National Center for Computational Sciences Snapshot
October 9, 2006

NCCS Science Highlights

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OAK RIDGE, Tenn. (October 5, 2006)—Oak Ridge National Laboratory's (ORNL's) Cray XT3 supercomputer, known as Jaguar, has become the fastest system in the world for running the Princeton Plasma Physics Laboratory's (PPPL's) flagship code for studying plasma microturbulence in fusion reactors.

PPPL's Stephane Ethier recently succeeded in running the Gyrokinetic Toroidal Code (GTC) on 10,386 of Jaguar's 10,424 processing cores, advancing 5.4 billion particles per step per second. That performance is a 13 percent improvement over the previous record of 4.8 billion particles per step per second set on Japan's Earth Simulator.

Ethier noted that GTC is one of only a few U.S. codes that have been benchmarked on the Earth Simulator. The Earth Simulator benchmark used up to 4096 processors.

Ethier said he is especially pleased with the efficiency at which the code was able to run on Jaguar's dual-core processors. "With regard to the increasing current emphasis on multi-core architectures," he said, "GTC has demonstrated better than 95 percent efficiency on the second processor of each dual-code node in these runs."

The Princeton researcher noted that the effort received substantial collaboration from staff at ORNL's National Center for Computational Sciences (NCCS).

"PPPL is most grateful to the staff of NCCS and especially to Scott Klasky and Don Maxwell for their extraordinary supporting efforts, which helped enable the timely achievement of these highly productive runs," Ethier said.

The milestone puts scientists a step closer to accurately simulating plasma behavior in fusion reactors such as the proposed ITER reactor, currently a top priority of the U.S. Department of Energy's Office of Science. The ITER project is geared toward reaching the fusion energy break-even point, getting more energy out of the reactor than goes into it.

PPPL chief scientist Williams Tang said the run on Jaguar was able to reach an extremely high statistical resolution, noting that the field of fusion simulation will continue to benefit as petascale computing systems become available.

"The ability to carry out such high-resolution calculations with associated very low noise levels enables better physics understanding of turbulent plasma behavior on realistic time scales characteristic of actual experimental observations," he said. "It holds great promise

for accelerating the pace of greater scientific discovery at the petascale range and beyond."

Turbulence is believed to be the primary mechanism by which particles and energy leave the confining magnetic field of a doughnut-shaped fusion system, leading to a loss of energy in the system. According to Tang, the process of designing and operating a reactor such as ITER must take this phenomenon into account. GTC is a three-dimensional code developed to study the dynamics of turbulence and associated transport driven by variations of temperature and density within the system.

UT-Battelle manages Oak Ridge National Laboratory for the Department of Energy.

NCCS Seminar Series Begins

University of California, Irvine physicist and NCCS user Zhihong Lin was in Oak Ridge last week to speak about his work and the future of fusion research using petascale computing systems.

Lin spoke at the Leadership Computing Facility (LCF) seminar series on October 3 on the topic "Gyrokinetic Particle Simulation of Turbulent Transport in Fusion Plasmas."

He was also in town to promote increased collaborations between Oak Ridge scientists and his fusion research team. He noted that his collaborations in Oak Ridge are especially important to him both because ORNL has a strong focus on computational science and because it serves as the U.S. headquarters for the ITER fusion reactor project.

Lin was very complimentary of the NCCS, both for its high-performance computing capabilities and for the expertise and help provided by its staff. He had especially high praise for his Scientific Computing Group liaison, Scott Klasky.

"This is a computer center," he said, "not just a hardware center. The computational science approach is very important for large-scale simulations, so much of the support is working closely with the application team. Scott is a key member of our team. He knows the application well, and he knows the hardware and software well."

NCCS Outreach

NCCS has been invited to choose a representative of the organization to operate as a contributing editor for *HPCwire*. With more than 57,000 readers weekly, *HPCwire* is the leading publication for all aspects of the high-performance-computing industry.
Leo Williams, a science writer for the NCCS, will be taking on this role. In this position Williams will be submitting at least four articles per year to *HPCwire* as well as reporting on other newsworthy events as they occur. NCCS is excited about this opportunity to share with the high-performance-computing community the scientific breakthroughs and advances taking place at the center.