

# ASCR and Community Research Priorities

Focusing on Relevance to Compiler Technology

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# The Mission of the Department of Energy

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The mission of the Energy Department is  
to ensure America's security and prosperity  
by addressing its energy, environmental, and nuclear challenges  
through transformative science and technology solutions.



# DOE Science Programs

## Basic Energy Sciences

- Understanding, predicting, and ultimately controlling matter and energy flow at the electronic, atomic, and molecular levels

## Advanced Scientific Computing Research

- Advancing state-of-the-art computational, networking, data, and software capabilities that enable scientific discovery

## Biological and Environmental Research

- Understanding complex biological, climatic, and environmental systems

## Fusion Energy Sciences

- Building the scientific foundations for a fusion energy source

## High Energy Physics

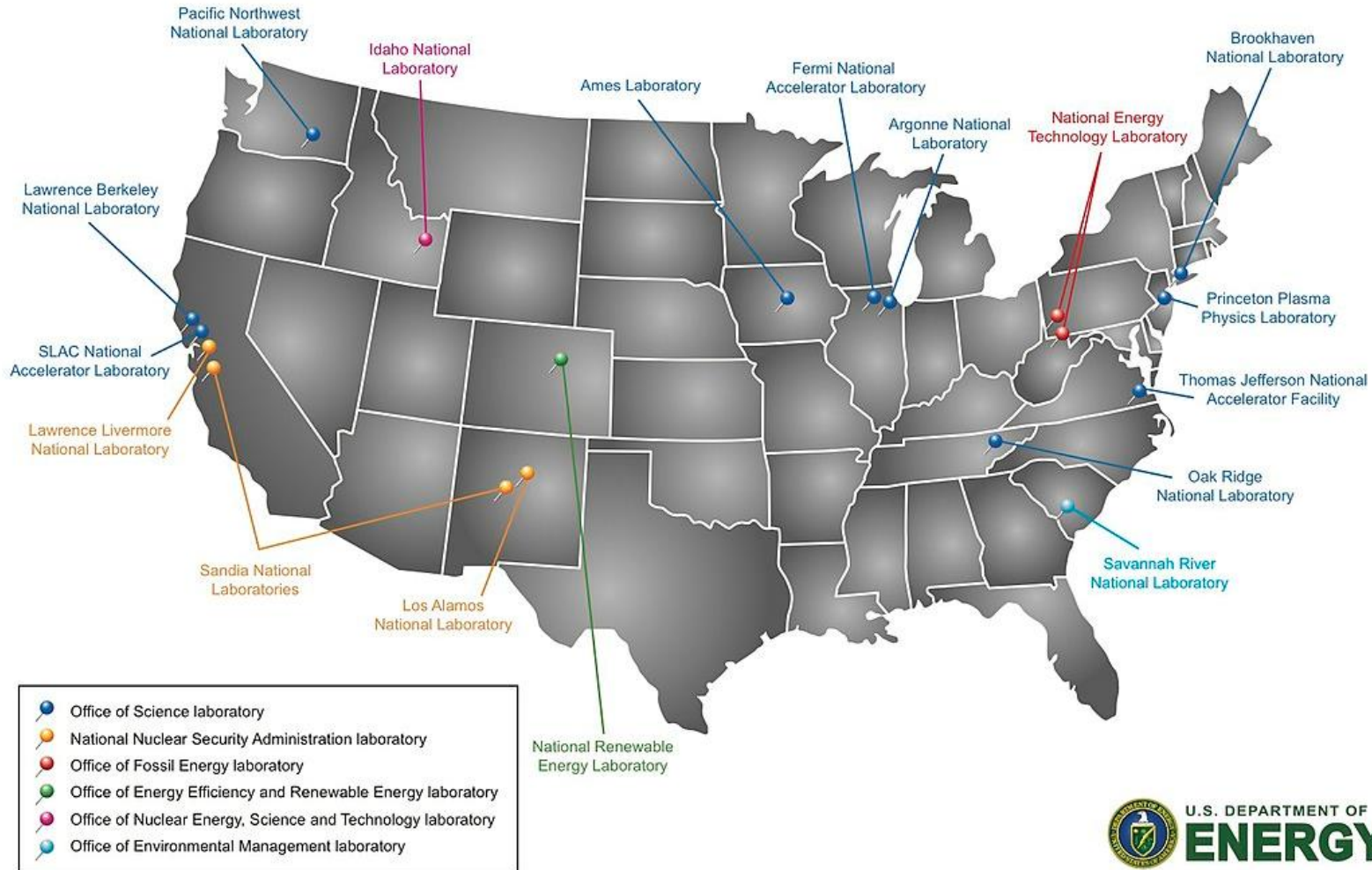
- Understanding how the universe works at its most fundamental level

## Nuclear Physics

- Discovering, exploring, and understanding all forms of nuclear matter



# DOE National Laboratories



<https://www.energy.gov/maps/doe-national-laboratories>



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# ASCR Program Structure

US Department of Energy (DOE), Office of Science (SC), Advanced Scientific Computing Research (ASCR)

