- GPIB controls to the instruments include those to set them up and those to initiate and get the results of measuring operations.

Implementation details : Our Experiments

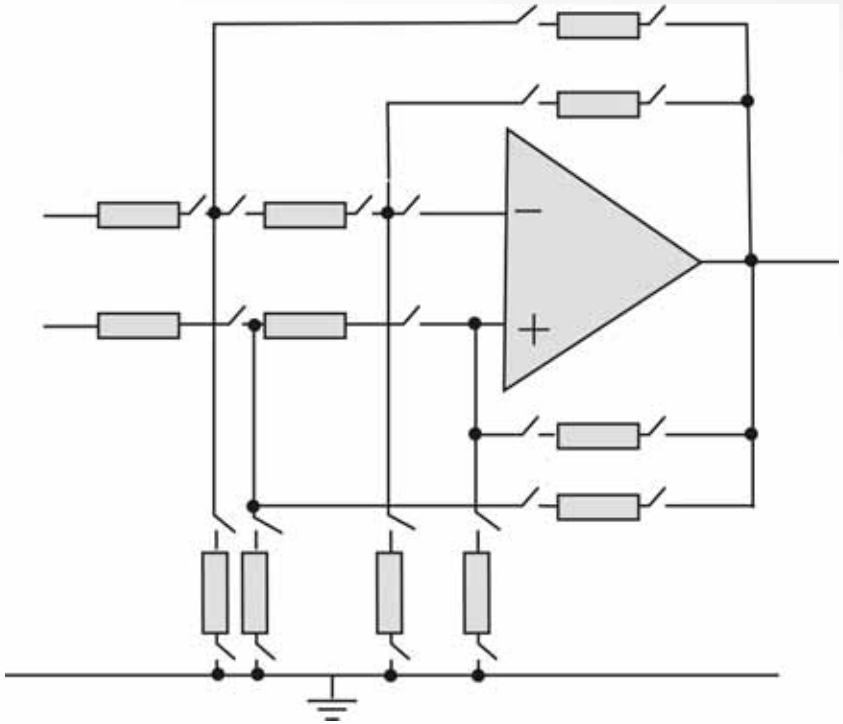
- **Operational Amplifier**

  We intends to create 13 experiments around Op-amp circuits. Presently about 4 are being developed using PHP and Mysql, but we are adopting the .NET framework (C#, C++,ASP.NET ,e.t.c,) and Java to allow easy integration into the MIT iLab architecture

- **Logic Gates**

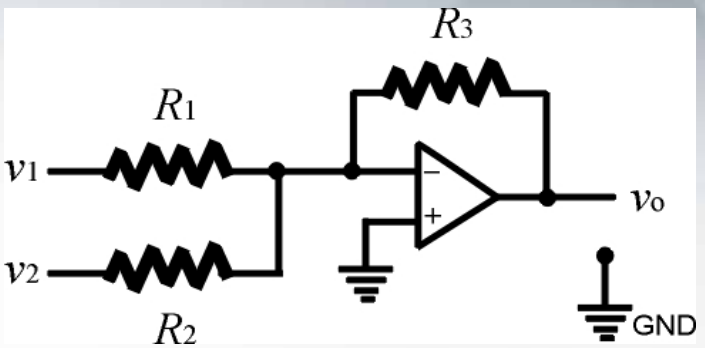
  Also being developed simultaneously with the Op-Amp.

Op-amp experiment

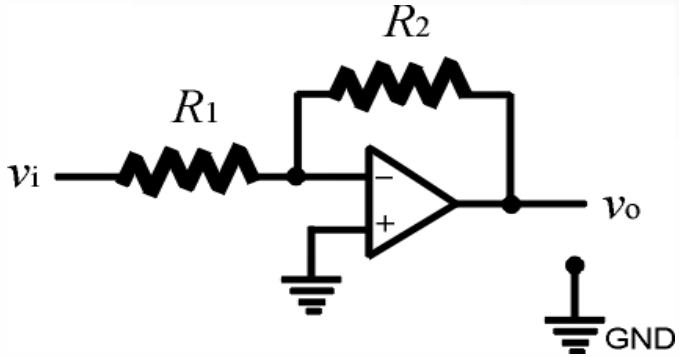


The Dozen Experiment circuit

(L.O.Kehinde , IJEEE Vol. 26, No.3, 1992)



