

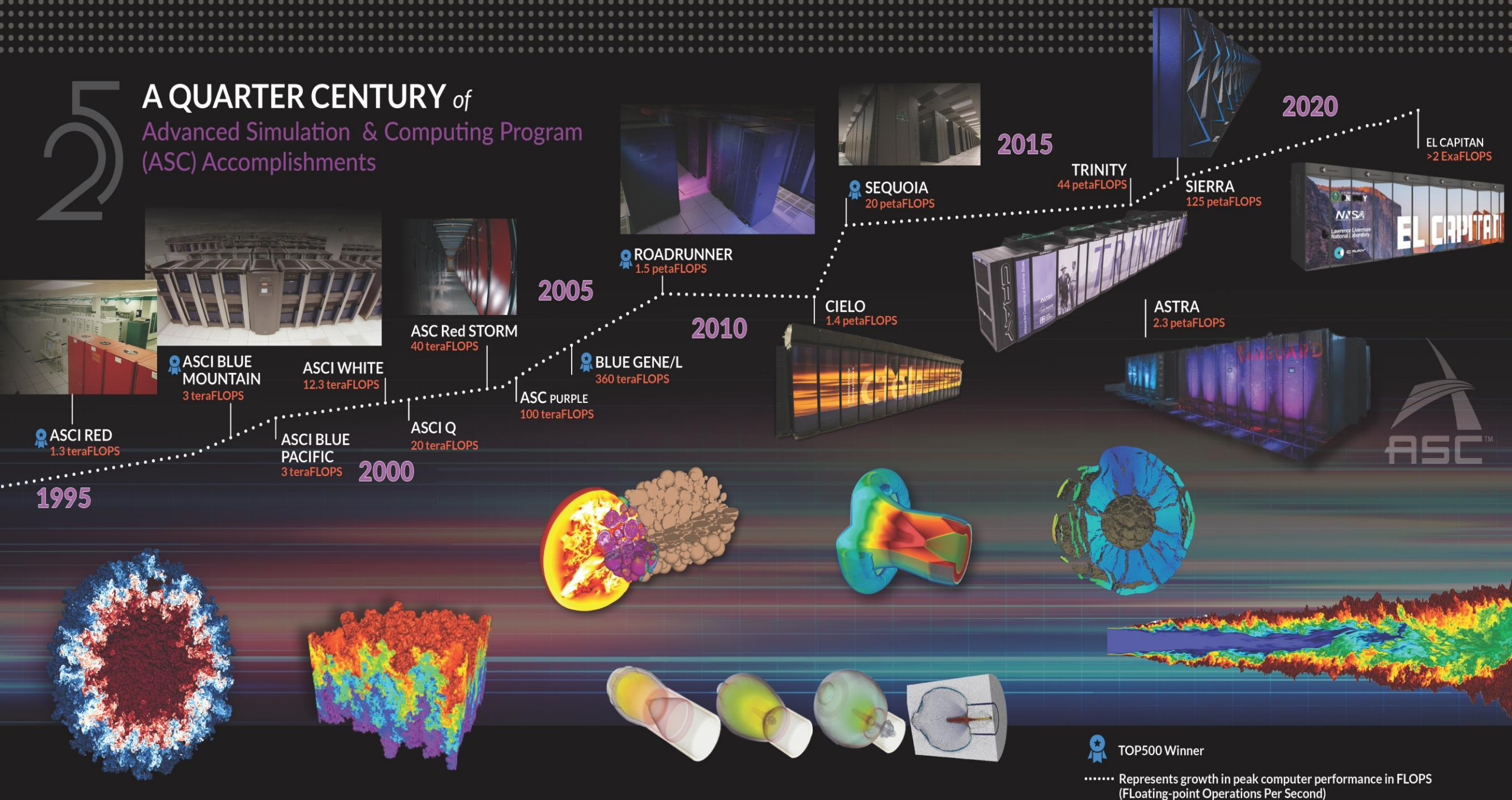
# NNSA Advanced Simulation and Computing (ASC) Program

