

AMD Barcelona + FlowVision-HPC

Belgium, Leuven, 22 July 2008 – CAPVIDIA presents results of testing multi-processor AMD Barcelona server (provided by NIAGARA Distribution Company) on complex CFD problems modeled with FlowVision-HPC (v3.06).

NIAGARA Distribution Company (<http://www.niagara.ru/>) provided to our CFD team a 1U-server based on 4-core AMD processors Barcelona type for testing the server scalability on large CFD size problems. The server configuration contains 4 Quad Core AMD Opteron 8347 processors operating at 1.9 Ghz (<http://www.supermicro.com/Aplus/system/1U/1041/AS-1041M-T2.cfm>) and total memory of 56 Gb. The project was named Barcelona after the name of the processors.



Software improvements:

Intensive work on **Barcelona** server enabled to better understand behavior and improve performance of **FlowVision-HPC** algorithms when applied for solving large-scale CFD problems using multiple processors. Graphical monitoring of processor loading and use of the memory allowed the developers to reveal bottlenecks in the scalability. In particular, balancing problem of loading the cores/processors, delays in parallel calculations, synchronization of parallel calculations and memory usage have been investigated and significantly improved. Large memory size (RAM = 56 Gb) allowed running large size problems with over 12 million cells effectively helping in detecting and eliminating convergence problems.

Test-cases:

Test Case 1. Two twin planes fly one behind another (the plane in the back is higher than the front one – see Fig. 1). The Mach number equals to 0.75. The simulation objective is to determine aerodynamic forces and moments acting on the planes.

Test Case 2. Two twin race-cars drive one behind another (the car in the back is displaced to the left – see Fig. 2). The velocity equals to 300 km/h. The simulation objective is to determine aerodynamic drag forces and moments acting on the cars.

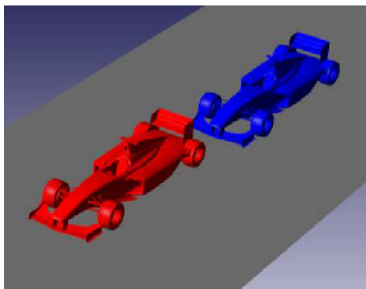


Figure 2. Geometry “Two twin race-cars”

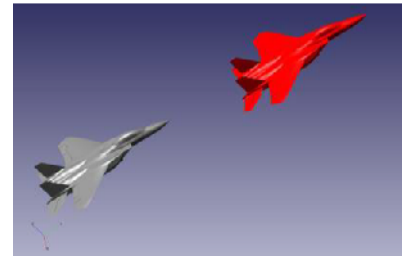


Figure 1. Geometry “Two twin planes”

Both test cases use very complex geometries requiring modeling with high number of cells to accurately resolve hydrodynamic effects.

Computational meshes and their decomposition

In both case we apply mesh adaptation to the surfaces of the objects (planes and cars) and inside volumetric objects encompassing them. The meshes are shown in Figs. 3, 4. The numbers of calculated cells in the first and second test-cases respectively are 6 059 622 and 3 201 704.

Decompositions of the meshes onto 16 processors are presented in Figs. 5, 6. Besides that, a grid comprising 12 082 310 cells was built for “Two twin motor-cars”. The grid is shown in Fig. 7, its decomposition onto 32 processors is demonstrated in Fig. 8 (only near-boundary cells are shown).

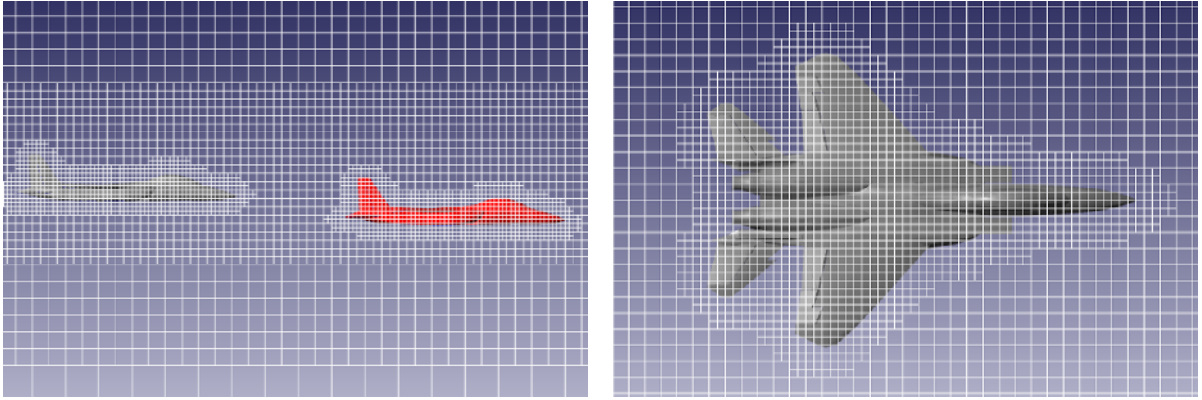


Figure 3. Adapted mesh for “Two twin planes”

