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Los Alamos NATIONAL LABORATORY

Oppenheimer Science and Energy Leadership Program (OSELP)

Software and Computing Strategy
for the Future of Weapons Physics Applications

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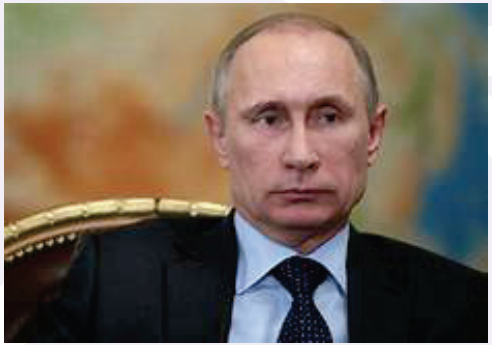
Mission drivers at the national level are evolving to accommodate a broadening landscape

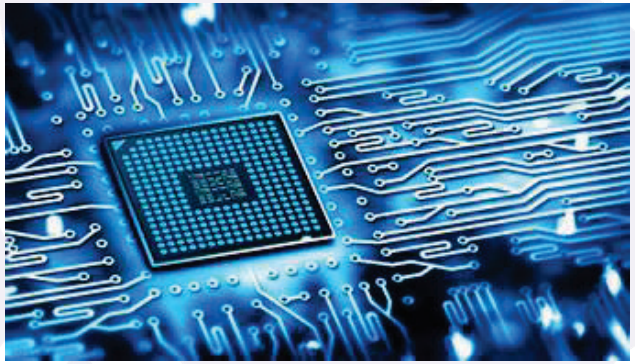


- The U.S. faces a rapidly evolving, threat-based environment with an associated expansion of national-level priorities
- Priorities continue to include all aspects of sustaining the existing, aging stockpile
- Now, however, we must also include consideration of options for a future deterrent
  - Efficacy of the deterrent against new threats (threat assessment and response)
  - Capability needs associated with new materials and modern manufacturing and production processes
  - Efficiency requirements for a modern workflow for weapons design

Russia's "invincible" new hypersonic Satan 2 super nuke

Additionally, the technology landscape associated with computing has become disruptive

Our software development and weapons design communities face a rapidly evolving computational environment



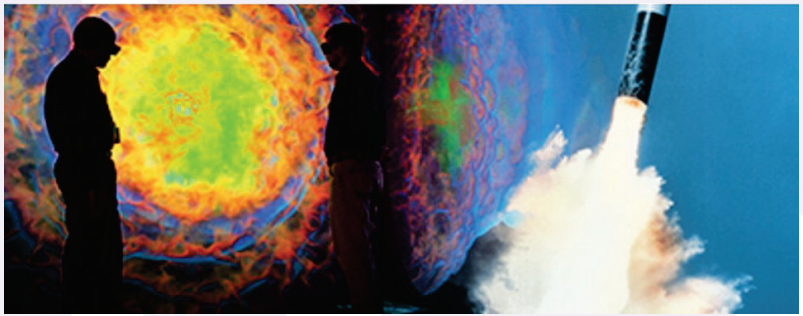
- Diversity of computing platforms and architectures
- A premium on code portability, credibility, and performance
- A variety of new computing approaches
  - Impacting the competitiveness and viability of our software
  - Providing opportunities for the development of new, transformational approaches

To be addressed while we maintain a top priority of uninterrupted mission execution through support of our design community partners

Simulation and computing are cornerstones of science-based stockpile stewardship

Nearly every aspect of assuring the safety, reliability, and effectiveness of the U.S. nuclear stockpile requires advanced, multi-physics, modeling and simulation capabilities:

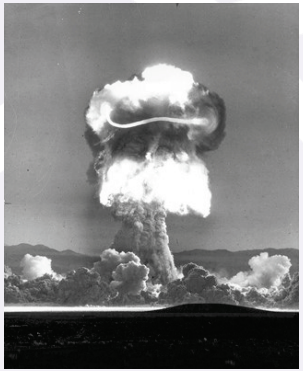
- From discovery science, where modeling and simulation live at the intersection of theory and experiment as part of the modern scientific method
- Through experimental science, where a variety of software is used to design and analyze both single-physics and integrated multi-physics experiments
- To our multi-physics software providing the necessary complement to experiment and designer expertise as a major component of our certification strategy



Doubtless, the future of U.S. nuclear deterrence will rely heavily on enduring, pedigreed, modeling and simulation capabilities

A strategy is needed to navigate the complex landscape between mission and new technology

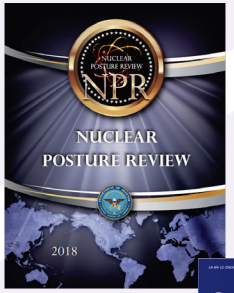
- Align with national-level priorities
- Evolve our software base
  - To best support the Weapons Program
  - While we exploit an evolving computational environment and new technology
- Create the efficiencies we will need to execute across the broadest cross-section of mission space
- Re-balance the pursuit of predictive capability with capabilities for a more responsive nuclear weapons enterprise
- Complement, support, and specifically address higher-level strategies
- Align capability development plans with mission requirements
- Align programs, groups, projects, staff, and set consistent expectations
- Develop one message to use as a common communication tool



