iLabs@MAK PIONEER COLLABORATION WITH EUROPE:

THE VISIT TO

CARINTHIA UNIVERSITY OF APPLIED SCIENCES,

VILLACH AUSTRIA

3RD -5TH OCTOBER, 2010

Report compiled by Doreen Orishaba

LIST OF ACRONYMS

ASIC	Application Specific Integrated Circuit
BSTE	Bachelor of Science in Telecommunications Engineering
CAUS	Carinthia University of Applied Sciences
CCOL^2	Center in Competence in Online Labs and Open Learning
CEST	Central European Summer Time
CPLD	Complex Programmable Logic Device
DATEx	Digital-Analog Telecommunications Experimenter
EE	Electrical Engineering
FOTEx	Fiber Optic Telecommunications Experimenter
FPGA	Field Programmable Gate Array
GOLC	Global Online Laboratory Consortium
iLab	Internet Laboratory
ISA	iLabs Shared Architecture
MAK	Makerere University
MIT	Massachusetts Institute of Technology
OLA	Online Laboratory Austria
READ	Remote ASIC Design Lab
REL	Remote Electronic Laboratory
REV	Remote Engineering and Virtual Instrumentation
VELO	Virtual Electronic Laboratory
USA	United States of America

1. Executive Summary

The iLabs@MAK- CAUS meet on 4th October, 2010 marked the genesis of the iLabs@MAK-Europe collaboration. Not only was it a forum for the two institutions to exchange insight into each other's activities and achievements, but it also became the platform for the agreement to: make contact with the Broad Band Internet Project connecting various sub-Saharan African countries so that Makerere University can be a direct beneficially; until the end of this year share at least one iLab from CUAS and Makerere University; for both institutions to forge a way forward for in a joint development of iLab Infrastructure for open source platforms (Linux); look into the possible setup of joint projects and search for founding; have Makerere University add it's Online Laboratories to the *Lab2go* web semantic; CUAS to try to get one place in the TARET Summer School for one Makerere student; free participation and accommodation in the EDUCON and REV Conferences in 2011 for one Makerere University student.

2. Background

Birthed at the Massachusetts Institute of Technology, USA by Professor Jesus del Alamo, the iLabs infrastructure has been adopted in various universities across the globe, including Makerere University in Uganda. The robustness and flexibility of the iLabs platform has attracted development of countless relevant internet-based remote laboratories for enrichment of the student learning experience among the numerous iLabs partners, which include iLabs Africa, iLabs Europe, iLabs China, iLabs USA, iLabs India, iLabs Australia and the CI-TEAM iLab Project, altogether leading to the formation of the Global Online Laboratory Consortium (GOLC).

The iLabs Shared Architecture (ISA) has been developed to provide a unifying software framework that can support access to a wide variety of online laboratories; whose users can be globally distributed across an arbitrary number of locations linked only by the Internet. To create a strong enough network, it is notably important that collaboration among the partners is greatly enhanced; a movement that iLabs@MAK is dedicated to.

Thus; upon the kind invitation from Professor Auer Micheal, the Head of the iLabs Team at Carinthia University of Applied Sciences, iLabs@MAK was represented by Micheal Kyesswa, Proscovia Nakazinga and Doreen Orishaba. The three patrons (who were at the time

doing internship with the Muehlbauer High Tech Company in Roding, Germany) endured the over 574km ride from Roding, Germany to Villach, Austria on the 3rd of October and were grateful that every minute of the seven-hour ride was worth it. Having set off from Roding at 09:00 (CEST), the iLabs@MAK patrons alighted from the train in Villach at 16:58 hours and were received by Mr. Danilo Garbi Zutin. He took them to the prior booked boarding house and later picked them for an extra-ordinarily sumptuous dinner, succeeded by a brief tour around the City Centre. Following the day's events, the patrons gratefully retired to their rest rooms to prepare for the next day.

3. Monday 4th October, 2010

Held at the CCOL[2] offices, the meeting started at 09:00am as scheduled. Both parties made presentations about the status of their teams, targets, challenges and details of the work done as par the year 2010. It was such a fruitful discussion.