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# 25

## A QUARTER CENTURY of Advanced Simulation & Computing Program (ASC) Accomplishments





# Advanced Simulation and Computing Mission

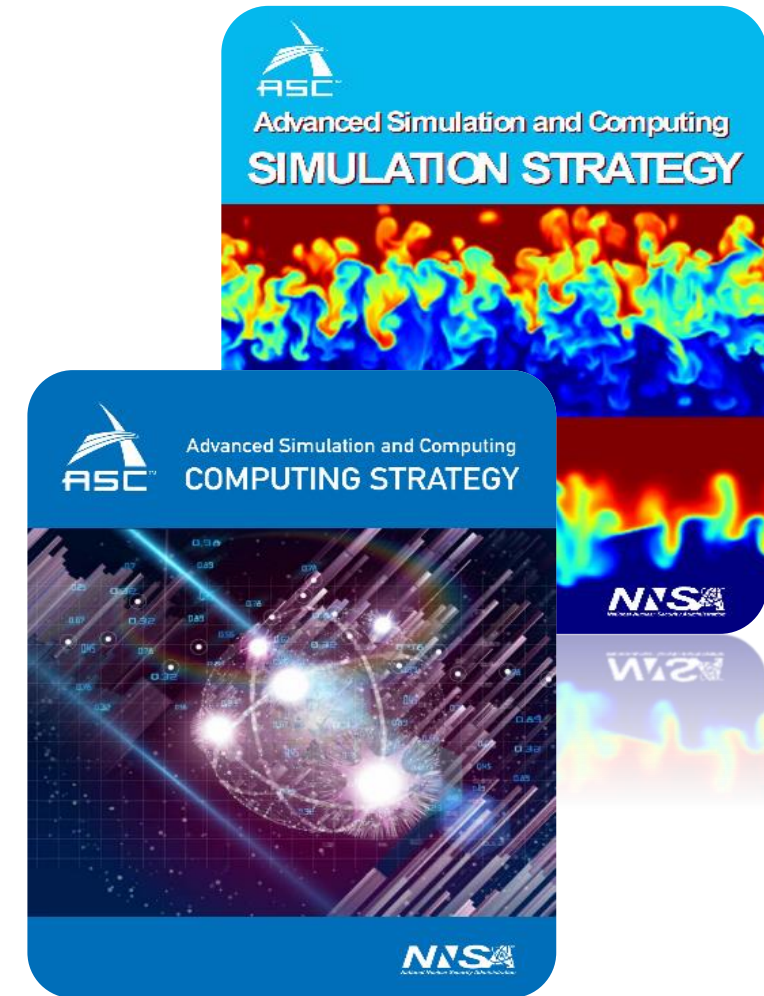
**ASC is predictive science through simulation: the people, state-of-the-art computational platforms, and simulation tools used in the annual certification of nuclear weapons stockpile:**

- **Prediction Through Simulation.** Deliver verified and validated physics and engineering codes to enable simulations and risk-informed decisions of nuclear weapons performance, safety, and reliability.
- **Robust Tools.** Develop robust models, codes, and computational techniques to support stockpile needs such as Significant Finding Investigations, Life Extension Programs, annual assessments, as well as evolving future requirements.
- **Balanced Operational Infrastructure.** Implement a balanced computing strategy of platform acquisition and operational infrastructure to meet Stockpile Management, Modernization and Stewardship Programs' needs for production computing and advanced simulation capabilities.

