

ASCR RESEARCH PRIORITIES

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ASCR Mission

The mission of the Advanced Scientific Computing Research (ASCR) program is to advance applied mathematics and computer science; deliver, in partnership with disciplinary science, the most advanced computational scientific applications; advance computing and networking capabilities; and develop, in partnership with U.S. industry, future generations of computing hardware and tools for science



Seminal DARPA study

Peter M. Kogge (editor), “Exascale Computing

Study: Te

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Energy

Memory

Resilience

**The
future
is
here!**

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We are at a critical juncture in extreme-scale computing

- Performance gains will come from our ability to handle massive concurrency...but how?
- Future node architectures are becoming clearer...what about the system?
- How to management data locality & movement?
- Myriad programming models – all painful for the application programmer, and no clear winner yet.
- Faults cannot be ignored anymore.
- How do we know it will work?
- How do we know it's correct?
- Even mathematics may need to be reworked.

With Crisis Comes Opportunity!

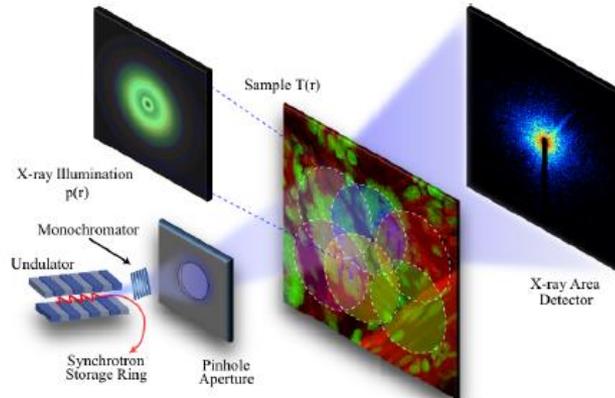
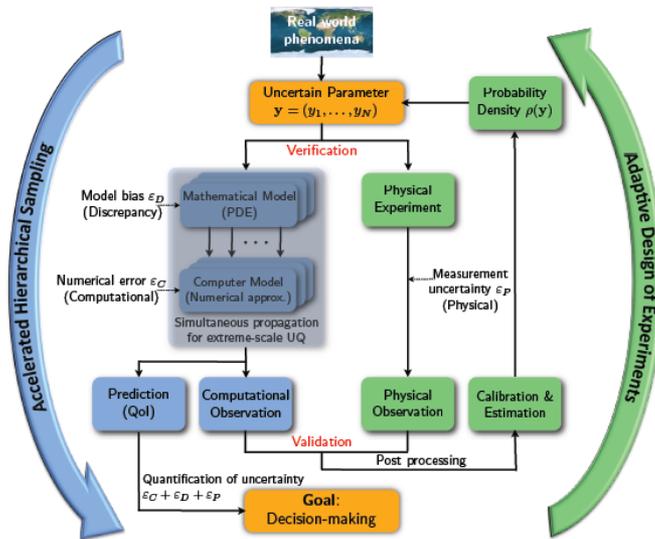


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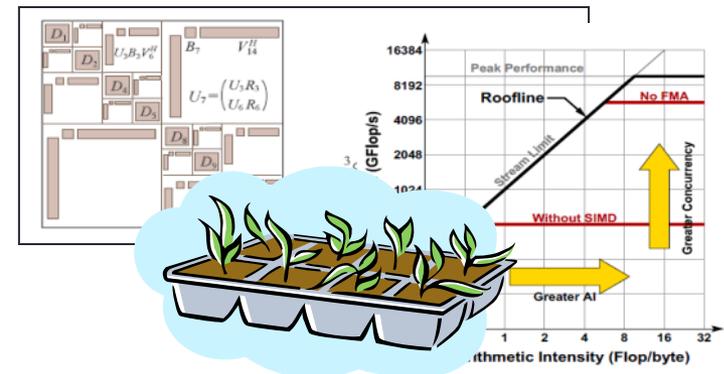
Recent ASCR Extreme-Scale Computing Initiatives: Mathematics

