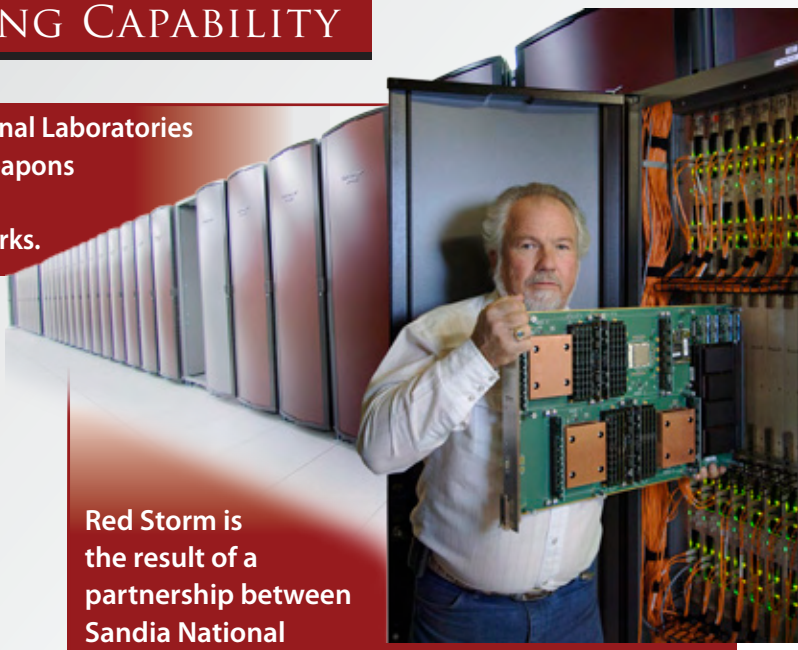
Red Storm

A New Dimension in Computing Capability

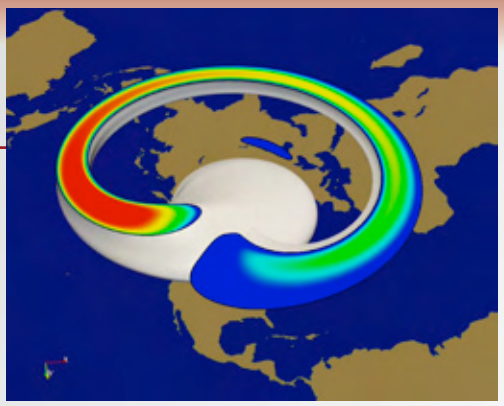
Sandia National Laboratories

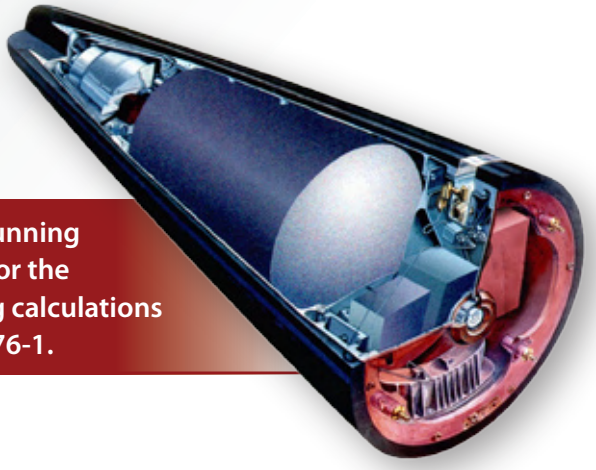
The 40 teraOPS Red Storm supercomputer at Sandia National Laboratories is critical to meeting NNSA deliverables for the Nuclear Weapons Stockpile. Red Storm scored the highest on two of the five High Performance Computing Challenge (HPCC) benchmarks.



Red Storm is the result of a partnership between Sandia National Laboratories and Cray, Inc. The SeaStar™ interconnect chip is key to the three-dimensional mesh topology that enables increased efficiency and scaling for engineering applications.

Early science runs on Red Storm during acceptance testing on the machine included ocean and climate simulations that scaled to the maximum available 10,368 processors.