3.1 Project Highlights at CAUS - by Prof. Micheal Auer

The host, Professor Micheal Auer welcomed the guests from iLabs@MAK and expressed his gratitude at their positive response to his invitation.

3.1.1 Team Composition

He went ahead to introduce the developers' team at the CCOL[2]; which composes of:

- 2 Professors
- 1 Senior Researcher
- 2 Researchers
- Lab Engineer
- Software Assistant
- 8 PhD and Master Student

3.1.2 Fields of Expertise and Resources

It was denoted that Prof. Auer, together with Prof. Andreas Pester, lead the team whose work spreads across the following fields:

- Virtual Laboratories
- Remote Laboratories

- Hybrid Laboratories
- XML Environments for data exchange and
- Semantic Lab Repositories

This range of work is supported by such resources as:

- OCW Mirror Server
- MIT iLabBroker Server
- Several Lab Servers
- CITRIX Application Sever
- Zope with EduCommons

It was reported that at the $CCOL^2$, there has been a transition from the Web 1.0 which included many web sites with unstructured textual content, to Web 2.0 where there are few large websites with specialized on specific types and content and now to the iLab Grid- Web 3.0 with many websites that have semantically structured content. In comparison with the other approaches to enabling of Online Labs, in the $CCOL^2$ point of view, the MIT iLabs Shared Architecture is best suitable for the Global Online Laboratory Grid.

3.1.3 CAUS Philosophy

At the $CCOL^2$, it is believed that there should be a clear separation between the environment and the experiment; use of commercial tools if possible, minimum effort on the Client side (only a web browser); effective re-use is possible and that implementations can also be used in other contexts.

3.1.4 Current Projects and Collaborations

The Projects Coordinated include:

i.   Remote Electronic Lab (REL)
ii.   Virtual Electronic Laboratory (VELO)
iii. Online Lab Austria
iv.   MARE- Joint European Master Degree Program Remote Engineering
v.   BIT 2010- Joint European Bachelor Degree in Information Technology

CCOL^2 partners in the PROLEARN, which is a Network of Excellence, LEAL (Interactive Programs in Industrial Automation), REAL(Remote Engineering and Application Laboratory) and OntoWiki, a Semantic Collaboration for Enterprise Knowledge Management, E-Learning and E-Tourism.

In the course of their projects, CCOL^2 partners with a number of Universities such as MIT in USA, FH Düsseldorf, Germany; Technische Universität Ilmenau, Germany; KTH Stockholm, Sweden; Princess Sumaya University Amman, Jordan; UNESP Sao Paulo Region in Brazil, Univeristy of Patras, Greece; University of Limerick, Ireland; University of Porto, Portugal; University Transylvania Brasov, Romania; Univeristy of Maribor, Slovenia; University of Barceleno, Spain; Technical University of Kiev, Ukraine; UNED Madrid Spain; University of Bucharest, Romania; University of St. Etienne, to mention but a few.

CCOL^2 is also in Bilateral Cooperation with many universities across the globe, including Stanford University, USA; TU Berlin, Germany; Columbia University, USA; University of Bridgeport CT, USA; Open University UK, University of Technology Sydney, Australia; Concordia University Montreal, Canada; University of Deusto, Spain; University of Zagreb, Croatia; University of Genua, Italy; University of Colimna, Mexico; University of Technology Bucharest; State University Moscow (MADI), Russia; Blekinge Institute of Technology, Sweden; University of Ljubljana, Slovenia; University of Reading, UK and also reaching out to Africa; University of Pretoria, South Africa and University of Bechar, Algeria.

3.1.5 Publications and Conferences

Together with its partners, CCOL^2 is also involved in publications that include:

- **iJOE**- International Journal of Online Engineering since 2005 (www.i-joe.org)
- **iJET**- International Journal of Emerging Technologies since 2006 (www.i-jet.org)
- **iJIM** – International Journal of Interactive Mobile Technologies - 2007 (www.i-jim.org)
- **iJAC** – International Journal of Advanced Corporate Learning since 2008 (www.i-jac.org)

CCOL^2 is also an active participant in the organization of the following conferences:

- ICL (International Conference on Interactive Computer Aided Learning), which has been held in Villach since 1998, in Hasselt in 2010 and in Bratislava in 2011.
- REV (International Conference on Remote Engineering and Virtual Instrumentation) since 2004, REV 2009 Bridgeport CT, 2010 Stockholm, 2011 Brasov.