<https://science.osti.gov/ascr>

## Facilities Division

National user facilities: ALCF, OLCF, NERSC, ESN



## Computational- Science Research and Partnerships Division

## Advanced Computing Technologies (ACT) Division

Computer Science

Applied Mathematics

Computational Partnerships

# ASCR R&D Funding

## Funding Opportunity Announcements (FOAs)

- <https://science.osti.gov/ascr/Funding-Opportunities>
- Announced on [grants.gov](https://grants.gov) (hint: sign up for email notifications for 'ASCR')
- Read each announcement carefully to understand who can apply and other restrictions/requirements
- Depending on the announcement, supports 2–5-year projects
- University researchers can apply directly (please coordinate with your organization's sponsored-research office)
- Subcontracting is often permitted, and sometimes collaborative applications are permitted

## Early Career Research Program

- <https://science.osti.gov/early-career>
- Research grants for five years
- Stays with PI if PI changes institutions
- Eligible within 10 years of Ph.D. (can apply up to three times)
- University-based researchers receive about \$150,000/year
- Topics released in the summer, pre-applications generally due in the fall

## DOE National Laboratory Announcements

- <https://science.osti.gov/ascr/Funding-Opportunities> (bottom of the page)
- Open only to DOE Laboratories
- Often allow subcontracts to support collaborators at other organizations

## Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)

- <https://science.osti.gov/sbir>
- Grants to for-profit US businesses with 500 or fewer employees (including affiliates)
- Phase I: ~\$200k for 6-12 months, Phase II: ~\$1M for 2 years
- Subcontracting is permitted, STTR: requires collaboration with a research Institution
- Topics released in the summer, pre-applications generally due in the fall

## Computational Science Graduate Fellowship (CSGF)

<http://www.krellinst.org/csgf/>





# Additional Information on ASCR's Website

<https://science.osti.gov/ascr/Funding-Opportunities>

<https://science.osti.gov/ascr/Community-Resources/Program-Documents>

About

Research

Facilities

Science Highlights

Benefits of ASCR

**Funding Opportunities**

Closed Funding Opportunity  
Announcements (FOAs)

Closed Lab Announcements

Award Search / Public Abstracts

Additional Requirements and

## Funding Opportunities

Look at past opportunity  
announcements

Non-profit organizations as well as for-profit organizations are welcome to apply for funding opportunities. ASCR solicitation for each research program is published on the ASCR website. The selection of researchers to fund is based on the merit of the proposal. For the most current information, visit the ASCR website. The original posting dates, changes, and comments are available on the ASCR website.

Office of Science Guidance on ASCR







Look at abstracts for current  
awards

Look at recent reports from ASCR-sponsored workshops. These reports discuss priority research directions, as identified by the research community, along with relevant background information, in various areas.

## ASCR Program Documents

Provided below is a listing of relevant articles, plans and ASCR-sponsored workshop reports.

Select this link to view the ASCR Program Documents Archive

	<b>ASCR@40: Four Decades of Department Of Energy Leadership in Advanced Scientific Computing Research</b> In December 2017, the Advisory Committee for DOE's Office of Advanced Scientific Computing Research (ASCR) was asked to document some of the major impacts of ASCR and its predecessor organizations. This seemingly simple request kicked off a multi-year process of information gathering, drafting, consulting, and refining. Input was provided by over 100 scientists. Full Report <a href="#">Full Report</a> Individual Story Summaries: <a href="#">Petalops for the People</a>   <a href="#">Building the Computational Workforce</a>   <a href="#">Supporting Science through Open-Source Software</a>   <a href="#">World-Leading Computing Facilities</a>   <a href="#">Building Better Computers</a>   <a href="#">Overcoming Scaling Challenges</a>   <a href="#">Making Sense of Big Data</a>   <a href="#">Grid Computing for High-Speed Collaboration</a>   <a href="#">Moving Big Data</a>   <a href="#">Uncertainty Quantification</a>   <a href="#">Applying Equations to Complex Problems</a>   <a href="#">Modeling and Simulation</a>
	<b>A Quantum Path Forward</b> Today, many scientific experts recognize that building and scaling quantum-protected and enhanced communication networks are among the most important technological frontiers of the 21st century. The international research community perceives the construction of a first prototype global quantum network—the Quantum Internet—to be within reach over the next decade. In February 2020, the U.S. Department of Energy (DOE)'s Office of Advanced Scientific Computing Research hosted the Quantum Internet Blueprint workshop to define a potential roadmap toward building the first nationwide quantum Internet. The workshop participants included representatives from DOE, national laboratories, universities, industry, and other U.S. agencies with serious interests in quantum networking. The goal was to provide an outline of the essential research needed, detail any engineering and design barriers, and suggest a path forward to move from today's limited local network experiments to a viable, secure quantum Internet. Workshop Report <a href="#">Workshop Report</a>
	<b>5G Enabled Energy Innovation Workshop (5GEEIW)</b> On March 10-12, 2020, the Office of Science (OS) organized a three-day workshop to deliver a community-based report highlighting 5G and beyond basic research, development, applications, technology innovation, infrastructure, and demonstration opportunities in support of the U.S. DOE mission. The brochure and report will help the DOE Office of Science understand both the challenges and the opportunities offered by 5G and emerging advanced wireless technologies in the areas of basic research, development, and integration into scientific user facility operations. Cover   Brochure <a href="#">Brochure</a>   Workshop Report <a href="#">Workshop Report</a>
	<b>Data and Models: A Framework for Advancing AI in Science</b> On June 5, 2019, the Office of Science (OS) organized a one-day roundtable to focus on enhancing access to high-quality and fully traceable research data, models, and computing resources to increase the value of such resources for artificial intelligence (AI) research and development and the OS mission. In this report, we consider AI to be inclusive of, for example, machine learning (ML), deep learning (DL), neural networks (NN), computer vision, and natural language processing (NLP). We consider "data for AI" to mean the digital artifacts used to generate AI models and/or employed in conjunction with AI models during inference. In part, this roundtable was motivated by the recognition that a large portion of science data currently are not well suited for AI. View Technical Report <a href="#">View Technical Report</a>
	<b>Storage Systems and I/O: Organizing, Storing, and Accessing Data for Scientific Discovery</b> In September, 2018, the Department of Energy, Office of Science, Advanced Scientific Computing Research Program convened a workshop to identify key challenges and define research directions that will advance the field of storage systems and I/O over the next 5-7 years. The workshop concluded that addressing these combined challenges and opportunities requires tools and techniques that greatly extend traditional approaches and require new research directions. Key research opportunities were identified. View Technical Report <a href="#">View Technical Report</a>
	<b>ASCR Workshop on In Situ Data Management</b> In January 2019, ASCR convened a workshop on In Situ Data Management (ISDM). The goal was to identify priority research directions (PIDs) to support current and future scientific computing needs, which will increasingly incorporate a number of different tasks that need to be managed along with the main simulation or data analysis tasks. The