Avoid unacceptable outcomes

Drivers of our software and computing strategy begin at the national level and …

• 2018 Nuclear Posture Review	National Policy
• NNSA Strategic Vision	DOE/NNSA
• Stewardship Capability Delivery Schedule	NNSA
• ASC Platform and Facilities Timeline	NNSA/ASC
• The Future of Nuclear Deterrence	Tri-Lab
• Laboratory Agenda	LANL
• Weapons Physics Directorate Strategy	ALDX
• Principal Goals and Strategy for the ASC Program	LANL ASC Program
• Weapons Program (XTD, OES, DSW, GS) Drivers	Division and



… cascade down through the LANL, ALDX, ASC, and LANL Division Office and Program Office levels, to include Laboratory and local Weapons Program goals and priorities

From the national level down to our local programs, the highest priorities fall into these five categories

Code Strategy Priorities

1. Supporting current NNSA and LANL mission needs and positioning LANL to provide future critical mission capabilities

2. Providing the underlying capabilities necessary to enable the confident and efficient design, certification, and assessment of both current and future stockpile systems

3. Enabling efficient utilization of modern computing platforms

4. Modernizing and transforming the ALDX code base

5. Developing the future workforce

Software and Computing Strategy Goals and Initiatives

Supporting Mission Needs	Providing Critical Capabilities	Strategically Utilizing Computing Platforms	Transforming Our Code Base	Developing the Future Workforce
Enable program success across the breadth of the NNSA and LANL mission landscape	Provide best-in-class capabilities to enable trusted, confident, and efficient weapons design, qualification, assessment, and certification	Execute mission with tailored and targeted platform utilization, while enabling the effective and efficient use of future architectures	Transform the multi-physics production and support codes into the advanced modeling and simulation software base of the future	Develop the future workforce, to provide ground-breaking scientific achievements in support of the Weapons Program mission
1.1 Provide continuing modeling and simulation support to the weapons design and assessment communities 1.2 Contribute to, and otherwise enable, the successful completion of SCDS Peg Posts 1.3 Support OES, ETM, and broader DSW modeling and simulation needs 1.4 Enable future design options and responsive design, assessment, and certification timelines 1.5 Establish the Enabling Manufacturing Project and enable other new production science and manufacturing initiatives	2.1 Complete critical ongoing capability development activities, and identify and address capability gaps 2.2 Enable the resolution of outstanding uncertainties associated with weapons performance, such as aging 2.3 Provide robust, verified and validated, high-fidelity, 3D modeling and simulation capabilities 2.4 Integrate more robust V&V/UQ into our software development processes 2.5 Actively design software products for increased efficiency throughout the designer workflow	3.1 Continue to execute current missions with targeted utilization of current CTS and Trinity platforms 3.2 Port to, optimize on, and demonstrate staged mission successes on Sierra 3.3 Enable rapid porting to, optimization on, and production utilization of Crossroads 3.4 Use our staged successes on Sierra, to enable production applications on El Capitan 3.5 Enable agile portability and utilization options for architectures beyond El Capitan	4.1 Continue to modernize and advance the capabilities and pedigree of the enduring multi-physics production software 4.2 Modernize and optimize supporting software, libraries, and data bases 4.3 Develop advanced machine learning, weapons science, and research and development software 4.4 Develop next-generation multi-physics production software for the future of weapons physics applications 4.5 Develop a shared capability and infrastructure model for efficiency in future software development	5.1 Establish best-in-class recruiting strategies and hiring principles to enable continuous improvement in quality of hire 5.2 Provide technical challenges, career development, and leadership opportunities to our staff 5.3 Establish a culture that optimizes staff performance and enables success in mission execution 5.4 Develop the technical capabilities and staff expertise required for mission agility and success 5.5 Align staff and leadership to execute this strategy in support of the broad Weapons Program mission

We envision a modern software base with the following attributes

- A balanced mix of high-fidelity, pedigreed, enduring capabilities, possessing the functionality to successfully execute current ***mission***, and more agile capabilities with the ability to responsively adapt to evolving mission needs
- Representing the cutting edge in numerical methods, physics models, and verified and validated multi-physics modeling and simulation ***capabilities***, and with the agility to enable rapid development and deployment of new capabilities
- Codesigned with hardware architects to exploit the latest advances in ***computing platforms*** and to leverage existing software development and computing technology
- Developed using emerging software development tools and best practices; and actively designed to ensure quality ***software*** products, and to enable robust performance, portability, maintainability, efficient development, and ease of use
- World class in reputation, to recruit the ***future workforce***, to retain exceptional talent, and to develop succession plans for leading technical roles and program and line leadership positions

Executing this complex strategy will come with challenges

1.1 Provide continuing modeling and simulation support to the weapons design and assessment communities

while we

3.5 Enable agile portability and utilization options for architectures beyond El Capitan

while we

4.4 Develop next-generation multi-physics production software for the future of weapons physics applications

We must execute our current mission, while we prepare for future missions and an increasingly uncertain future

Questions?