- IMCL (International Conference on Interactive Computer Aided Mobile Learning) since 2006 in Amman, Jordan.
- ICBL (International Conference on Interactive Computer Aided Learning) since 2007 in Florianopolis, Brazil, 2011 Guatemala.
- ICELW (International Conference on E-Learning in the Working Place)-New York (2008)
- IEEE EDUCON (International Engineering Education Conference) start 2010 in Madrid, 2011 Amman, 2012 Morocco.

3.1.6 Summer School

CCOL^2 organizes Summer School for PhD and Masters Students with Industrial Partners NI; Agilent, EMONA Instruments. Below is an account of the venue and the topic handled since 2007.

1. February 2007 Villach Austria Remote Control
2. July 2008 Ilmenau, Germany Wireless Communications
3. July 2009 Maribor-Villach Applications of Remote Virtual & Technologies
4. July 2010 Blekkinge, Sweden Signal Processing
5. July 2011 Vienna, Austria
6. July 2012 Bilbao, Spain

3.1.7 Standard Lab Solutions

With the main goal of enabling *Easy-to-use Development Environments*, CCOL^2 has devised and implemented the following measures:

1. Remote Electronic Lab (REL) with real and Virtual Instruments – ELVIS and VISIR
2. Virtual Electronic Lab (VELO) based on Citrix Application Server
3. ASIC Design Lab (Hybrid Lab)
4. MicroWeb Server (Embedded Web Server)
5. Semantic Lab Portal (lab2go)
6. XML Data Exchange Tools

Examples of Labs currently in use include: the Hybrid Lab, the Online ASIC Design Lab and use of the READ hardware.

3.1.8 Future Prospects

For the future trends, CCOL[2] plans on:

- Formation of Collaborative Labs (Collaboratories) which is a collaboration between groups of users
- Development of mobile labs and mobile users
- Promotion of Distributed Labs
- Development of more hybrid or mixed reality labs
- Global dissemination of developed labs

3.2 Report from Makerere University - by Doreen Orishaba

Notable in its work, iLabs@MAK has achieved the following:

i. Growth from one developer in 2005 to a **dynamic sustainable team** of more than 17 undergraduate student developers, 4 graduate developers, a Research Coordinator, the Project Administrator and the Principal Investigator.

ii. **Development of iLabs** in the fields: Digital Electronics, Communication Theory, Digital Transmission, FPGA Based Digital Electronics, Fiber Optic Communications, Digital Signal Processing and Control Systems Engineering Control.

iii. **Integration of iLabs into Curricula**: The developed iLabs have been integrated into the programs B Sc. Electrical Engineering, Telecommunications Engineering and Computer Engineering in the Faculty of Technology. The Microelectronics Lab has also been outsourced from MIT.

iv. **Acquisition of Equipment**: The development and Integration of the iLabs has been supported by such hardware as 5 NI ELVIS II boards, 1 EMONA DATEx board; EMONA FOTEx board, NI FPGA board, NI SPEEDY 33, QNET DC Motor Trainer, LabVIEW ARM, LabVIEW 2009, 2 Lego Robotics Kits and a Networked Computer Lab with 14 workstations.

v. **Publications**: The paper entitled 'Developing Online Laboratories for Modulation and Combinational Logic Circuit Analysis Using NI ELVIS II Platform, published by IEEE- CS, was presented at the ITNG2010 Conference in Nevada, Las Vegas. Another entitled 'New Dimensions in Teaching Digital Electronics: A Multimode Laboratory Utilizing NI ELVIS II, LabVIEW and Multisim was presented at the

REV2010 Conference in Stockholm. A chapter was contributed to the Teaching With Online Laboratories and Pedagogical Design Book Project on Internet-Based Labs.

vi. **Collaboration with** MIT, NI and the other African partners UDSM and OAU.

vii. **Training Workshops**: iLabs@MAK organizes various workshops to orient the student users of the remote labs, help developers enhance their skills and also prepare the new teams of researchers in the pertinent fields.

viii. Initiation of collaboration with other Ugandan universities to spread the iLabs embrace to include Busitema University and Kyambogo University.

ix. **Outreach to secondary schools** through facilitation of training in the applications of LabVIEW and MULTISIM, and organization of the Robotics Challenge.

x. Formation of the **National Remote Engineering Consortium**: iLabs@MAK organized the first meeting geared towards this cause in November 2009 and is planning the second meeting for November 2010.

