A VISIR Lab Server for the iLab Shared Architecture

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Abstract— **This paper describes the work done at the Carinthia University of Applied Sciences towards integrating VISIR-based labs on the iLab architecture. The Virtual Systems in Reality (VISIR) project is carried out by the Blekinge Institute of Technology, Sweden and features a platform for performing experiments in different domains.**

VISIR; iLab Shared Architecture; online laboratories; web services.

I. INTRODUCTION

The VISIR system developed by the Blekinge Institute of Technology, Sweden provides an extraordinarily flexible environment in which students can construct and test different circuits. The modularity of the VISIR hardware permits for some flexibility level concerning the resources (circuit components and lab equipments) students have at their disposal to construct and test circuits. Beyond this, the VISIR platform is remarkable in the interactivity it presents to students. Electronic circuits can be built and tested by students with a degree of freedom normally associated with a traditional, hands-on electronics laboratory. Integrating VISIR and iLabs turns out to be a way to provide several users from the iLabs community the possibility to use and/or deploy VISIR-based online laboratories inside their existing ISA framework.

This paper will present the first results of the work carried out at the Carinthia University of Applied Sciences in cooperation with the Blekinge Institute of technology to integrate the VISIR workbench as a Lab Server and client into the iLab Shared Architecture (ISA). An introduction about VISIR and ISA will be presented and then the actual proposed work will be detailed.

II. THE VISIR PROJECT

The VISIR (Virtual Systems in Reality) project was started by the Blekinge Institute of Technology, Sweden in partnership with National Instruments and Axiom EduTech in Sweden. The goals of the project were to create/modify software modules for online laboratories using open source technologies and to set up online lab workbenches [1]. The VISIR platform offers an online workbench where users can perform electronics experiments. Students can wire a desired circuit and use different laboratory equipment to test that circuit. The experiments performed with VISIR are highly interactive and allow a real time control of the equipment. One of the most interesting aspects of the platform is that it features an expandable relay switching matrix where lab instructors can attach several components as well as whole circuits depending on the experiments to be performed. With the help of a virtual breadboard implemented as a VISIR client module the students can assemble several different circuits with different component sets available and pre-configured by the laboratory administrator/instructor. The tasks of the lab instructors are to add components to the library, update the components list that specifies where the components are connected at the relay switching matrix and update the *maxlists*. The possible connections are specified in the components list.

The original VISIR online workbench offers the following flash client modules:

- A Breadboard for wiring circuits
- Function generator, HP 33120A
- Oscilloscope, Agilent 54622A
- Triple Output DC Power Supply, E3631A
- Digital Multi-meter, Fluke 23

The equipments used by VISIR are plug-in boards installed in a National Instruments PXI (PCI eXtensions for Instrumentation) chassis.

Due to the modularity and flexibility of the VISIR lab server and client software the task of integration it within ISA is made much less complex. More details on that will be provided in the following sections.

III. THE ILAB SHARED ARCHITECTURE

The iLab Shared Architecture (ISA) is a web services based software framework that aims at providing access to online laboratories assuming that they share some characteristics. It distinguishes the tasks of using a specific lab that comprises an experiment from the tasks of managing users' accounts, user authentication and other tasks that follow a lab session. This clear separation of roles is one of the main advantages of the iLab Shared Architecture. ISA does not focus in a specific type of laboratory but provides a set of general purpose functions for lab developers. ISA is divided into three tiers that provide different services. These tiers are client, Service Broker and lab server. The Service Broker is the core of the architecture and provides user authentication, authorization, experiment data storage and access to scheduling services. The lab clients and lab servers are lab domain specific. Fig. 1

depicts the iLab Shared Architecture with the distributed services.

