ORNL Jaguar Supercomputer Advances to Second in the World

System is the world's most powerful for open science

Upgrades to Oak Ridge National Laboratory's (ORNL's) Jaguar supercomputer have made it the second fastest system in the world and the single fastest for open scientific research. Jaguar's new ranking comes from the Top500 List, a semiannual tally of the world's fastest computers released Wednesday, June 27, at the 2007 International Supercomputer Conference in Dresden, Germany.

The Leadership Computing Facility (LCF) at ORNL is committed to delivering the nation's most capable computational system for open science and applying it to a set of compelling scientific and engineering problems of national importance. The system is at the center of a large and vibrant portfolio of research, technology transfer, and education and outreach activities.

"By fielding the most powerful open computer system, ORNL and the DOE [Department of Energy] Office of Science demonstrate dedication to solving the world's most challenging scientific and engineering problems, from a deeper understanding of climate change to the creation of new materials to the ability to harness electricity from fission and fusion energy," said Thomas Zacharia, associate laboratory director for computing and computational sciences. "We are very excited about the contributions we have been able to make to scientific discovery, and we fully expect these contributions to accelerate in the coming months and years."

The LCF resources at ORNL are available to the open science community through DOE's Innovative and Novel Computational Impact on Theory and Experiment (INCITE) program, which is currently seeking leadership research proposals for 2008. Researchers who need the power of Jaguar should visit the INCITE Web page (http://hpc.science.doe.gov) for more information.

Scientists are using the system to advance knowledge in a wide variety of research fields. A team of climate scientists is performing simulations that are improving our understanding of carbon dioxide's role in global warming. The team contributed simulations for the Fourth Assessment Report

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of the Intergovernmental Panel on Climate Change, sponsored by the United Nations.

"[On Jaguar] we got 100-year runs in 3 days," said Peter Gent of the National Center for Atmospheric Research, chairman of the Community Climate System Model Scientific Steering Committee. "The simulation of the El Niño–Southern Oscillation is the most impressive new result in 10 years. This was a significant upgrade of how we do science with this model. Forty years per day was beyond our dreams," Gent went on to say that scientists are now in a position to test the full carbon-nitrogen cycle.

Fusion researchers use Jaguar to simulate the multinational ITER fusion reactor, a device that will bring the world closer to a clean, abundant energy source by heating an ionized gas to a temperature ten times hotter than the sun. In fact, one fusion application—called AORSA—has achieved 87.5 trillion calculations per second (87.5 teraflops) on Jaguar, which is 74 percent of the system's theoretical peak. These unprecedented simulations are allowing researchers to achieve three-dimensional views and reveal never-before-explained features of fusion reactor dynamics.

Other fields are seeing comparable achievements. Scientists are using Jaguar to provide a fundamental understanding of combustion, helping make the most of current energy sources by building the foundation for cleaner, more efficient engines and power generators. Biologists are simulating enzymes, leading the way to products ranging from more effective biofuels to new drugs for preventing transplant rejection. Astrophysicists are using the system to explain the deaths of stars, the nature of dark matter, and the gravitational waves created by merging black holes.

The largest problem ever for the High-Performance Linpack benchmark—used to evaluate systems on the Top500 List—was solved on Jaguar. This achievement points to Jaguar's superior balance between processor speed and system memory. As a result of this balance, the system was able to solve a matrix problem of order 2.2 million containing nearly 5 trillion elements.

"It is the largest problem that I know of that's ever been done," said Jack Dongarra of the University of Tennessee–Knoxville and ORNL, cocreator of the list.

Jaguar is a Cray XT4 comprising 124 cabinets containing more than 11,700 dual-core AMD processors. The system achieved 101.7 teraflops on the Linpack benchmark, which is more than 85 percent of its theoretical peak of 119 teraflops.

Jaguar has at least one more upgrade in its future, with quad-core processors replacing the system's dual-core processors in late 2007. That upgrade will once again more than double Jaguar's performance—to a peak of 250 teraflops. By late 2008, a new Cray "Baker" system will be installed, capable of 1,000 teraflops (1 petaflops). Both machines will employ the upcoming quad-core AMD Opteron processors.

The Top500 List, compiled by Dongarra, Hans Meuer of the University of Mannheim in Germany, and Erich Strohmaier and Horst Simon of Lawrence Berkeley National Laboratory, has been maintained since 1993. The entire list can be viewed at www.top500.org.

National Center for Computational Sciences

Located at:
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6161
Phone: 865-241-7202
Fax: 865-241-2850
E-mail: help@nccs.gov
URL: www.nccs.gov