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<https://www.ornl.gov/ASCR-CoDesign/>

[Home](#) [Agenda](#) [Video Presentations](#) [Accepted Position Papers](#) [Position Paper Submission](#) [Contacts](#)

232 Registered Attendees

- 86 Observers
- 146 Participants
  - 110 - Laboratory Staff
  - 18 - University Faculty/Staff
  - 13 - Industry (including AMD, ARM, GE, Google, Intel, Micron, NVIDIA, Qualcomm, Xilinx)
  - 5 - Other Federal Agencies

## ASCR Workshop on Reimagining Codesign

Sponsored by the U.S. Department of Energy,  
Office of Advanced Scientific Computing Research

March 16-18, 2021

11:00 am to 5:00 pm ET

ASCR Point of Contact: Hal Finkel





# ASCR Workshop on Reimagining Codesign: Videos

<https://www.ornl.gov/ASCR-CoDesign/>

Keynotes were provided by:

- Neil Thompson, MIT
- Margaret Martonosi, Princeton/NSF
- Andreas Olofsson, Zero ASIC

**Organizing Committee:**

[John Shalf](#), LBL

[Andrew A Chien](#), ANL

[Jeff Vetter](#), ORNL

[Jim Ang](#), PNNL

[Adolfy Hoisie](#), BNL

[Si Hammond](#), SNL

[Ian Karlin](#), LLNL

[Scott Pakin](#), LANL



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The screenshot shows the website's navigation bar with links: Home, Agenda, Video Presentations, Accepted Position Papers, Position Paper Submission, and Contacts. The main header reads "ASCR Workshop on Reimagining Codesign" followed by "Sponsored by the U.S. Department of Energy Office of Advanced Scientific Computing Research" and "March 16-18, 2021". A blue callout box points to the "Video Presentations" link, containing the text: "The Video Presentations page has videos of most plenary sessions."

**Day 1**

[Introduction and Workshop Logistics](#)

Hal Finkel - [Welcome and Opening Remarks](#)

Barbara Helland - [View from Department of Energy](#)

[Keynote Speaker](#) – Neil Thompson, MIT

Catherine Schuman - [Top-Down Neuromorphic Hardware Co- Design via Machine Learning and Simulation](#)

Ryan Grant - [Co-design of System Software for Compute Accelerators and SmartNICs](#)

Thomas Flynn - [Real-time data-driven codesign of hardware and software for analysis of high-throughput scier](#)

Eric Cheng - [Project 38: Innovative Architectures for High-Performance Computing Systems](#)

Andreas Gerstlauer - [Algorithm-Architecture Codesign for Irregular and Sparse Problems](#)

# ASCR Workshop on Reimagining Codesign: Position Papers

<https://www.ornl.gov/ASCR-CoDesign/>

- A general call for position papers was issued.
- The organizing committee reviewed the papers.
- One author of each accepted paper was invited to participate in the workshop.
- Collection of accepted position papers:

<https://doi.org/10.2172/1843574>



The Accepted Position Papers page has the 86 accepted position papers.