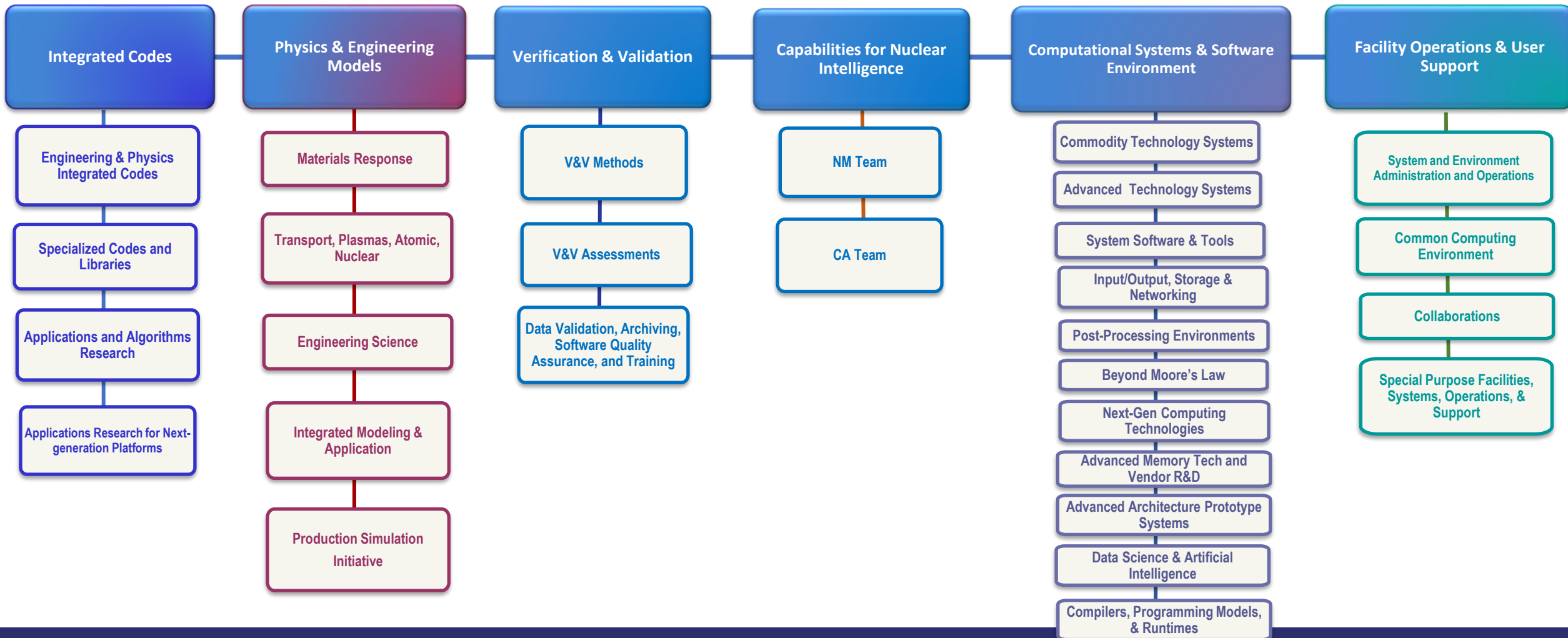


# ASC 10-Year Strategic Guidance

- Deploy modeling and simulation capabilities for assessing the performance, safety, and security of an evolving stockpile
- Deliver modeling and simulation services for optimizing designs and addressing threats
- Develop simulation tools for an efficient production complex
- Provide a stable, production-level high-performance computing (HPC) capability for current and future NNSA nuclear deterrent missions
- Modernize and sustain the ASC computing infrastructure (classified and unclassified)
- Collaborate with industry to keep pace with hardware advances, especially in artificial intelligence and quantum computing areas



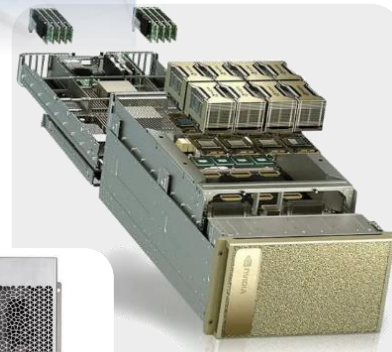
# National ASC Work Breakdown Structure (FY2025)