UQ for Extreme-Scale Science: Quantified Confidence for Risk-informed Decision-making



Math & Stat for Data-Centric Science: Integration of observational data, experimental data, simulation and models DOE scientific facilities

RX-Solvers: extreme, resilient solvers with demonstrated performance



The Exascale Mathematics Working Group (EMWG)

<https://collab.mcs.anl.gov/display/examath/Exascale+Mathematics+Home>

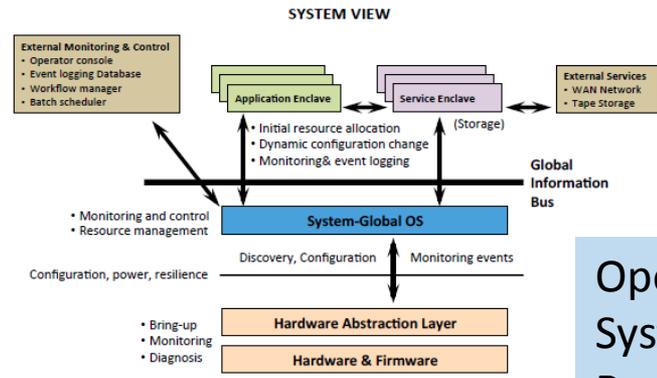
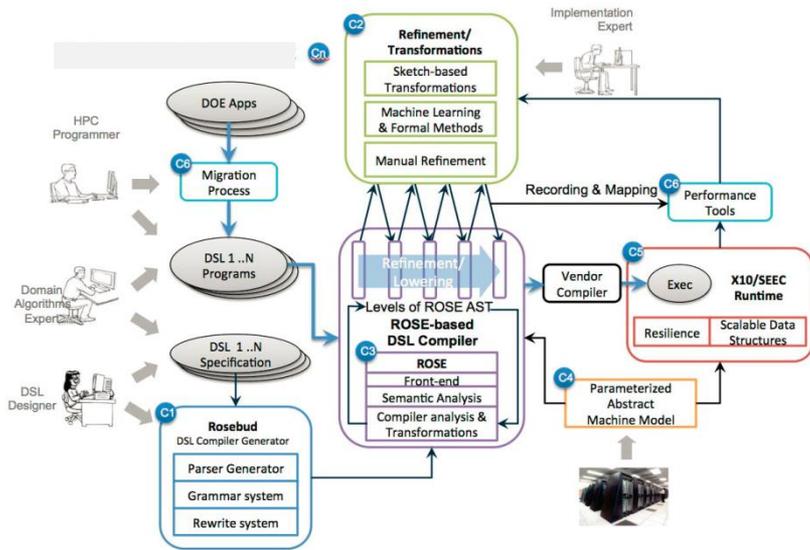
The Department of Energy (DOE) Office of Science Program on Advanced Scientific Computing Research has formed an Exascale Mathematics Working Group (EMWG) for the purpose of identifying mathematics and algorithms research opportunities that will enable scientific applications to harness the potential of exascale computing.

The EMWG's charter is to:

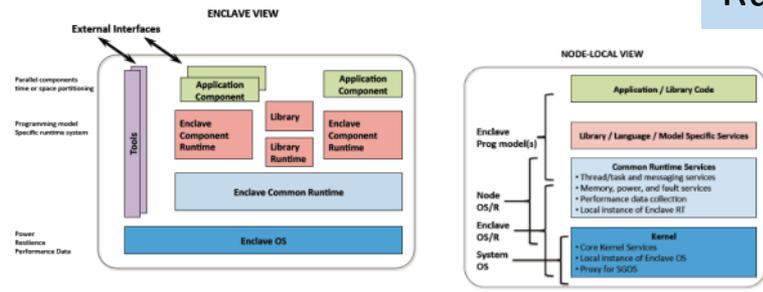
- Analyze potential gaps in current thinking about applied mathematics for the exascale;
- Identify new algorithmic approaches that address exascale challenges;
- Identify mathematics to address new scientific questions accessible at exascale, especially through integration across applied mathematics sub-disciplines;
- Identify a holistic, co-design approach for applied mathematics exascale research that more directly involves a dialogue with application scientists and computer scientists; and
- Submit a report of the findings to the DOE Office of Science.