The various challenges faced by the project in the due course were also aired out. These included limited bandwidth, insufficient funding for the numerous activities, inadequate equipment and relative rigidity among the intended users of the iLabs.

To curb these limitations, Prof. Auer volunteered to contact the in charge of the Broad Band Internet Project connecting various sub-Saharan African countries so that Makerere University can be a direct beneficially; and also to liaise with such organizations as National Instruments Foundation and EMONA Instruments to provide more support.

After a brief tea break, a detailed account of the experiments developed and done was given.
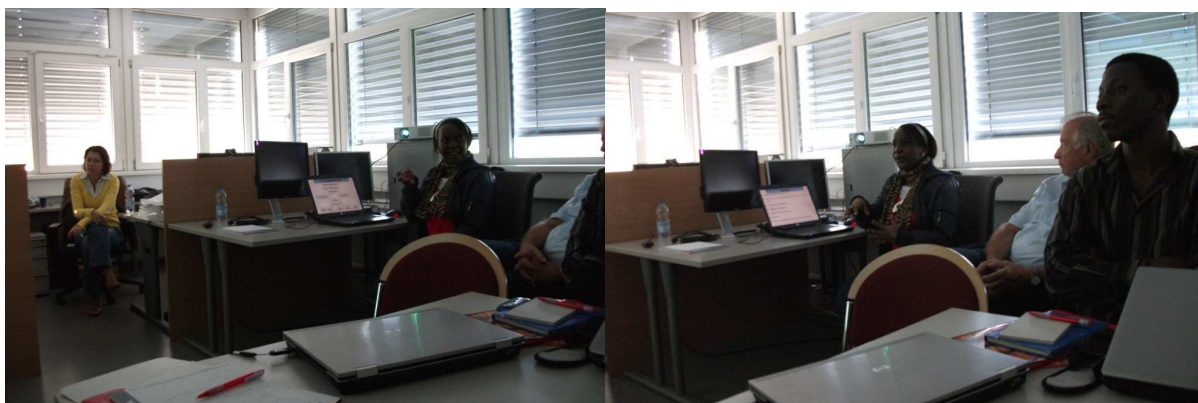
During the Presentations: L-R: Tina, Doreen, Prof. Auer, Kyesswa

3.3 iLabs at Makerere University - by Micheal Kyesswa

3.3.1 Deployed Labs

Various batched labs have been developed and deployed to support the programs:

- Filter Circuits used in Network Theory I – 2nd year BSc E and BSTE

- Logic Gate Characterization used in Introduction to Digital Electronics –1st year BSc. EE and BSTE

- Amplitude Modulation in Communications Engineering I – 3rd year BSc. EE & BSTE

- Resistor characterization used in Circuit Theory I - 1st year BSc. EE and BSTE

- Frequency Response of RLC circuits for Circuit Theory I – 1st year BSc. EE & BSTE

- Precision Rectification used in Electronic Circuits - 2nd year BSc. EE and BSTE

- Half wave rectifier circuits used in Circuit Theory I - 1st year BSc. EE and BSTE and Electronics 1 for BSc Computer Eng.

- Diode Characterisation used in Physical Electronics I – 1st year BSc. EE and BSTE and Electronics 1 for BSc Computer Eng.

- The two BJT Characterization experiments from MIT for use in Electronics Circuits for 2nd year BSc. EE and BSTE

For each lab, more than 160 students carry out the experiments and as part of coursework contributing to their final mark.

3.3.2 Interactive Labs

For the first time, research was done in interactive iLabs in the year 2009/2010. Four fields were covered: Fibre Optic Communications, FPGA, Control Systems and Digital Signal Processing. The version 3.0.2 of the Merged Service Broker was built, giving support to LabVIEW 2009.

