SCIENCE

Holy petaflop*

New supercomputer's blazing speed attracts line of researchers eager to put its power to use

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THE COLUMBUS DISPATCH

***Petaflop: one thousand trillion calculations per second**

OAK RIDGE, Tenn. -- At its peak, the new Cray XT5 Jaguar supercomputer at the Battelle-managed Oak Ridge National Laboratory can perform 1.64 quadrillion calculations per second.

When running sustained programs, it weighs in at 1.059 quadrillion calculations, or 1.059 "petaflops."

Quadrillions? Petaflops? Confused? Trust us, this computer is fast. Very fast.

But believe it or not, 1.059 quadrillion calculations is only good enough to rank as the second-fastest computer on the planet.

The IBM Roadrunner, built for the Los Alamos National Laboratory in New Mexico, hums along during sustained runs at 1.105 quadrillion calculations per second, according to the TOP500 Supercomputers list.

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"That's a lot of power," said Kevin Wohlever, director of supercomputing operations at the Ohio Supercomputer Center, where an IBM cluster of computers can make 21.9 trillion calculations per second.

"But it's the combination of power and the amount of memory and storage that enables it to do what others can't."

The Jaguar and Roadrunner are more than twice as fast as their next competitors.

The National Center for Computational Sciences at Oak Ridge is managed by UT-Battelle, a private nonprofit organization created by the University of Tennessee and Battelle.

And the Jaguar is really not *a* computer. It is actually 181,000 computer cores contained in eight rows of racks on a floor the size of a college basketball court.

It cost about $100 million, according to Arthur S. "Buddy" Bland, director of the Leadership Computing Facility project, which installed the machine.

Who uses this thing? Researchers from Oak Ridge and other national labs, NASA, universities and corporations such as Boeing and General Motors are scheduled to use the Jaguar this year.

Some of the work includes:

• Creating the most-detailed climate-change models.

• Testing nanomaterials and the interactions of subatomic particles.

• Creating ways to make alternative fuels even cleaner.

• Increasing the efficiency of jet engines.

• Making better bubbles in detergents and fire extinguishers.

Michael Heroux, a member of the technical staff at Sandia National Laboratories in New Mexico, plans to use the Jaguar to model how

An older Oak Ridge supercomputer bears famous visitors' autographs.

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Scientists from across the country and abroad go to the Oak Ridge National Laboratory to use its new supercomputer, the second-fastest in the world.

Pipe fitter Bryon Phillips helps

antimicrobial peptides, a class of antibiotics, interact with and pass through the layers of cell walls.

The work, his team hopes, will help lead to medicines that can treat a number of diseases and antibiotic-resistant bacteria.

A team led by Alexei Kritsuk, a research scientist at the University of California at San Diego, plans to model the supersonic turbulence in molecular clouds around the spiral arms of the Milky Way.

The turbulence, researchers think, triggers star formation.

"We need a really big supercomputer to run this," Kritsuk said.

Big supercomputers need big power.

"That's one reason the computer center was built here," said Bill Cabage, an Oak Ridge spokesman.

The Tennessee Valley Authority built a substation at Oak Ridge so that the Jaguar can eat its 7 megawatts of electricity at peak performance, Bland said.

"Seven megawatts is enough electricity to handle the peak needs of about 2,200 AEP customers," said Pat Hemlepp, a spokesman for American Electric Power Co., based in Columbus.

And big supercomputers need big cooling systems.

If the Jaguar used conventional air cooling, "It would require the airflow provided by a jet engine," Wohlever said.

Instead, a refrigerant is pumped through pipes in the computer cabinets. The refrigerant is vaporized, pulling the heat from the processors.

At the end of the eight rows of cabinets, heat exchangers pump 6,000 gallons of icy-cold water per minute to condense the refrigerant, which then returns to the system.

Researchers say the effort is worth it.

to install the new supercomputer's cooling system, which uses a refrigerant and thousands of gallons of water a minute. Battelle has a role in the national supercomputer center in Oak Ridge, Tenn.

This supercomputer at the Lawrence Livermore National Laboratory in California was the fastest computer when it was installed in 2001.

"Such a machine enables us to do a lot of things previously not possible," said Kevin Trenberth, head of the climate-analysis section at the National Center for Atmospheric Research in Boulder, Colo.

The center is studying how the carbon cycle together with changing ocean and land ecosystems are affecting climate.

Current climate models break up Earth into 100- to 150-kilometer grids. Researchers would like to go smaller, but they don't have the computer memory and power to process more detailed information.

The Jaguar computer can handle models for 60-kilometer grids.

The increase in power and memory would allow the inclusion of factors that can't fit into current models, or the analysis of more layers of the atmosphere at one time, Trenberth said.

In the computing world, records are short-lived, and the hunger for more speed is insatiable.

Oak Ridge plans to install a computer capable of 25 petaflops by 2012, 100 to 250 petaflops by 2015, and an exoflop, or 1,000-petaflop, machine by 2018.

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By the numbers

1.64 quadrillion

Calculations per second at top speed

362 terabytes

Amount of memory, about 180,000 times more than a home computer

181,504

Processors, equal to 181,504 home computers

284; 5,700

Number of cabinets and amount of square footage to house the system

6,000 gallons

Volume of water used every minute to cool the system

4,385

Miles of wiring needed to connect all components

85

Decibels of noise the system generates during operations

7

Megawatts of power used to run the computer, equal to the peak power use of 2,200 homes.

Source: Battelle
