**Workshop Title:** Teaching With Embedded Xinu: An Inexpensive Hands-on Laboratory that Promotes Student Engagement with Operating Systems, Architecture, and Networking Curricula

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**Abstract:** The Nexos Project is an NSF-funded effort to develop inexpensive, hands-on, embedded system laboratory experiences with a high “wow factor” at multiple levels of the college computer science curriculum. This workshop will share ready-made curriculum resources that have been used successfully to teach hardware systems, operating systems, realtime/embedded systems, networking, and compilers with the Embedded Xinu platform at several colleges/universities. Commodity wireless router hardware or equivalent virtual machines, combined with freely-available software and tools, make for a powerful and flexible learning platform without having to fake any components. Come see what Nexos has to offer for your program.

**Intended Audience:** Undergraduate-level and introductory graduate-level educators interested in hands-on laboratory experiences in their systems courses.

**Presenter Background:** Dr. Dennis Brylow is an Assistant Professor of Computer Science at Marquette University. He has been using Xinu as a research and teaching platform for five years in courses ranging from lower-division computer organization and operating systems to upper-division and graduate-level embedded systems and networking courses. He has ported Xinu to multiple RISC platforms, and pioneered the use of inexpensive consumer devices as a target platform for experimental operating systems laboratories. Brylow’s prior Xinu papers in SIGCSE, WCAE (Workshop on Computer Architecture Education), WESE (Workshop on Embedded Systems Education) and *SIGBED Review* have outlined a coherent sequence of embedded system projects that can be woven through the standard undergraduate CS curriculum; this workshop will explore how Embedded Xinu is being used in a variety of academic institutions. Development of the Nexos Project is funded in part by the NSF
Course, Curriculum and Laboratory Improvement (CCLI) program (DUE-CCLI-0737476) and by Cisco Systems.

Dr. Paul Ruth is an Assistant Professor of Computer Science at the University of Mississippi. He adopted Xinu as a platform for teaching systems courses during the summer of 2008. He has replicated Brylow’s Linksys WRT54GL-based Xinu laboratory at the University of Mississippi and has used the Xinu laboratory for teaching Operating Systems courses at the under-graduate and graduate levels over three semesters. Further, he has ported the core Xinu projects to the QEMU machine virtualization platform as an effort toward reducing the initial cost of adopting Xinu and to extend the abilities of Xinu to internet-scale networking projects.

Brylow has previously led more than half a dozen workshops for educators.

Materials Provided:
Each participant will be provided with the following:

1. A “HowTo” guide on building the laboratory hardware, cross-compilation tools, and laboratory software.
2. The base Xinu system and a primer on modifying the system in order to design assignments appropriate for their courses.
3. Our curriculum guide for several existing courses.
4. An account on an existing Xinu laboratory with which they can experiment after the workshop.
5. Directions on using QEMU virtual machines with which they can experiment with many of the Xinu assignments using their own PCs.

Rough Agenda:
The workshop will be divided into three primary sections:

1. Constructing an Embedded Xinu Laboratory [1hr]
   - Modifying a Linksys WRT54GL [25mins]
   - Server hardware requirements/configuration [15mins]
   - Software Tools (Configuration and Use) [20mins]

2. Curriculum [1hr]
   - Documentation and Online Help [15mins]
   - Curriculum (Assignments) [30mins]
   - Automated Testing [15mins]

3. Hand-on Laboratory Experience [1hr]
   - Process Scheduling – a typical operating systems lab assignment [50mins]
   - Grade the projects [10mins]

Audio/Visual and Computer requirements: We require wireless Internet access, a digital projector, and a whiteboard / chalkboard. Laptop recommended. All OSs are supported, but wireless network connectivity and a secure shell client will be required.