EXASOLVERS

Extreme Scale Solvers for Coupled Problems

Exascale systems will be characterized by billion-way parallelism. Computing on such extreme scales requires suitable methods. The ExaSolvers 2 project hence investigates such methods:

- **Parallel adaptive multigrid** (G-CSC, University Frankfurt): The multigrid method is of optimal complexity and hence suited for extreme scale parallelism. The group from Frankfurt develops their own parallel multigrid framework ug4 which also adapts mesh resolution in order to increase the solution efficiency.
- **Time parallelization** (ICS, USI Lugano): In transient simulations, not only the simulation domain but also the investigated time frame can be divided and handled on different execution units in parallel in order to efficiently use the massive parallelism of future systems.
- **Optimization and inverse problems** (Trier University): By means of inverse problems, it is possible to determine simulation parameters that can't be measured due to e.g. subminiature structures, inaccessible environments, etc. However, usage of the aforementioned methods for optimization and inverse problems provides further potential to use exascale systems efficiently.
- **Uncertainty quantification** (RWTH Aachen): The group from Aachen uses low rank hierarchical tensors to quantify uncertainties of simulations, which allows to further increase the amount of parallelism that can be used efficiently.
- **Energy efficiency** (HLRS, University Stuttgart): Due to their massive parallelism, Exascale systems will require huge amounts of energy. We hence investigate methods to increase the energy efficiency of such systems on multiple levels, i.e. algorithmic efficiency, efficiency-aware implementation as well as adaption of hardware parameters (e.g. reducing the CPU's core frequency, known as Dynamic Voltage and Frequency Scaling)

A collaboration with the Japanese ADVENTURE project has been established in order to deploy the performance engineering expertise of the project partners from Japan on codes developed by the ExaSolvers 2 project. In return, ADVENTURE is going to integrate our methods into their framework.

In order to assess the developed methods, a simulation of transdermal drug delivery through the human skin with detailed resolution of the lipid scale is used as benchmark application.

Further Information:

https://gcsc.uni-frankfurt.de/simulation- and-modelling/ug4

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