Author	Institutional Affiliation
Alex Aiken	Stanford/SLAC
Tim Ansell	Google
Richard Arthur	GE Research
Amro Awad	North Carolina State University
Amro Awad	North Carolina State University
Abdel-Hameed Badawy	New Mexico State University
Prasanna Balaprakash	Argonne National Laboratory
Kevin Barker	Pacific Northwest National Lab

[Missing pieces for accelerating co-design to meet the growing Moore's Law](#)

[An \(Evolving\) Rubric for Modeling Maturity](#)

[Codesign for Disaggregated Memory Architectures: Opportunities](#)

[Microarchitecture-Centric Codesign for Reduced TCO and High Performance](#)

[Utilizing Recent Advances in NLP-ML for HW/SW Codesign](#)

[An AI System for AI Codesign](#)

[Advanced Architecture Assessment Within a Codesign Methodology](#)



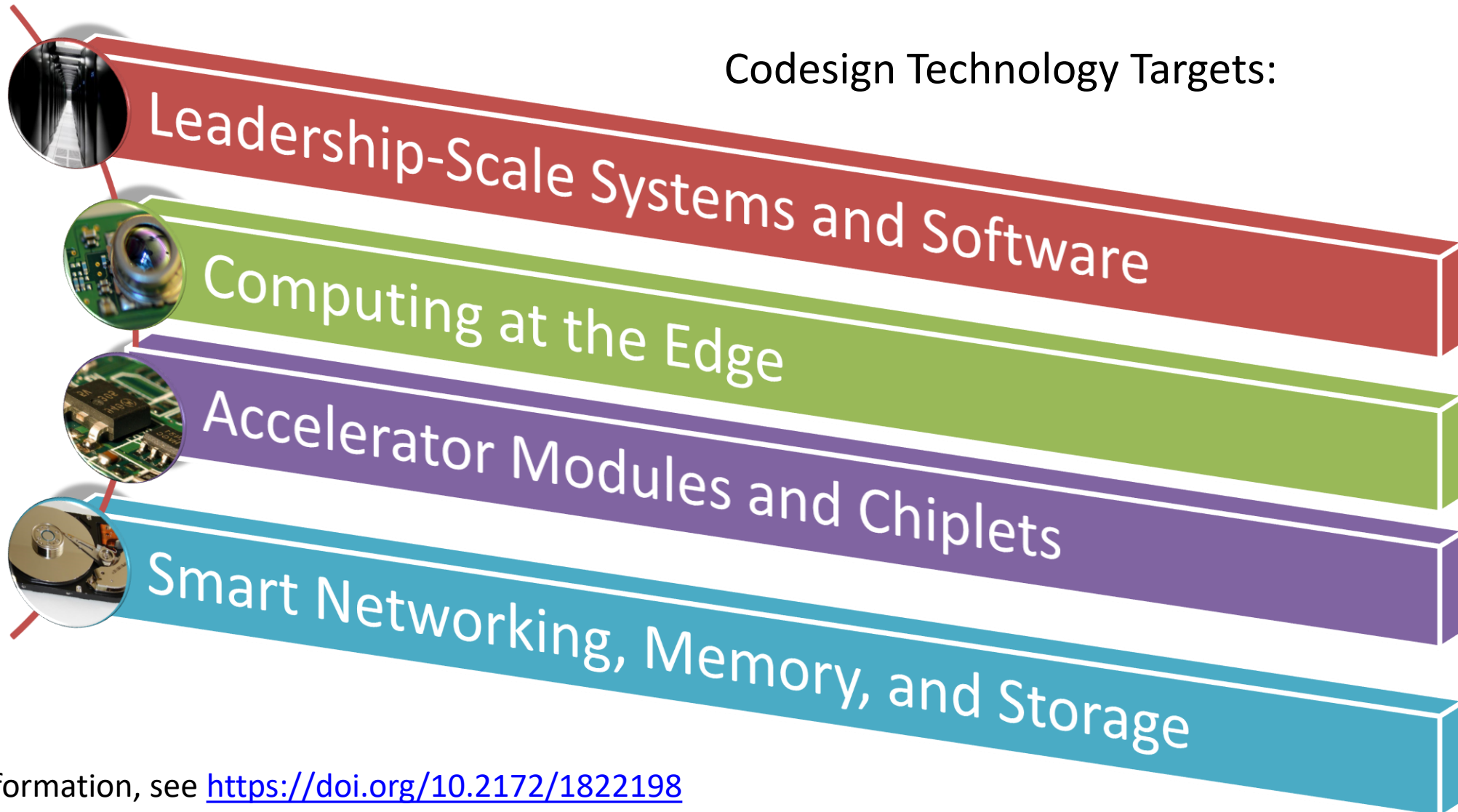
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# ASCR Workshop on Reimagining Codesign: Technology Targets

<https://www.ornl.gov/ASCR-CoDesign/>

## Codesign Technology Targets:



For more information, see <https://doi.org/10.2172/1822198>



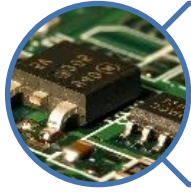
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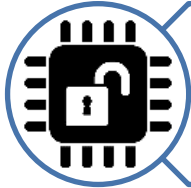
# ASCR Workshop on Reimagining Codesign: Enabling Technology Factors

<https://www.ornl.gov/ASCR-CoDesign/>

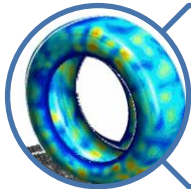
## Enabling Key Technology Factors:



