Space science simulation at UNH now better, faster, cheaper

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Cashing in on the underlying technology that seamlessly renders graphics for state-of-the-art video games, space scientists at the University of New Hampshire have bundled together 40 PlayStation3 consoles to affordably simulate one of the "grand challenges" of modern computational science - the interaction between Earth's magnetic field or "magnetosphere" and the solar wind. Climate change is another supercomputing grand challenge.

"You need a lot of computing power to do video games realistically, to run the graphics, and there are lots of projects in which people have used PlayStations to do scientific calculations," says space physicist and magnetospheric modeler Joachim "Jimmy" Raeder of the UNH Institute for the Study of Earth, Oceans, and Space (EOS).

Indeed, as was recently announced, the new $133 million "Roadrunner" supercomputer at the Los Alamos National Laboratory will use the same technology created to power video games to solve classified military problems.

The heart of the supercomputing power, and of PlayStation3's gee-whiz graphics, is a chip called the Cell Broadband Engine, which can perform up to two-hundred-billion operations per second. The superchip was co-developed by Sony, IBM, and Toshiba.

Until now, Raeder's simulation group at EOS's Space Science Center (SSC) has been running its vastly complex Open Geospace General

Circulation Model - a "magnetohydrodynamic" simulation of the interaction between Earth's magnetosphere and the solar wind - on an 8,000-pound, $750,000 collection of 320 processors. They will now be able to achieve the same computing speed with the 40 PlayStations at $400 a piece.

However, in order to be able to run the simulation on the game consoles, the PlayStation hardware needed significant "tweaking" to accommodate an open-source operating system. Moreover, it required Raeder's SSC colleague Kai Germaschewski nearly two month's of effort to reprogram the simulation program itself before it could run on the new superchip.

The 40-PlayStation supercomputer can theoretically perform up to 8 trillion operations per second. However, Raeder notes, a mere one trillion per second is a more realistic number since no program can fully exploit the computer hardware.

Of course, even that kind of mind-boggling speed is far short of the one thousand trillion operations per second (what's termed a "teraflop") that the Los Alamos machine recently achieved by using what would be the equivalent of 20,000 PS3 consoles cobbled together.

But UNH's relatively modest effort will get Raeder's group ready for the first civilian teraflop machine the National Science Foundation (NSF) will make available to civilian researchers by 2011.

"When that machine comes online we will be ready to take full advantage of it," says Raeder.

Raeder's project is being funded by a four-year, $1.5 million NSF grant recently won by his simulation group at SSC. Work on the PS3 project also involved Doug Larson, Daniel Bergeron, and Andrew Foulks of the UNH computer science department.

The simulation work done by the SSC group is connected with a NASA mission on which Raeder is a co-investigator.

The Time History of Events and Macroscale Interactions during Substorms or THEMIS mission hopes to resolve one of the oldest mysteries in space physics - what physical process in near-Earth space initiates the violent eruptions of the aurora that occur during a period of one hour or less. This period, known as a substorm, is when energy is rapidly released in the magnetospheric tail and creates the brilliant northern (and southern) lights.

The two-year mission consists of five identical probes that will study the violent, colorful eruptions of auroras. The simulation work done at UNH will help scientists better understand and interpret the data they're getting from the THEMIS spacecraft.

Source: University of New Hampshire