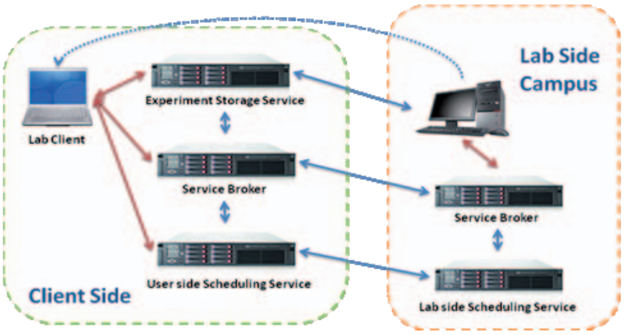

Figure 1. The iLab Shared Architecture

A. *Scheduling*

In the interactive iLabs, experiments cannot be queued for execution as a typical lab session of such an experiment might take several minutes to execute. Therefore, a scheduling service had to be implemented. The scheduling service of ISA consists of two separated Web services, the User-side Scheduling Service (USS) and the Lab-side Scheduling (LSS).

Only the Service Broker can authenticate a user and determine if he/she has the right to schedule a lab session. The user uses the USS to schedule a session for a lab, based on the available time slots published by the LSS. The LSS is responsible for setting the policies for a specific lab and can run with different USS's and lab servers. The policies mentioned might be a lab setup, etc. In order to use the ISA scheduling services, an Online Lab must be built in a way that scheduling for a specific user will be ensured [14].

B. *Ticketing*

The scenario involving an interactive experiment the level of complexity is much higher as other services are involved in the authentication process. The authentication was implemented in the form of ticketing. This mechanism allows some services to issue tickets that allow the access to some resources. A ticket coupon is the authorization item transmitted between the services [14].

A typical scenario involving this mechanism would be the following. As soon as a student logs in and is authorized to execute an experiment, tickets are created along with a coupon representing the collection. The coupon is passed to the lab client. In order to connect to the lab server, the client sends the coupon to the lab server that retrieves than the ticket with the Service Broker. If a valid ticket is returned, the user is authorized for the amount of time reserved to use the lab. Also for storing the data with the ESS, a ticket coupon is passed to the ESS, which retrieves the data storage ticket. Ticketing is also based on Web services and must be provided by the developer of the lab server [14].

IV. INTEGRATION OF VISIR INTO ISA

In order to allow iLab users to perform experiments with the VISIR platform it was decided to implement a VISIR iLab lab server taking as a basis for the development the existing Time of Day lab server. Therefore some design requirements had to be specified:

1. Use ISA interactive services to store experiment results and schedule lab sessions
2. Use the original VISIR flash client, measurement and equipment servers
3. Allow teachers/instructors to create pre-configured experiments

By comparing VISIR and iLabs it is obvious that both have some overlapping characteristics and services, but also different design goals. The iLab Shared Architecture is not focused in any specific type of experiment but rather in providing mechanisms for the creation and maintenance of a lab session by means of standard interfaces based in Web Services regardless the nature of the online laboratory.

The model adopted by ISA to deliver online experiments facilitates the practice of sharing resources (online laboratories) without the burden to manage users from other institutions.

The VISIR Web Application and ISA adopt different approaches to deal with authorization to use resources and with user management.

ISA implements a ticketing mechanism to deal with authorization to use resources. When access to a resource is requested a ticket is issued by the domain Service Broker registered to this specific resource. The Service Broker redirects the user to the requested resource and forwards credential information along with the request. These credentials are a coupon ID, passkey and the ticket issuer GUID (Global Unique Identifier) that the resource being accessed uses to retrieve the ticket from the ticket issuer (Service Broker) via the Service Broker Web services interface. This mechanism is used by the interactive iLab shared architecture to authorize access to distributed resources. The type of the ticket may vary according to the resource being accessed (Experiment execution, Manage Lab Server, etc). The ticket is an XML document and the information contained in its payload might vary according to the ticket type. For example, a ticket of an experiment execution request has in it payload the following information:

- Experiment Storage Server Address
- Start Execution Time
- Experiment Duration
- User Group Name
- Service Broker GUID
- Experiment ID
- User Time Zone

In iLab group policies rather than user policies are used. Observing the ticket payload above one notice that only the user group information is given to the lab server, what means

