

DEVELOPING ILAB ARCHITECTURE FOR NIGERIAN POLYTECHNICS

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ABSTRACT

iLabs as developed in (Massachusetts Institute of Technology) MIT, has been in use in different universities across the globe. The potential presented by this high-tech development is a viable tool for better comprehension of engineering technique. This articles verifies the viability of implementing iLab architecture in polytechnic framework and hence recommend the adoption of iLabs in the Nigeria polytechnic since presently they need little adjustment to meet up with the requirement of establishing an iLab.

INTRODUCTION

Online laboratories (iLabs) are experimental facilities that can be accessed through the Internet, allowing students and educators to carry out experiments from anywhere at any time. Remote labs enrich science and engineering education by vastly increasing the scope of experiments that students have access to in the course of their academic careers. Harnessing the Internet, MIT's iLab middleware enables students to use real instruments, rather than simulations, via remote online laboratories using their browser. Unlike conventional experimental facilities, iLabs can be shared and accessed widely by students and other audiences across the world that might not otherwise have the resources to purchase and operate costly or delicate lab equipment [1].

iLabs in MIT currently include microelectronics, chemical engineering, polymer crystallization, structural engineering, and signal processing laboratories as case studies for understanding the complex requirements of operating remote lab experiments and scaling their use to large groups of students

at MIT and around the world. iLabs comprise software based designs that are easily brought online to manage complex laboratory experiments [2].

iLabs has been tested with the aim of enhancing the delivery and quality of higher education by utilizing the Massachusetts Institute of Technology (MIT) iLabs Shared Architecture (ISA). The remote laboratories focused on 19 different universities across five continents. The project provided students with a low-cost, flexible, convenient and reliable experimentation platform. It also opened up specific beneficial areas including collaboration between universities, staff student exchanges between these universities and MIT, funding opportunities, the possibility of collaboration between universities in different countries on the use of scarce laboratory equipment, and the collaboration of students between universities in different countries on specific laboratories. Other benefits of the online laboratories include sharing laboratories between institutions; fostering inter-institution collaboration; providing higher quality laboratory education for cash-strapped schools; reduced lab cost per

institution and increased number of labs available per student. By providing iLabs, students can gain exposure to tools and resources that would elevate their academic experiences, extend and increase the effectiveness of existing educational programs and increasing the employability of the students [3].

REQUIREMENTS FOR IMPLEMENTATION OF ILABS IN THE POLYTECHNIC

- **Networking and Internet accessibility**

From our survey, it is discovered that the structure of the polytechnic is characterized by independent internet access points of low bandwidth connectivity (512kbps max). There has not been an established networking of the laboratories in the institution. Hence the laboratories cannot have access to internet which is a prerequisite for a functional ilab architecture. Establishing high speed reliable internet connectivity has really been a huge challenge in the polytechnic system in terms of technicality and finance. However iLabs requires some basic foundational networking to be done. The laboratories where these labs are to be done need internet access and generally good networking architecture of not less than 2Gbps speed. The ilab innovative will bypass the much need for high speed connectivity but will definitely need a good internet and networking architecture to function effectively. In Kenya, poor internet connectivity impacted on their education but however, they were able to implement ilabs and open course ware (OCW) in their local networks [3]. This can equally be applied in the Nigerian polytechnic system.

- **Alliance and Collaborative Agreement**

Alliance agreement will have to be developed with ilab service brokers; for example MIT (Massachusetts Institute of Technology). Some higher institutions in Africa are currently undertaking initial test run experience of the ilab architecture for their laboratory experiments. These institutions include; Obafemi Awolowo University, (OAU) Nigeria, Makerere University Uganda and University of Dar-es-Salaam (UDSM) Tanzania. [4] The iLab Architecture falls into three distinct parts; The Lab Server: connected to the lab equipment and deals with the actual operation of the equipment. The Lab Client: installed on the student's computer and is the interface to the operation of the laboratory. Lastly, the Service Broker: mediates exchanges between the Lab Server and the Lab Client over the Web and provides common administrative services, such as authentication and data storage [5] At the establishment of a collaboration agreement, clients will create account with the iLab service broker domiciled in their institution through a web link. The account will be grouped according to the course specific interest (e.g Microelectronics, power electronics, etc). The client account information is unique for the participating student. This is to enable a track on the learning experience of the participating student. Also the log of his earlier experiments can be accessed by the client [6]. The institution involved can also keep a track of the experimental results obtained and the learning experience of every participant through the school database. Figure 1 gives an idea of the connection requirement for a successful ilab development.

• FUNDING

Funding iLabs in terms of provision of adequate networking/internet accessibility (bandwidth problem) and suitable operating systems could be on the high side.

This could be offset by the networking of polytechnics in a particular region, for example the south-east, south-west, south-south. Funds for this project could be accessed through the Tertiary Education Trust Fund (TETFUND) intervention under the following subheads.

