High-Order GPU-Based Compressible Fluid Flow Solver for Unstructured Grids

by

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This presentation will discuss the development of a scalable and efficient high-order unstructured compressible fluid flow solver for GPUs. The solver utilizes energy stable flux reconstruction schemes in both tensor-product and simplex elements, allowing the achievement of arbitrary order of accuracy for flows over complex geometries. Because of the high arithmetic intensity associated with energy stable flux reconstruction schemes and their element-local nature, they are well suited for GPUs. The single-GPU solver developed in this work achieves speed-ups of up to 45x relative to a serial computation on a current generation CPU. Additionally, the multi-GPU solver scales well, and when running on 32 GPUs achieves a sustained performance of 2.8 Teraflops (double precision) for 6th-order accurate simulations with tetrahedral elements. In this talk, the techniques used to achieve this level of performance are discussed and a performance analysis is presented. To the authors’ knowledge, the aforementioned flow solver is the first high-order, three-dimensional, compressible Navier-Stokes solver for mixed unstructured grids that has been implemented for a multi-GPU cluster.