

Exascale Computing Project (ECP) Overview

Presented to Future Trends in Nuclear Physics Computing

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EXASCALE COMPUTING PROJECT

ECP mission need

On July 29, 2015 the President established the National Strategic Computing Initiative (NSCI) to maximize the benefits of HPC for US economic competitiveness and scientific discovery.

DOE is a lead agency within NSCI with the responsibility that the DOE Office of Science and DOE National Nuclear Security Administration will execute a joint program focused on advanced simulation through a **capable** exascale computing program emphasizing sustained performance on relevant applications.

Programmatic components of the ECP

- It is a partnership between SC and NNSA, addressing science and national security missions
 - Relies on investments by SC/ASCR and NNSA/ASC
- ECP does not procure exascale systems
 - ECP includes only activities required for the delivery of the exascale computing capability (procurements of exascale systems will follow SC and NNSA processes and timelines)
 - NNSA/ASC Advanced Technology Development and Mitigation (ATDM) supports activities for the delivery of exascale applications, software, and technology
- Relationship of the ECP to the National Strategic Computing Initiative
 - On July 29, 2015, an executive order established the National Strategic Computing Initiative (NSCI) to ensure a coordinated Federal strategy in HPC research, development, and deployment.
 - DOE, along with the DoD and NSF, co-leads the NSCI. Within DOE, SC and NNSA execute the ECP, which is the primary DOE contribution to the NSCI.

The ECP is a Lab-led *Project* transitioning from the DOE exascale research activities

- DOE has been funding research related to exascale challenges for 5+ years
- Starting in FY 2016, the Exascale Computing Project (ECP) is being launched as a joint SC/NNSA partnership using DOE's formal project management processes
- The ECP is led by DOE laboratories

ECP Goals

- Develop a broad set of modeling and simulation applications that meet the requirements of the scientific, engineering, and nuclear security programs of the Department of Energy and the NNSA
- Develop a productive exascale capability in the US by 2023, including the required software and hardware technologies
- Prepare two or more DOE Office of Science and NNSA facilities to house this capability
- Maximize the benefits of HPC for US economic competitiveness and scientific discovery

ECP Scope is Based on Mission Needs and Requirements

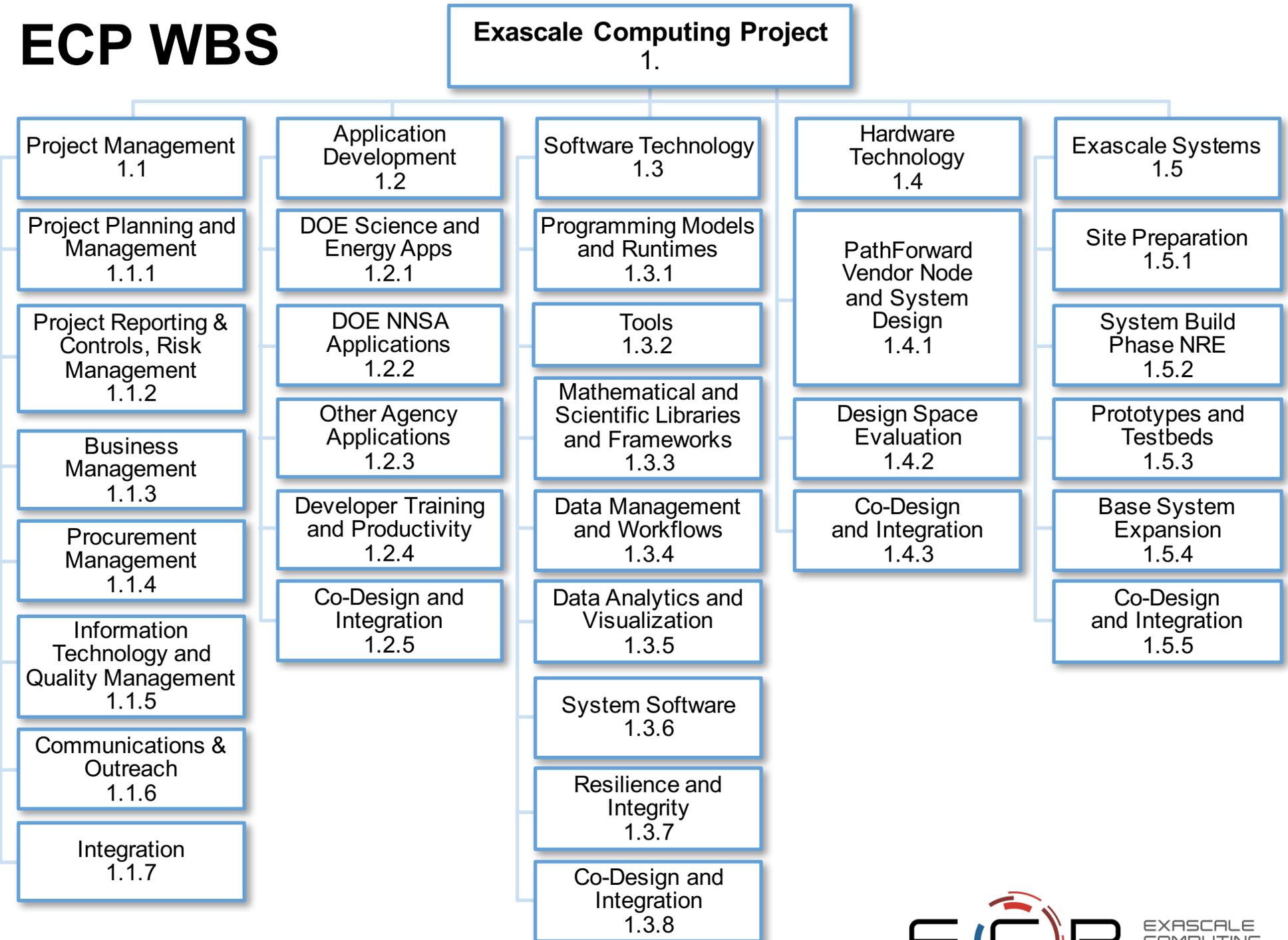
- Scope was determined based on
 - Breadth of the mission-critical DOE and NNSA applications
 - Historical and current software requirements of DOE and NNSA applications
 - Input on future needs from 133 DOE and NNSA lab responses to the applications RFI
 - Reports of DOE and NNSA workshops on application and software needs for exascale
 - Reports of workshops and analyses of hardware requirements
 - Analyses of computing technology trends
 - Identifying gaps in vendor product plans
 - Experiences from the NNSA ASCI program