Recent ASCR Extreme-Scale Computing Initiatives: Computer Science

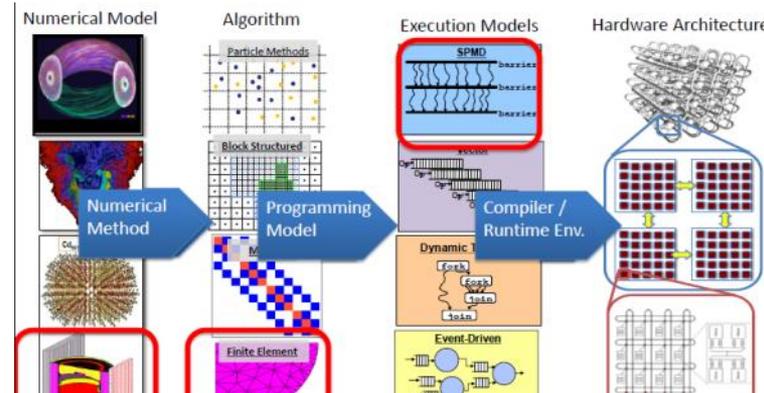
X-Stack: energy efficiency, resilience, programmability, scalability, performance portability, interoperability



Operating System & Runtime



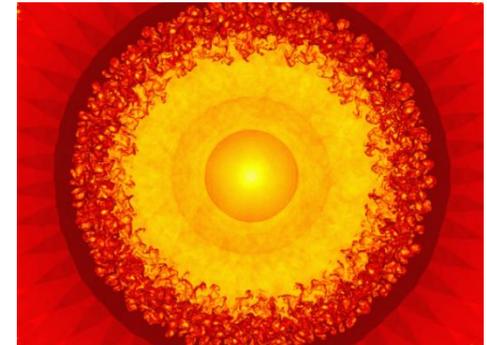
Performance Modeling & Execution Models



The Resilience Tech Council

(from presentation by Michael Heroux & Al Geist, “DOE Resilience Tech Council Overview”)

- **Mission:** Define and assess the effective execution of a resilient computing R&D program.
- **Objectives:**
 - Define and prioritize resilience goals *that lead to running apps*.
 - Gather and synthesize user and center experiences.
 - Define broad requirements (avoiding specification).
 - Inform program offices, nexuses, application developers.
 - Assess progress against *goal of running apps*.
 - Provide progress and gap assessments for programs.
 - ID subsequent goals and requirements.
 - Develop *actionable suggestions*. Be precise.
- **Success metric: Applications run. Period.**

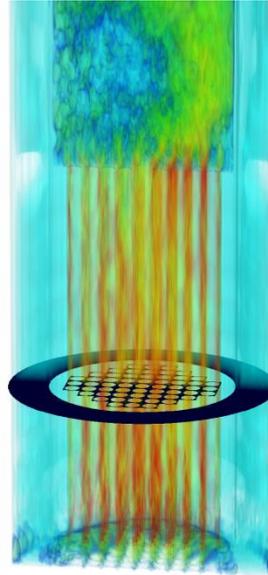
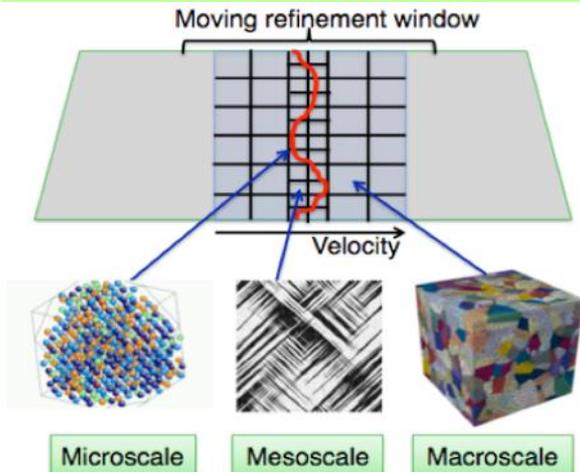