Summing Amplifier



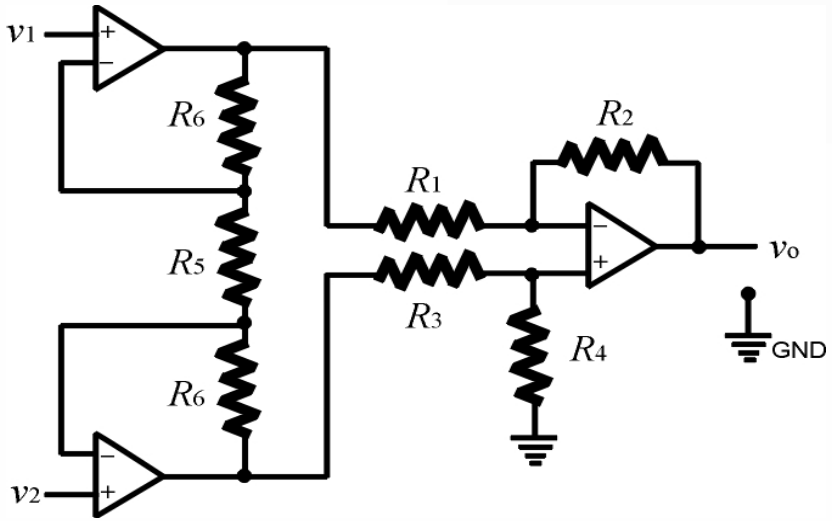
non-inverting Amplifier

Our Experiments (cont'd)

Other experiments

- The dozen Op Amp circuit encapsulates most Op-Amp circuits of interest to the experimenter, including integrators and differentiators. Etc.

- Other future options are Instrument amplifier etc.



Instrumentation Amplifier

Our Experiments (cont'd)

