Coupled Unsteady Fluid-Dynamics and Aero-Acoustics Simulations of a Realistic Car Mirror - A Comparison of Cloud and High Performance Computing

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Abstract: Computational Fluid Dynamics is already an established tool in the development of a number of industrial devices of the aircraft and automobile industry, but other branches of mechanical engineering as well. In order to design the next generation of devices, simulations with high resolution in space and time are required. Continuously tightening regulations, such as restrictions on noise emission levels, increase the demand of simulation methods combining several physical aspects, such as fluid flow and noise.

The investigation of flow induced noise is still a demanding task. The wave nature of noise requires unsteady simulations where the noise sources are either prescribed by a time dependent model or extracted from a CFD simulation. This approach is a type of hybrid multi-physics simulation. Particularly for realistic devices with a complex geometry, the flow phenomena need a high spatial and temporal resolution in order to generate a reliable sound prediction. Such geometries require large simulation grids, an efficient parallelisation of the software and a parallel computing architecture with enough speed-up to perform simulations as a sequence of parameter studies leading to decisive results for the devices.

Facilities for High Performance Computing are frequently concentrated in computing centers operated by public funds. For commercial entities these are typically not accessible or only under restrictive conditions. Consequently, enterprises established and maintained their own HPC facility. Recent developments suggest the use of Cloud Computing architectures for performing parallelized simulations. This is particularly interesting for small enterprises which deliver simulation services to other entities but cannot afford to invest in and to operate a large simulation cluster.

The authors investigate flow and noise around an automobile side mirror as a study case for the performance of a coupled CFD and aero-acoustics software on at least two different architectures: a) parallel multicore-PC cluster and b) a Cloud architecture. The software is a development of the Karlsruhe Institute of Technology. On the Cloud architecture it is embedded into a platform concept developed by the authors which aims to offer simulation software and resources to SMEs. The platform work flow and its computational performance is analyzed against a typical work flow and performance of a HPC cluster.

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