Presenter: Donato Magarielli, GE AVIO SRL

Aeronautics Large-scale Pilot in Lexis: context, objectives and first outcomes

Playing in the aeronautical market, the demand for reduced fuel consumption is leading to new engine architectures, oriented towards an even higher propulsive efficiency. Nowadays, there are significant efforts to get increasingly reliable performance prediction, searching for more realistic solutions and using multi-physics simulation approaches able to anticipate problems, typically encountered in the detailed design phases. This implies the adoption of CPU-demanding, data-intensive and time-consuming CAE simulations based on sophisticated numerical solvers. The synergy among next-generation HPC/Cloud/Big Data management technologies are opening new scenarios for the design and optimization of aircraft engines, enabling innovative and faster investigation strategies and providing unprecedented levels of accuracy and detail.

Through the “Aeronautics Large-scale Pilot” work package in Lexis project, Avio Aero has launched a challenging research activity focused on significantly improving the feasibility and exploitation of advanced numerical modeling capabilities for critical components of aircraft engines. From both a digital technology and business perspective, Avio Aero intends to obtain a marked step change: less time-consuming computational analyses that exploit newly designed, improved and/or tightly coupled HW/SW components able to open the doors to the “real time” design approach. To meet this ambitious objective, the industrial applicability of last generation HPC/Cloud/BD platforms is under investigation by means of two aeronautical engineering case studies, one regarding a turbomachinery application and the other one referring to mechanical rotating parts.

More specifically, referring to the Turbomachinery use case, the improvement of TRAF, a CFD code developed by the University of Florence, is currently ongoing to drastically reduce the execution time of fluid dynamics analyses on low pressure turbines. Specifically designed to assist turbomachinery designers, the code solves steady/unsteady 3D, Reynolds-averaged Navier-Stokes equations in the finite volume formulation on multi-block structured grids. The last version of TRAF, that relies on a hybrid OpenMP/MPI code architecture and runs on only CPU-based HPC resources, has been profiled to evaluate its scalability, to detect any bottlenecks and to identify some action points for optimizing the running time. Moreover, development activities for profiling and enhancing a newly developed GPU-enabled release of this code are currently underway.

As regards the Rotating parts use case, the numerical investigations aim at assessing NanofluidX capabilities in simulating the multiphase flow inside a high-speed gearbox cooled with an oil-jet system. Conceived and optimized for use on clusters of GPUs, NanoFluidX, by Altair Engineering, is a smoothed particle-based hydrodynamics simulation tool to predict multi-phase flows around complex geometries under complicated motion, which are difficult to handle using CFD approaches based on Finite Volume Methods. In order to investigate the discretization level suited for well reproducing both the liquid and gas phase motion, this code has been tested in some simplified cases, consisting of an oil-jet directed towards a single wheel. Next steps will be aimed at studying the forces exchanged between gear and liquid, comparing results with torque experimental data as well as CFD simulations performed with a numerical code based on Finite Volume Method.