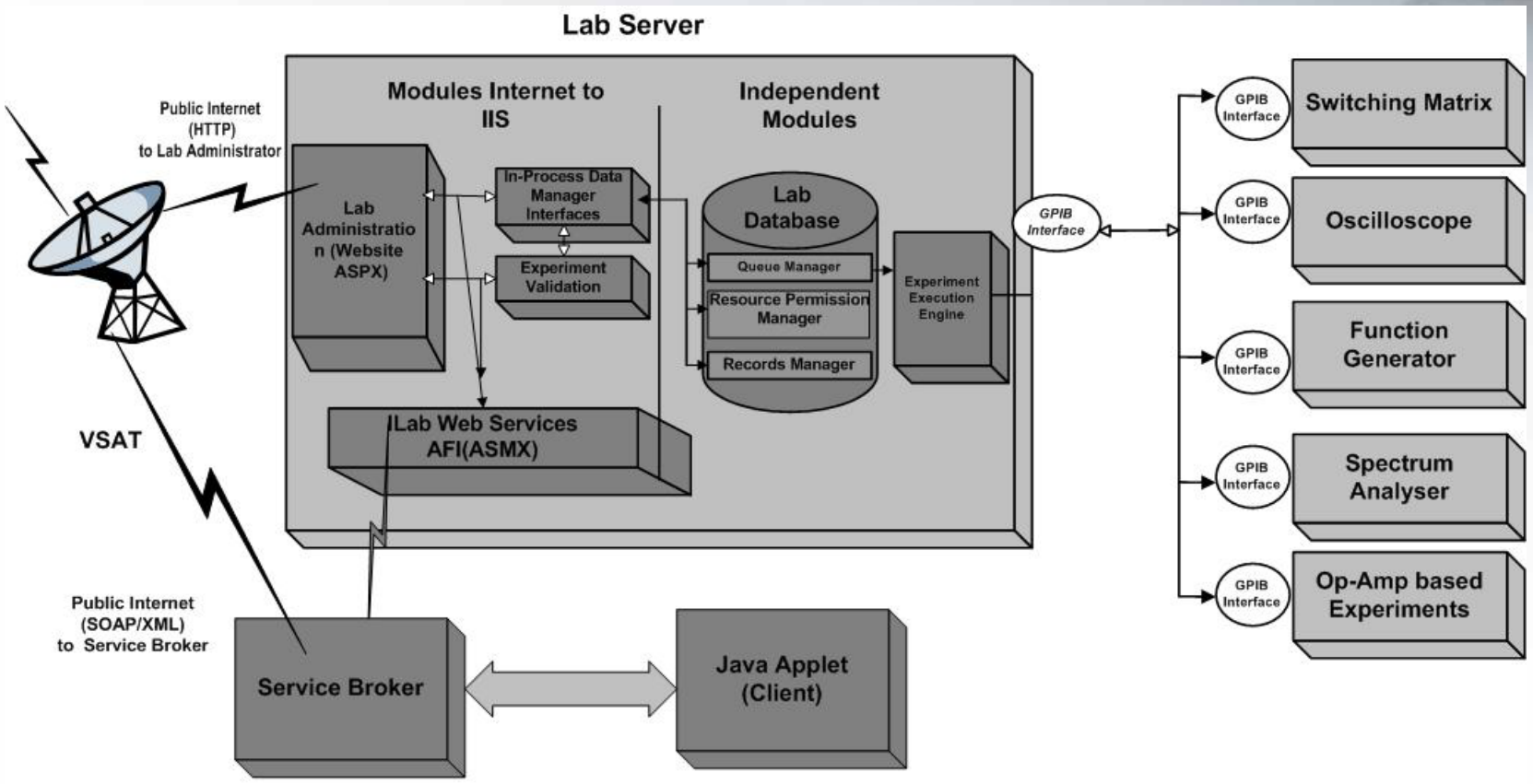


Figure. 2 Op-amp Based Experiment Using MIT ilab Batched Architecture

Our Experiments (cont'd)

