Sandia's High-Performance Computing

Sandia supercomputer research solving real-world problems today, reaching for exascale performance tomorrow
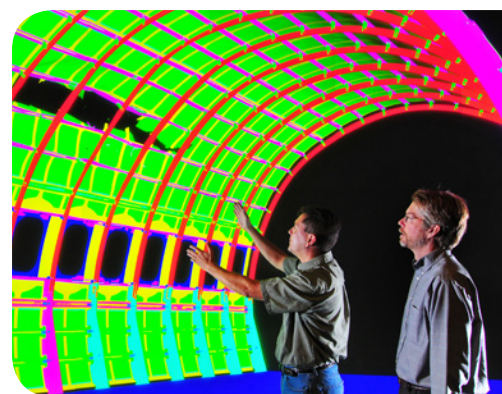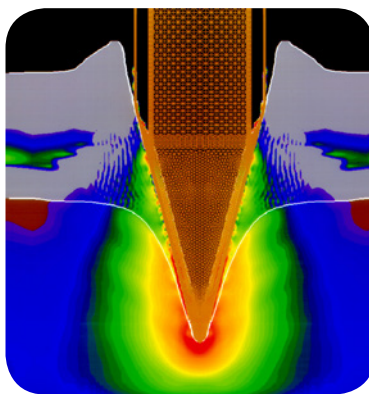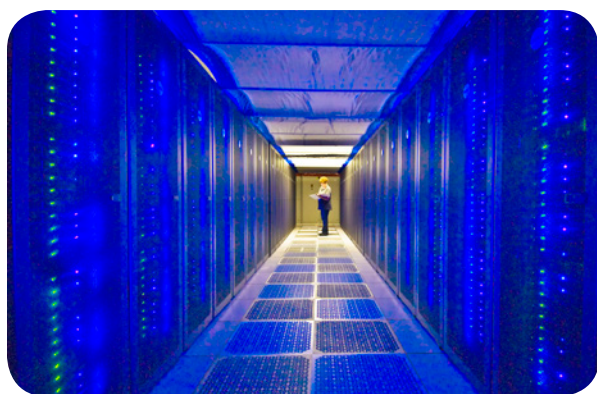
Solutions to today's complex scientific and engineering problems often require the enormous power of high-performance supercomputers. When the United States stopped nuclear testing in 1992, Sandia and other national laboratories increased their use of supercomputer simulations to help certify the safety and effectiveness of the U.S. nuclear stockpile. This computational capability meets other challenges, such as mapping the functional circuits of the human brain, predicting the spread of epidemics and analyzing Internet traffic to expose malicious adversaries.

A World Leader in Supercomputer Development

The modern era in high-performance computing began in the late 1980s with the emergence of massively parallel-processor machines. Thousands of individual microprocessors act together to divide up huge problems and process data. Sandia won the inaugural Gordon Bell Prize in 1987 for showing that scientific applications could achieve a thousandfold speedups on massively parallel processors, and it became the first national lab to make all its supercomputing systems parallel.

