

Runtime Systems

Exascale Computing Initiative (ECI)

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DOE Exascale Computing Initiative (ECI)

R&D Goals

- **Create dramatically more productive systems**
 - Usable by a wide variety of scientists and engineers for more problem areas
 - Simplifies efficiency and scalability for shorter time to solution and science result



FY2011:

MOU between the SC and NNSA for the Coordination of Exascale Activities
Exascale Co-Design Centers Funded
Request for Information: Critical and Platform Technologies

FY2012:

Programming Environments (X-Stack)
FastForward: Vendor Critical / Cross Cutting technologies

FY2013:

Exascale Strategy Plan to Congress
Operating System / Runtime (OS/R)
Meeting with Secretary Moniz, “go get a solid plan with defensible cost”

FY2014:

Meetings with HPC vendors to validate ECI timeline, update on exascale plans and costs
Established Nexus / Plexus lab structure – determine software plans and costs
FastForward 2: Exascale Node designs
DesignForward 2: Conceptual Designs of Exascale Systems
External Review of “Exascale Preliminary Project Design Document (EPPDD)”

FY2015:

Release to ASCAC “Preliminary Conceptual Design for an Exascale Computing Initiative”
Generate requirements for exascale systems to be developed ECI and deployed in FY-2023
Complete next version of the ECI Project Plan

FY2016:

Initiate the Exascale Computing Initiative (ECI)
Develop and release FOAs and RFPs, for funding in FY-2016



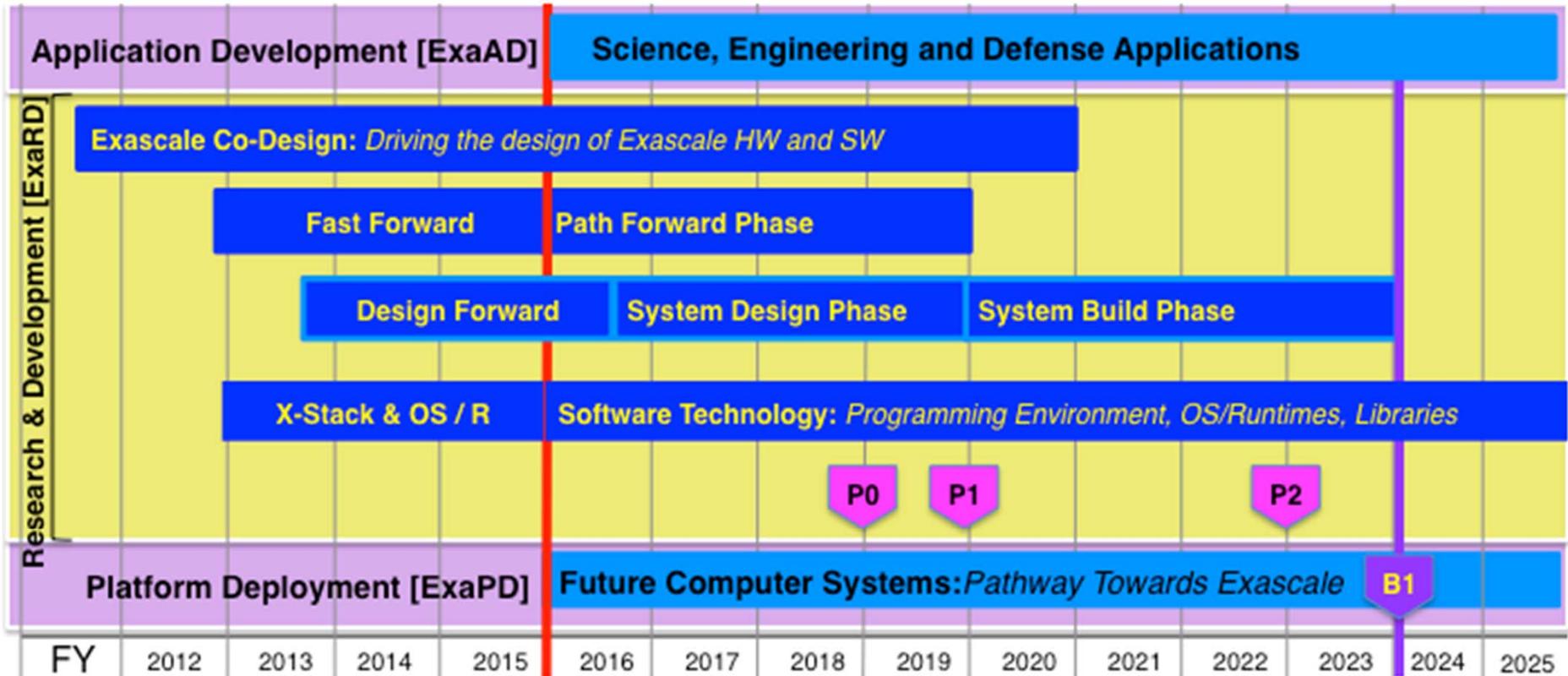
Exascale Challenges

- Four primary challenges must be overcome
 - Parallelism / concurrency
 - Reliability / resiliency
 - Energy efficiency
 - Memory / Storage
- Productivity issues
 - Managing system complexity
 - Portability
 - Generality
- System design issues
 - Scalability
 - Efficiency
 - Time to solution
 - Dependability (security and reliability)
must be integrated at all levels of the design



