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

ZONAL FLOW SOLVER (ZFS): A HIGHLY EFFICIENT MULTI-PHYSICS SIMULATION FRAMEWORK

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Key words: *Code coupling, Multi-physics simulations, High-performance computing*

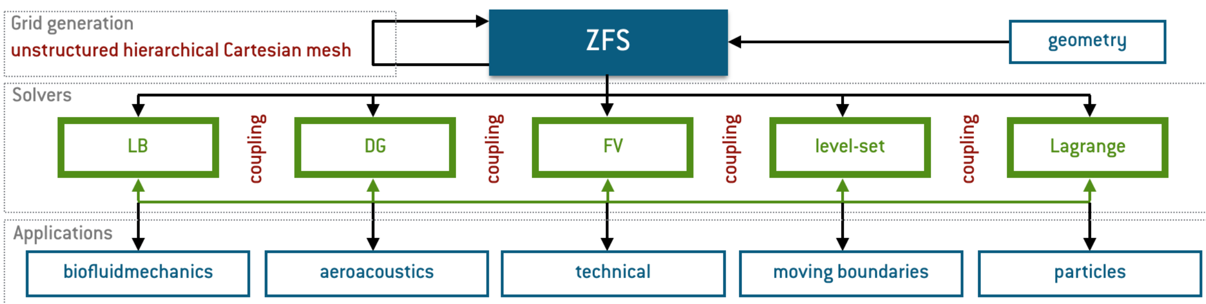

Figure 1: Overview of the coupling framework in ZFS.

Multi-physics simulations are at the heart of nowadays engineering applications. The trend is towards more realistic and detailed simulations demanding highly resolved spatial and temporal scales of various interacting physics. As a consequence, numerical codes need to run efficiently on high-performance computers to solve engineering problems in a reasonable amount of time. Therefore, the framework Zonal Flow Solver (ZFS) that features lattice-Boltzmann (LB), finite volume (FV), discontinuous Galerkin (DG), level-set, and Lagrange solvers (see Fig. 1), has been developed. The solvers can be combined to simulate, i.a., quasi-incompressible flow, aeroacoustics, compressible flow, moving boundaries, and particle dynamics. They act as individual modules, make use of geometry parallelization, feature dynamic refinement and dynamic load-balancing, and share an unstructured hierarchical Cartesian mesh which is generated with ZFS' massively parallel grid generator. ZFS is MPI/OpenMP parallelized, is ported to GPUs and KNL systems, and scales across top HPC systems such as the JUQUEEN system at Jülich Supercomputing Centre, Forschungszentrum Jülich, and the HAZEL HEN system at High-Performance Computing Center Stuttgart.
In the talk, the general structure of the framework, the parallelization approach, the involved solvers, their coupling, and their scalability will be presented. The presentation will be complemented by various multi-physics applications, i.e., coupled lattice-Boltzmann / particle simulations for respiratory flows, fully-resolved particle, fan, and combustion simulations, and finite volume / discontinuous Galerkin simulations for coupled LES / aeroacoustics problems. Furthermore, an outlook on future developments will be given.