In 1997, Sandia's ASCI Red architecture was first worldwide to break one teraflop, or a trillion operations per second. In 2004, in partnership with Cray Inc., Sandia developed the Red Storm platform, which grew into a commercial success for Cray and evolved into the Red Sky and Red Mesa supercomputers. If researchers can solve problems like disposal of waste heat, future systems may reach exaflop speeds, or a million trillion operations per second.
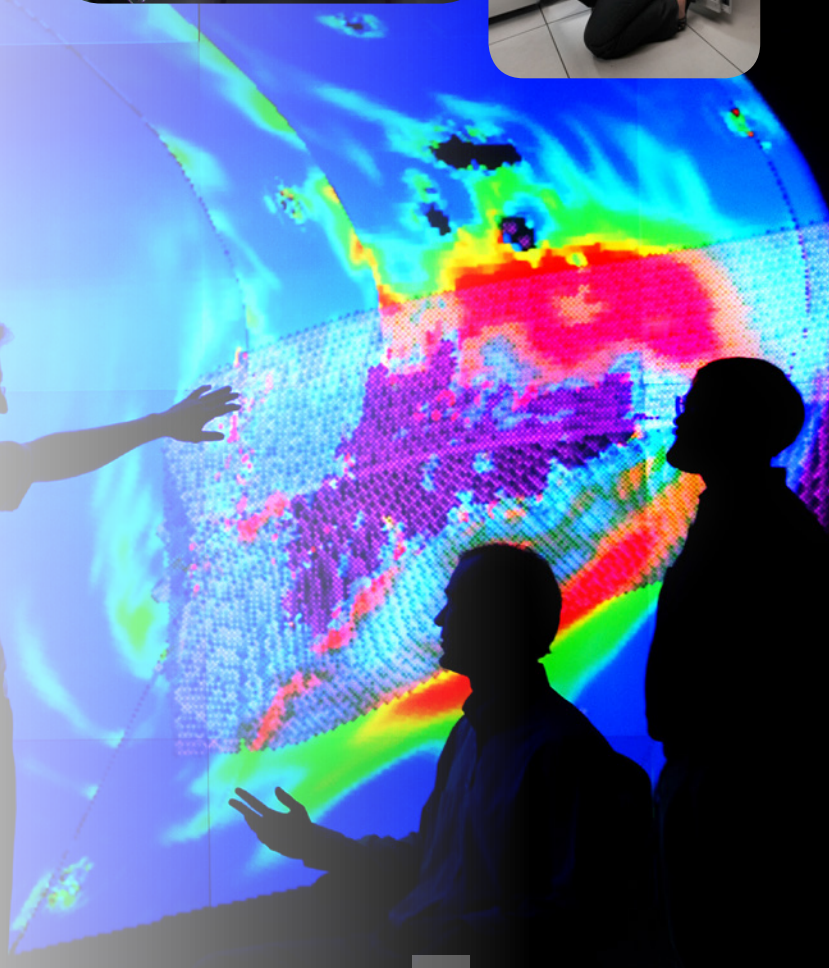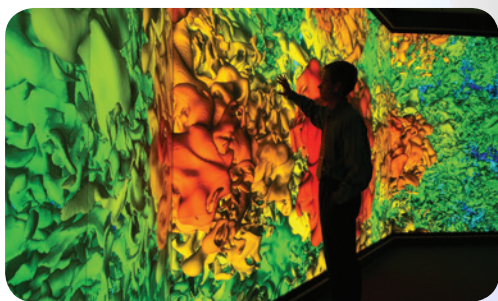
Sandia's Award-winning Research

Sandia's commitment to improve supercomputing performance earned three R&D 100 Awards over 10 years for software designs that increase the efficiency of massively parallel computing across a variety of science and engineering systems. More recent initiatives have addressed the "memory wall," which slows down the processing speed. It is the barrier between data storage (the memory) and where it's manipulated (the processors). Sandia also is researching novel memory architectures that more efficiently and rapidly deliver data to the processors and developing new programming languages to improve supercomputers' productivity. Sandia led an international team in 2010 to release Graph500, a new supercomputer rating system that more realistically assesses performance by measuring how well machines analyze large graph-based structures to link huge numbers of data points. Today, Sandia and others are rethinking the fundamentals of supercomputer design, scalability and energy efficiency.

Supercomputers Help Solve Wide Variety of Problems

Sandia supercomputing applications are employed worldwide. Almost every research area at the laboratories is strengthened by supercomputer modeling and simulation that permits researchers to visualize reactions too small or hidden for instruments to image. High-performance computing helps answer fundamental scientific questions, analyzing materials from everyday water to exotic substances formed by comets colliding with planets. By understanding the nanostructure of graphene, for example, a single sheet of carbon atoms someday may supplant silicon as the material of choice for semiconductor microcircuitry in computer and smart phone chips. Supercomputers also help analyze electrical circuitry, develop strategies to deflect an asteroid on a collision course with Earth and model wildfire or water resources for homeland security.

U.S. DEPARTMENT OF **ENERGY**

NNSA National Nuclear Security Administration

Sandia National Laboratories