**Advanced, modular packaging technologies** providing for the high-performance composition of components optimized for different computational motifs, potentially from different organizations



**Open-source hardware designs** allowing open, low-risk collaboration among academics, laboratories, and industry



**AI-driven technologies, paired with advanced system modeling**, creating intelligent, data-driven workflows for hardware design and software development



**Critical metrics for energy efficiency, security, and other system properties** have joined performance, power usage, and reliability as first-class design constraints



The foundations laid in pursuit of exascale computing have generated applications capable of using first-generation heterogeneous GPU computing resources through **portable programming models and adaptive system software**

For more information, see <https://doi.org/10.2172/1822198>

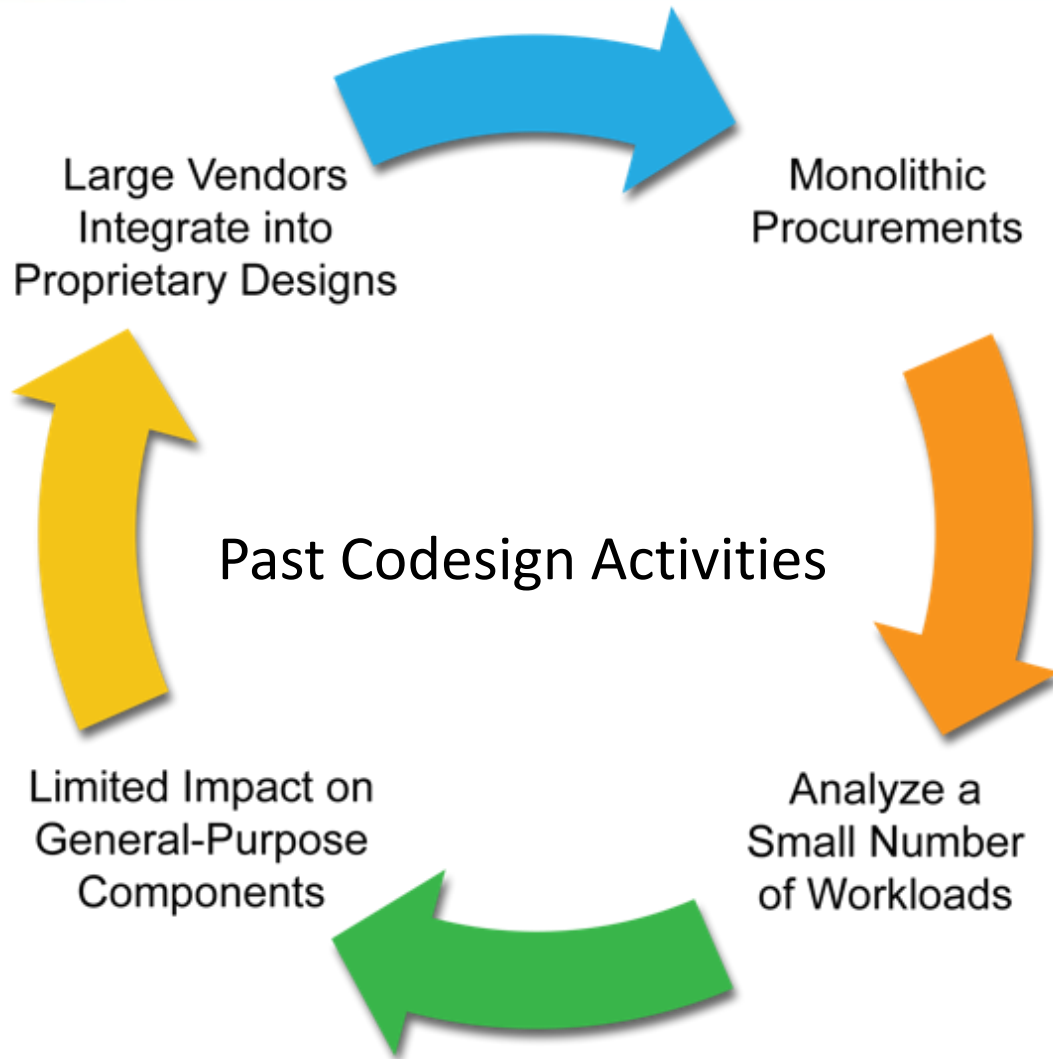


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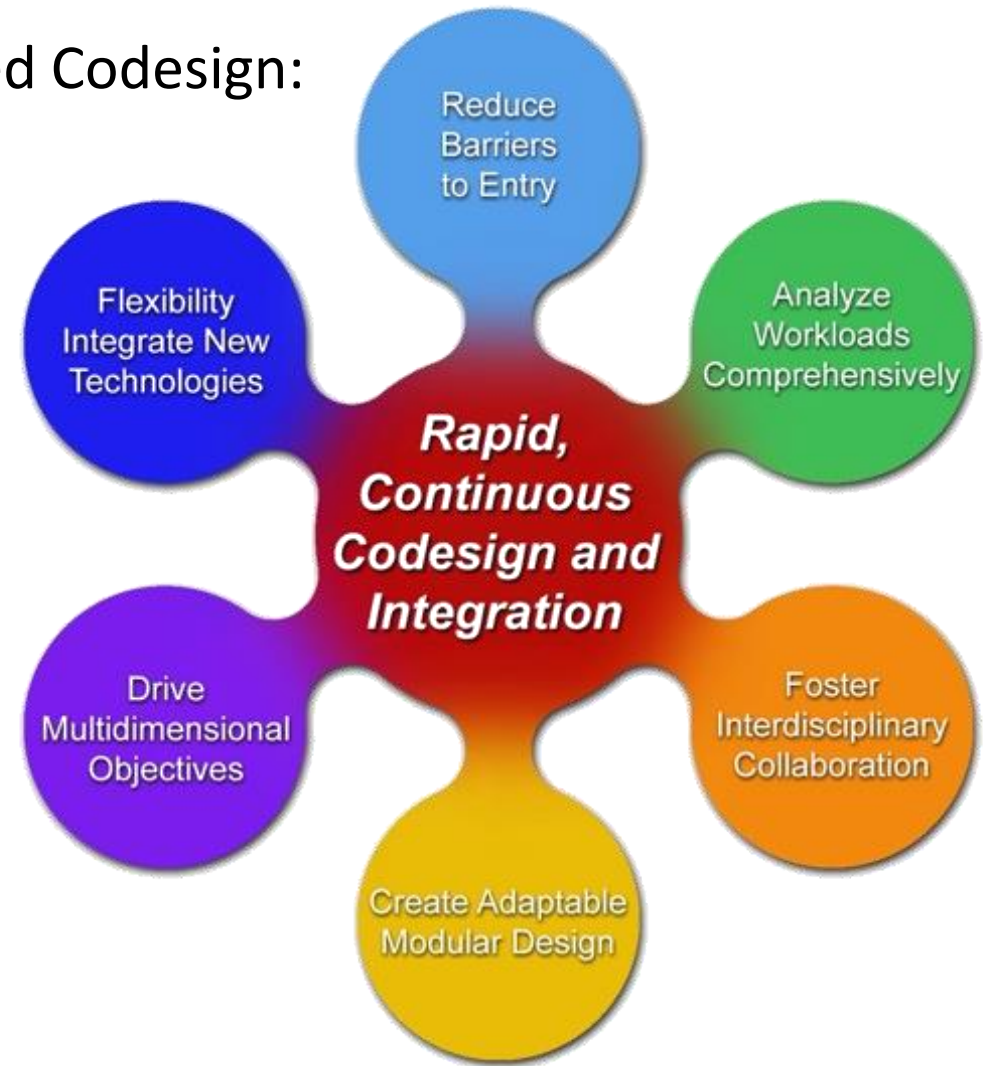
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# ASCR Workshop on Reimagining Codesign: Past vs. Future

<https://www.ornl.gov/ASCR-CoDesign/>



## Reimagined Codesign:



For more information, see <https://doi.org/10.2172/1822198>



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## Priority Research Directions:

### 1. Drive Breakthrough Computing Capabilities with Targeted Heterogeneity and Rapid Design

**Key Questions:** What new methods and technologies are required to rapidly create breakthrough hardware designs? How can we ensure that they align to support increasingly diverse and demanding computing requirements?

### 2. Software and Applications that Embrace Radical Architecture Diversity

**Key Question:** What novel approaches to software design and implementation can be developed to provide performance portability for applications across radically diverse computing architectures?

