

# Programming Challenges for Petascale and Multicore Parallel Systems

Vivek Sarkar

Rice University  
vsarkar@cs.rice.edu

**Abstract.** This decade marks a resurgence for parallel computing with high-end systems moving to petascale and mainstream systems moving to multi-core processors. Unlike previous generations of hardware evolution, this shift will have a major impact on existing software. For petascale, it is widely recognized by application experts that past approaches based on domain decomposition will not scale to exploit the parallelism available in future high-end systems. For multicore, it is acknowledged by hardware vendors that enablement of mainstream software for execution on multiple cores is the major open problem that needs to be solved in support of this hardware trend. These software challenges are further compounded by an increased adoption of high performance computing in new application domains that may not fit the patterns of parallelism that have been studied by the community thus far. In this talk, we compare and contrast the software stacks that are being developed for petascale and multicore parallel systems, and the challenges that they pose to the programmer. We discuss ongoing work on high productivity languages and tools that can help address these challenges for petascale applications on high-end systems. We also discuss ongoing work on concurrency in virtual machines (managed runtimes) to support lightweight concurrency for mainstream applications on multicore systems. Examples will be given from research projects under way in these areas including PGAS languages (UPC, CAF), Eclipse Parallel Tools Platform, Java Concurrency Utilities, and the X10 language. Finally, we outline a new long-term research project being initiated at Rice University that aims to unify elements of the petascale and multicore software stacks so as to produce portable software that can run unchanged on petascale systems as well as a range of homogeneous and heterogeneous multi-core systems.