# ASC Trilab Computing Environment

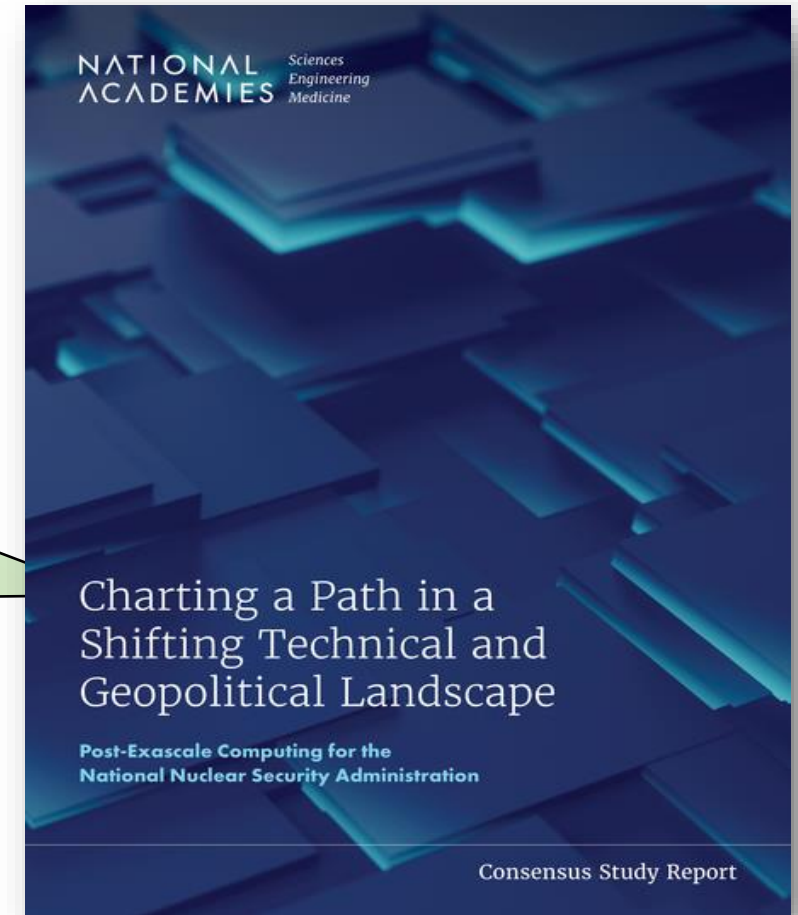
- ASC is investing HPC and AI R&D and platform deployments across NNSA enterprise because we can use combine these to drastically enhance our national security capabilities:
  - Upcoming *El Capitan* at LLNL @ 2+ ExaFLOPS
  - *Crossroads* at LANL
  - *Spectra* at SNL
  - *Commodity Technology Systems* at 3 NNSA labs and sites
  - Additional HPC and AI hardware & testbeds



# Legislative Language for the NASEM Post-Exascale Study

As mandated by Congress in the **2021 National Defense Authorization Act**, a committee was established by the National Academies of Sciences, Engineering, and Medicine to review “the future of computing beyond exascale computing to meet national security needs at the National Nuclear Security Administration.” In the context of the NNSA mission needs, the committee was asked to evaluate future technology trajectories as well as the U.S. industrial base required to meet those needs.

<http://nap.nationalacademies.org/26916>

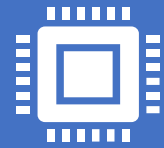


# NASEM Post-Exascale Study – Recommendations

Recommendations are grouped into three main categories:

## HPC Procurements & Roadmaps for the NNSA

Hardware, procurement models, software and mission workflows



## Investment in foundational and applied R&D

Including specific call-outs for inter-disciplinary R&D and focus on AI/ML



## Workforce, partnerships and training

Inter-government, inter-agency, University and international partnership programs





# ASC Academic Alliance Program

## 2022 NNSA Strategic Vision

### ADAPTIVE WORKFORCE & RESILIENT INFRASTRUCTURE

NNSA will recruit, invest in, and nourish a high-performing, diverse, and flexible workforce that can meet the unique policy, technical, and leadership needs of our mission today and well into the future. We champion all aspects of diversity, equity, inclusion, and accessibility so that NNSA and its enterprise benefit from the full range of America's talent. Efforts to minimize personnel attrition are a high priority, as is investing in university programs to support our future workforce.