### 3. Engineered Security and Integrity from Transistors to Applications

**Key Questions:** How does codesign consider needs for end-to-end scientific computing and scientific data security, provenance, integrity, and privacy? What computer security innovations from the commercial computing ecosystem (e.g., trusted execution environments) can be codesigned to provide security for DOE scientific discovery? How do we validate components with increasingly diverse supply chains and sources of development?

### 4. Design with Data-Rich Processes

**Key Questions:** What are the quantitative tools that are practical, accurate, and applicable to codesigning various layers of the hardware/software stack and of data-driven, dynamic, irregular workflows, such as those occurring in experimental science or AI/machine learning workloads?

For more information see <https://doi.org/10.2172/1822198>. The workshop report will be available from <https://doi.org/10.2172/1822199> upon publication.

# ASCR Workshop: The Management and Storage of Scientific Data



## WHAT DO OUR SCIENTISTS AND FACILITIES NEED?

### EXAMPLES

- Experimental/observational data science
- Workflows, data processing pipelines, ML/AI applications
- FAIR principles, introspection, provenance



## WHAT NEW TECHNOLOGIES MIGHT BE BENEFICIAL?

### EXAMPLES

- In situ and in transit data analysis
- New storage, memory, networking technologies
- Disaggregated, dynamically provisioned resources

<https://www.osti.gov/biblio/1845705-management-storage-scientific-data>



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# ASCR Workshop: The Management and Storage of Scientific Data

## 1. High-productivity interfaces for accessing scientific data efficiently

### Key Questions:

1. How can application developers search and access important information seamlessly in massive amounts of scientific data?
2. What changes are needed to existing I/O application programming interfaces (APIs) to enable complex AI workflows?
3. What are effective interfaces and abstractions for capturing user intent for optimizing data management?