ECP Technical Approach

ECP will pursue a ten-year plan structured into four focus areas:

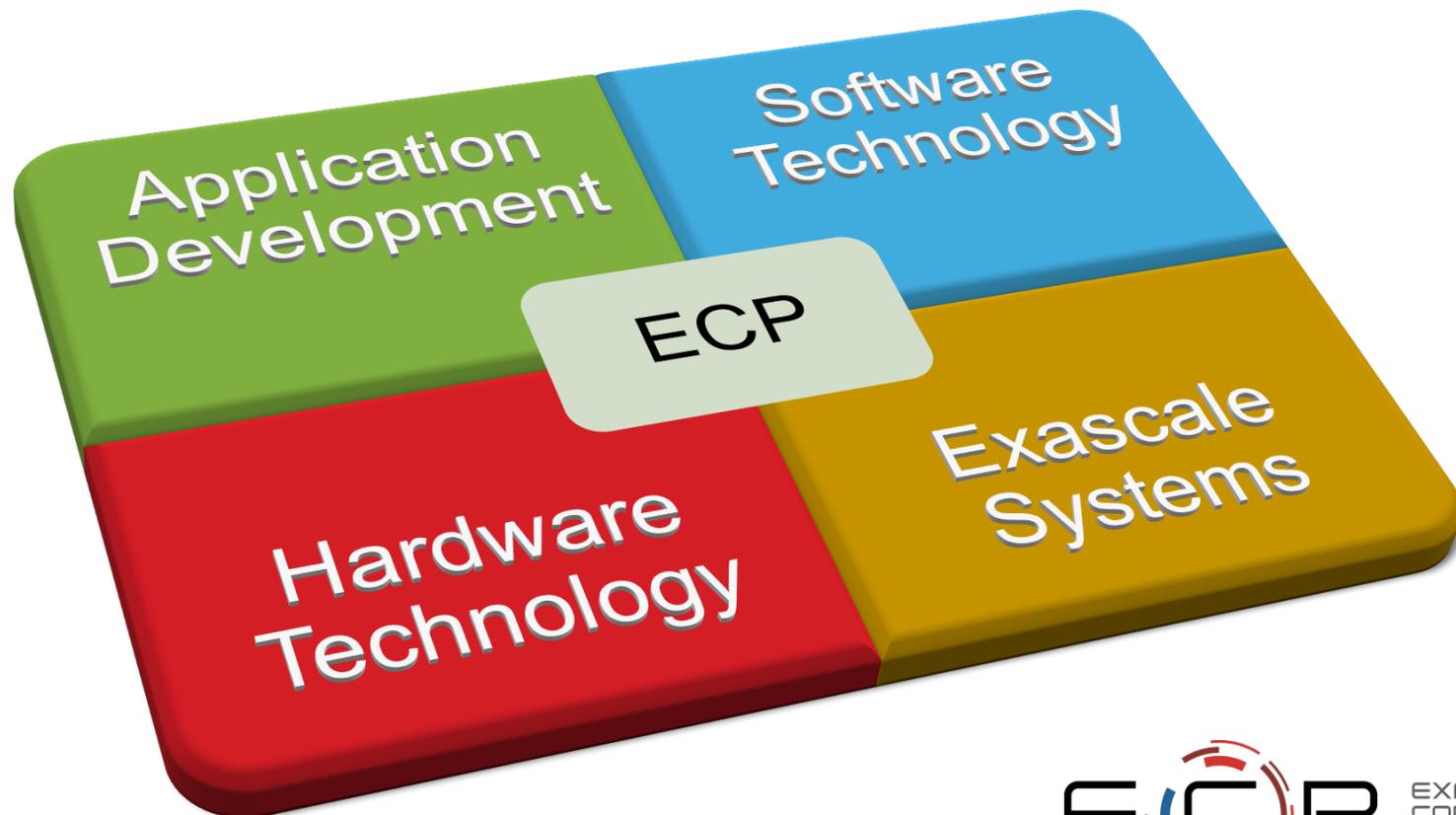
- **Application Development** deliver scalable science and mission performance on a suite of ECP applications that are ready for efficient execution on the ECP exascale systems.
- **Software Technology** enhance the software stack that DOE SC and NNSA applications rely on to meet the needs of exascale applications and evolve it to utilize efficiently exascale systems. Conduct R&D on tools and methods that enhance productivity and facilitate portability.
- **Hardware Technology** fund supercomputer vendors to do the research and development of hardware-architecture designs needed to build and support the exascale systems.
- **Exascale Systems** testbeds, advanced system engineering development (NRE) by the vendors, incremental site preparation, and cost of system expansion needed to acquire capable exascale systems