We must also continue revitalizing our infrastructure, both by reestablishing capabilities lost after the Cold War and modernizing facilities that have degraded over the last 30 years. This infrastructure refurbishment is moving forward in sync with our weapons modernization and nuclear security programs and must leverage improvements in manufacturing and other technologies. A modern and flexible nuclear complex remains key to the resilience of the Nation's deterrence capabilities and ensures that NNSA remains responsive to evolving mission requirements.

Resilient infrastructure also requires investing in modern information technology and cybersecurity solutions to protect our assets against growing threats, safeguard our ability to deliver on the mission, and provide a state-of-the-art work environment for our workforce.

### INTEGRATED ENTERPRISE MANAGEMENT & OPERATIONS

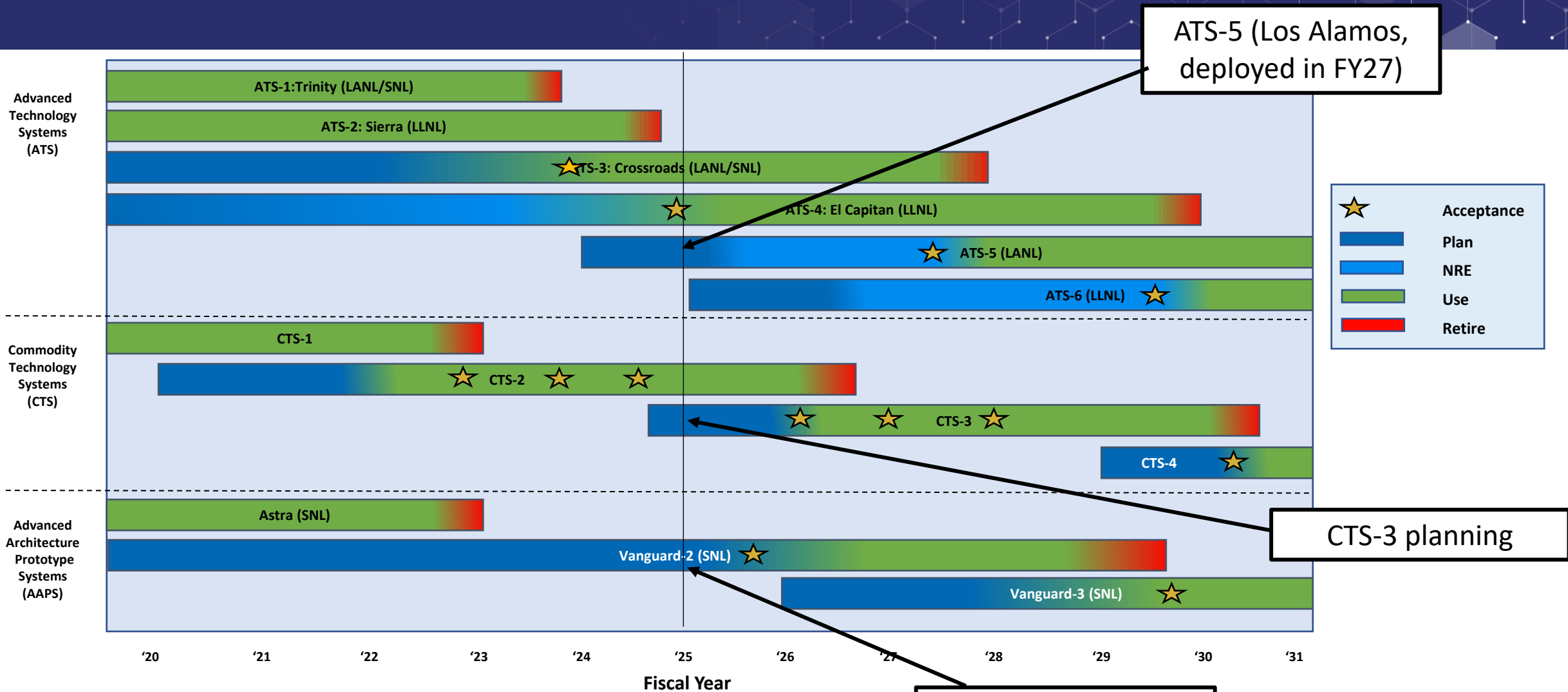
Effective governance and management incorporates mission integration and efficient execution across the NSE. This collaborative approach among our federal, laboratory, plant, and site partners is critical to NNSA's success. We will continue to work together to assure schedule and technology alignment, improve efficiency, and accelerate delivery. We will harness the greatest capabilities that our Management and Operating partners offer, especially as they continue to share best practices from across the nuclear portfolio, industry, and academia. Embracing this flexibility allows each laboratory, plant, and site to optimize itself to both deliver for NNSA and contribute to vital national priorities.