## 2. Understanding the behavior of complex data management systems in DOE science

### Key Questions:

1. How can disparate information from multiple sources regarding data management activities be fused into useful knowledge?
2. In what ways can people and software leverage this knowledge to improve the reliability and performance of data management systems?

<https://www.osti.gov/biblio/1845705-management-storage-scientific-data>

# ASCR Workshop: The Management and Storage of Scientific Data

## 3. Rich metadata and provenance collection, management, search, and access

### Key Questions:

1. What metadata and provenance are needed to support FAIR principles?
2. How do we support collection, storage, and search of rich metadata and provenance?
3. How can we use rich metadata and provenance for optimizing data management?

## 4. Reinventing data services for new applications, devices, and architectures

### Key Questions:

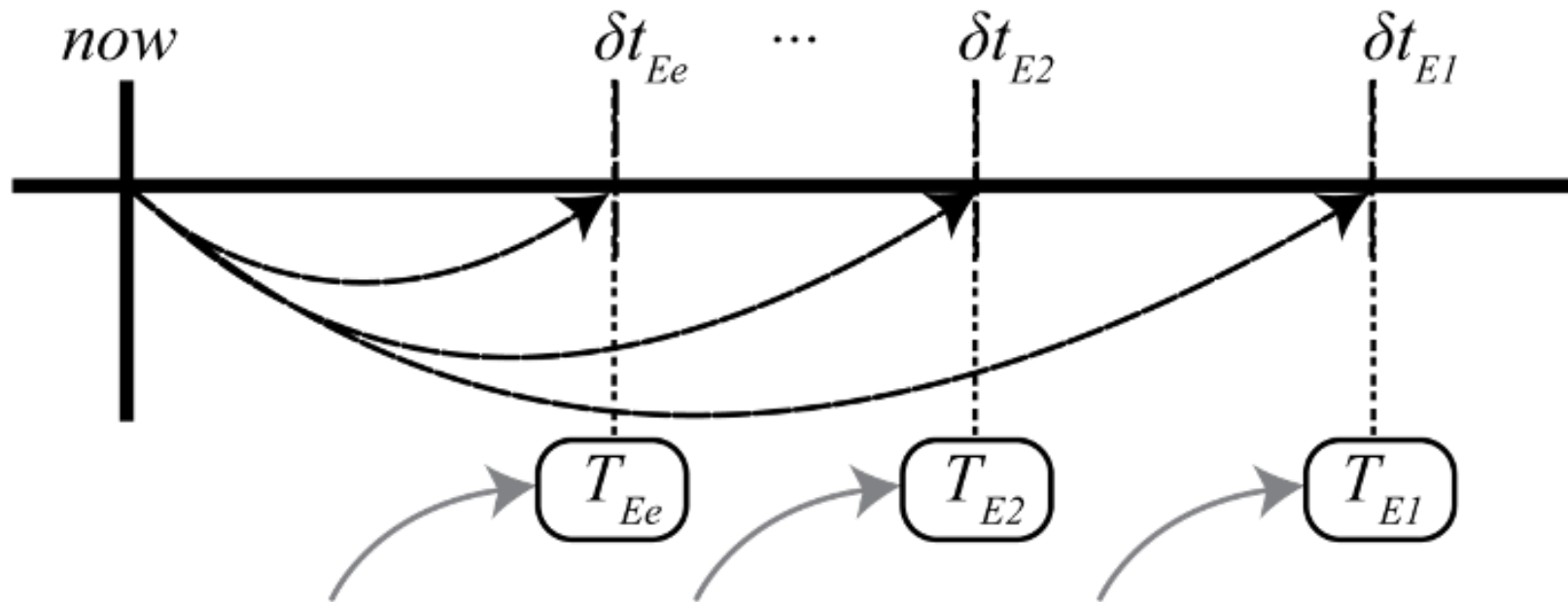
1. Using a co-design approach, how do we create specialized data services leveraging emerging device technologies to enable revolutionary breakthroughs across the breadth of DOE science?

<https://www.osti.gov/biblio/1845705-management-storage-scientific-data>



# ASCR Roundtable on Parallel Discrete Event Simulation (PDES)

- September 20, 2021. 12-5pm Eastern Time.
- 21 participants from 8 labs (ANL, BNL, LANL, LBL, LLNL, ORNL, PNNL, SNL).
- ASCR points of contact: Hal Finkel, Randall Laviolette
- Parallel Discrete Event Simulation (PDES): Simulations modeling systems characterized by discrete state changes of, and discrete interactions between, a distributed collection of entities.





