iLabs: A Scalable Architecture for Sharing Online Experiments

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Abstract *— We have developed a software architecture to support a scalable community of online experiments for use by students at multiple campuses. This work is based on MIT's over five year experience in deploying online laboratories in several engineering disciplines (reported at ICEE 2002 and 2003). The iLab architecture provides highly reliable, generic services that are independent of any particular experiment domain, including services for user authentication, authorization, experiment storage, and scheduling. We have been guided by two architectural principles. First, we have striven to free the developers of an online experiment not only from as much code development as possible, but also from user management responsibilities and policy issues. For example, our architecture favors (but does not require) that students' experiment results should be managed and stored by a generic server on their own campus (termed the "Service Broker") rather than by the server that executes experiments (termed the "Lab Server"). In fact, the Service Broker provides all the services necessary for student management without imposing any fixed policies. The faculty who teach the students (rather than those implementing the labs) are free to set policies on who can share results, on who counts as a "student" of a particular class, etc. The developer of the Lab Server grants access not to individual students, but instead to groups of students credentialed by the student's own Service Broker. Second, we believe that the architecture should make no assumptions about the platforms used by students, experiment implementers, or university IT support. Clients and servers communicate via web services. We have already completed a reference implementation for "batched experiments", those in which the entire course of an experiment can be specified before execution begins. This implementation has been tested successfully by deploying the MIT Microelectronics WebLab (an online microelectronics device characterization test station) over the Spring 2004 semester in a large undergraduate subject at MIT involving over 100 students. In this case the generic Service Broker, implemented in the .NET environment, mediated between a Windows 2000-based Lab Server and a graphic Java client. Students and faculty performed administrative operations using a standard browser over a secure web connection. We have extended the architecture to support interactive experiments and are in the process of building a prototype. We are also adding functionality to support searching for attributes in XML-encoded experiment result records. Our goal is for this architecture and our reference implementations to spur the development of new online laboratory experiences and encourage the formation of educational consortia to share the expense and management of online labs. We are already exploring its use to make several MIT labs available to colleagues in Europe, Africa, and the Middle East.*

Index Terms *— online experiments, web services, scalable architecture, laboratory consortium*