3.3.3 Improving Existing iLabs

To ensure quality of the availed Labs, the Makerere Team seeks to work on the following:

- Integrating the Frequency Domain Functionality of the EMONA DATEx into the ISA

- Scaling the MAK Digital Electronics iLabs to support Synchronous Logic Circuit Experiments

- Integrating Data Acquisition, Monitoring and Control Capabilities into FPGA Labs

- Developments of a generic Linux-based Lab Server

3.3.4 Vision 2012

iLabs@MAK has a vision of having iLabs integrated in the entire curricula of the programs BSc EE, BSTE and BSc Computer Engineering by the year 2012. Currently, research is going on in the development of iLabs in the fields Solar Cells Technology and Radio Frequency Engineering, as well SMS Scheduling for Interactive Labs.

Having heard the engagements at Makerere University, the hosts also took time to explain the work going on at CCOL[2] in detail.

3.4 Online Laboratories at CAUS - by Danilo Garbi Zutin

3.4.1 Remote Electronics Lab

The REL makes use of both the real and virtual instruments- the NI ELVIS and the VISIR.
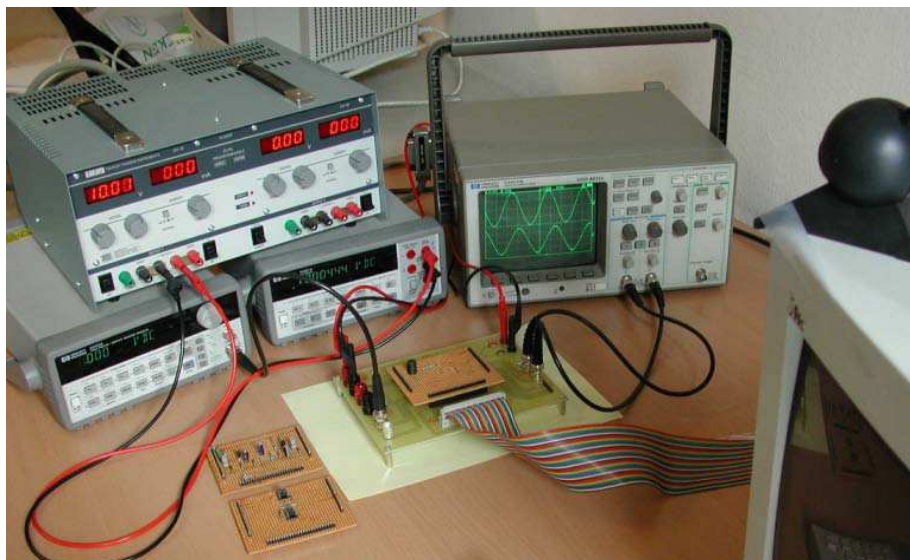
3.4.2 The Virtual Electronic Lab

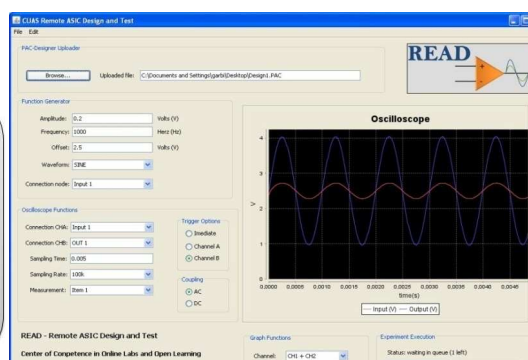This was developed at CAUS and is a part of the Online Laboratory Austria.
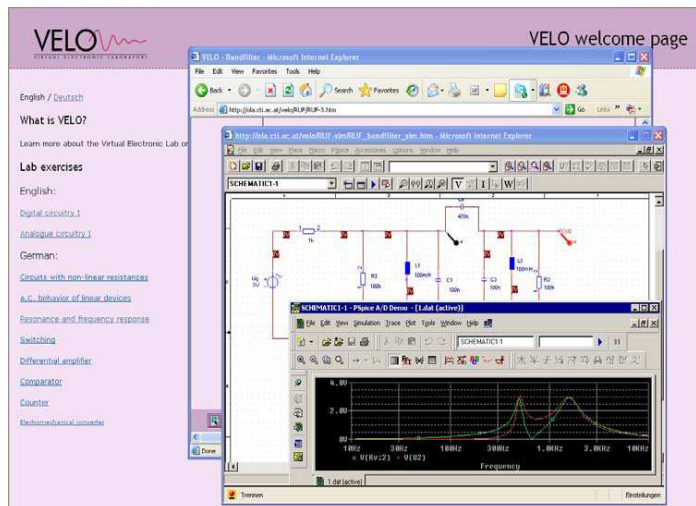
3.4.3 Mixed Reality Lab/ Hybrid Lab

