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Mechanics Simulation Capabilities Overview

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Computational Simulation Group

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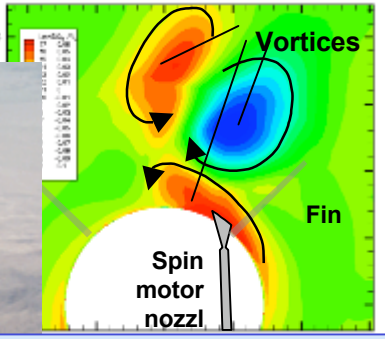
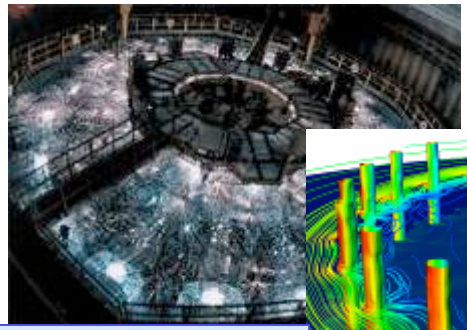
Computational simulation is the best way to address Sandia's diverse nuclear weapons challenges

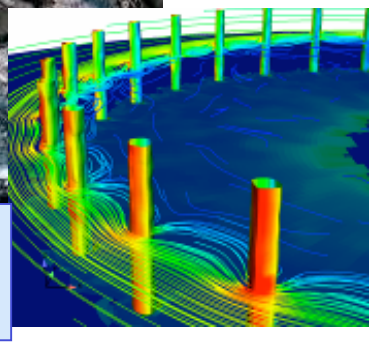
Modeling and simulation enhances and replaces test-based qualification



Resolution of weapon Issues uncovered in qualification and surveillance

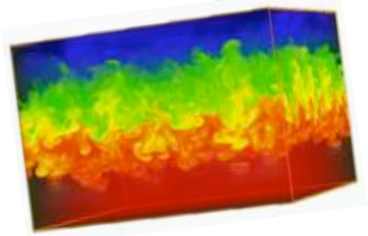
Modeling and simulation allows probing broad environments; too many scenarios to test





Breakthroughs in science enabled by modeling and simulation

The Advanced Simulation & Computing (ASC) Program has championed computational efforts



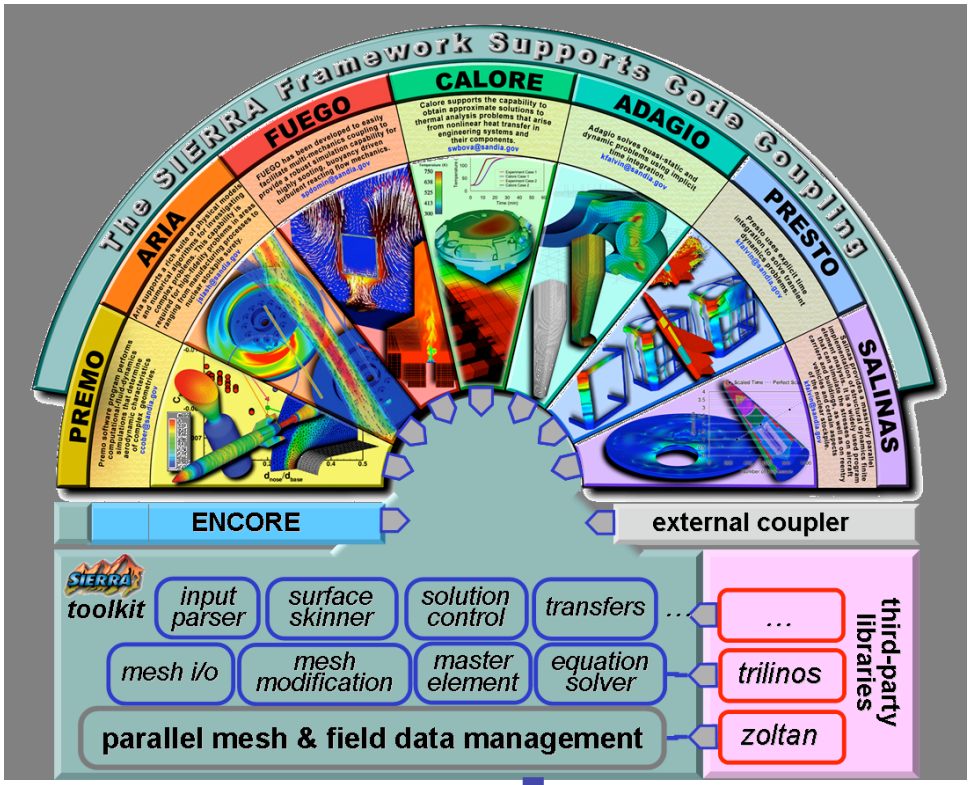
Red Storm Capability High Performance Computer

