It's About Time

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Abstract. All widely used software abstractions lack temporal semantics. The notion of correct execution of a program written in every widely-used programming language and in nearly every processor instruction-set today does not depend on the timing of the execution. Computer architects exploit the fact that timing is irrelevant to correctness with aggressive performance-enhancing techniques such as speculative execution, branch prediction, dynamic dispatch, cache memories, virtual memory, etc. While these techniques improve average case performance, they do so at the expense of controllability, repeatability, and predictability of timing. But temporal behavior matters in almost all systems, but most particularly in networked embedded systems. Even in systems with no particular real-time requirements, timing of programs is relevant to the value delivered by programs, and in the case of concurrent and distributed programs, also affects the functionality. In systems with real-time requirements, including most embedded systems, temporal behavior affects not just the value delivered by a system but also its correctness. This talk will argue that time can and must become part of the semantics of programs and computer architectures. To illustrate that this is both practical and useful, we will describe recent efforts at Berkeley in the design and analysis of timing-centric software systems. In particular, we will focus on two projects, PRET, which seeks to provide computing platforms with repeatable timing, and PTIDES, which provides a programming model for distributed real-time systems.

Biography

Edward A. Lee is the Robert S. Pepper Distinguished Professor and former chair of the Electrical Engineering and Computer Sciences (EECS) department at U.C. Berkeley. His research interests center on design, modeling, and simulation of embedded, real-time computational systems. He is a director of Chess, the Berkeley Center for Hybrid and Embedded Software Systems, and is the director of the Berkeley Ptolemy project. He is co-author of five books and numerous papers. He has led the development of several influential open-source software packages, notably Ptolemy and its various spinoffs. His bachelors degree (B.S.) is from Yale University (1979), his masters (S.M.) from MIT (1981), and his Ph.D. from U. C. Berkeley (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.