This integrates different kinds of online labs for example use of Java Applets and movies for instruction purposes, Simulation Tools and Remote Lab for measurements and tests. An example of the Hybrid Lab is the Microprocessor Remote Lab which is developed with the partner Universitat Politecnica du Cataluña, Barcelona.

The Remote ASIC Design Lab (READ Lab) is another Hybrid Lab. It is a combination of a virtual lab and a remote lab. It is an online development of Digital (Xilinx) and Analog (Lattice) ASICs. For implementation, an ASIC (Digital/Analog) design system is run on a lab server, a simulation of the design using PAC- Designer 5.0 is then also run on the lab server, and a download of the design is run on the connected hardware (evaluation boards). Tests and measurements are done with real or virtual instruments via the internet. The READ hardware allows for realization of Electronics Experiments with an analogue programmable device (ispPAC10) and can also be integrated with the iLabs Shared Architecture. The READ Client is delivered as a Java Applet and provides a GUI for the user that facilitates the visualization of measured signals. Graphing Functions are implemented with *JFreeChart Library*.
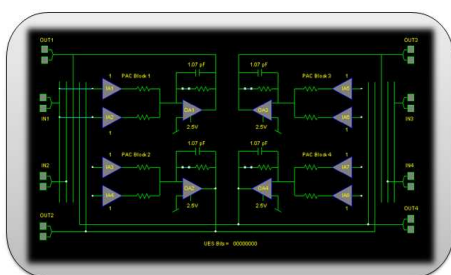
READ User Interface   *PAC Designer User Interface*

The ispPAC Uploader Module is an extra module added to the experiment engine and ensures that the desired circuit is being tested. It is developed with the PAC-Designer Software Development Kit and provides an API for accessing functions. The . PAC Files are XML based describing the PAC-Designer simulation parameters and Information for the JTAG interface. The client reads the .PAC file, wraps it inside the experiment specification XML string and sends it to the Lab Server.

Lunch Break

The Austrian hospitality is unquestionable. Before hearing from the next presenters, the guests were treated to a hearty meal at one of the city restaurants, washed down with refreshing drinks and sharing of experiences from the developers with diverse origins and culture.

To facilitate exchange of the ilabs, CAUS has taken a step further in developing an interesting forum for sharing the formulated labs.

3.5 Lab2go- a Semantic Framework to Publish and Exchange Online Laboratories - by Christian Maier

Lab2go is a semantically enriched repository for online laboratories. The invention of this forum was motivated by the need to:

- Develop a generic description model with semantic web technologies

- Provide Communication channels for researchers and users

- Improve search mechanisms

- Facilitate the access to online laboratories

The Semantic Web provides techniques to create models linking different resources by means of properties; and provides techniques to query data based on the properties. The models that can be created are Resource Description Frameworks (RDFs) and Web Ontology Language (OWL).
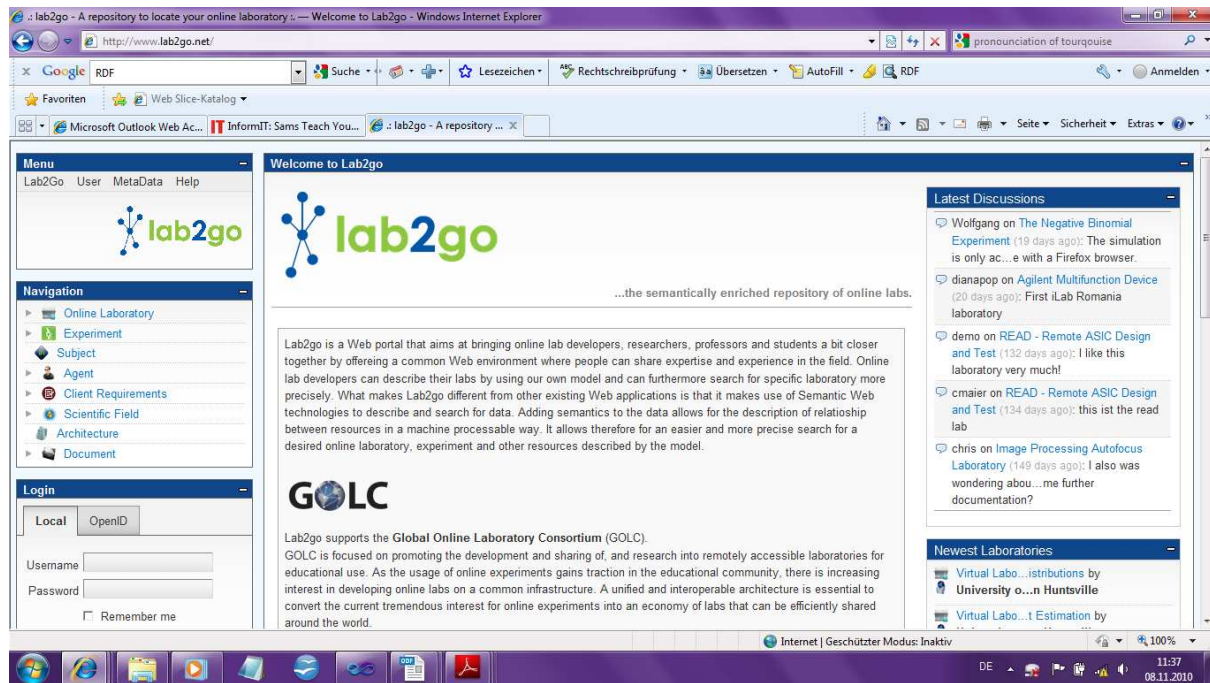

The Lab2go Home Page: **http://www.lab2go.net**

With *Lab2go*, the following scenarios are possible:

- Editors can create and edit Metadata

- User Feedback can be accessed through use of Comments and Rating

- Different Search Mechanisms- Facet based browsing, use of filters, keyword search as well as tagging.

3.6 iLab Romania- by Diana Pop

iLab Romania is one of the projects from Transylvania University of Brasov, managed by Prof. Doru Ursuti under the Center for Valorization and Transfer Competence (CVTC). It is accessible on following the link ***http://ilab.unitbv.ro/***. This is a sign of the good partnership between CAUS and TU, Brasov.

The first implemented laboratory was the **Conduction Measurement (Four Probe Method)**. It measures the conductivity and Hall Parameters of thin films for nano-structured materials.
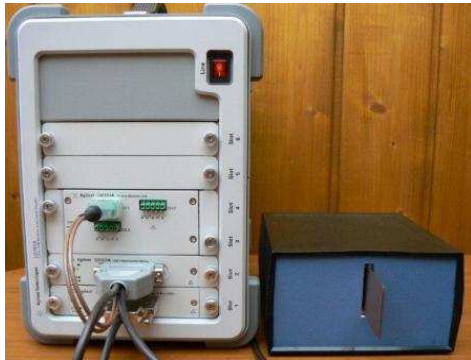
Hall Measurement System   *Agilent USB Device Attached*

CPLD Laboratory

The CPLD lab is a Digital Electronic Interactive Laboratory developed at and used in one of the lectures from Remote Engineering Master Program at the CAUS. The real device was developed by the Technical University Ilmenau, Germany.

The major aim of the lab was to develop a system for remote prototyping and testing of digital systems that allow users to perform tests on real devices remotely over the Internet. The digital system was designed with the Altera MAX+ Plus II development Environment.

3.7 Crowning of the Day

After the undoubtedly enlightening presentations, the guests were given a tour around the institute's remote labs server room as well as the conventional laboratories. Unlike Makerere's case where the electronics labs are 'mobile' (the equipment has to be carried to and from the room to do an a conventional lab), the labs at CAUS are spacious and well equiped. They also host demonstrations of some students' projects, as shown below. Of the particular interest was the robot they assembled and configured with walking control, object identification and object location modules; and another that can solve Rubik' cube.

