Advanced Simulation & Computing

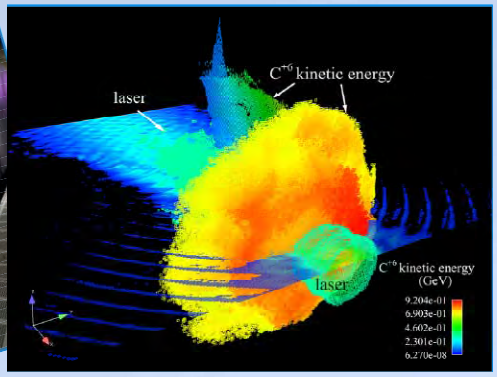
The NNSA Advanced Simulation and Computing (ASC) Program supports the U.S. Defense Programs' shift in emphasis from test-based confidence to simulation-based confidence. Under ASC, computer simulation capabilities are developed to analyze and predict the performance, safety, and reliability of nuclear weapons and to certify their functionality. The science, technology, and codes developed through the ASC Program are now also being used to support a broader range of critical national security interests, ranging from nuclear nonproliferation and forensics to national energy independence.

The national security mission is a compelling driver for world-class leadership in simulation and computing. Working with industry, NNSA has consistently led the way for U.S. preeminence in high performance computing (HPC). Computer systems built for the ASC program have dominated the international Top500 Supercomputer list for most of the 15 years since the list was created in 1993, and have played a major role in revitalizing the U.S. HPC industry and opening new markets for companies such as IBM and Cray. In turn, by leveraging technology with broad commercial applications, the ASC Program has found a cost effective way to develop the technology needed to support scientific computing at the grand scale required to solve the country's toughest national security problems.

America Competes

Working with industry, NNSA has led the way for US preeminence in high performance computing (HPC)

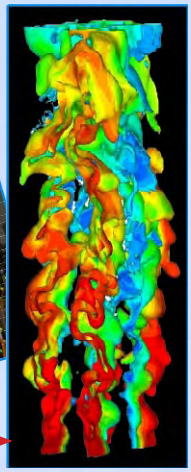
ROADRUNNER (Los Alamos National Laboratory)



On May 26, 2008, Roadrunner set the current world record and broke the Petaflop barrier, exceeding one million billion mathematical calculations per second. The system's innovative hybrid architecture, which uses IBM PowerXCell 8i processors as powerful accelerators, opens new markets for IBM and new horizons for scientific applications such as the VPIC laser plasma interaction shown.
For more information, go to ***www.lanl.gov/orgs/hpc/roadrunner***.

Direct Numerical Simulation of Stratified Premixed Turbulent Combustion – Three cases were run on three different Red Storm – class systems

RED STORM (Sandia National Laboratories)




United States -20


United Kingdom -4


Switzerland -4


Japan -4


Finland-2


Denmark -1


Australia -1

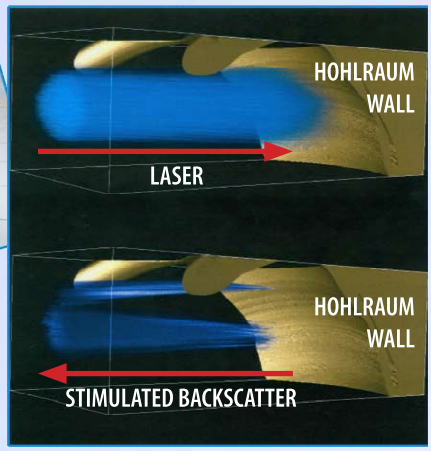

Norway -1

The Red Storm design has found application beyond nuclear weapons analysis to serve the broader HPC community. There are over 35 derivative systems around the world, with 20 in US.

Red Storm revitalizes a US industry increasing HPC market share: With the commercialization of Red Storm as the XT3, Cray's market share rose from 6% in 2002 to 21% in 2006*.

*Source: IDC #209251 Technical Computing Systems: Competitive Analysis, November 2007

BLUEGENE/L (Lawrence Livermore National Laboratory)



Concurrently using 196,608 processors in a single run, the high-fidelity simulations of a three-dimenisonal laser beam interacting with target is critical to achieving fusion ignition on the National Ignition Facility.

BlueGene/L is refining the design of the National Ignition Facility, scheduled to achieve fusion ignition in 2010. Obtaining controlled laboratory fusion is the holy grail of national energy independence.

