Performance Assessment and Parallelization Issues for Large-Scale Applications of the CFD Code NSMB

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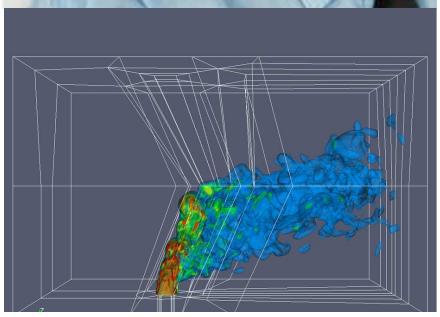
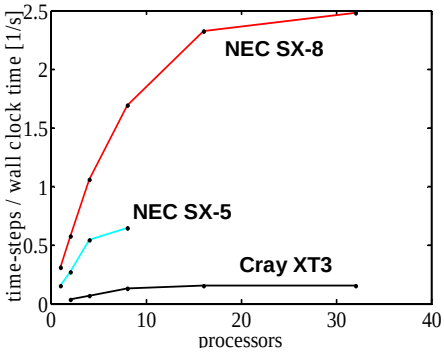
Large-Scale Applications of CFD Code

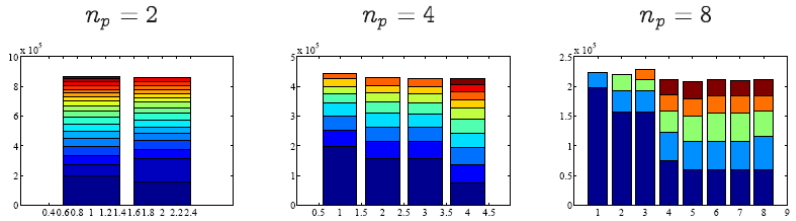
The flow simulation code NSMB (Navier-Stokes Multi Block) is often applied to turbulent jets such as the flow from a smokestack into a crossflow. In a recent comparative benchmarking investigation the performance of NSMB was measured on various scalar and vector platforms (Cray XT3 and NEC SX-5 at CSCS, NEC SX-8 at HLRS). By virtue of an only moderate number of blocks of differing size, NSMB shows load-balancing issues which inhibit a good parallel scaling on these systems. The authors assessed the block-splitting technique and its effect on the parallel performance. The original test case used 34 structured blocks with a total of 2 million cells, and the simulation consumed about 2000 CPU hours on a NEC SX-8.





Reasons to Apply Block-Splitting Technique

As seen in the figures below, the application is characterized by a very unbalanced distribution of the work. When using more than 8 processors in a parallel computation, many of them are idling most of the time. An alleviation of this load-balancing problem can be found in the block-splitting technique, where the total number of blocks is artificially increased by splitting them. The finer granularity of the domain decomposition allows for a more homogeneous distribution of the work to the individual processors, which leads to a more efficient parallelization and a drastically improved performance.



Improvement of Parallel Scaling

Block splitting is generally beneficial for all kinds of architectures. However, the strong single processor of the NEC SX-8 pays off. The overall performance is much better on the NEC SX-8. For the given kind of application fewer high-performance CPUs (NEC SX-8) are more favorable than a high number of lower-performance CPUs.