Architectural Support for Cyber-Physical Systems

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Abstract
Cyber-physical systems are integrations of computation, communication networks, and physical dynamics. Although time plays a central role in the physical world, all widely used software abstractions lack temporal semantics. The notion of correct execution of a program written in every widely-used programming language today does not depend on the temporal behavior of the program. But temporal behavior matters in almost all systems, and most particularly in cyber-physical systems. In this talk, I will argue that time can and must become part of the semantics of programs for a large class of applications. To illustrate that this is both practical and useful, we will describe a recent effort at Berkeley in the design and implementation of timing-centric software systems. Specifically, I will describe PRET machines, which redefine the instruction-set architecture (ISA) of a microprocessor to embrace temporal semantics. Such machines can be used in high-confidence and safety-critical systems, in energy-constrained systems, in mixed-criticality systems, and as a Real-Time Unit (RTU) that cooperates with a general-purpose processor to provide real-time services, in a manner similar to how a GPU provides graphics services.

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Biography
Edward A. Lee is the Robert S. Pepper Distinguished Professor in the Electrical Engineering and Computer Sciences (EECS) department at U.C. Berkeley. His research interests center on design, modeling, and analysis of embedded, real-time computational systems. He is the director of the nine-university TerraSwarm Research Center (http://terraswarm.org), a director of Chess, the Berkeley Center for Hybrid and Embedded Software Systems, and the director of the Berkeley Ptolemy project. From 2005-2008, he served as chair of the EE Division and then chair of the EECS Department at UC Berkeley. He is co-author of six books and hundreds of papers. He has led the development of several influential open-source software packages, notably Ptolemy and its various spinoffs. He received the B.S. degree in Computer Science from Yale University, New Haven, CT, in 1979, the S.M. degree in EECS from the Massachusetts Institute of Technology (MIT), Cambridge, in 1981, and the Ph.D. degree in EECS from the University of California Berkeley, Berkeley, in 1986. From 1979 to 1982 he was a member of technical staff at Bell Telephone Laboratories in Holmdel, New Jersey, in the Advanced Data Communications Laboratory. He is a co-founder of BDTI, Inc., where he is currently a Senior Technical Advisor, and has consulted for a number of other companies. He is a Fellow of the IEEE, was an NSF Presidential Young Investigator, and won the 1997 Frederick Emmons Terman Award for Engineering Education.