Accelerating the numerical simulation of unsteady heavy-vehicle aerodynamics using GPUs and Culises

Abstract: Computational Fluid Dynamics (CFD) is a well-established tool in industry and academic research. A large part of simulations relies on the solution of large-scale systems of linear equations (SLEs), where the solution of a system can consume more than 50% of the total CPU time.

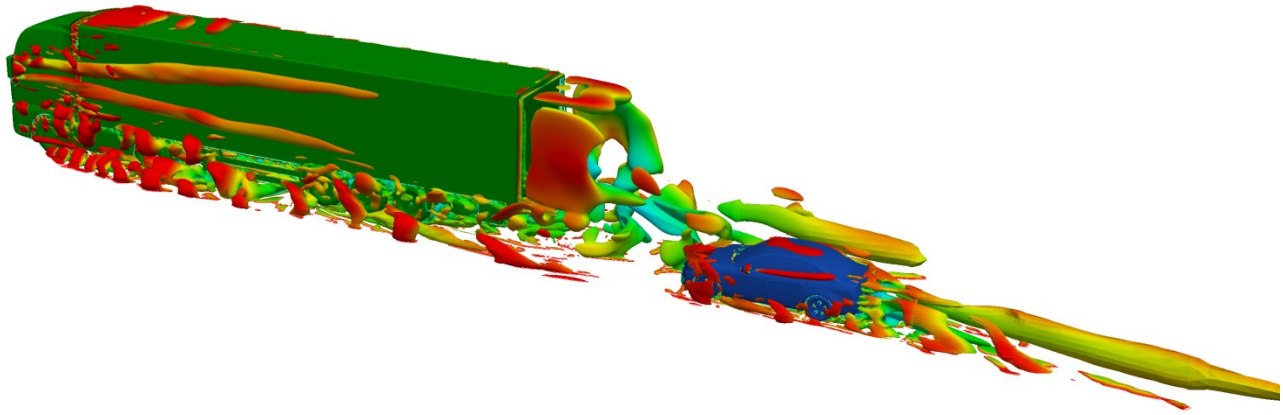

Figure 1: Aerodynamic flow simulation of car-truck interference with CFD solver OpenFOAM®.

CFD simulations of heavy duty vehicles (see e.g. Fig. 1) generate systems with tens of millions of unknowns and the solution of such systems can consume tens of thousands of CPU-hours on latest supercomputer hardware. Based on that, solution of SLEs is a promising candidate that can be offloaded from CPU to GPU processing. FluiDyna has followed this approach and developed Culises, a library for state-of-the-art solution of SLEs that is targeted on hybrid GPU-CPU platforms. In Fig. 2, a schematic view of our hybrid GPU-CPU approach is shown. Culises can be connected to parallel CFD codes, such as OpenFOAM®, via an application-specific interface. In this talk, the capability of Culises for acceleration of large-scale OpenFOAM® simulations is going to be shown. Therefore Culises employs computing power of multiple Tesla GPUs of Nvidia's newest Kepler generation.

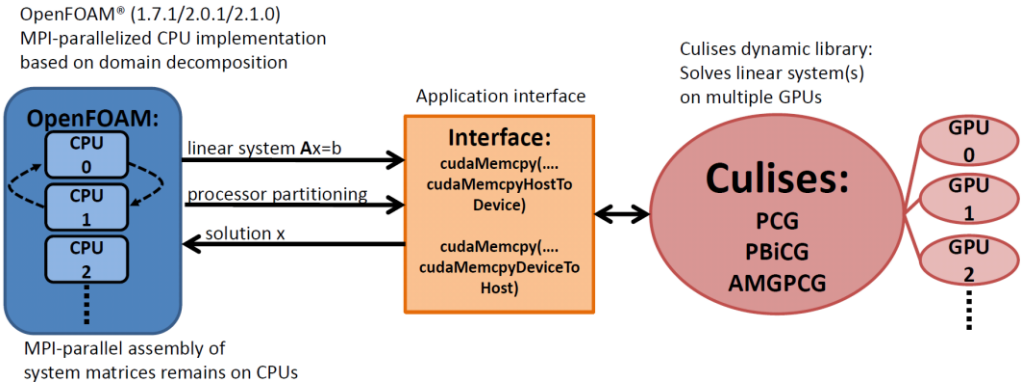

Figure 2: Schematic overview of coupling between OpenFOAM® and FluiDyna's library Culises employing multiple GPUs.