TLCC2

Tri-Lab Linux Capacity Cluster—Unifying computing across the NNSA defense complex

The Tri-Lab Linux Capacity Cluster 2 (TLCC2) represents a multi-million dollar and multi-year contract to provide multiple procurement options exceeding 3 petaFLOP/s in commodity technology systems. Under the terms of the contract, computing clusters built of scalable units (SUs) were delivered to Lawrence Livermore, Los Alamos, and Sandia National Laboratories between October 2011 and June 2012. Each SU represents 50 teraFLOP/s of peak computing power and was designed to be interconnected to create more powerful systems. The SUs were divided among the three labs, with each lab configuring the SUs into clusters according to mission needs. These computing clusters are providing needed computing capacity for NNSA's day-to-day work managing the nation's nuclear deterrent.

Sited at Lawrence Livermore, the ASC Zin supercomputer is now "generally available" to NNSA scientists fulfilling NNSA's national security missions.

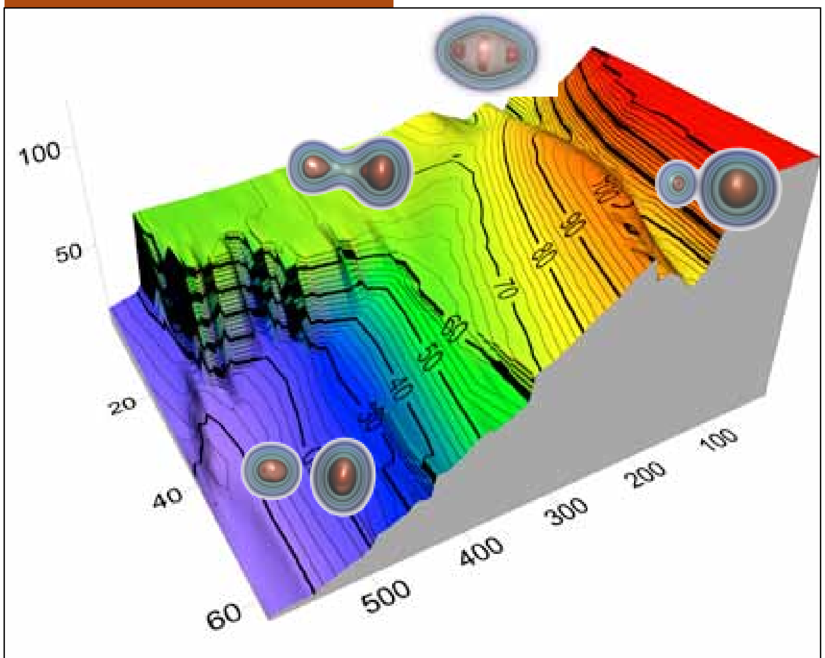
In October 2011, LLNL received the first of 18 SUs, which were combined into a single classified cluster named Zin, with a peak speed of 970 teraFLOP/s. Additional SUs were combined to create the single unclassified cluster named Cab, which has a peak speed of 431 teraFLOP/s. Cab is in the "collaboration zone," where users in the new High Performance Computing Innovation Center (HPCIC) can access the machine. A third cluster, Merl, is a small resource shared by Lawrence Livermore and the ASC Program for small to moderate parallel jobs. The names of the three supercomputers were inspired by the Livermore area wine country.

TLCC2 is NNSA's second joint procurement of this type and replaces the clusters procured in 2007 that are nearing retirement. This tri-lab procurement model reduces costs through economies of scale based on standardized hardware and software environments at the three labs.

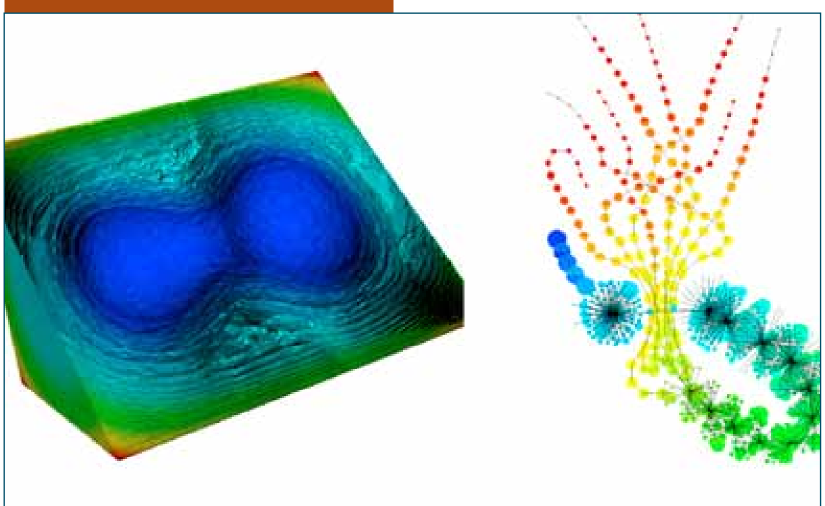
LLNL-MI-587913

Scientists have begun to use the TLCC2 computers for programmatic simulations. The figures shown below illustrate how these state-of-the-art computing capabilities can advance our understanding of nuclear fission, a fundamental problem of basic science with critical applications for national security.

Nuclear fission is the process by which an atomic nucleus breaks into two or more smaller fragments by releasing a very large amount of energy. This mechanism has been used for several decades in nuclear reactors for energy production and in nuclear weapons. In supernovae, it drives the formation of heavy elements in stellar burning processes and is, therefore, a key mechanism to understanding the formation and abundance of elements in the universe.



Current theories of fission rely on advanced methods of quantum theory implemented in large-scale numerical simulations. The goal is to understand under which specific conditions the complex interactions of the constituents of the nucleus can lead to a breakup of the system and to accurately predict the consequences of this process.



During fission, everything happens as if the atomic nucleus is stretched up to its breaking point. In the course of this process, millions of different quantum configurations are explored. Computing each of them on a standard computer would take thousands of years. Thanks to the TLCC2 computers, the time to run these simulations is reduced to a few hours or days.

Understanding the aging of nuclear materials or the precise amount of energy released during fission requires identifying the exact moment at which the nucleus has ceased to be whole and has finally split in two fragments—the scission point. Because the nucleus does not break like a piece of glass or a wood stick, but rather like cotton candy, theorists must take into account complex quantum entanglement and tunneling effects and rely on advanced topological methods to identify the scission point.

Theory of Nuclear Fission. Above: Nuclear energy of plutonium 240 as a function of its deformation. Below: Mapping of the 3D volume rendering of the nuclear density to joint contour nets used to identify a scission point.

Physics: N. Schunck, W. Younes, D. Gogny, LLNL
Visualization: A. Knoll, Argonne National Laboratory, and D. Duke, H. Carr, University of Leeds, UK