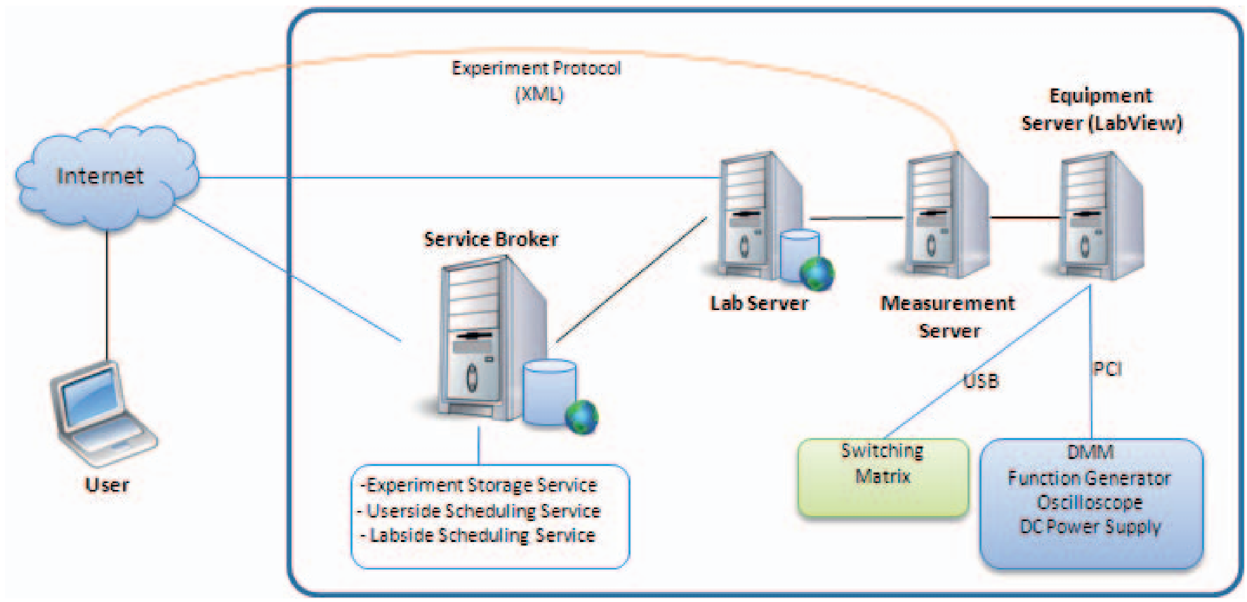

Figure 2. VISIR as an iLab Lab Server

that the lab server does not know the identity of the user executing the experiment.

The lab server, service broker and the other interactive services from ISA should accomplish the same functionalities that the original VISIR Web application does, that means provide the mechanism to load the flash client and maintain the direct communication between the client and the measurement server. Furthermore, as detailed previously in this chapter, it should provide the flash client with information about the modules and components to be loaded as well as necessary information the measurement server needs to authenticate a client before it is allowed to request other commands. Fig. 2 depicts the overall view of the system. Basically this picture shows the interactive services of ISA replacing the original VISIR Web application.

Another feature provided by the VISIR Web interface is the possibility to manage and prepare laboratory experiments that will be available for the students. This means creating a pre-configured profiles with a components set or a pre-assembled circuit on the virtual breadboard for a specific laboratory exercise. These functionalities are very specific for the VISIR Electronics laboratory and were integrated into the lab server management interface.

By using the iLab group policy an administration group on the service broker was created that gives access to the management functions and other configuration interfaces of the VISIR Lab Server (e.g. Process Agent Self Registration, experiment management, etc). Only users which are members of this group have access to the management interface.

On the client side the original flash modules were used. They add an extremely important value to the experiments carried out with VISIR because they do embody pedagogical aspects and resemble the real instruments' interfaces.

