Reconfigurable Systems, New Tools and New Math

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Abstract

Computing hasn't changed much in nearly 50 years... That is, while the price/performance of computing hardware has improved dramatically over the years, and computers have gotten considerably easier to use, our underlying models of computation and our most common methods of hardware and software engineering have remained largely unchanged since the earliest days of computing.

Although the entire computing industry has been driven primarily by IC feature size (and thus Moore's law) for more than three decades, several new developments and trends would indicate that a sea change is imminent. Reconfigurable and adaptive systems will inevitably become the next mainstream computing technology, replacing a wide class of instruction-based and ASIC-based computers -- and making new and better tools not only desirable but essential.

We will argue that not only better tools, but new mathematical foundations are needed that permit grounded formal representations, unified and common to both hardware and software, from the earliest specification of a computation through to implementation and testing. Specification, design, verification, and debugging should be represented as a seamless whole, rather than by a collection of language extensions and ad hoc techniques.

Several new mathematical forms will be shown that hold promise for future engineering tools and the full realization of the power of reconfigurable computing.

Bio

Richard Shoup obtained his BSEE degree in 1965 and Ph.D. in Computer Science in 1970 from Carnegie Mellon University in Pittsburgh. His Ph.D. thesis was the first to explore programmable logic, a precursor technology to Programmable Logic Devices and Field Programmable Gate Arrays.

While waiting for reconfigurable hardware to become practical, Shoup became one of the first employees at the Xerox Palo Alto Research Center, where he built one of the first digital frame buffers and developed painting and animation software for applications in graphic arts. For his pioneering computer graphics work, Shoup later received several awards including an Emmy and an Academy Award. He left Xerox in 1979 to co-found Aurora Systems, an early manufacturer of digital videographics and animation systems, where he served as President and Chairman.

In early 1993, Shoup joined Interval Research Corporation in Palo Alto, where he worked in the areas of reconfigurable computing, hardware and software architectures, design tools, and mathematics of computation. In 2000, he co-founded the Boundary Institute, a small non-profit research group studying foundations of physics and mathematics. More recently, he has also consulted with a number of reconfigurable and adaptive computing companies in Silicon Valley.