6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

Designing and programming the ExaHyPE

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Key Words: *Hyperbolic equation systems, task-based programming, application programming interface, performance analysis interfaces.*

ExaHyPE is a H2020 project where an international consortium of scientists writes a simulation engine for hyperbolic equation system solvers based upon the ADER-DG paradigm. Two grand challenges are tackled with this engine: long-range seismic risk assessment and the search for gravitational waves emitted by rotating binary neutron stars. The code itself is based upon a merger of flexible spacetree data structures with highly optimised compute kernels for the majority of the simulation cells. It provides a very simple and transparent domain specific language as front-end that allows to rapidly set up parallel PDE solvers discretised with ADER-DG or Finite Volumes on dynamically adaptive Cartesian meshes.

This talk starts with a brief overview of ExaHyPE and demonstrates how ExaHyPE codes are programmed, before it sketches the algorithmic workflow of the underlying ADER-DG scheme. We rephrase steps of this workflow in the language of tasks. Our talk clarifies how such a task-based approach materialises in ExaHyPE applications and what implications arise to the user w.r.t. development attitude. From hereon, we demonstrate which features we provide to perform ExaHyPE performance analysis, and how we allow users to tune their codes to particular machines.

This is joint work with groups from Frankfurt's FIAS, the University of Trento, as well as Ludwig-Maximilians-University Munich and Technical University of Munich. We focus on results obtained on Intel KNL nodes provided by the RSC Group, on Broadwell results from Durham's supercomputer Hamilton, and on results from the SuperMUC phase 2 supercomputer at Leibniz Supercomputing Centre. All software is open source [1] and first papers including the software documentation [2] clarify aspects of the software design [3,4].

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