# Multi-Core and Heterogeneous High Performance Cloud Computing

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**Abstract:** Cloud computing has become the dominant paradigm for making computing available at scale while reducing the cost of providing that computing and allowing for dynamic provisioning. Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) all provide compute and storage capabilities to users at different levels of the software stack. IaaS provides infrastructure to users at the level of a virtual machine and boot image that can include an operating system and a base software stack, which can be specified by the user. Compute services are typically provided on commodity servers based on the x86 processor architecture that hide hardware architecture details by design. At the same time, data centers (including computing providers) are becoming limited by power and general-purpose single-core processor performance has leveled off and is even decreasing. Applications that require additional computational performance will increasingly rely on exploiting parallelism, compute accelerators (e.g. GPUs), and heterogeneous architectures.

In this talk, I will discuss research that we are performing to make heterogeneous, high-performance computing available in the cloud, and a research agenda based on introspective systems that will enable users and applications to manage parallelism and heterogeneity in increasingly complex and dynamic environments.

**Bio:** Stephen Crago leads the Adaptive Parallel Execution (APEX) group, which seeks novel ways to automate parallel computing. Such automation is becoming crucial as parallelism gains rapidly outpace manual programming abilities. The team includes experts in computer architecture, parallel programming, cloud computing, reconfigurable computing, wireless communication, and tool development.

Crago's interests include computer architecture, multiprocessors, high-performance, heterogeneous cloud computing, embedded processing, performance analysis and optimization. He also works in intelligent control of computing resources, and optimizations for processing time, throughput, efficiency and scalability and in algorithm implementation and hardware prototyping for novel computing architectures.

Crago joined ISI in 1997 and has led many projects, large and small, across the range of his research interests. He received his Ph.D. in computer engineering from the University of Southern California.