TURBULENCE RESEARCH HELPING TO REDUCE ENERGY CONSUMPTION

Professor Javier Jiménez from the department of Aeronautics at the Universidad Politécnica Madrid was in charge of the PRACE project called "Entrainment Effects in Rough-wall Boundary Layers".

Boundary layers refer to the layers of fluid closest to the surface of moving objects, such as aeroplanes or ships, where the effects of viscosity are most significant. All flows faster than a few metres per second and thicker than a few centimeters are turbulent. Knowing about turbulence is necessary , as around 10% of total global energy consumption is spent on
overcoming turbulent friction.

Europe's largest supercomputer in Jülich was used on the project from November 2010 to October 2011. The project used 40 million core hours on the JUGENE Blue Gene/P supercomputer. The data analysis will take about two years, but some results are already clear.

It was found that even roughness of 1/10 mm on a wing surface changes the entire boundary layer. Cleaner planes and ships should, nevertheless, save up to 2% of the transport energy required.

The IBM Blue Gene/P supercomputer is a hybrid architecture multiprocessing system. It consists of a large number of independent computing nodes interconnected with several networks. Each computing node consists of 4 Power-PC 450 CPUs working at 850 MHz and 2 GB of dedicated physical memory in which applications can run. Each core is capable of performing 4 floating point operations per cycle, thus the total processing power of a computing node amounts to 13.6 GFLOP/s. 32 computing nodes are placed on a node card, and 32 node cards fit into a rack. The system is modular and can be composed of as many as 72 racks, for a total of 1 PFLOP/s and 144 TB RAM.

A process executes on a block of computing nodes in one of the following three modes:
Symmetric multiprocessing mode (SMP) :   The process can utilize the Linux pthreads library or OpenMP to support multi-threading in the node and can utilize Message-Passing Interface for communication with other nodes.
Virtual node mode (VN) :   There are 4 MPI tasks per node and a single thread per each task. Multi-threading is not supported in VN mode and the tasks can communicate with each other using MPI.
Dual mode (DUAL) : a hybrid one . pthreads, OpenMP and MPI can be used

JUGENE was ,at the introduction ,the second fastest computer in the world. It was the ninth fastest computer in the world according to TOP500 in April 2012. It includes 294,912 processor cores, 144 terabyte memory, 6 petabyte storage in 72 racks and a peak performance of about 1 petaflops.
JUGENE was scheduled for decommission for 31 July 2012 and has been replaced by the Blue Gene/Q system JUQUEEN.

References :
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http://www.prace-ri.eu/IMG/pdf/Data_IO_Optimization_in_GROMACS_Using_the_Global_Arrays_Toolkit-2.pdf