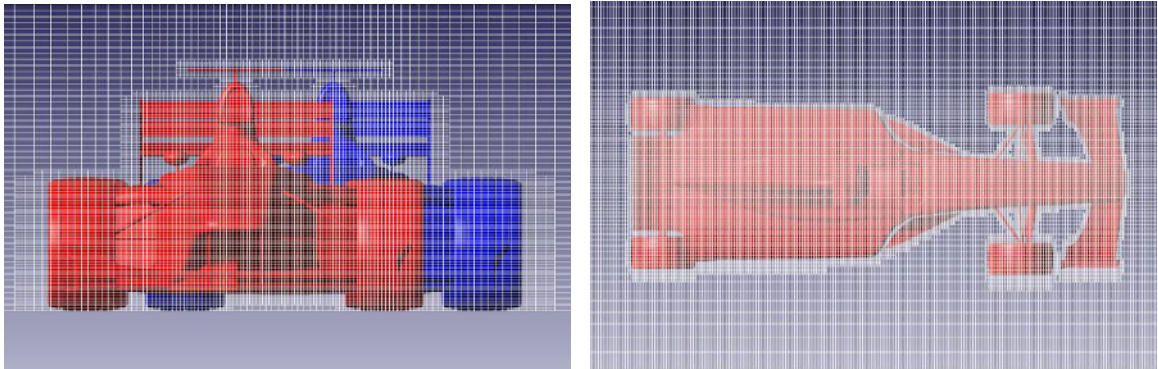


Figure 4. Adapted mesh for “Two twin race-cars”

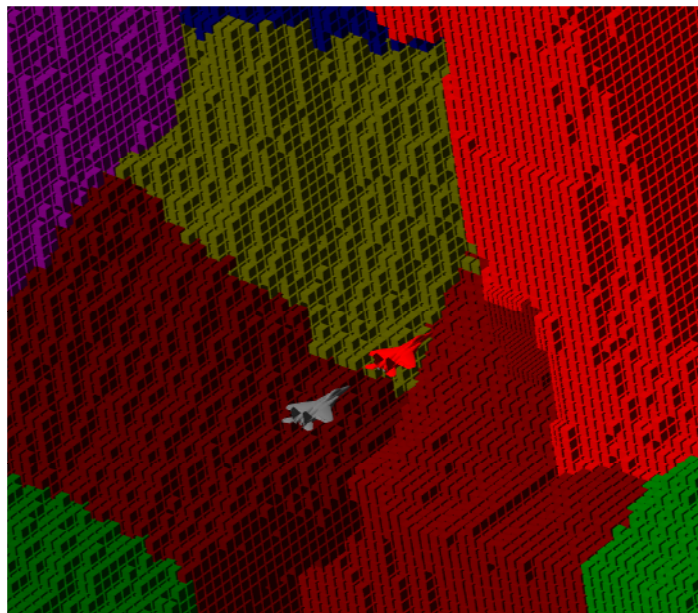


Figure 5. Mesh decomposition onto 16 processors for “Two twin planes”

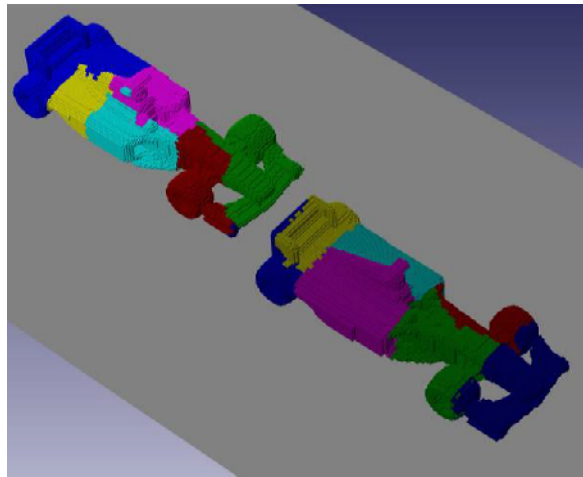


Figure 6. Mesh decomposition onto 16 processors for “Two twin race-cars”

