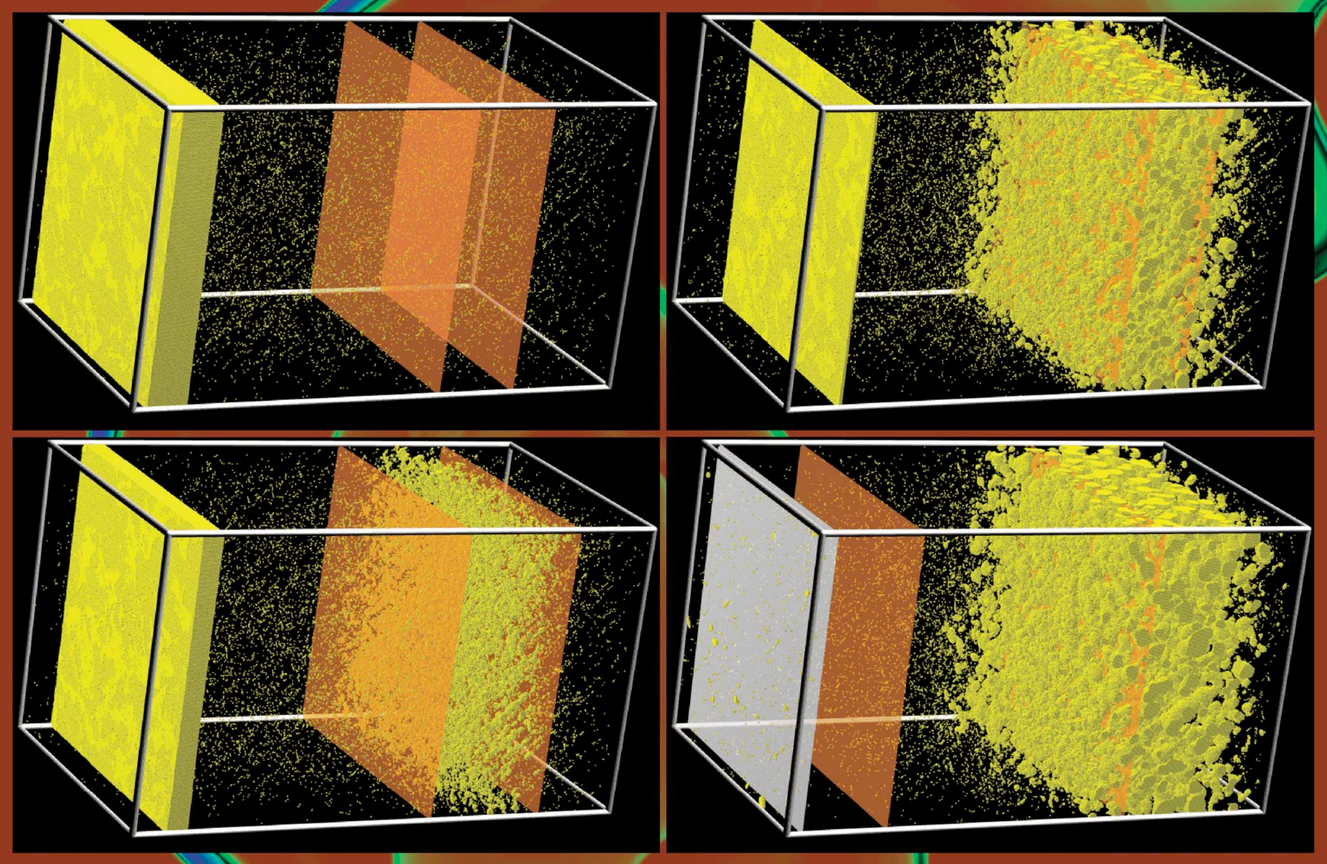
# Advanced Architectures



## Higher Fidelity Leads to Increased Predictive Ability

Through its Advanced Architectures program, ASC stimulates research and development efforts that explore alternative computer designs that promise dramatic improvement in performance, scalability, reliability, packaging, and cost. These computers are problem-optimized systems focused on programmatic needs and cost-effectiveness. They are designed to achieve extreme speeds in addressing specific stockpile issues. Often, programmatic needs require the simultaneous development of enhanced algorithms and performance codes that will run well on these new systems.

In the images to the left, the IBM BlueGene/L supercomputer at Lawrence Livermore National Laboratory, with 131,072 CPUs connected by multiple high-performance networks, enables a completely new class of physical problems to be investigated. Excellent performance and scalability have been demonstrated on a classical molecular dynamics code, SPaSM, on BlueGene/L. Simulations involving up to 160 billion atoms on 65, 536 processors are reported, consistently achieving 24.4 - 25.5 teraOPS for the commonly used Lennard-Jones 6-12 pairwise interaction potential. These images show nucleation, growth, and linkup of voids that takes place between 36 ps and 48 ps of simulation time. (Courtesy Los Alamos National Laboratory.)

BlueGene/L is an example of an ASC Advanced System. This machine is well-suited to run molecular dynamics applications at extreme speeds to address materials aging issues confronting the Stockpile Stewardship Program. BlueGene/L is also used to explore the potential of system-on-a-chip technologies to achieve extreme speed while minimizing floor space and electrical power consumption.

Lightning, a Linux cluster system at Los Alamos National Laboratory, has 1,408 dual-processor AMD Opteron nodes with a Myrinet interconnect and a peak speed of 43 teraOPS/s. Lightning has 50 terabytes of temporary high-speed parallel storage and enjoys an award-winning architecture developed at Los Alamos (Science Appliance) and a software suite (Clustermatic) that can completely control a cluster.

The Red Storm supercomputer, at 40 teraOPS/s, represents a highly balanced and integrated capability machine well suited to running a mix of weapons performance, stockpile science, and engineering applications.

Sandia National Laboratories teams with another government agency to explore Petaflops computing using the Cyclops Processor-In-Memory (PIM) advanced architecture in a system of the configuration shown below. Cyclops' processor chips have 80 "cores" or microprocessor units. The high degree of parallelism on each chip supports very compute-intensive applications, such as Direct Simulation Monte Carlo (DSMC) methods.

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