Picture courtesy Paul Woodward, in presentation to RTC titled *Resilient Computation at the Petascale: What can the application do, and what does this require of others?*

Recent ASCR Extreme-Scale Computing Initiatives: Computational Partnerships

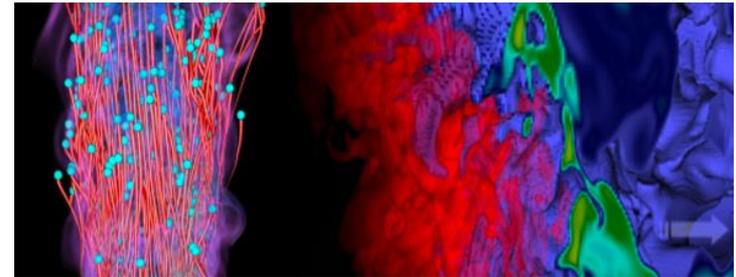
Exascale Co-Design Center for
Materials in Extreme Environments
(ExMatEx)

<http://www.exmatex.org>



Center for Exascale Simulation of
Combustion in Turbulence (ExaCT)

<http://exactcodesign.org>



Center for Exascale Simulation of
Advanced Reactors (CESAR)

<https://cesar.mcs.anl.gov>

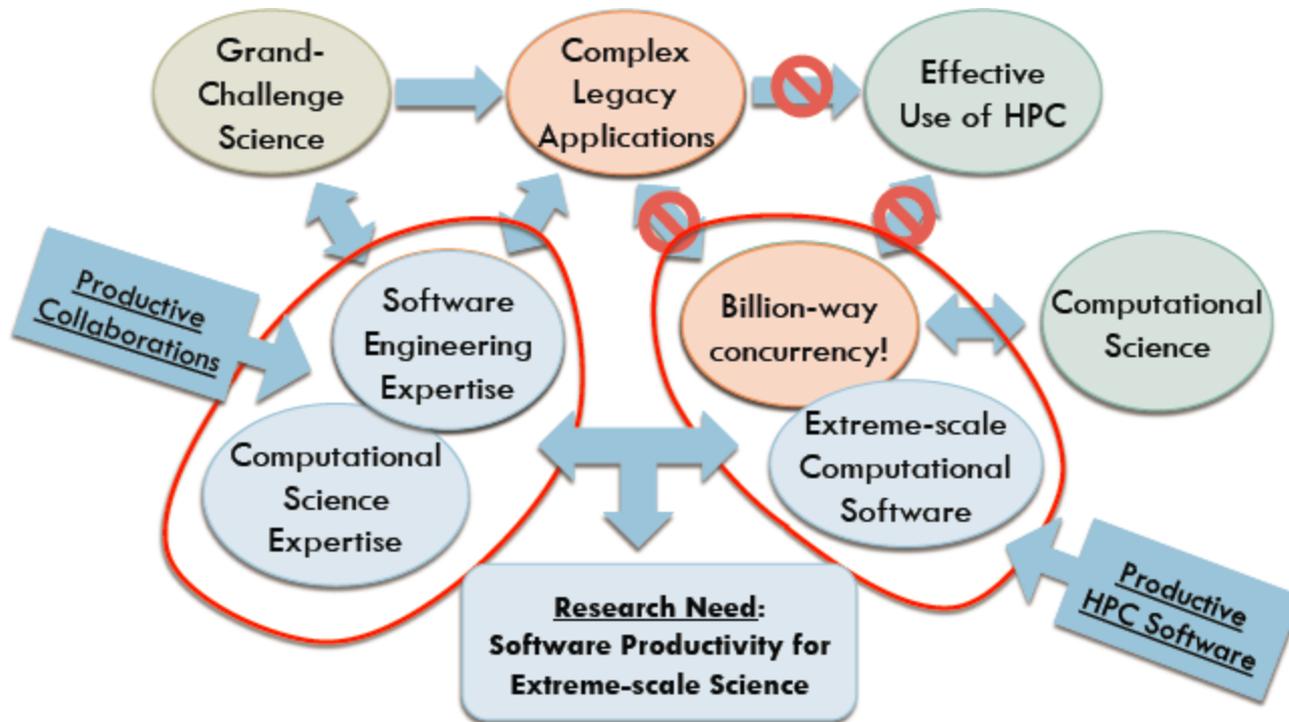
**Co-Design Centers provide realistic case studies
for the Exascale Ecosystem**