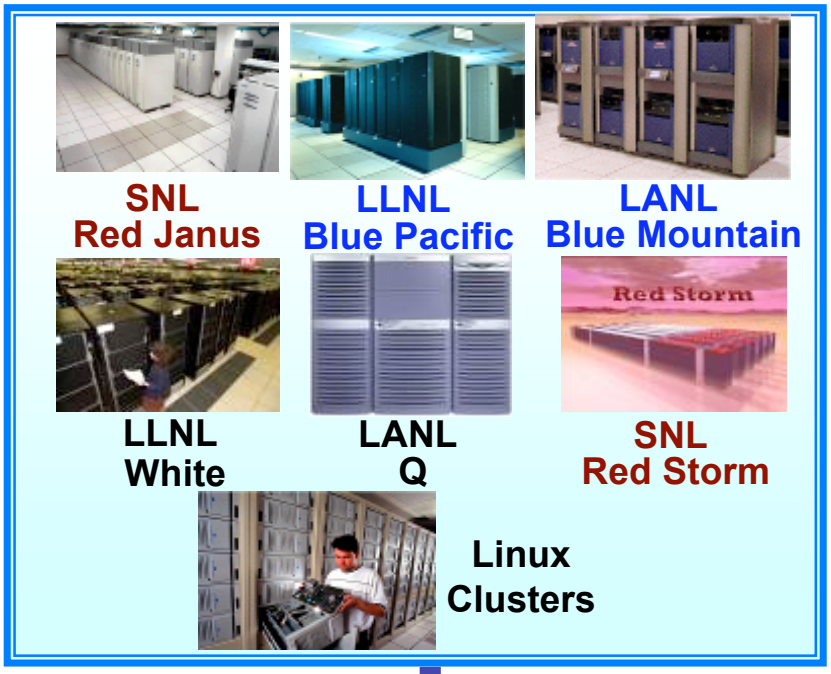
ASC Mission: Provide the science-based simulation capability to assess and certify the safety, performance and reliability of nuclear weapons and their components without nuclear testing

ASC Strategic Alliances

SIERRA is the framework on which our mechanics simulations are built

- Designed for scalability on MPP hardware, e.g., large problems on large machines.
- Designed for coupled physics simulations.
- DOE ASC program funded for ~10 years





SIERRA has a wide range of coupled mechanics simulation capabilities

Premo – compressible fluid mechanics with subsonic through hypersonic flows

Aria – non-newtonian reacting flow with free surfaces and complex material response

Fuego – low mach number turbulent reacting flow participating media radiation

Calore – heat transfer with limited convection, chemistry, and enclosure radiation

Adagio – Nonlinear solid mechanics, quasistatics, implicit dynamics, failure and tearing