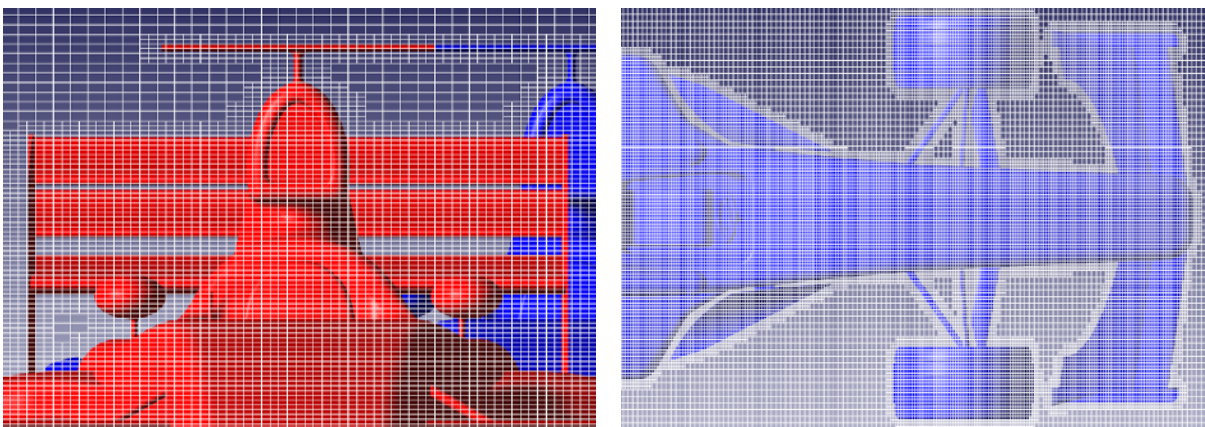


Figure 7. Adapted mesh ~12 million cells

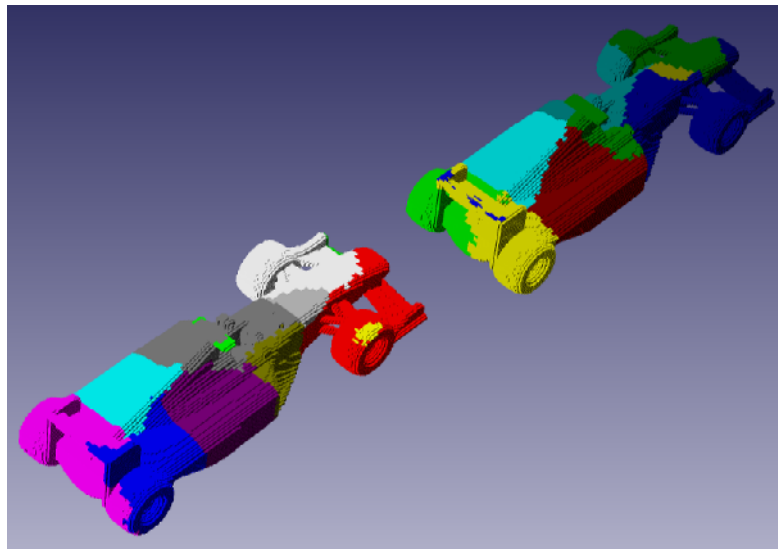


Figure 8. Mesh decomposition ~12 million cells onto 32 processors

Results

Results of the numerical experiments on the medium meshes (6 and 3 million cells) are presented in Figs. 9, 10.

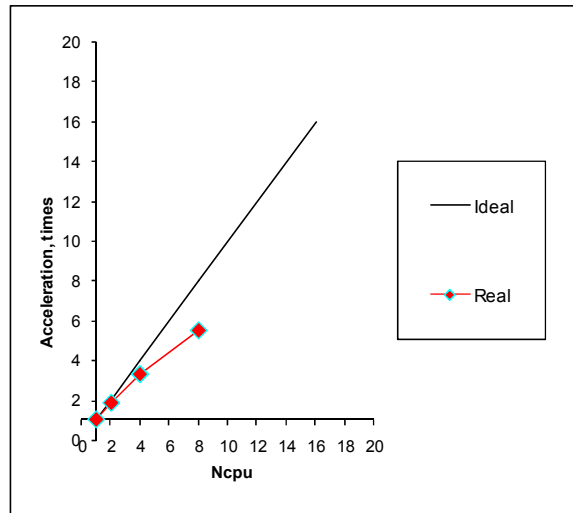


Figure 9. Acceleration of calculations for “Two twin planes”

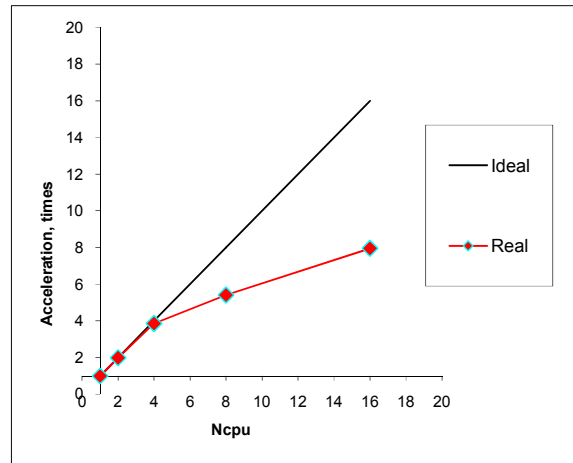


Figure 10. Acceleration of calculations for “Two twin race-cars”

Conclusions

The experiments have shown high efficiency of the 1U-server in solving aero-hydrodynamic problems with FlowVision-HPC. Large RAM (56 GB) enabled solving a problem with 12 million computational cells. A good level of scalability is achieved for up to 32 processors. The next target is testing even larger project containing 50 million computational cells.

The FlowVision team expresses its acknowledgement to NIAGARA Distribution Company for providing the opportunity to test the Barcelona server and hope to continue this successful collaboration.