Sharing laboratories across different Remote Laboratory Systems

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***Abstract*—An educational remote laboratory is a software and hardware tool that enables students to remotely access real equipment located in the university as if they were in a hands-on-lab session. In order to be able to increase the curricula of universities, software infrastructures and toolkits that make the development and maintenance of remote laboratories easier arose, such as the MIT iLab project, the Labshare Sahara project, or WebLab-Deusto. Making different systems collaborate at infrastructure level is highly desirable so as to successfully share laboratories with different characteristics. This contribution summarizes the integration of WebLab-Deusto laboratories inside the iLab Shared Architecture, as well as the integration of iLab batch laboratories inside WebLab-Deusto.**

***Keywords*-distance learning; technology enhanced learning; remote laboratories; interoperability**

I. Introduction

The Labshare project survey [1], made on all 34 Australian universities offering undergraduate engineering programs, suggests that remote labs offer superior features in terms of flexibility, utilization, space saving, and safety issues. A unique feature is that they can be federated, so two remote universities can exchange their labs and therefore having twice more labs in their curricula. Indeed, the survey cited above reflects that interviewed executives were more interested in getting involved for the pedagogic merits of the remote labs.

In order to exploit such a federation of remote labs, a software infrastructure that makes it possible to develop, deploy, manage and share remote labs is required. Targeting this, different remote lab systems have arisen: MIT iLabs [1] [2], Labshare Sahara [2], WebLab-Deusto [3] [3]. The approaches taken by these systems are different, and even key features of some of them are not supported on the rest. This is common given the wide background differences in remote labs in terms of technologies and approaches to create the labs. In order to build an ecology of remote labs [4], not only a software infrastructure is required, but also a deep understanding of the student audiences. Since each system has been influenced by different student audiences, building bridges between two systems, when feasible, make it possible for each system to consume labs designed for other audience.

In this line, [5] proposed the LabConnector application protocol interface (API) as a bridge between iLabs and Labshare Sahara focused at protocol level, evaluating it with an iLab labs located in the University of Queensland being consumed by Labshare Sahara. While the bridge itself might have technical difficulties in becoming adopted by other systems, it represented a clear step forward in the interoperability of remote lab systems.

[1]http://ilab.mit.edu
[2]http://www.labshare.edu.au
[3]http://www.weblab.deusto.es

II. Bridging WebLab-Deusto labs in MIT iLabs

The iLab Shared Architecture (ISA) only supports scheduling through booking in the case of interactive labs, while WebLab-Deusto only supports queuing.

In order to handle this issue, the "no scheduling" option was selected in the ISA for the integration. Using this option, the ISA relies completely on the Lab Server, sending all the users that attempt to use the lab to the Lab Server. A Lab Server was implemented that uses this scheme to rely the scheduling on WebLab-Deusto. Being WebLab-Deusto labs presented as regular iLab labs, the authentication and authorization can be managed through the iLab tools. Furthermore, if the particular host institution desires to share the labs with other universities, it is possible using the ISA.

III. Bridging MIT batch iLabs labs in WebLab-Deusto

An experimental bridge of batch iLab labs into WebLab-Deusto has been implemented. This way, it becomes possible to consume iLab labs from WebLab-Deusto instances. So as to process the requests sent by iLab Lab Clients, a translator of a subset of the possible requests to their corresponding request type in WebLab-Deusto was developed. Once they have become WebLab-Deusto requests, WebLab-Deusto uses its pluggable scheduling system to handle the requests with a new scheduling plug-in for the iLab integration. This plug-in will convert the requests again and forward them to an external iLab Lab Server, therefore acting WebLab-Deusto as a Service Broker.

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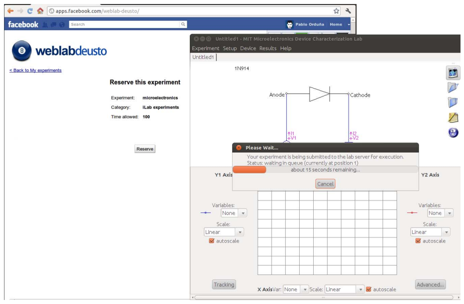

Fig. 1. MIT Microelectronics WebLab through WebLab-Deusto in Facebook

Given that it has been implemented as a plug-in in the core of the scheduling system of WebLab-Deusto, all the messages are automatically stored so educators can track the usage performed by students. The authentication and authorization is managed by WebLab-Deusto, and since it supports creating accounts and being authenticated through OAuth 2.0 with Facebook, iLab expermients can be used through it (fig 1).

Finally, being implemented as a plug-in also allows WebLab-Deusto to use other plug-ins of WebLab-Deusto, so inter-institutional chains can be built. As described in figure 2, students can access WebLab-Deusto in their institution (Institution A in the example), and through the plug-in resolver they can use an iLab plug-in contacting an iLab Lab Server in the same institution. Furthermore, through the federation plug-in, it is possible to connect WebLab-Deusto with other WebLab-Deusto in the Institution B, which has also set up the iLab plug-in with yet another institution (Institution C). More complex chains, even supporting distributed load balance, can be built with this approach.

However, this bridge is experimental since only those request types required to validate, submit, wait and retrieve the results. Those request types required to store user information in their session have not been implemented, since WebLab-Deusto lacks of this interesting feature, it could not be implemented in the bridge.

IV. Conclusions

In the presented bridges, the major advantage is that students already used to one system can consume labs of the other using the solution they know and for which they already have credentials. Students and educators of one institution can use federated laboratories developed even in other framework.

In the case of WebLab-Deusto being consumed by the iLab Shared Architecture, it enables the use of WebLab-Deusto using the iLab federation model. This means that if an iLab Service Broker has a number of WebLab-Deusto labs included, it can share these to other iLab Service Broker. For instance, the Service Broker at the University of Deusto can share WebLab-Deusto labs through the iLab system to the iLab-Europe Service Broker [4], so users there will automatically be able to consume those labs. Additionally, the iLab Shared Architecture benefits from three features provided by WebLab-Deusto: a) consuming other federation model, so users of an iLab Service Broker bound to a WebLab-Deusto instance will be able to use labs of other WebLab-Deusto instance if the two WebLab-Deusto instances are federated; b) support of queue based interactive labs; c) load balancing of labs among different copies -i.e. if there are two copies of one WebLab-Deusto laboratory, it will manage the queues so the load of users will be balanced in a transparent way for the iLab system-.

[4] http://www.ilab-europe.net/

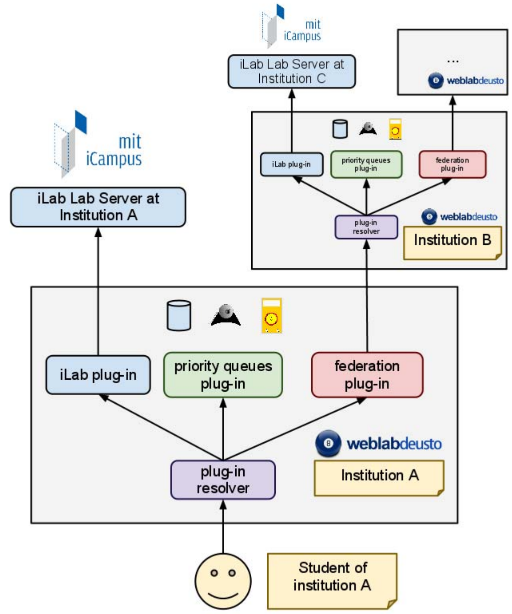

Fig. 2. Architectural overview of the iLab on WebLab-Deusto integration

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