- i. Capacity building for the system operator to keep the ilabs secure
- ii. Provision and maintenance of the operating systems. [12]

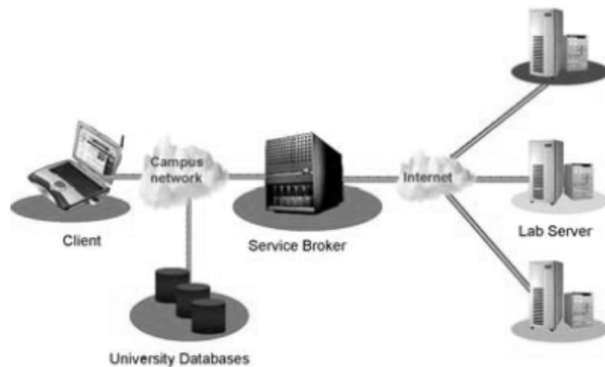


Fig 1. Typical MIT ilab architecture

• SYSTEM REQUIREMENT

Since ilabs are computer based, it is expected that the computer system will meet up with the following conditions:

- Windows 2000, XP, Netscape 4.7 (or newer) with Java Plugin 1.4.2 or greater, Internet Explorer 6.0 (or newer), with Java Plugin 1.4.2 or greater
- MIT Athena Computing Environment (Sun and Linux based machines

only), Mozilla, with default Athena settings Solaris: Java Plugin 1.4.2 or greater with Mozilla 1.7.5

- Linux: Java Plugin 1.4.2 or greater with Mozilla 1.7.5 [7]

TYPICAL ILAB EXPERIMENT IN ELECTRONICS

Presented is a typical ilab experiment on MIT ilab platform

Objective: The Lab measures voltage-current characteristics of a semiconductor diode.

Resources: Agilent 4155B - Semiconductor Parameter Analyzer: It performs the required current and voltage measurements on any connected device such as a transistor or diode.

Agilent E5250A - Low Leakage Switching Matrix: Multiplexes the I/O signals from the Agilent 4155B

Agilent 16442A - Test Fixture: Houses a device or circuit that is connected to the system. Provides a means for the I/O signals from the Agilent 4155B to be broken out of their triaxial lines and connected to individual device terminals.

Agilent 34970A - Data Logger: Used with a digital multimeter module to record the ambient temperature of the lab for the student. This information is useful as input to device models/simulations.

All of this equipment is connected via a common GPIB communication interface to a computer that controls all three of the Agilent devices [8]

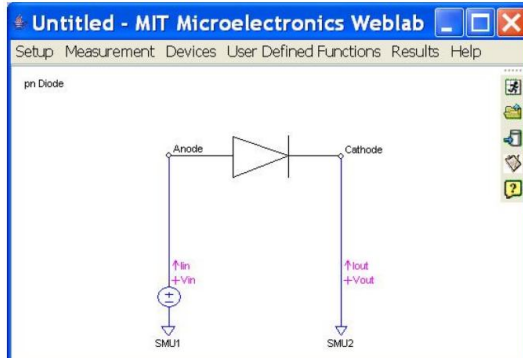


Fig 2: Semiconductor Diode under test

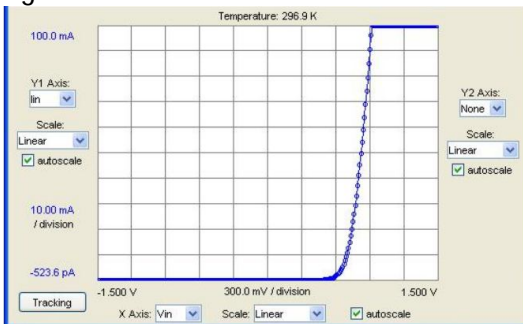


Fig 3: Output plot of diode characteristics



Fig 4. Agilent 4155B – Semiconductor Parameter Analyzer

The device uses sweep function to obtain the most recent result of the characteristics in-view. The result of the experiment as shown is also applicable to other semiconductor devices.

ILAB LIMITATIONS

- Bandwidth: The protocols for iLabs require efficient bandwidth for proper functionality. Hence results of experiment will be transmitted on plain text format due to bandwidth inefficiency [9]

- Installation and Maintenance Cost: Initial cost of installing an ilab may be considered high as the software is proprietary to the developers. Although it is scalable to different platforms, special skill will be needed to run and maintain a good security level for the ilab server. A typical ilab developer will need knowledge of C+, VisualBasic, SQL and Microsoft SQL server, ASP and IIS, web services, XML and ilab architecture. [10], [11] Experimental Setup: The nature of experiment setup is controlled by default settings. This limits destructive situations as can be obtained in physical experiment. For instance; the number of data points in the results generated is limited to a particular value. There is a maximum voltage or current that can be applied to the leads of a device, Only one applet instance can be opened per internet browser.

CONCLUSION

iLab is a viable tool for better comprehension of engineering techniques. Although it is a research in progress, it cannot currently be recommended as a complete replacement for hardware experiments especially in the developing world where there are enormous limitations to this high-tech learning tool. However, iLab is offers an unending opportunity for the development of engineering education especially in the polytechnics in the country. The limitations in the use of ilab do not out-weigh the opportunities it also presents. Hence it is

highly recommended that polytechnics should follow the line of this new high-tech development since they only need an upgrade to their already existing systems to meet up with the requirements for establishment of ilabs in their institution. Also, the attendant advantage of research networking provided by iLabs cannot be over-emphasized.

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