Online FPGA laboratory for interactive digital design

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Abstract *— Recent advances in digital electronics technology have had a huge impact on the learning situation for students enrolled in digital design courses. Up until now, Field Programmable Gate Arrays (FPGAs) have been used as small circuit-boards that incorporate buttons and small interactive features. The introduction of PCI-hosted boards with large FPGA devices enables students to utilize the power of designing real devices through a remote laboratory. Remote laboratories in other disciplines have been subject to development for several years and has proven effective with respect to hardware resources and availability[1]. The laboratory is built on Web Services to maximize the flexibility of hosting applications and give access to interfaces at different trusted levels. This is ensured through object oriented modeling of the hosting application. Securing a laboratory against unwanted access is of prime importance when dealing with hardware configuration modules. At the lowest levels of access, the system is vulnerable and service requests must be subjected to rigid fault checks. An application that emphasizes the different features in the PCI-based FPGA development board has been realized at the lowest Web Services interface level and with the highest trust. The application utilizes this interface to demonstrate the flexibility of the system topology on several levels of abstraction; from the lowest level where sub-applications interface the resources on the development board, to higher levels where sub-applications designed as separate learning modules present an easy to use visual interface for the user. A special design called One Instruction Processor is implemented as a prototype and presents a user interface comparable to those of common digital simulators and uses public domain software for simulation, allowing users to switch between simulation and physical execution views. A further development of course modules for digital design will aid students in their understanding of how high level languages are transformed into logical operations. Such modules can be designed for easy integration into learning objects and for interfacing with Learning Management Systems (LMS) that support the Shareable Courseware Object Reference Model (SCORM) [2].*

Index Terms *—Field programmable gate array, FPGA, Remote Laboratory, Web Services, digital design.*

[1] T. A. Fjeldly and M. S. Shur, *LAB on the WEB, Running Real Electronics Experiments via the Internet*, John Wiley & Sons, New York, NY (2003).
[2] Friesen K and Mazloumi N, "Integration of learning management systems and web applications using web services", *Advanced Technology for Learning, Vol.1, No.1, 2004, p16-24*