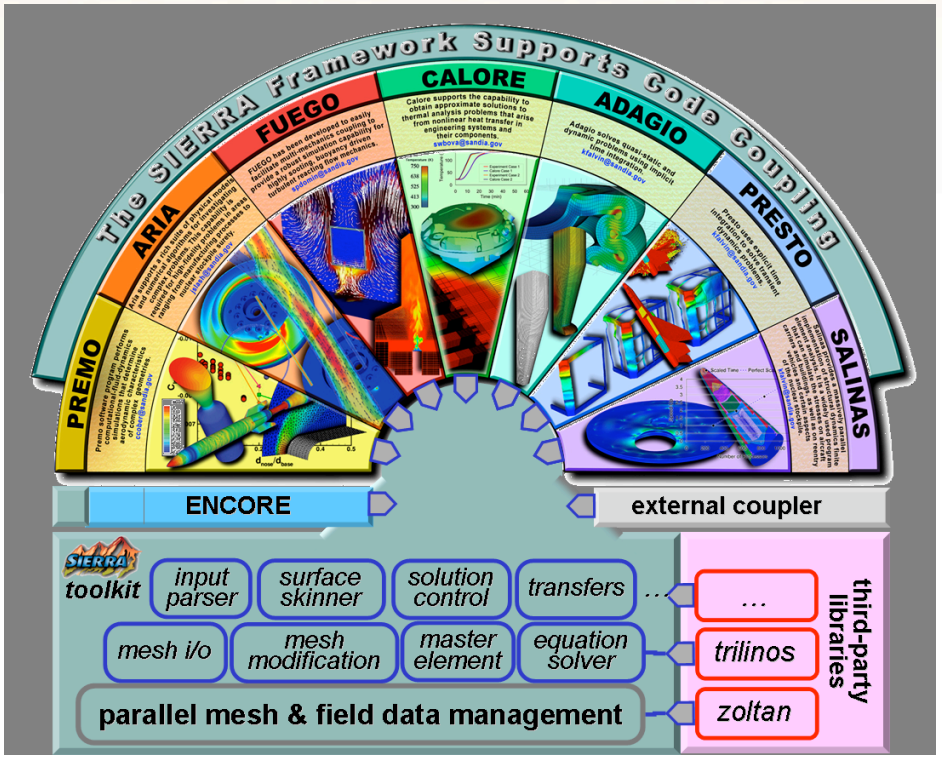
Presto – nonlinear solid dynamics with explicit time integration, nodal-based tets, remeshing, particle methods, cohesive surface elements, contact, and material failure

Salinas – linear structural dynamics and modal analysis of complex structures

SIERRA is built on a toolkit of efficient and scalable services

Toolkit of FE application services

- Mesh & field data management (parallel, distributed)
- Transfer operators for mapping field variables from one mechanics to another
- Solution controller for code coupling
- Solvers and load balancing
- Error estimation
- Coupling to other engineering analysis codes
- Access to communications libraries and other parallel services

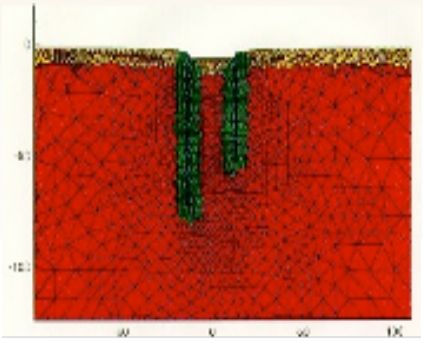


- Uncertainty quantification, sensitivity analysis, verification and validation support

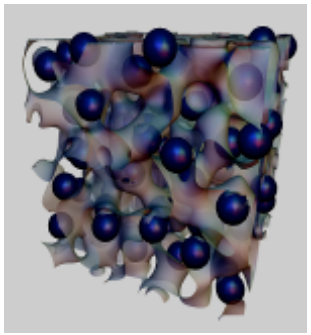
SIERRA development is continuing

We are developing a comprehensive strategy for the next decade to achieve predictive computational simulation

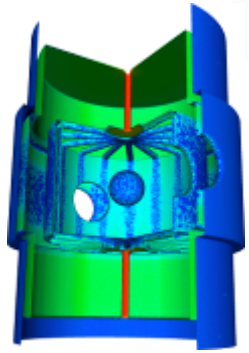
- New codes/mechanics modules meeting mission needs
- Multiphysics and code coupling
  - E.g., porous media flow with coupled thermal, fluid, structural interactions
- Improved physics insertion
- Enhanced algorithmic and toolkit development
- Increased code usability, reliability, robustness and performance
- Enhancements to computing environment to reduce time to analysis
- New computational capabilities for Uncertainty Quantification (UQ) & Quantification of Margins (QMU)



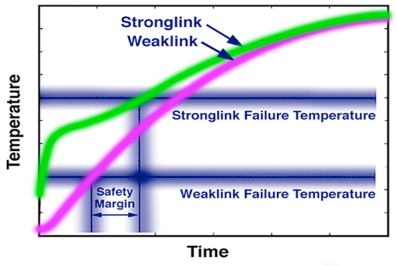
Multi-scale Algorithms



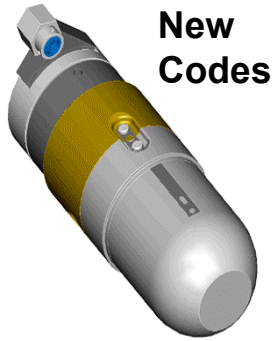
Computational Materials



Enhanced Physics



UQ/QMU Tool Development



New Codes

Our customers are many & varied with NNSA being our largest funding source