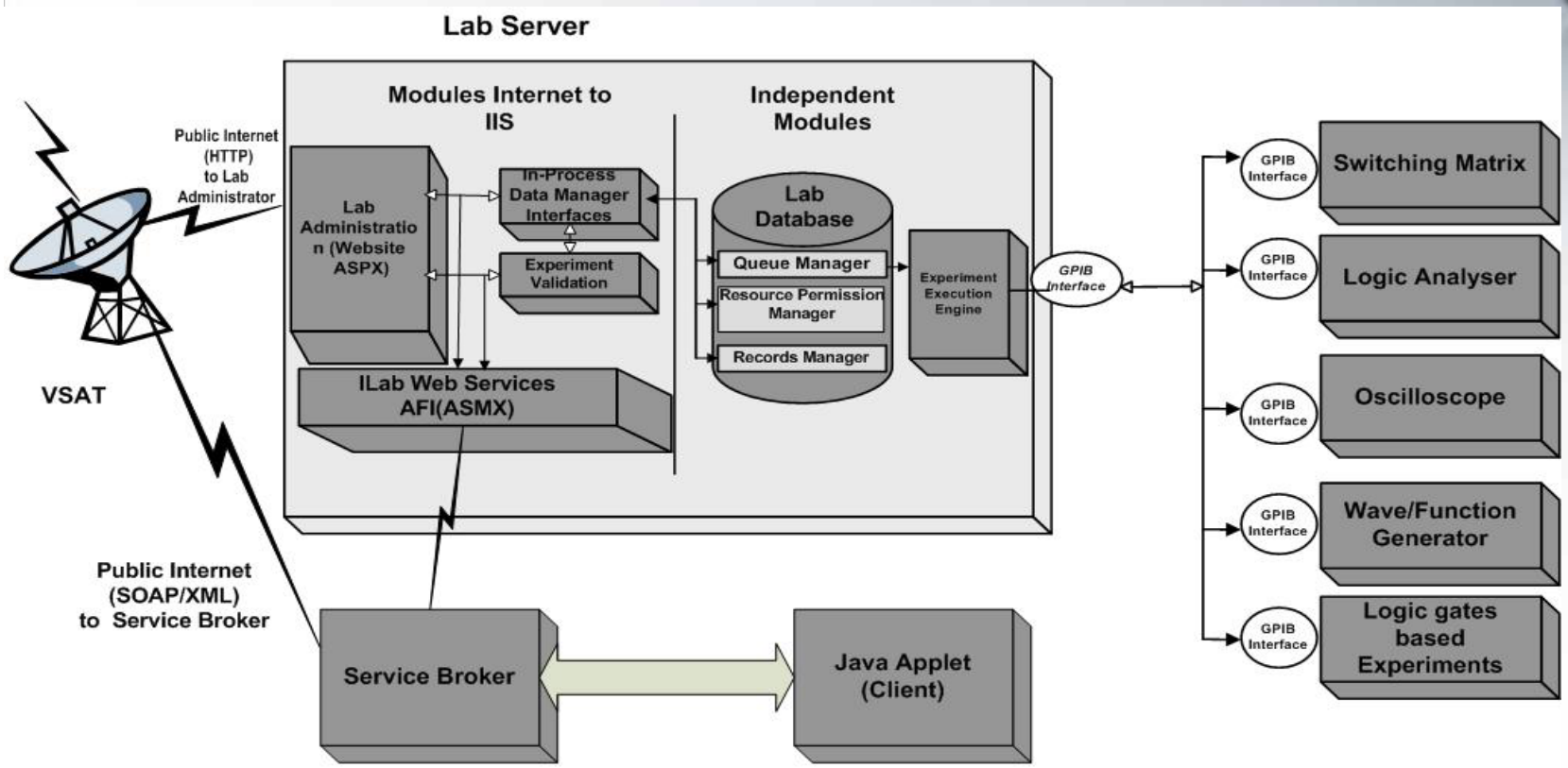


Figure. 3 Logic gates based Experiments Server MIT ilab Batched Architecture

Existing network infrastructure

- Infrastructure provided by a unit called information Technology & Communications Unit (INTECU).

- **Responsibility of INTECU**

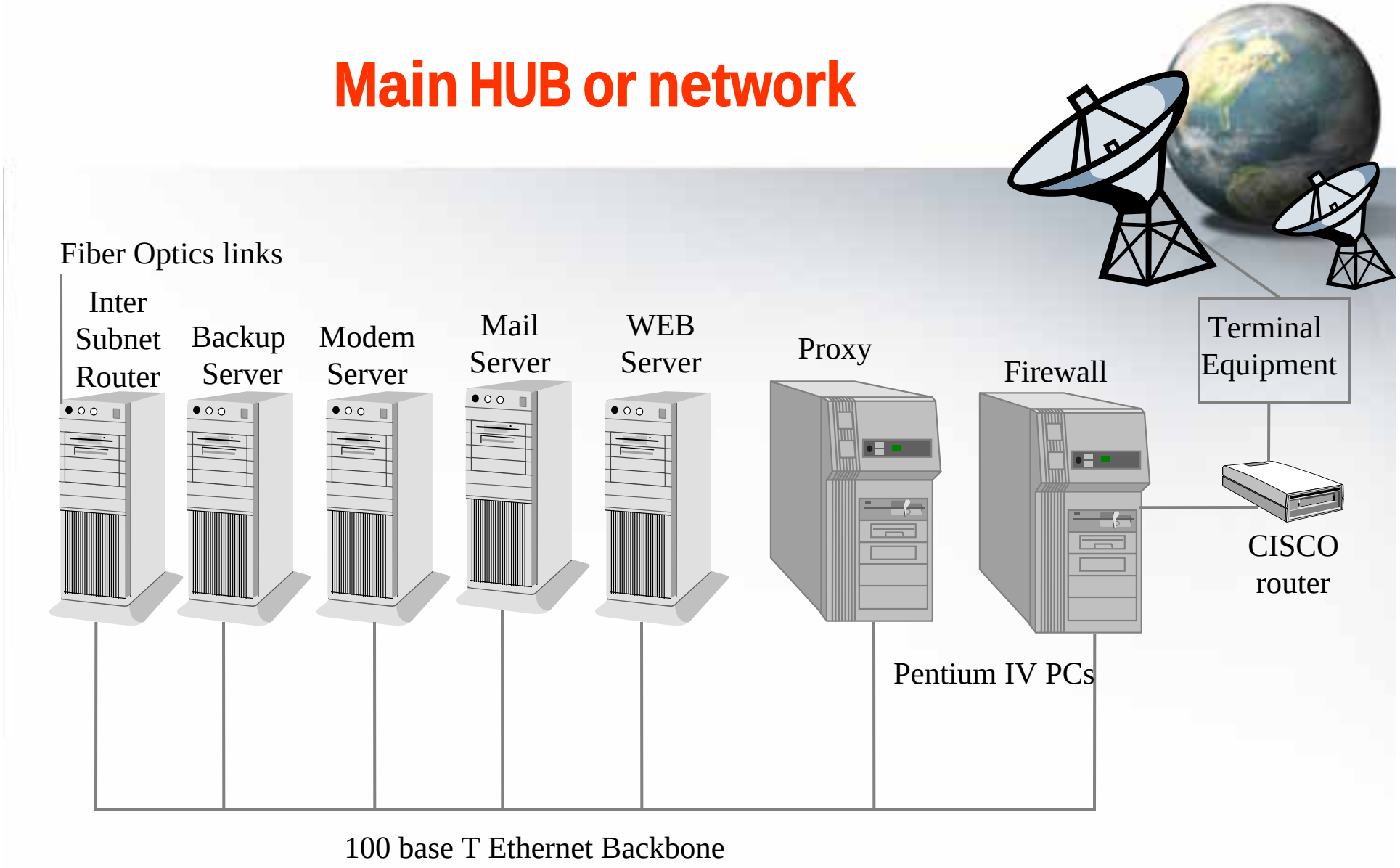
  -Regulation of all ICT issues on Campus.