The client modules are loaded by a Web application where the user is redirected to perform the experiments. This application retrieves the credential information from the URL query portion and uses it to retrieve the ticket from the service broker (if it has not been stored on the lab server database). This Web application loads the flash modules and populates a list with available experiment setups previously created by the laboratory instructor.

The flash client interface with the virtual breadboard can be seen on Fig. 3. A list with all prepared experiments is populated. These experiments were created by the lab instructor via the lab server administration interface and are stored in the lab server database.

The experiment client is delivered as a Flash application and resembles real instruments used in a real laboratory. Each instrument is implemented as a Flash module and can be dynamically loaded as the instruments are needed. A JavaScript enabled browser loads the Flash client and passes several parameters to the client. Some of these parameters determine the Flash modules to be loaded, the components available in the components bin and circuits implemented on the breadboard. When one of the available experiments is selected by the student, the flash modules are reloaded and the the desired components to be loaded in the components bin is passed to the flash application via *flashvars*.

Conclusion

The VISIR platform for electronics experiments provides a highly flexible online workbench as circuits can be built and tested in a similar way as in traditional hands on laboratories. Due to that reason we believed that providing a VISIR iLab lab server could bring valuable assets to the iLab Shared Architecture. In the other side, this approach would allow iLab users to take advantages with the use of VISIR and foster collaboration.

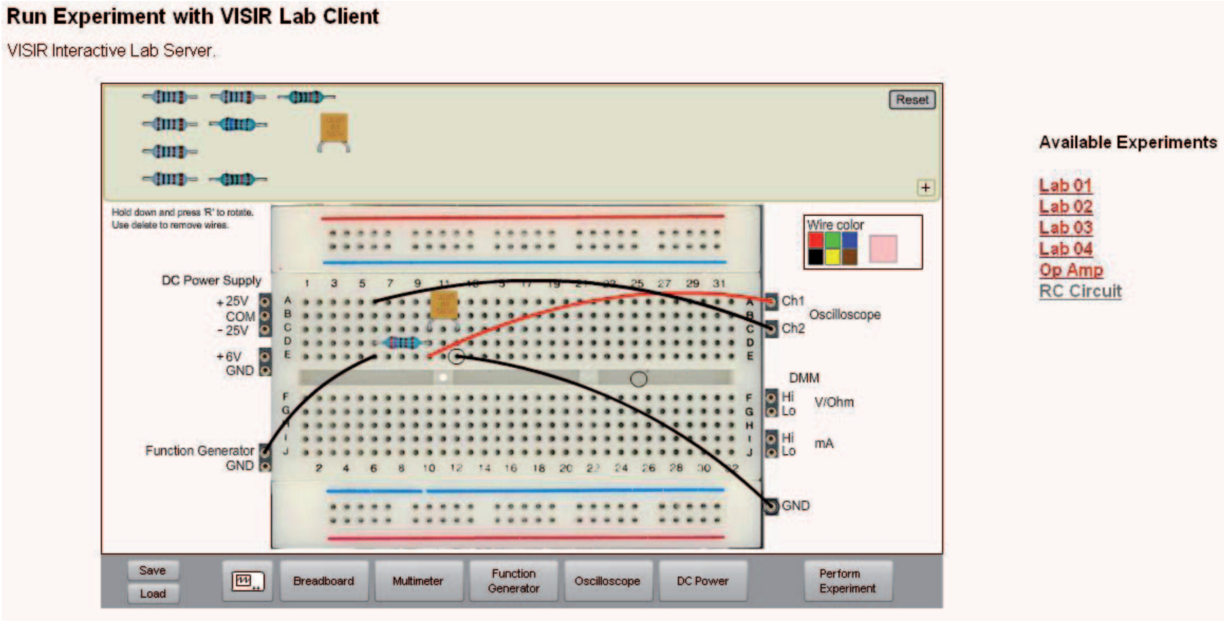

Figure 3. The VISIR Lab Client

The iLabs Shared Architecture was built based on the philosophy that each institution or university willing to use Online Laboratories hosted in other institutions should be responsible for their own users. This responsibility should not be delegated to the institution hosting the labs or even to the Online Lab owner. Therefore, it is desirable that each institution have its own Service Broker, although, it might not make sense to have a Service Broker if someone intends to have only one lab server. Beyond these issues that concern the philosophy of ISA, there are absolutely no technical restrictions or limitations against other practices.

