Energy Awareness and Uncertainty in Design at Microarchitecture Level

Abstract

Power consumption has emerged as the most critical design constraint for both low power and high performance design drivers. While in the case of low power or portable applications battery lifetime increase is the target goal, for high-end systems the impact of sky-rocketing energy costs is exacerbated by increasing process and system parameter induced variability. Since decisions taken at microarchitectural level have the largest impact on both performance and power, on one hand, and variability, on the other hand, models and associated metrics are needed for their joint characterization and analysis. This talk addresses this problem by presenting microarchitecture-level statistical models for characterizing both process and system parameter variability by concentrating on variations induced by gate length and on-chip temperature variability. To assess how these variations affect or are affected by microarchitecture decisions, we propose a joint performance, power and variability metric that is able to distinguish among various design choices. As a design-driver for the modeling methodology, we consider a clustered high-performance processor implementation, along with its Multiple Clock-Domain (MCD), or Globally Asynchronous, Locally Synchronous (GALS) counterpart. Results show that, when comparing the baseline, synchronous and its GALS counterpart, microarchitecture-driven impact of process variability translates into 2-10% faster local clocks for the GALS case, while when taking into account the effect of on-chip temperature variability, local clocks can be 8-18% faster. If, in addition, voltage scaling is employed, the GALS architecture with DVS is 26% better in terms of the joint quality metric employing energy, performance, and variability.

Biography

Diana Marculescu is currently an Associate Professor of Electrical and Computer Engineering at Carnegie Mellon University. She received her M.S. in Computer Science from "Politehnica" University of Bucharest, Romania in 1991 and her Ph.D. in Computer Engineering from University of Southern California in 1998. She is the recipient of a National Science Foundation Faculty Career Award (2000-2004), of an ACM-SIGDA Technical Leadership Award (2003), of the Carnegie Institute of Technology George Tallman Ladd Research Award (2004) and a Best Paper Award from IEEE Asia South-Pacific Design Automation Conference (ASPDAC 2005). Diana Marculescu is an IEEE-Circuits and Systems Society Distinguished Lecturer (2004-2005), a member of Executive Board of the ACM Special Interest Group on Design Automation (SIGDA) and a member of IEEE. Her research interests include energy aware computing, CAD tools for low power systems and emerging technologies (such as electronic textiles or ambient intelligent systems).