Preface

Highest-scale parallel computing remains a challenging task that offers huge potentials and benefits for science and society. At the same time, it requires deep understanding of the computational matters and specialized software in order to use it effectively and efficiently.

Maybe the most prominent challenge nowadays, on the hardware side, is heterogeneity in High Performance Computing (HPC) architectures. This inflicts challenges on the software side. First, it adds complexity for parallel programming, because one parallelization model is not enough; rather two or three need to be combined. And second, portability and especially performance portability are at risk. Developers need to decide which architectures they want to support. Development or effort decisions can exclude certain architectures. Also, developers need to consider specific performance tuning for their target hardware architecture, which may cause performance penalties on others. Yet, avoiding architecture specific optimizations altogether is also a performance loss, compared to a single specific optimization. As the last resort, one can maintain a set of specific variants of the same code. This is unsatisfactory in terms of software development and it multiplies the necessary effort for testing, debugging, performance analysis, tuning, etc. Other challenges in HPC remain relevant such as reliability, energy efficiency, or reproducibility.

Dedicated software tools are still important parts of the HPC software landscape to relieve or solve today's challenges. Even though a *tool* is by definition not a part of an application, but rather a supplemental piece of software, it can make a fundamental difference during the development of an application. This starts with a debugger that makes it possible (or just more convenient and quicker) to detect a critical mistake. And it goes all the way to performance analysis tools that help to speed up or scale up the application, potentially resolving system effects that could not be understood without the tool. Software tools in HPC face their own challenges. In addition to the general challenges mentioned above there is the *bootstrap challenge*—tools should be there early when a new hardware architecture is

introduced or an unprecedented scalability level is reached. Yet, there are no tools to help the tools to get there.

Since the previous workshop in this series, there have been interesting developments for stable and reliable tools as well as tool frameworks. Also there are new approaches and experimental tools that are still under research. Both kinds are very valuable for a software ecosystem, of course. In addition, there are greatly appreciated verification activities for existing tools components. And there are valuable standardization efforts for tools interfaces in parallel programming abstractions.

The 9th International Parallel Tools Workshop in Dresden in September 2015 included all those topics. In addition, there was a special session about user experiences with tools including a panel discussion. And as an outreach to another community of computation intensive science there was a session about Big Data algorithms. The contributions presented there are interesting in two ways. First as target applications for HPC tools. And second as interesting methods that may be employed in the HPC tools.

This book contains the contributed papers to the presentations at the workshop in September 2015.[1] As in the previous years, the workshop was organized jointly between the Center of Information Services and High Performance Computing (ZIH)[2] and the High Performance Computing Center (HLRS).[3]

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Andreas Knüpfer
Tobias Hilbrich
Christoph Niethammer
José Gracia
Wolfgang E. Nagel
Michael M. Resch

[1] http://tools.zih.tu-dresden.de/2015/.

[2] http://tu-dresden.de/zih/.

[3] http://www.hlrs.de.

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