National Nuclear Security Administration

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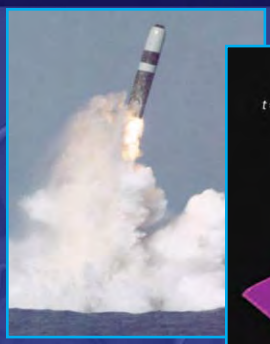
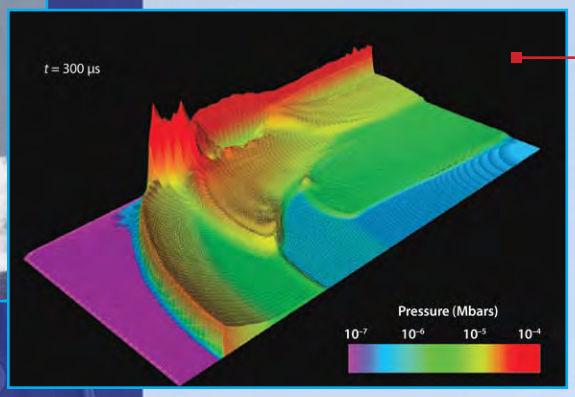
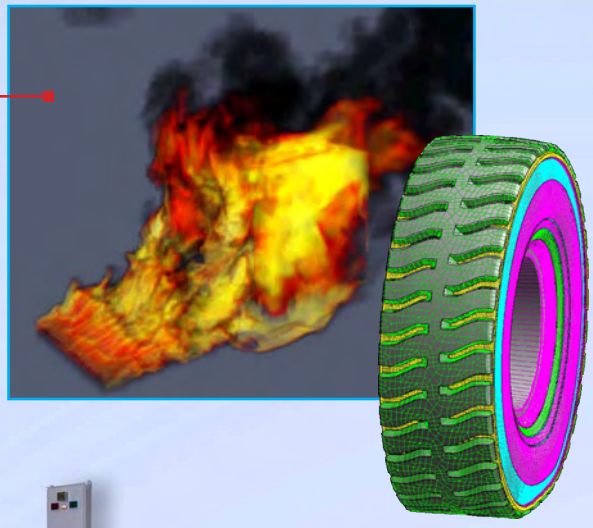
America Competes

The national security mission is a compelling driver for world-class leadership in simulation and computing



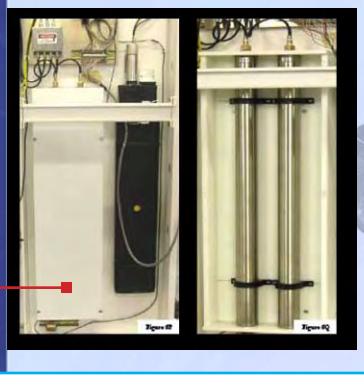


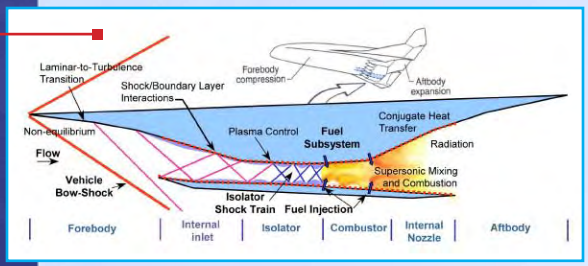
In the absence of underground nuclear testing, assessment of the US nuclear deterrence is enabled by weapons simulation codes, validated through experimentation. A simulation from a Los Alamos National Laboratory Shavano Project code shows time evolution of a shock, to be compared to an experiment.

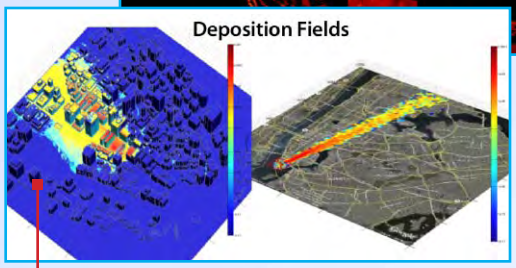


The fire simulation image shows a calculation result of a fire interacting with an object in a transportation container. This simulation was conducted on Sandia National Laboratories' Red Storm supercomputer using weapons engineering (ASC) codes. These codes also contribute to US industrial applications as represented by the Goodyear tire simulation shown on the right.

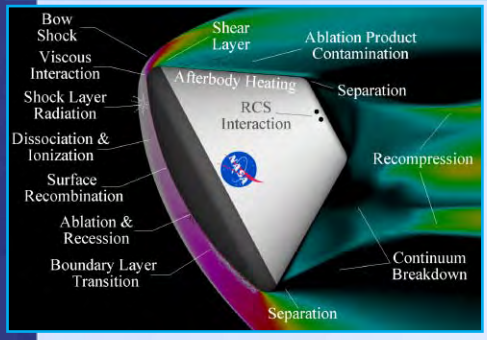
ASC radiation transport calculations support conceptual studies enabling future development and deployment of systems capable of detecting illicit movement (i.e. smuggling) of Special Nuclear Material, particularly in difficult-to-access and difficult-to-measure situations. A TSA Vehicle Portal Monitor is shown with Neutron and Gamma Ray detectors.







The ASC Predictive Science Academic Alliance Program (PSAAP) has collaborated with US academic institutions to establish five Centers of Excellence for validated, large-scale, multidisciplinary, simulation-based Predictive Science. This consortium maintains a steady stream of subject matter experts ready to work on issues of national security interest.



ASC codes have unique capabilities for simulating the effects from weapons of mass destruction in urban environments to assist with managing the consequences. Using evidence gathered from an actual nuclear event, ASC codes can "reverse-engineer" the design of the nuclear weapon and other details, thereby helping identify the perpetrators.

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