Agency Priority Goal Action Plan

# High Performance Computing (Exascale/Artificial Intelligence)

**Goal Leader(s):**

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# Overview

## Goal Statement

To meet Administration Priorities and sustain U.S. preeminence in the strategic area of high performance computing (HPC), which underpins national and economic security, develop and deliver the next generation of integrated HPC capability by engaging in research and development to create a capable exascale computing ecosystem that integrates hardware and software capability delivering at least 100 times the performance of current 10 petaflop ($10^{15}$ floating point operations per second) systems across a range of applications representing government needs and societal priorities such as Artificial Intelligence (AI) technologies. By September 30, 2021, begin deployment (receiving and installing hardware) of at least one Exascale Computing system.

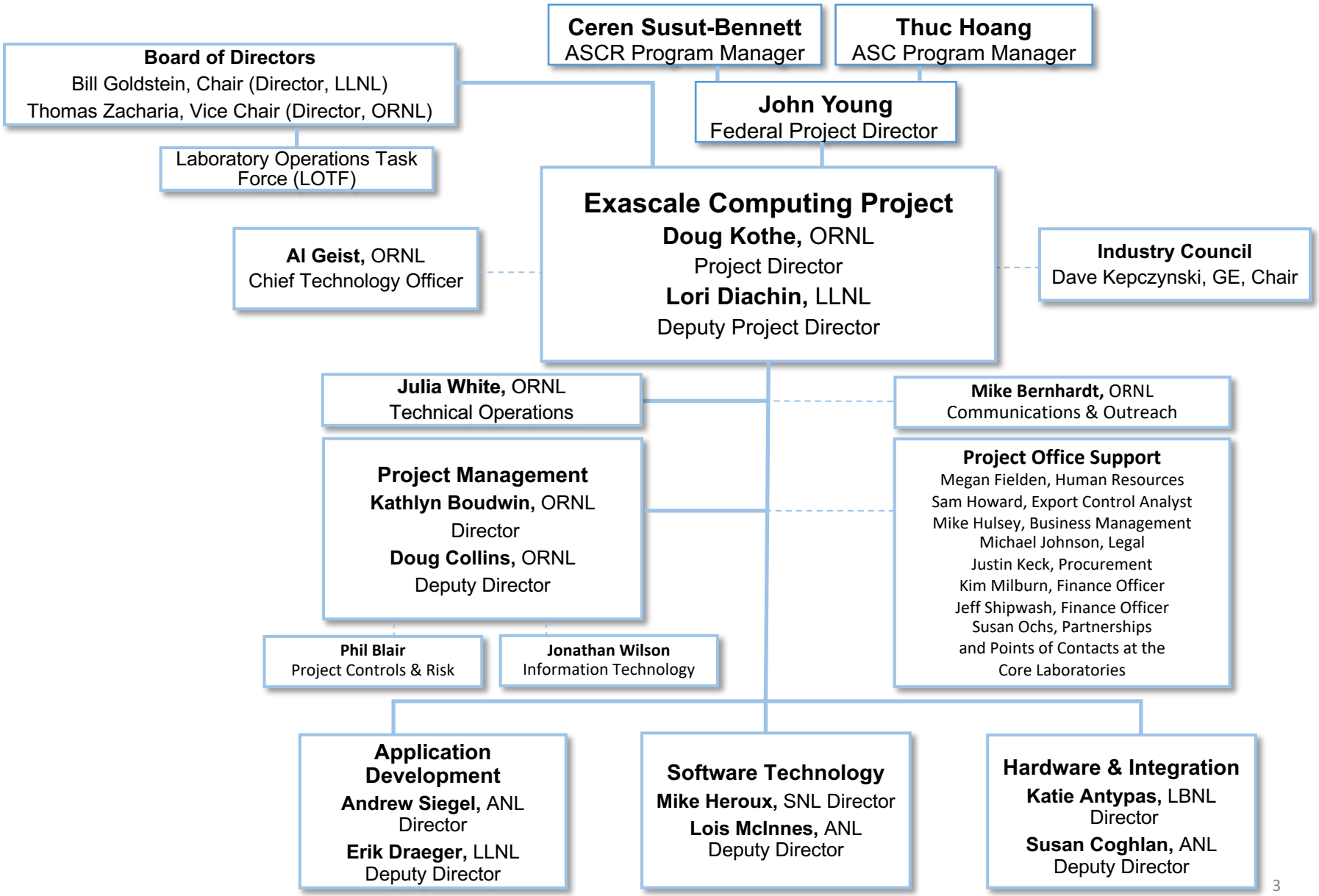
## Challenge

- Maintaining U.S. leadership in a globally competitive high performance computing environment in order to deliver the most innovative simulation and data science solutions that dramatically enhance U.S. economic competitiveness, strengthen national security, and enable solutions to the most challenging scientific problems.

## Opportunity

- Developing and delivering the next generation of integrated high performance computing capability requires mutually supportive research and development in hardware and software that benefits not only the DOE's missions in science, energy, and security, but U.S. industry's ability to innovate and maintain leadership in highly-competitive global markets, especially information technology.

# Leadership & Implementation Team



# Goal Structure & Strategies

- Employ the principles of Project Management to guide major acquisitions.
- Focus on investments that support a broad range of scientific disciplines.
- Finalize exascale designs as soon as possible to provide a clear target for science applications.
- Maintain strong engagement between the exascale project and High Performance Computing (HPC) facilities.
- Ensure continuous deployment of exascale software on testbed systems for testing and to inform applications development.