13 | 2022 STRATEGIC VISION

- **Academic Strategic Alliance Program (ASAP): 1997 -2008**
  - 5 Centers
- **Predictive Science Academic Alliance Program (PSAAP I): 2008 – 2013**
  - 5 Centers
- **PSAAP II: 2014 – 2020**
  - 5 Multidisciplinary Simulation Centers (MSCs) and Single-Discipline Centers (SDCs)
- **PSAAP III Centers: 2020 – 2025**
  - 9 MSCs, SDCs, and Focused Investigatory Centers (FICs)
- **(NEW) PSAAP IV: 2025-2030**
  - <https://psaap.llnl.gov/>



# Upcoming ASC Procurements...



ATS-5 (Los Alamos, deployed in FY27)

CTS-3 planning

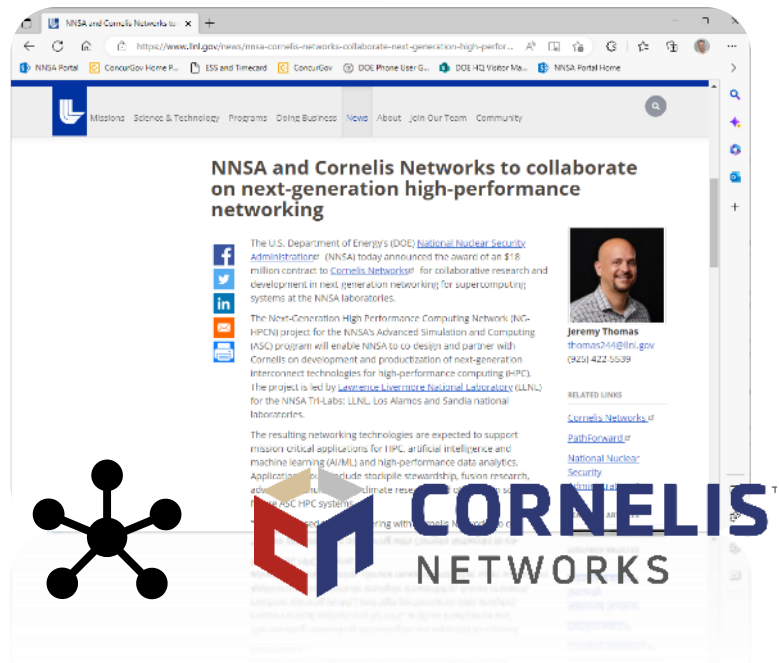
Vanguard-II Hardware Evaluation

# R&D and Prototyping Activities



## Advanced Memory Technologies

- New materials for memory
- Novel foundational DRAM designs
- Compute/Memory Architecture