Part of the Server Room

One of the Conventional Labs
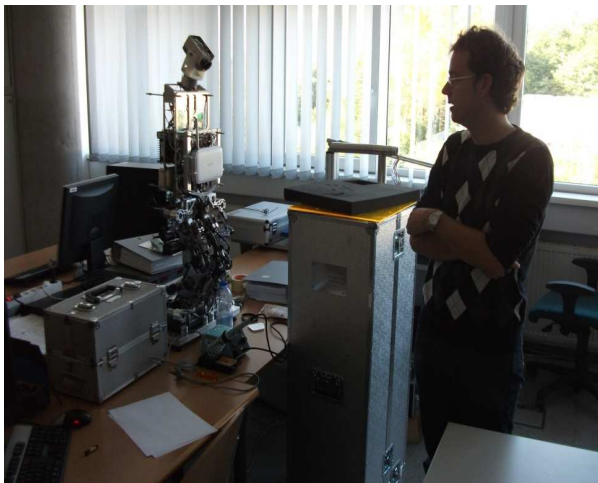
Some of the Student Projects

Well knowing the stay was not a long one, the hosts still wanted their guests to 'have it all'. Being an adventurous crew, the guests were taken for a trip to the mountains, had a moment at the boundary that separates three countries: Austria, Italy and Slovenia and were also treated to the mouth-watering Italian Pizza.

Prossie Giving a Vote of Thanks

At the Mountain Top

On the Streets of Italy   *Devouring the Italian Pizza*

Grateful for the irreplaceably fruitful day, guests retired to their rooms, and were seen off at the train station the next day at 8:40am. They endured another 7-hour ride back to Roding, ready to encourage the fostering of the new-born collaboration.

4. Meeting Pointers and Recommendations

i.   This was the first official meet between CCOL[2] of CAUS and iLabs@MAK. Though thousands of miles apart, both parties agreed that this collaboration should be fueled since they have some common goals. It is also hoped that CCOL[2] will be present for the iLabs Africa Meeting in Uganda in July 2011.

ii. To help curb the problems faced by iLabs@MAK due to limitations in bandwidth, Prof. Auer offered to initiate communication with the Broad Band Internet Project that is connecting various sub-Saharan African countries so that Makerere University can be a direct beneficially.

iii. Sharing of labs is a core cause to both institutions; hence until the end of this year, at least one iLab from CUAS and Makerere University should be shared. It is recommended that they identify which labs would be relevant and helpful for any of their supported programs/ courses and make them available.

iv. Among the current iLabs@MAK research interests is the exploration of the possibility of implementation of a Linux based server. Incidentally, it is also of interest to CCOL2. It was thus suggested that the two teams combine effort towards the development of iLab Infrastructure for such open source platforms.

v.   In the bid to support the iLabs@MAK budget, Prof. Auer also offered to look into the possible setup of joint projects and search for support and founding from such organizations as National Instruments Foundations and EMONA Instruments.

vi.   Makerere University was urged to add it's Online Laboratories to the **Lab2go** web semantic ***http://www.lab2go.net/,*** an online lab repository where developers can share expertise and experience in the field.

vii.   CUAS would try to get one place in the TARET Summer School for one Makerere student. Under the theme 'Signal Processing', the summer school in July 2010 was in Blekkinge, Sweden and is planned to be held in Vienna, Austria for the year 2011. Summer schools are organized by CCOL^2 together with industrial partners such as NI, Agilent and EMONA Instruments. Nothing beats gaining of experience more than exposure.

viii.   CAUS also waived off the fee for two papers from iLabs@MAK for publication in any of the IAOE journals *iJOE, iJET, iJIM* and *iJAC*.

ix.   Free participation and accommodation in the EDUCON and REV Conferences in 2011 for one Makerere University student.

Needless to explain, clearly collaboration with CAUS will go along way in giving iLabs@MAK a push towards realization of many of its goals, both the plans laid out and those yet to be drawn. I also believe the benefits will be two way because Makerere also has a lot to offer.

5. Acknowledgements