Red Storm rising

Jason Repik, Cray contractor, checks out a Red Storm panel. (Photo by Randy Montoya)

A new series of measurements — the next step in evolving the criteria to determine more accurately the efficiency of supercomputers — has rated Sandia National Laboratories' Red Storm computer the best in the world in two of six new categories, and very high in two other important categories.

Red Storm had previously been judged sixth fastest computer in the world on the older but more commonly accepted Linpack test.

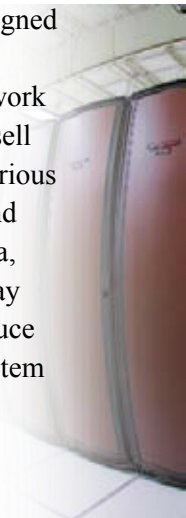
The two first-place benchmarks measure the efficiency of keeping track of data and of communicating data between processors. This is comparable to how well a good basketball team works its offense — rapidly passing the ball to score against an opponent.

An unusual feature of Red Storm's architecture is that the computer can do both classified and unclassified work with the throw of a few switches. The transfer does not require any movement of discs and is secure. There are no hard drives in any Red Storm processing cabinets. A part or even the whole of the machine can be temporarily devoted to a science problem, and cross over to do national security work.

The capability of the machine to put its entire computing weight behind single large jobs enabled one Sandia researcher to get an entire year's worth of calculations done in a month.

Cray partnership

Red Storm's architecture was designed by Sandia computer specialists Jim Tomkins and Bill Camp. The pair's work has helped Sandia partner Cray Inc. sell 15 copies of the supercomputer in various sizes to U.S. government agencies and universities, and customers in Canada, England, Switzerland, and Japan. Cray holds licenses from Sandia to reproduce Red Storm architecture and some system



HPCC benchmark results available at: http://icl.cs.utk.edu/hpcc/hpcc_results.cgi

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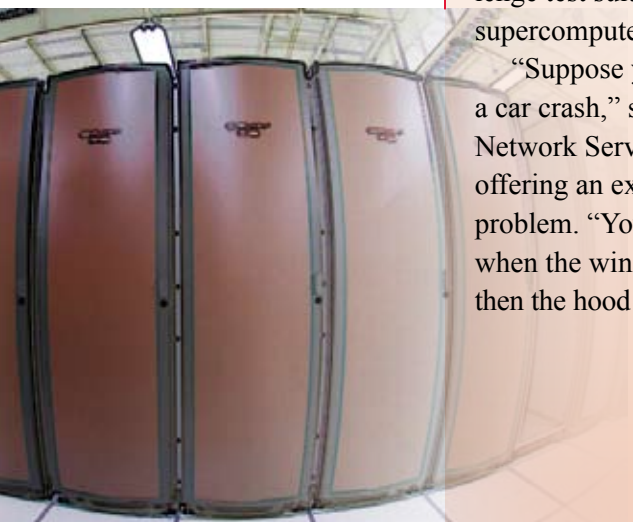
The Sandia-designed Red Storm supercomputer has modeled how much explosive power it would take to destroy an asteroid tracking toward Earth, how a raging fire would affect critical components in a variety of nuclear weapons, and how changes in the composition of Earth's atmosphere might impact global warming. The machine has been ranked as the world's most efficient in two of six categories.

Sandia's Red Storm supercomputer



software, says Tomkins. Red Storm was funded by the National Nuclear Security Adminstration's Advanced Simulation and Computing program.

In the early 1990s, supercomputer manufacturers distinguished the capabilities of their products by announcing Theoretical Peak numbers. These figures represented how fast a computer with many chips in parallel circuits could run if all processors worked perfectly and in unison. The number was — at best — considered a hopeful estimate.

Next came the Linpack benchmark, which provided a real, but relatively simple series of algorithms for a supercomputer to solve. Since 1993, those interested in supercomputers watched for new Linpack numbers, published every six months, to determine and rank the fastest computers in the world. For several years, the fastest was Sandia's ASCI Red supercomputer.

Most recently, the limitations of this approach have encouraged the Linpack founders, in conjunction with supercomputer manufacturers, to develop still more realistic tests. These indicate how well supercomputers handle essential functions like the passing between processors of large amounts of data necessary to solve real-world problems.

What's coming at you?

In this revised series of tests — called the High Performance Computing Challenge test suite — Sandia's Red Storm supercomputer has done extremely well.

"Suppose your computer is modeling a car crash," says Sandia Computing and Network Services Director Rob Leland, offering an example of a complicated problem. "You're doing calculations about when the windshield is going to break. And then the hood goes through it. This is a very discontinuous event. Out of the blue, something else enters the picture dramatically.

"This is the fundamental problem that Sandia solved in Red Storm: how to monitor what's coming at you in every stage of your calculations," he says. "You need very good communications infrastructure, because the information is concise and very intense. . . and because the incoming information is very unpredictable, you have to be aware in every direction."

Moving through traffic

To David Womble, acting director of Computation, Computers, and Math at Sandia, "The question is [similar to] how much traffic can you move how fast through crowded city streets." Red Storm, he says, does so well because it has "a balance that doesn't exist in other machines" between the ability of a processor to get data it needs from anywhere in the machine quickly and how fast each processor can do the additions, multiplications and other operations it needs to do in solving problems.

More technically, Red Storm posted 1.8 trillion bytes per second on the HPCC test to measure the total communication capacity of the internal interconnects. Sandia's achievement in this category represents 40 times more communications power per teraflop (trillion floating point operations) than the result posted by IBM's Blue Gene system, a competing system with 10 times as many processors.

Red Storm is the first computer to surpass the 1 terabyte-per-second performance mark for measuring communications among processors — a measure that indicates the capacity of the network to communicate when dealing with the most complex situations.