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Recent ASCR Extreme-Scale Computing Initiatives: Software Productivity



**Productivity in science fundamentally depends
on productivity in software**



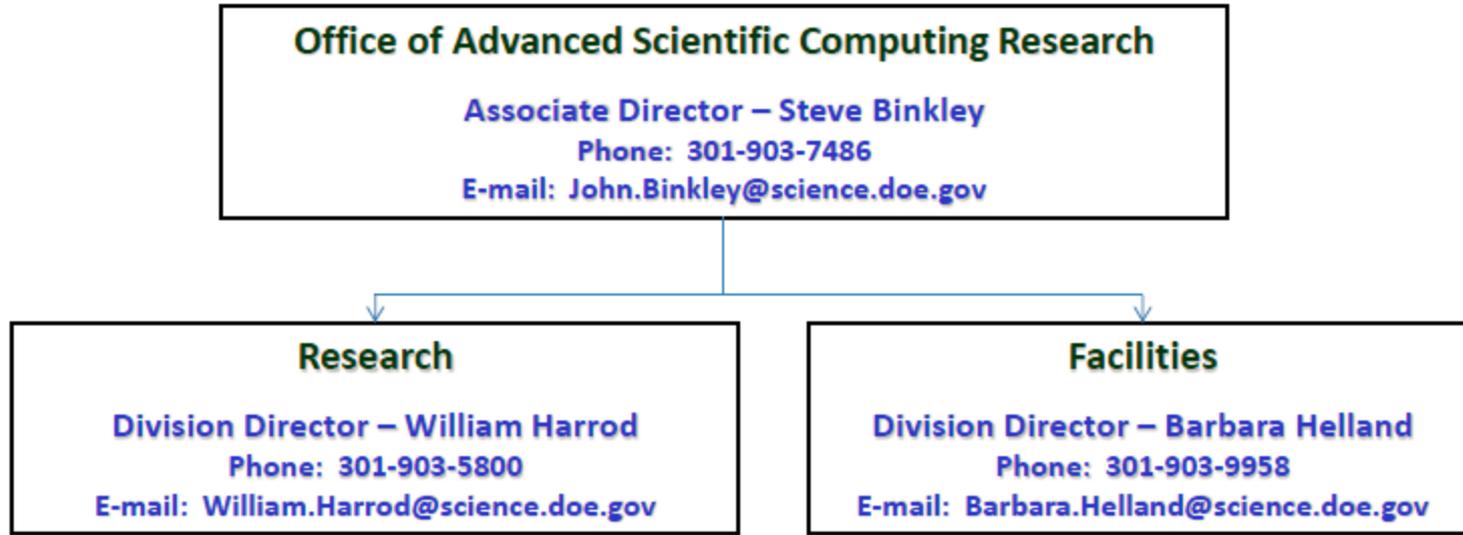
Which brings us back to...what are we going to do now??

- Jack Deslippe (NERSC) has a lunch-time presentation on strategy to address immediate issues
- At a minimum, we need a transition strategy for our math libraries
- We also need to look at I/O, storage, and data management issues
- All these need to happen while we look to long-term solutions that may involve disruptive technologies!

To keep science going in times of great change, we need short-term fixes and long-term strategy!



ASCR at a Glance



Relevant Websites

ASCR: science.energy.gov/ascr/

ASCR Workshops and Conferences:

science.energy.gov/ascr/news-and-resources/workshops-and-conferences/