ECP WBS



ECP Holistic Structure

Capable exascale computing requires close coupling and coordination of key development and technology R&D areas.



ECP Integration is an essential function of the leadership team

- ECP leadership team members participate in evaluation of all major decisions
- Focus area directors will work closely to ensure that
 - the ECP applications will be ready to use the exascale systems productively
 - the supporting software will meet the needs of the applications and run effectively and efficiently on the exascale architectures
 - the architectures and the hardware technologies of the exascale systems are designed to support a broad range of ECP application computational characteristics

ECP Laboratory Team

Project Director Deputy	Paul Messina, ANL Stephen Lee, LANL
Project Management Director	Kathlyn Boudwin, ORNL
Applications Development Director Deputy	Doug Kothe, ORNL Bert Still, LLNL
Software Technology Director Deputy	Rajeev Thakur, ANL Pat McCormick, LANL
Hardware Technology Director Deputy	Jim Ang, SNL John Shalf, LBNL
Exascale Systems Director Deputy	Terri Quinn, LLNL Susan Coghlan, ANL
CTO	Al Geist, ORNL
Integration Manager	Julia White, ORNL

1.2 Application Development

Mission Need

Create and/or enhance important DOE applications through development of models, algorithms, and methods; integration of software and hardware using co-design methodologies; systematic improvement of exascale system readiness and utilization; and demonstration and assessment of effective software and hardware integration.