ECI Project Schedule

ECI Funding



- 
P0 Node Prototype
- 
P1 Petascale Prototype
- 
P2 Exascale Prototype
- 
B1 Initial Exascale Delivery

ECI Project Scope

1 ExaAD -- Application Development 2 ExaRD -- Research & Development 3 ExaPD -- Platform Development and Delivery

1.1 **Integrat**
 1.1.1 NNSA
 1.1.2 Materi
 1.1.3 Climat
 1.1.4 Code 3
 1.1.5 Code 4

2.4 Software Technologies
 2.4.1 Software Stack (SS)
 2.4.2 Applied Math (AM)
 2.4.3 Data Management (DM)
 2.4.4 Data Analytics and Visualization (DV)
 2.4.5 Collaborative Environments (CE)
 2.4.6 Productivity (PR)
 2.4.7 Performance Execution (PE)
2.5 Integrity Technologies
 2.5.1 Cybersecurity (SR)
 2.5.2 Resiliency (SR)
 2.5.3 Program verification and validation (SS)

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 Training

2.6.1 System Design
 2.6.2 System Build
 2.7 Transition to Production
 2.7.1 System Engineering (SE)
2.8 Prototypes and Testbeds
 2.8.1 Testbeds
 2.8.2 Prototypes
2.9 Researcher Training
 2.9.1 Outreach and Training



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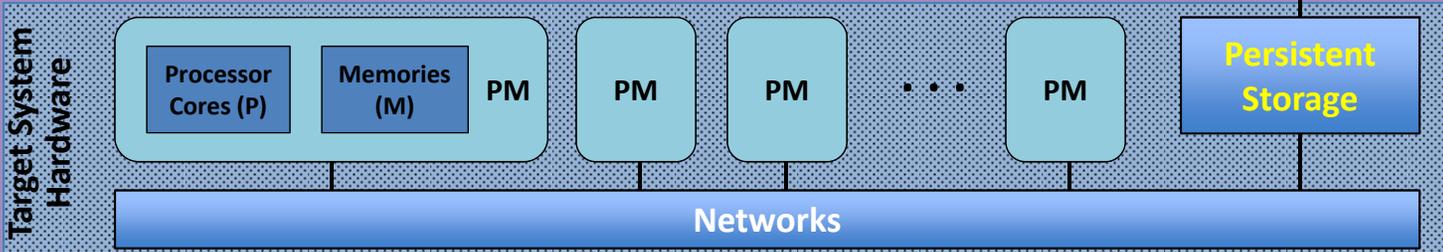
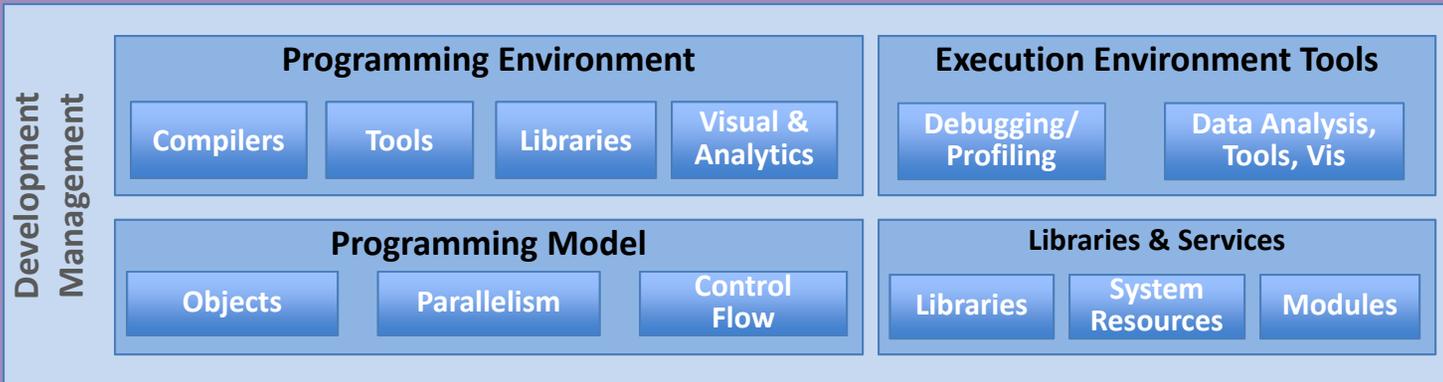


Extreme Scale Stack

Performance & Productivity Objectives

Collaborative Workflows

Applications



Execution Model

Productivity Model

Resilience Model

Energy Model

Stack Information Bus

RTS Workshop Objectives

1. Propose, discuss, and determine the required characteristics of future extreme scale runtime systems
2. Discuss a research and development roadmap that will result in one or more high quality runtime system software packages that could be deployed in the 2023 timeframe, on extreme scale systems
3. Identify research questions that need to be resolved within the context of current experience and knowledge,
4. Devise metric, measures, benchmarks, and means for testing and evaluation for prototypes of runtime systems



Expected Outcomes

- 1. Research Agenda**
- 2. Driving Applications and Workflows**
- 3. Interrelationships of Runtime with OS and Programming Interfaces/Models**
- 4. Metrics of Evaluation, Optimization, and Comparative Analysis**
- 5. Major program accomplishments and decision points**



Parallel Session Breakouts

- **Sessions I & II:** Runtime Systems Architecture
- **Sessions III & IV:** Runtime Systems Design
- **Sessions V & VI:** Runtime Systems Research Questions
- **Sessions VII & VIII:** Runtime R&D Roadmap

