FLUSEPA - a Navier-Stokes Solver for Unsteady Problems with Bodies in Relative Motion: Toward a Task-Based Parallel Version over a Runtime System

1. Aerodynamic Solver

The aerodynamic solver of FLUSEPA is particularly suited for unsteady computations, even if they do not imply bodies in relative motion.

2. Motions and Intersections

Multiple meshes around several bodies. Boosters and the main stage are meshed independently. Load are gathered during aerodynamics computation then a DGF formulation is used to compute the relative motion. When necessary, a new intersection is computed.

3. Parallelization and Limitations

The parallelization of the aerodynamic solver relies on domain decompositions and ghost cells. Ghost cells (in gray) allow to communicate between different domains. Values of the neighbor domains are filled using communications.

4. StarPU : a runtime system

A Directed Acyclic Graph (DAG) is generated on the fly: submitting a task is a no-hanging operation. Tasks are then computed around the computational units.

5. Task generation (aerodynamic solver)

Use of a domain decomposition inside each node in order to generate tasks. For each sub-domain, cells and faces are considered differently and are represented by "handles" in StarPU. Using these handles and generation functions, tasks and dependencies are generated.

6. Current results and perspectives

Results in shared memory

Perspectives for the Aerodynamic solver

- Distributed version
  - Validate the results
  - Incorporate a load balancing system
  - Possible improvement by task description of the problem
  - Parallel iterations of the solver. The method only implies a global communication for setting the time step, but this is manageable in a different way.

Perspectives for the whole application

- Rewrite interaction with tasks
- Co-scheduled Interaction and Aerodynamics