

A fully-automated workflow of 3D transient and adaptive simulations on national supercomputers

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ABSTRACT

Transient 3D simulations are well known for their incremental process by updating the evolving solution from one timestep to another [4, 5]. Some of them can take several days calculation over thousands of cpus. That is the case for aerothermal problems such as jet impingement cooling for engine cavities [1]. Beside the modeling and numerical challenges associated to such problems, the simulation scheduling and runs into supercomputers still a main issue of their deployment at large scales [3]. Indeed, the fault-tolerance handling and the walltime per job policy impose to supercomputer' users the implementation of dedicated checkpoint/restart capabilities to recover physical time. This task cannot only be considered as implementation issue but a problem dependent issue. The nature of numerical schemes; explicit or implicit; discretisations; static or dynamic (AMR) affect the policy of checkpointing and solution recovery and reconstruction.

The present work focuses on the methods and algorithms that underlie the high-fidelity analysis of Aerothermal problems. Solving such problems involves the coupling of unsteady Navier-Stokes equations and the heat transfer equation on complex geometries. The multiscale nature of the problem, the complexity of the geometry and the unsteadiness of the flow lead to a large-scale problem requiring a large amount of parallel resources.

We propose in this work a parallel adaptive finite element scheme that adapts the mesh dynamically with respect to the multiscale variation of the solution [2]. The finite element solution is used to drive the mesh adaptation in a fully parallel way. The proposed framework is used here to run a 3D complex jet impingement cooling system. The computation was executed over more than thousand cores for two weeks into national supercomputers.

Moreover, this work brings a new formulation of load balancing that takes into account the restarting issues. The restart targets a different amount of resources by a light and fast repartitioning procedure. A detailed analysis of this approach will be presented and discussed on realistic aerothermal test cases.

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