DEVELOPMENT OF A NEW NATIVELY PARALLEL LES FRAMEWORK BASED ON FOSS AND TARGETED TOWARDS EASE OF USE AND MAINTENABILITY

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During the investigation of the presence of Coherent Structures in numerically generated LES flow fields, the aging in house VKI Fortran LES code of the EA Dept. has shown a series of limitations and shortcomings that led to the decision of relegating it to the status of Legacy Code and of discontinuing its development.

A new natively parallel LES solver has then been developed in the EA Dept., where all the shortcomings of the legacy code have been addressed and modern software technologies have been adopted both for the solver and the surrounding infrastructure, delivering a complete framework based exclusively on Free and Open Source Software (FOSS) to maximize portability and avoid any dependency from commercial products.

The new parallel LES solver retains some basic characteristics of the old legacy code to provide continuity with the past (finite differencing, staggered grid, multidomain, domain conformity), but improve in almost all the remaining aspects: the flow can now have all the three directions of inhomogeneity, against the only two of the past, the pressure equation can be solved using a three point stencil for improved accuracy, and the viscous terms and convective terms are computed using a Computer Algebra System, to derive discretized formulas in an automatic way. A new high resolution conservative scheme has been adapted to the three-dimensional staggered grid from a collocated bi-dimensional one, and a system of master-slave simulations has been developed to run in parallel a slave simulation (on 1 processor) for generating the inlet data for the master simulation (n-1 processors). The code can perform domain autopartitioning (Figure 1), has embedded documentation (Doxygen), has a CVS repository (version managing) for ease of use of new and old developers.

As part of the new framework, a set of Visual Programs have been provided for OpenDX, a FOSS powerful Flow Visualization and analysis tool, aimed as a replacement for the commercial Tecplot, and a bug tracking mechanism via bugzilla and a cooperative wiki for developers and users. The new solver is ready to be used again for Coherent Structures analysis, as confirms Figure 2, where the flow coming from the left invests a wall mounted cube inside a turbulent plane channel. In the Figure the "Q" Isosurfaces (Hunt-Moin criterion), representing Coherent Structures, are shown.

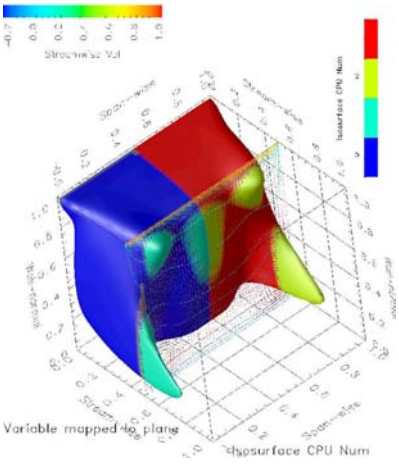
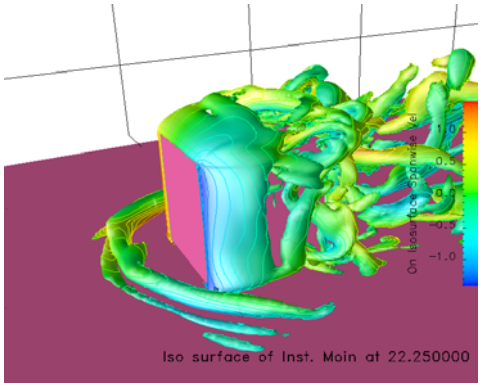


Figure 1: Domain autopartitioning, 4 CPUs rendering the same domain



Wall mounted cube inside a channel. the "Q" criterion shows the different flow topology in the front of the obstacle and in the wake.

Figure 2: "Q" Isosurfaces (CS) with spanwise velocity contours