  -Establishment of hardware & software infrastructure.

  -Assemblage of computers.

  -Manpower Training in ICT.

Main HUB or network



Brief network description.

* TCP/IP Protocol.
* Linux Operating System used extensively
* 3 Subnets initially, now 18 Subnets and 8 cybercafés.
* Initially Spread Spectrum wireless radio linking subnets to main centre, now Fiber Optic Links to all Buildings.
* Full Internet facilities available on campus.
* VSAT connectivity with 3.8m, and 2.4m dishes operating at at 4.2 GHz and 6.2 GHz in the C band.
* A third VSAT on ground to be used for KU band.

Our iLab Activities So Far contd:

- ♦ **Developing Human Infrastructure**
  - – One graduate student spent 2 weeks in MIT.

  -staff work on curriculum development for relevant subjects.

  -focus groups studying MIT architecture.

  -Instrumentation group brainstorming on developing hardware and software for op-amp and logic gate experiments.

  -Two staff/students coming to MIT in July to study curriculum development and various aspects of the iLab.

Our Observations So Far :

♦ **cost**

- some of the devices and software needed are expensive.

♦ **The possibility of developing devices in-house**

- there is good possibility that some parts can be developed in-house. Of course we have to look critically at accuracy concerns (instrumentation grade items…)

Future Thrusts:

Though it is a bit early to talk about the future, since we are barely starting, in truth, some future work should be kept in focus:

- **GUI improvement**
- **Development of cheaper items by ourselves**

(caveat: will involve trade-offs. The question is, can we afford the loss in accuracy?)

- **full cross-platform/platform-independent system** (both server, broker and client)

- **Any future thrusts will be based on full cooperation with MIT for properly coordinated development.**

Need For Inter-Africa Collaboration

- **iLab is a developing system in the new Virtual Laboratory use paradigm**
  - Virtual labs hold the greatest promise for third world nations.

- **The African partners need to forge a common front**
  to investigate how this platform can be used to correct some deficiencies plaguing the academic system.

- **We need to work together to best complement MIT's efforts.**
  (ilab Africa Forum?)

CONCLUSION

- **Concluding remarks…**

- **The idea is not to deviate from MIT's aims but to work together with MIT to evolve a notable MIT standard.**
- **Grateful to MIT for sharing the new idea with Africans.**

THANK YOU

Engr. Prof. L. O. Kehinde

(on behalf of the OAU iLab team)