## Next Generation HPC Networks

- NIC + Switch Codesign
- Scale out (larger machines)
- Cost/perf optimizations

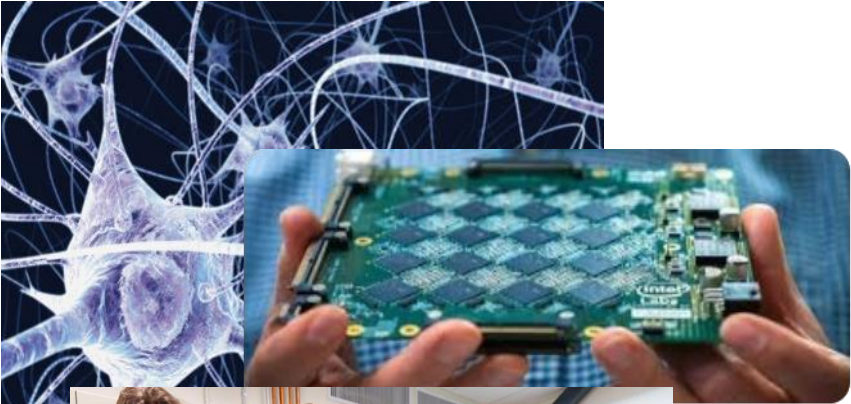
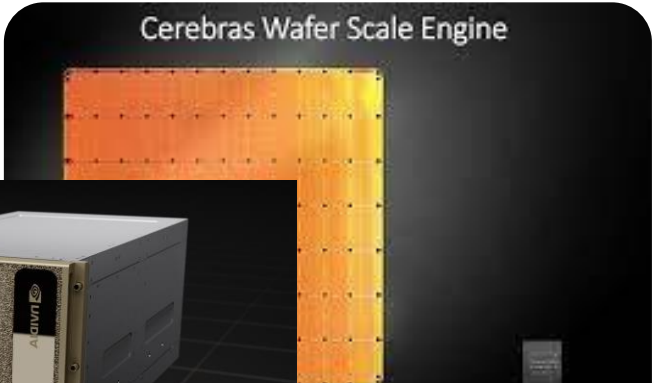