# Summary of Progress – FY 20 Q1

Q1, FY20: Technical Design review for the Exascale Computing Project (ECP)

*DOE received independent verification and documentation of the Exascale Computing Project's technical design review during the Independent Project Review conducted by the Office of Science's Office of Project Assessment on December 3-5, 2019. The independent review of the technical design review found the project design to be thorough and well documented and with no actionable findings or recommendations.*

# Summary of Progress – FY 20 Q2

Q2, FY20: Independent Project Review in support of Critical Decision-2 (CD-2) (establishment of cost, schedule and scope baselines) for Exascale Computing Project

*The Office of Science Office of Project Assessment conducted an Independent Project Review on December 3–5, 2019 to assess the Exascale Computing Project's (ECP) readiness to proceed to CD-2/3. The Independent Project Review team issued a final report on February 6, 2020 and concluded the project was ready and should proceed with requesting CD-2/3 approval.*

Q3 and Q4 Key Milestones were also completed in Q2:

- Q3, FY20: Energy Systems Acquisition Advisory Board (ESAAB) by the Under Secretary for Science (S-4) in conjunction with the Under Secretary for Nuclear Security (NA-1)
- Q4, FY20: Cost, Schedule and Scope baselines for the Exascale Computing Project established and documented through completion of CD-2

*The ESAAB was held on February 25, 2020 and CD-2 was approved by Under Secretary Dabbar on February 25, 2020.*

# Summary of Progress – FY 20 Q3

Q3 and Q4 Key Milestones were completed in Q2 (as discussed on previous page)

## Additional Accomplishments

Spack, part of DOE's Exascale Computing Project software ecosystem, is an easy-to-use, versatile, and scalable software package management tool for high-performance computing (HPC) applications that won a 2019 R&D 100 award and a special recognition medal in the "market disruptor" category. Spack automates the software build workflow, reducing deployment time for large software stacks from weeks to hours. Spack's original 100 or so packages have grown into a library of more than 3,500, with a large and active community of more than 450 contributors to this open source software. Spack is in use for software deployment on six of the world's top 10 supercomputers, many other HPC centers, and software development communities - including adoption as an end-to-end development tool for the high-energy physics community at Femilab and CERN.

# Summary of Progress – FY 20 Q4

Q3 and Q4 Key Milestones were completed in Q2 (as discussed on previous page)

## Additional Accomplishments

ECP Application Integration researchers worked with the application performance teams at the Argonne Leadership Computing Facility, Oak Ridge Leadership Computing Facility and National Energy Research Scientific Computing Center. Together they helped to prepare and optimize critical applications for exascale architectures through knowledge of the application domain as well as the hardware, compilers, and other features of the planned exascale systems. Working with both facility staff and the application teams, a number of advances have been realized, such as: reducing the memory footprint in an accelerator physics application by a factor of two; speeding up a quantum chemistry code by 40x by implementing a new GPU-based numerical tensor algebra library; and demonstrating a nearly 30x speedup on GPUs in a key alignment algorithm of a metagenomics application.

# Key Milestones

- The milestones for the Exascale Computing Project follow existing best practices for project management of large acquisitions. An "early as possible" approach to system design provides clear targets for science applications. Coupled to continuous deployment of software on testbed platforms, this strategy ensures system users will be capable of leveraging the full capabilities of the system once it is available.

| Milestone Summary | | | |
|---|---|---|---|
| **Key Milestone** | **Milestone Due Date** | **Milestone Status** *[e.g., Complete, On-Track, Missed]* | **Comments** *[Provide discussion of Progress, changes from last update, Anticipated Barriers or other Issues Related to Milestone Completion]* |
| Technical Design review for the Exascale Computing Project | Q1, FY20 | Complete | Project technical Design Review conducted FY19 |
| Independent Project Review in support of Critical Decision-2 (establishment of cost, schedule and scope baselines) for Exascale Computing Project | Q2, FY20 | Complete | Independent Project Review conducted Dec. 3-5, 2019 |
| Energy Systems Acquisition Advisory Board (ESAAB) by the Under Secretary for Science (S-4) in conjunction with the Under Secretary for Nuclear Security (NA-1) | Q3, FY20 | Complete | ESAAB held on February 25, 2020 |
| Cost, Schedule and Scope baselines for the Exascale Computing Project established and documented through completion of Critical Decision -2 | Q4, FY20 | Complete | Critical Decision-2 was approved by Under Secretary Dabbar on February 25, 2020 |
| Go decision executed by both vendor and National Lab for first exascale system | Q1, FY21 | | |
| Independent Project Review finds that the project is on track for receiving hardware on schedule. | Q2, FY21 | | |
| Early access system available to exascale applications | Q3, FY21 | | |
| Begin deployment of first exascale system by beginning to receive and install hardware | Q4, FY21 | | |

# Additional Information

## Contributing Programs

Organizations:

- Office of Science
- National Nuclear Security Administration

Program Activities:

- Advanced Scientific Computing Research (SC)
- Advanced Simulation and Computing (NNSA)

President's Management Agenda

- N/A

Regulations:

- N/A

Tax Expenditures:

- N/A

Policies:

- N/A

Other Federal Activities:

- Part of the National Strategic Computing Initiative

## Stakeholder / Congressional Consultations

The Department has provided numerous House and Senate briefings on the exascale projects and incorporates congressional direction and guidance as necessary. HPC exascale works with Universities, the National Laboratories, researchers, other federal agencies, and the private sector to build upon existing policies and procedures, best practices and initiatives.