

Tools for High Performance Computing 2013

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Editors

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Front cover figure: Numerical simulation of a Kelvin–Helmholtz instability. Illustration by Lars Haupt, Center for Information Services and High Performance Computing (ZIH), 01062 Dresden, Germany

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Preface

Ongoing research towards specifications and designs for prospective Exascale systems highlights daunting challenges: billion-way parallelism, more levels of parallelism, a very low memory per core ratio, potential for mean-time-between-failures of less than a day, high potential for silent bit errors even in the presence of error-correcting code memories, reduced I/O bandwidths per core, and energy considerations that could require application awareness. Without upcoming disruptive computer hardware, the operation and usage of such systems will require extreme diligence. Research in areas such as parallel programming paradigms, runtime systems, compilers, operating systems, system libraries, and fault-tolerant algorithms can provide answers to some of these challenges, but will not be able to hide all of these effects from application developers.

Such a situation motivates the use of specialized tools for high performance computing (HPC) more than ever. Performance optimizers can aid application programmers in the identification of additional potential for parallelism, identify inefficient use of specific levels of parallelism, and incorporate feedback from energy monitors to identify wasteful resource usage. Debugging and correctness tools could integrate feedback from the operating system and fault tolerant system libraries to highlight the presence and impact of system faults. Simulators and automatic optimizers could identify inefficient data movement patterns, optimize process/thread mappings, or even highlight potential errors from silent memory faults.

This year's International Parallel Tools Workshop in Dresden, the seventh in a series of workshops that started in 2007, highlights how tools must carefully consider these challenges. Presentations on the state of the art in HPC tools both include activities to incorporate advances in programming paradigms, system libraries, and novel information sources, as well as new concepts for data analysis, presentation, correlation, prediction, simulation, and visualization in order to ensure that application developers will not be overwhelmed by the massive amounts of data

that tools can generate even for the Petascale era. The contributions of this year's workshop include the following topics:

- Performance analytics that maximize insight of performance data
- A workflow that captures the essential behavior of existing parallel applications and automatically generates benchmark codes with the ability to extrapolate said behavior at Exascale levels
- A simulator to analyze compute node performance and energy usage that overcomes the scalability limitations of cycle accurate simulators
- A performance prediction framework that both incorporates feedback from performance counters and energy measurements
- An approach to automatically detect and prioritize performance bottlenecks with differential analysis
- An evaluation of tool support for the task concept of the OpenMP shared memory programming paradigm
- Advanced functionality in an online performance analysis framework that includes an integration with automatic performance tuning
- An approach for holistic I/O analysis that combines application and system events
- An approach addressing a specific class of memory usage errors in GPGPU accelerated applications using CUDA

These topics highlight how tools face several of the challenges that increased hardware complexities impose. At the same time, the workshop presentations include updates and demonstrations of multiple widely available tools, as well as success stories on their use. Thus, the workshop serves both as a forum for application developers that want to apply tools, as well as for tool developers as a knowledge exchange. This audience combination enables fruitful and engaged discussions of current and future challenges in order to ensure that tools meet their requirements on current and future HPC systems.

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