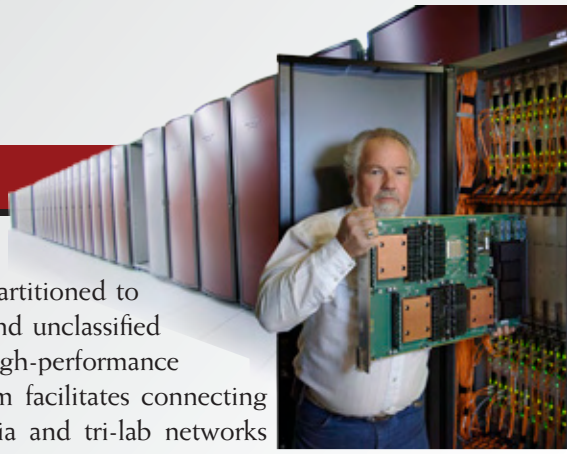
All three NNSA laboratories are running large-scale weapon simulations for the stockpile on Red Storm, including calculations to support qualification of the W76-1.

Introducing Red Storm to the news media at Sandia National Laboratories, NNSA Administrator Linton Brooks said, *"Some of my colleagues in the scientific community now say that scientists in the future will grow up thinking there is theory, there is experiment, and there is simulation—three ways in which we advance scientific knowledge."* —February 8, 2006

Advanced Simulation & Computing™

National Nuclear Security Administration

Introducing Red Storm



Red Storm is a massively parallel processing (MPP) supercomputer at Sandia National Laboratories/New Mexico that recently joined the ranks of the Advanced Simulation & Computing (ASC) supercomputers monopolizing world computing records. Red Storm was uniquely designed by Sandia and Cray, Inc., to address the highly complex nuclear weapons stockpile computing problems that particularly characterize the simulations required by an engineering laboratory such as Sandia. Red Storm allows modeling and simulation of complex problems in nuclear weapons stockpile stewardship that were only recently thought impractical, if not impossible.

ASC researchers at Los Alamos and Lawrence Livermore are also finding it a valuable resource.

Red Storm is partitioned to support classified and unclassified operations. Its high-performance Input/Output system facilitates connecting with external Sandia and tri-lab networks and storage. Red Storm is scalable from one cabinet to hundreds up to 10,000 processors. The architecture is scalable to greater than 100 teraOPS.

Sandia's collaboration with Cray supports commercialization of the technology. This not only increases national competitiveness in supercomputing, but results in a wide user knowledge base to detect and fix errors and problems.

What Features Make Red Storm Unique?

The ASC computing resources offer different advantages for different kind of applications. Red Storm specializes in MPP problems that require considerable interaction and coordination of the high-volume AMD processors running an application.

Red Storm was constructed of commercial off-the- shelf parts supporting the custom IBM-manufactured SeaStar interconnect chip. The interconnect chips, one of which accompanies each of 10,368 AMD Opteron™ compute node processors, make it possible for Red Storm's processors to pass data to one another efficiently while applications are running. The interconnect is also key to the three-dimensional mesh that allows 3-D representations of complex problems. Red Storm holds a world record in visualization and two of the High Performance Computing Challenge (HPCC) benchmarks, PTRANS and RandomAccess.

A flat architecture is another unique feature. A simple design means that information can pass more directly from processor to processor without having to pass through many levels of processors in a complex hierarchy. The Catamount operating software runs the application with a user-friendly Linux system serving as the user interface.

How Does Red Storm Excel?

Red Storm excels in the three HPCC benchmarks that are particularly relevant to the kinds of problems it was designed to address: STREAM, PTRANS, and RandomAccess. It has the highest performance in the latter two when compared to the current baseline submissions for the HPCC benchmarks.

- STREAM measures sustainable memory bandwidth. Red Storm's higher memory bandwidth keeps the processors from being starved for data and makes the Central Processing Unit more efficient.
- PTRANS is a useful measure for the total communications capacity of the internal interconnect. This high score means that data can flow freely between the 10,368 Red Storm processors without bottlenecks or congestion.
- RandomAccess indicates the performance in moving individual data elements as opposed to long arrays of data. Red Storm has the ability to coordinate the many interactions of various processors.

What Are Red Storm's Applications?

Red Storm's primary use is in U.S. nuclear stockpile work: designing new replacement components, virtual testing of components under hostile, abnormal, and normal conditions, and assisting in weapons engineering and weapons physics.

For more information, contact Sandia ASC communications: Reeta Garber (ragarbe@sandia.gov), Michael Townsend (mtowns@sandia.gov).

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.