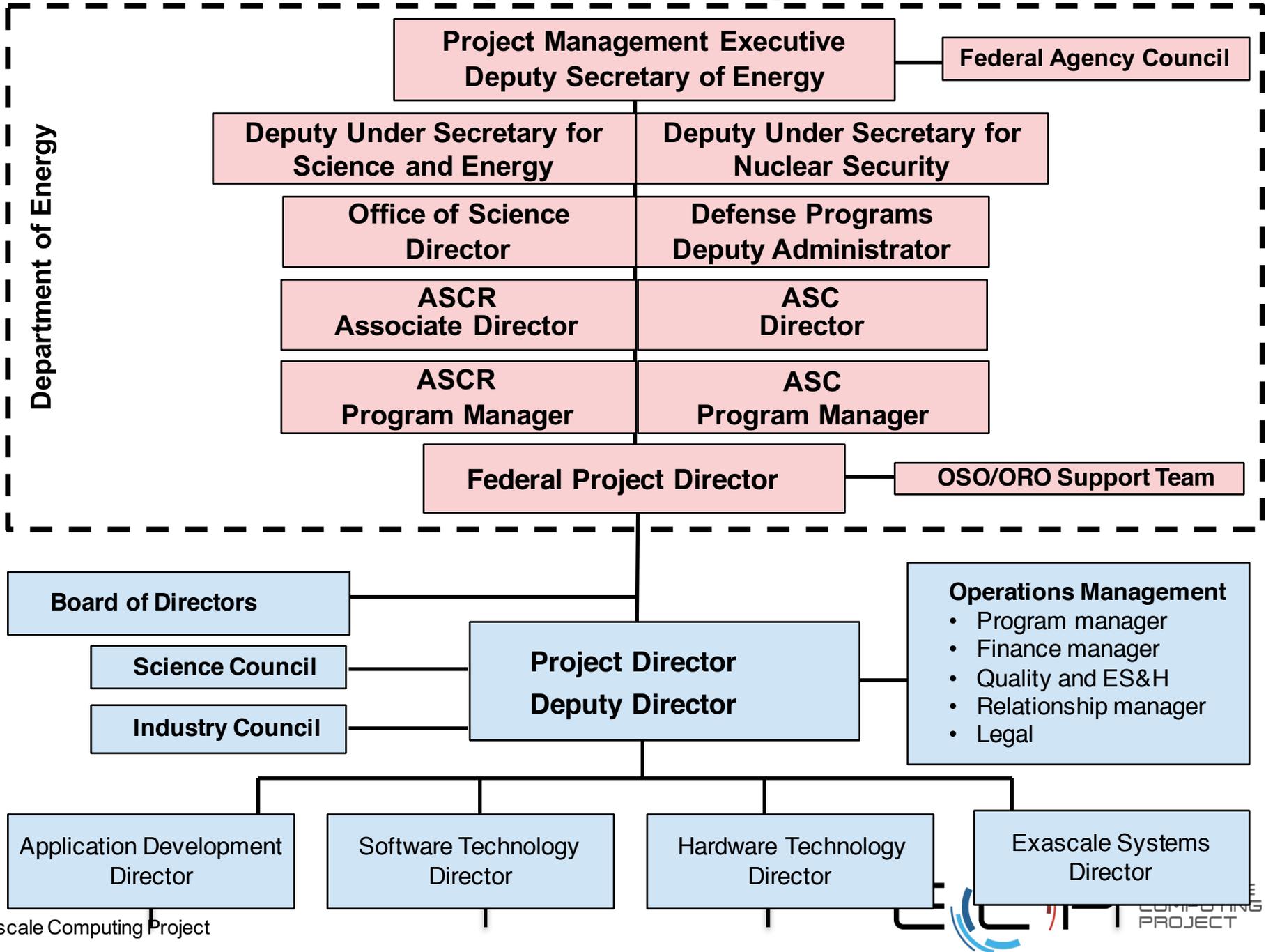
Vision

Deliver a broad array of comprehensive science-based computational applications that effectively exploit exascale HPC technology to provide breakthrough modeling and simulation solutions, yielding high-confidence insights and answers to the nation's most critical problems and challenges in scientific discovery, energy assurance, economic competitiveness, health enhancement, and national security.

1.2 Application Development Scope

- Support the development of selected applications that will use exascale systems to tackle challenge problems
 - In DOE Science and Energy Programs (1.2.1)
 - In DOE NNSA Defense Programs (1.2.2)
 - In other federal agencies such as NIH, NSF, NOAA, NASA (1.2.3)
- Disseminate and transfer application development knowledge, lessons learned, and best practices across application teams to improve the efficiency and depth of the development process
 - Through targeted training (1.2.4.1) and deployment of tools and methodologies to enhance developer productivity (1.2.4.2)
- Establish co-design centers to
 - Develop crosscutting software technologies frequently encountered in applications (motifs such as AMR and PIC) and collaborate with applications to integrate them (1.2.5.2)
- Develop and release proxy apps (1.2.5.3) representative of ECP apps and motifs to
 - Aid in the evaluation of exascale systems and technology
 - Serve as useful models for both application and software technology developers
 - Serve as useful models for vendor architecture design and performance activities