## Advanced Architecture Prototypes

- Novel accelerators beyond GPUs
- Reconfigurability
- Advanced storage concepts



# Investment in Evolving Architectures



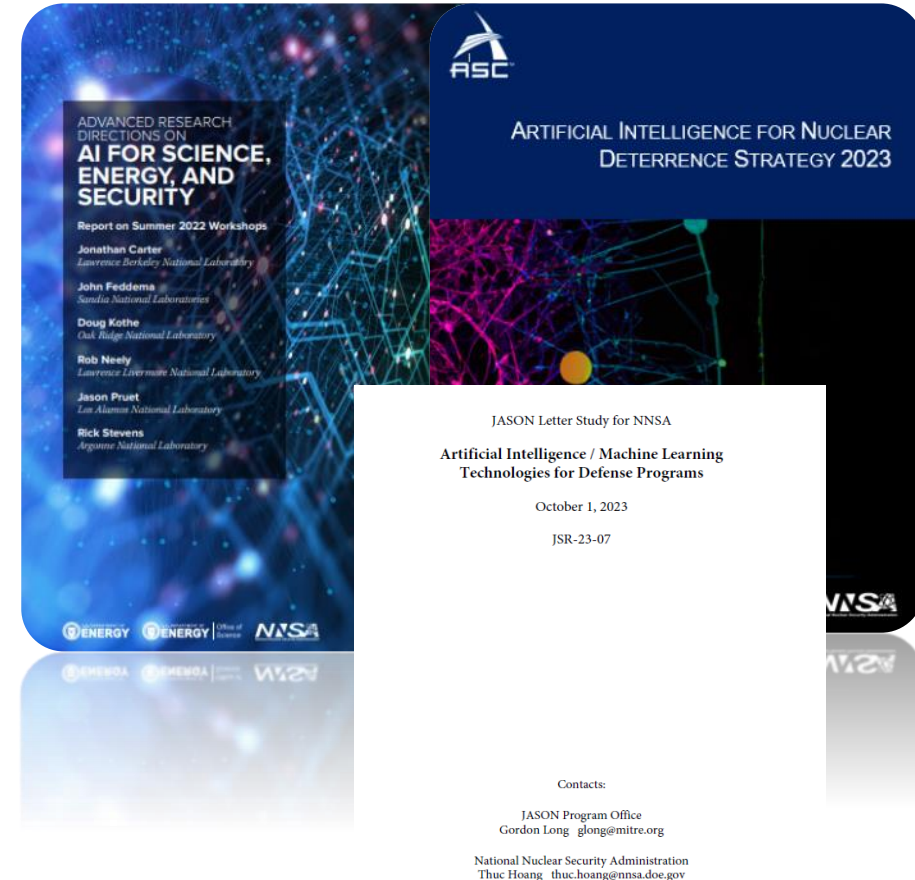
**Machine Learning**

**Neuromorphic**

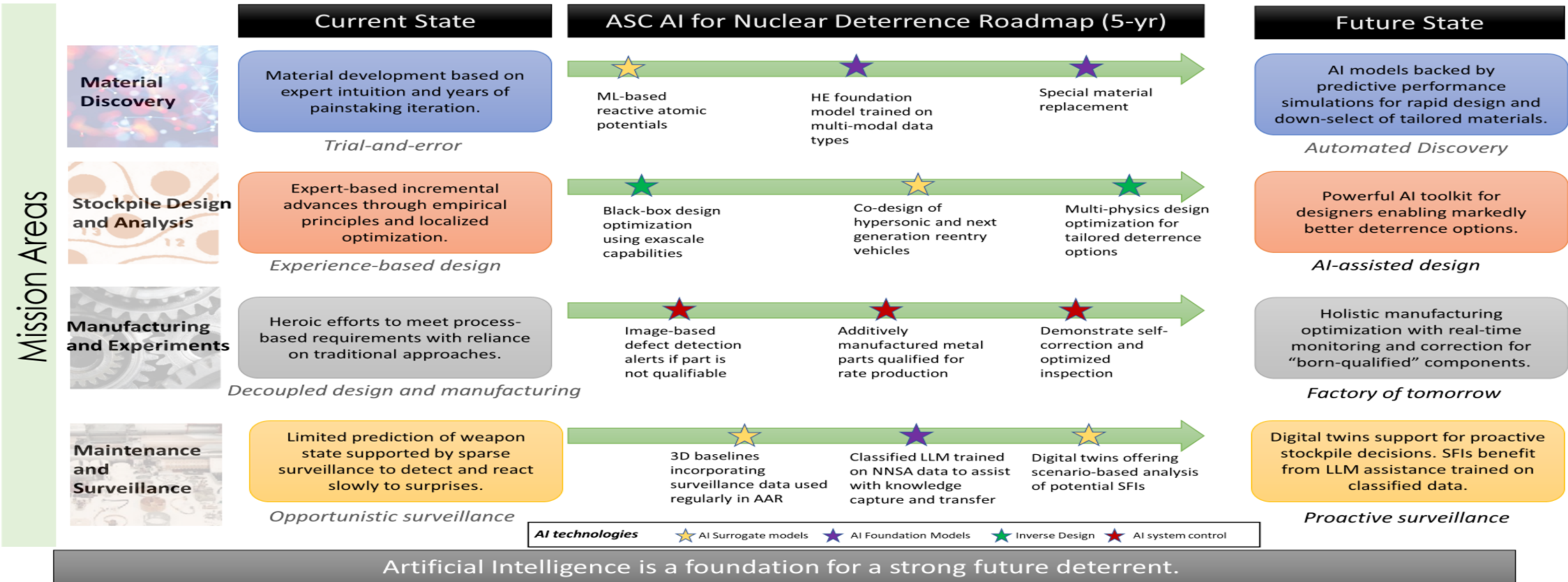
**Quantum**

# AI and Machine Learning

- DOE AI4SES report
- JASON letter study (summer 2023)
  - Identified and prioritized opportunities
  - AI trustworthiness and compliance are high priorities
- 2024 ASC AI for Nuclear Deterrence Strategy focuses on four main areas:
  - Foundational R&D for AI/ML
  - Application to mission areas
  - Investment in data infrastructure
  - Workforce and Partnerships



# AI for Nuclear Deterrence (AI4ND)





# Final Thoughts

- For the past 29 years, ASC has been successful in providing the needed simulation and computing services for NNSA Defense Programs.
- For the future, ASC will still employ advanced, exascale computing, in concert with all/any other viable computing architectures/technologies that will help sustain and improve ASC code performance.
- ASC will continue to work with other DOE programs and U.S. agencies, industry, academia and international collaborators to develop and deploy required solutions for its mission.

