Universität Basel

Research Project

MLS: Multilevel Scheduling in Large Scale High Performance Computers

Third-party funded project

Project title MLS: Multilevel Scheduling in Large Scale High Performance Computers
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Departement Mathematik und Informatik / High Performance Computing (Ciorba)
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High performance computing systems are increasing in size (in terms of node and core count) and diversity (e.g., core types per node), leading to an increase in their available parallelism. Hardware parallelism can be found at several levels, from machine instructions to global compute sites. This results in several corresponding levels of software parallelism, from scalar instructions to global job queues. Unfortunately, exploiting the available hardware parallelism even at a single level is notoriously challenging, in part due to difficulty in exposing and expressing parallelism in the computational applications. Exposing, expressing, and exploiting parallelism is even more difficult when considering the increase in parallelism within each level and when considering more than a single or a couple of parallelism levels. Scheduling and load balancing are vital parts of any successful effort of coordinating and managing parallelism in high performance computing.

This project proposes to investigate and develop multilevel scheduling (MLS), a multilevel approach for achieving scalable scheduling in large scale high performance computing systems across the multiple levels of parallelism, with a focus on software parallelism. By integrating multiple levels of parallelism, MLS differs from hierarchical scheduling, traditionally employed to achieve scalability within a single level of parallelism. MLS is based on extending and bridging the most successful (batch, application, and thread) scheduling models beyond single or a couple of parallelism levels (scaling across) and beyond their current scale (scaling out).

The proposed MLS approach aims to leverage all available parallelism and address hardware heterogeneity in large scale high performance computers such that execution times are reduced, performance targets are achieved, and acceptable efficiency is maintained. The methodology for reaching the multilevel scheduling aims involves theoretical research studies, simulation, and experiments.

The expected outcome is an answer to the following research question: Given massive parallelism, at multiple levels, and of diverse forms and granularities, how can it be exposed, expressed, and exploited such that execution times are reduced, performance targets (e.g., robustness against perturbations) are achieved, and acceptable efficiency (e.g., tradeoff between maximizing parallelism and minimizing cost) is maintained? This proposal leverages the most efficient existing scheduling solutions to extend them beyond one or two levels, respectively, and to scale them out within single levels of parallelism. The proposal addresses four tightly coupled problems: scalable scheduling, adaptive and dynamic scheduling,

heterogeneous scheduling, and bridging schedulers designed for competitive execution (e.g., batch and operating system schedulers) with those for cooperative execution (e.g., application level schedulers).

Overall, the project aims to make a fundamental advance toward simpler to use large scale high performance computing systems, with impacts not only in the computer science community but also in all computational science domains.

Keywords parallel and distributed computing; large scale computing; multilevel parallelism; concurrency and data locality; dynamic load balancing; scheduling and load balancing; single-level scheduling; high performance computing; multilevel scheduling
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Add publication

Published results

3716004, Eleliemy, Ahmed; Mohammed, Ali; Ciorba, Florina M., Simulating Batch and Application Level Scheduling Using GridSim and SimGrid, Publication: Other Publications (Forschungsberichte o. ä.)

Add documents

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