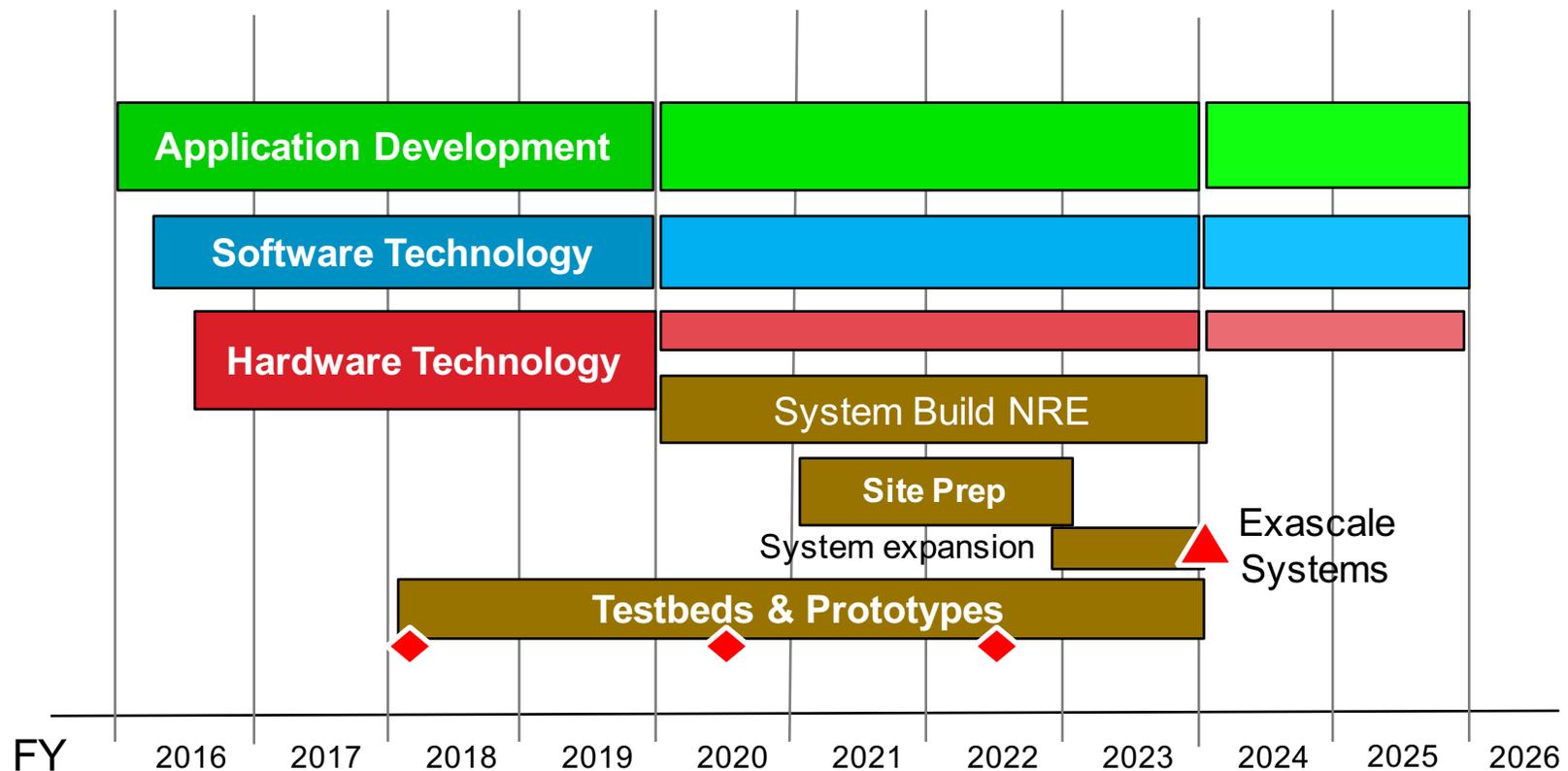
Proposed ECP Project Management Structure



ECP Timeline

The Project has three phases:

- Phase 1 – R&D before DOE facilities exascale systems RFP in 2019
- Phase 2 – Exascale architectures and NRE are known. Targeted development
- Phase 3 – Exascale systems delivered. Meet Mission Challenges



ECP method of accomplishment

- ECP will fund and manage work at the national laboratories, industry, and universities
- In most cases ECP will provide incremental funding to teams that already have a funding base
 - Build on existing activities
 - “incremental” does not mean small
- There is a formal solicitation and selection process
- There are specific deliverables and reviews of major milestones and deliverables

ECP follows a rigorous solicitation and selection process

- The call, review, and selection process for activities initiated under ECP is generally:
 - Request for Information (RFI)
 - Review against published criteria
 - Down selection to a reduced number for direct Request for Proposal (RFP)
 - Review against published criteria, and
 - Selection
- Selection criteria include quality of the team, relevance to exascale, match to mission needs, technical feasibility
- Process steps, RFIs, RFP, and criteria are tuned as appropriate for the technical project under consideration.
- The ECP focus area leaders select teams of subject matter expert reviewers
 - review results inform the decision process, which is finalized within the ECP to ensure integration across the project.

Questions?