Spliss: Transparent Integration of Emerging HPC Technologies into CFD Solvers and Applications

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Solving linear equation systems is an integral part of implicit methods in computational fluid dynamics (CFD). It affects their numerical robustness as well as their computational efficiency, in particular, for complex applications. The efficient solving of large linear systems that result from the discretization of the Reynolds-averaged Navier-Stokes equations (RANS) in CFD methods requires algorithms that are well adapted to the specific numerical problems, which is usually not covered by generic solver libraries. The Sparse Linear System Solver (Spliss) aims to provide a linear solver library that, on the one hand, is tailored to requirements of CFD applications but, on the other hand, independent of the particular CFD solver. Key design aspects of the library are computational efficiency and parallel scalability for current and emerging HPC technologies.

This presentation highlights the benefits of the Spliss library for CODA, the next-generation CFD solver for aircraft aerodynamics developed by DLR, the French aerospace lab ONERA, and Airbus. Focusing on the specific task of linear-system solving allows for integrating more advanced, but also more complex, hardware-adapted optimizations, while at the same time hiding this complexity from the CFD solver. One example in this presentation is the usage of GPUs. Spliss enables the execution of the computationally intensive linear solver on GPUs. However, the Spliss interface design provides this capability to a user in a transparent way. By that means, CODA can leverage GPUs without the necessity of any code adaption in CODA. In this presentation we evaluate first performance results of CODA using Spliss to run on a GPU cluster. In addition, we compare results with the new Spliss library to established libraries like PETSc to verify the correctness of the implemented methods as well as to evaluate the performance achieved with the different libraries.