Due to the advantages that ISA provides we decided to pursue this idea to integrate a VISIR lab Server and make VISIR experiments available to ISA users.

Moreover, remote systems can be very useful when applied to solutions involving the often substantial costs of transporting people or equipment. Different institutes and schools could share experiments and knowledge in a collaborative manner that parallels real-life working conditions. Also, by using remote solutions, it is possible for institutions with more limited financial resources to take advantages of expensive equipment installed at other institutions by means of a cooperative network of remote systems. From that perspective, users, educators and students could more efficiently take advantage of the use of online labs if these are available inside of a common framework, that means, being deployed by means of standard interfaces.

REFERENCES

[1] M. E. Auer, W. Gallent, The Remote Electronic Lab as a Part of the Telelearning Concept as the Carinthia Tech Institute (Published work style). Villach, Austria, 2000.

[2] National Instruments Corporation: “LabView Basics I Course Manual”, Austin, TX: National Instruments Corporation, 1998.

[3] W. Gallent, “Remote Electronic Lab (Thesis or Dissertation style),” Ms. dissertation, Dept. of Electronics., Carinthia University of Applied Sciences., Villach, Carinthia, 2000.

[4] http://www.w3schools.com

[5] C. Mergl, “Comparison of Remote Labs in Different Technologies (Thesis or Dissertation style),” Ms. dissertation, Dept. of Electronics., Carinthia University of Applied Sciences., Villach, Carinthia, 2006.

[6] URL: http://www.ni.com

[7] Sam Lee and Mayur R. Mehta, “Establishing a Remote Lab for Teaching Enterprise Application Development”, Information Systems Education Journal, Vol. 4, No. 50, pp 1-7, August 8, 2006.

[8] James E. Corter, Jeffrey V. Nickerson, Sven K. Esche, Constantin Chassapis, “Remote Versus Hands-On Labs: A Comparative Study”, 34th ASEE/IEEE Frontiers in Education Conference, Session F1G, 20–23 October 2004, Savannah, GA, USA.

[9] Qin Shuren, Bo Lin and Liu Xiaofeng, “Development of the Networked Virtual Instrument Lab for Vibration Measuring Based on Microsoft.Net”, Instrumentation and Measurement Technology Conference, IMTC 2004, Como, Italy, 18-20 May 2004.

[10] “NI Educational Laboratory Virtual Instrumentation Suite (NI LVIS)”, http://zone.ni.com/devzone/cda/tut/p/id/3711.

[11] I. Gustavsson et al. “A Flexible Electronics Laboratory with Local and Remote Workbenches in a Grid”, International Journal of Online Engineering, Vol 4, No 2 (2008).

[12] V. J. Harward, J. A. del Alamo, S. R. Lerman P. H. Bailey, J. Carpenter, et. al., "The iLab Shared Architecture: A Web Services Infrastructure to Build Communities of Internet Accessible Laboratories," Proceedings of the IEEE , vol.96, no.6, pp.931-950, June 2008.

[13] H. Soumare, R. Schroff, J. L. Hardison, et al. „A Versatile Internet-Accessible Electronics Workbench with Troubleshooting capabilities“, REV 2010 Conference, Bridgeport CT, USA, 2010.

[14] Hardison, J. L., DeLong, K., Bailey, P. H and Harward, V. J. 2008. Deploying Interactive Remote Labs Using the iLab Shared Architecture, 22-25 October 2008, NY, Saratoga Springs.

[15] I. Gustavsson et al., “The VISIR project – an Open Source Software Initiative for Distributed Online Laboratories”, *Proceedings of the REV 2007 Conference*, Porto, Portugal, June 25 – 27, 2007.