# ASCR Roundtable on PDES: Use Cases

- Motivating use cases discussed included:
  - Transportation and Mobility Applications
    - A collection of distributed agents (e.g., vehicles and infrastructure controllers), each optimizing either their individual utility (e.g., user travel time) or system efficiency (e.g., minimize congestion or fuel).
    - Transportation systems are becoming increasingly complex and interconnected (e.g., real-time GPS and camera data feeds, 5G, and smart infrastructure and vehicles). [Also applies analogously below.]
  - Energy Grid Applications
    - Models distributed control systems for, and behavior of, smart grids and renewable energy grids.
  - Internet and Cybersecurity Simulations
    - Models networking infrastructure (hosts, routers, etc.) and protocols.
  - Material Science Applications using Kinetic Monte Carlo
    - Models many processes including crystal grain growth, thin film growth, dopant migration in semiconductors, and material evolution due to radiation damage.
  - Epidemiological Planning, Response, Policy, and Decision-making
    - Models collective societal behavior from individual stochastic decisions and coupled physical systems.
  - Simulations for Hardware Co-Design and Large-Scale Scientific Infrastructure
    - Models hardware and application behavior across many scales, from circuits to supercomputers.

## Parallel Discrete Event Execution on High Performance Computing Platforms

PDES brings notable opportunities for hardware/software co-design.

Thus, both PDES for co-design and co-design for PDES are relevant for future research.

Discrete event execution style is vastly different from most traditional supercomputing-based simulations

Translates to

- Different optimizations
- Different communication patterns
- Different latency needs
- Different bandwidth needs
- Different buffering requirements
- Different scheduling needs
- Different synchronization requirements
- Different flow control schemes

PDES needs a different runtime

- Qualitatively different runtime infrastructure, optimized and tuned for discrete event applications

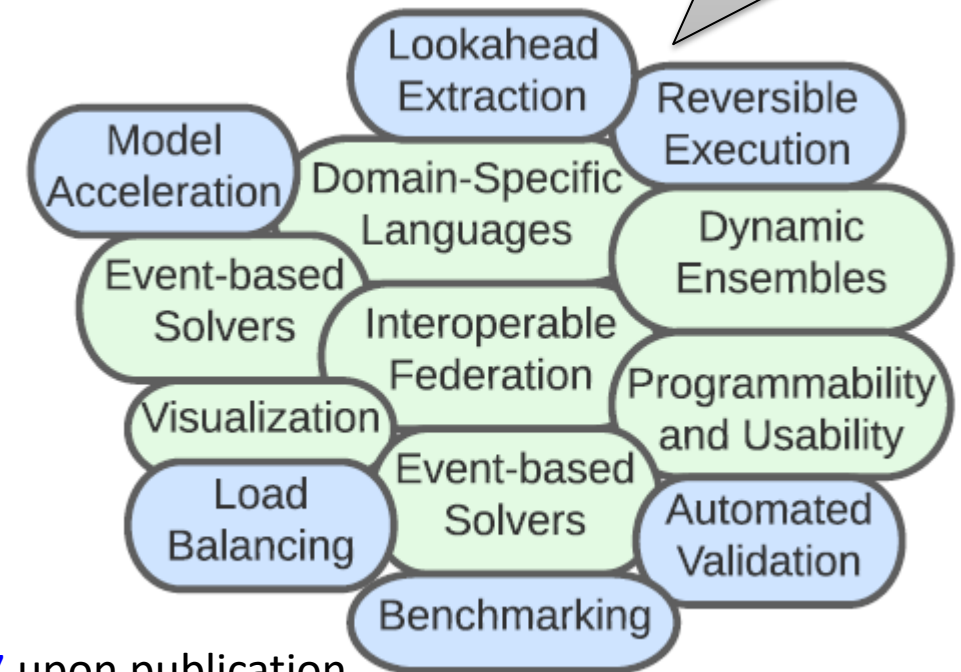


# ASCR Roundtable on PDES: Research Opportunities

Research opportunities identified in:

- Core Advancements (Inner Technologies)
  - Exploiting supercomputing/accelerator architectures
  - Parallel decomposition, dynamic load balancing, and event scheduling
  - Incorporating AI/ML (as surrogates, for speculative execution, etc.)
- Usability Advancements (Outer Technologies)
  - Interoperable and federated execution
  - Adaptive ensembles
  - Visualization techniques
  - Use of streaming data
  - Interfaces and domain-specific languages (e.g., for lookahead extraction, reverse execution)
  - Runtime adaptation, event aggregation, and scheduling
- Advancements for the Scientific Enterprise and Mission Applications
- (Cross-cut Technologies)
  - Simulations of the DOE Science Enterprise
  - PDES-based Mathematical Solvers
  - Benchmarks and other domain-informed developments

Interestingly, compilation for reversible execution also comes up in work on energy-efficient and quantum computing.



The roundtable report will be available from <https://doi.org/10.2172/1855247> upon publication.

# Some Other Past ASCR Workshops and Roundtables



## Roundtable Report: Terahertz and 6G Wireless Communications in Science and Extreme Environments

The main objective of the roundtable is to explore the potential of Terahertz (THz) and 6G communications in extreme environments such as industrial, manufacturing, and large critical scientific facilities (for example, light sources, accelerators, high-performance computers, data centers, neutron sources, etc.). In contrast to commercial wireless networks (5G included), which are optimized for best-effort broadband voice and Internet of Things (IoT) services.

**Report** October 1, 2020



## 5G Enabled Energy Innovation Workshop (5GEEIW)

On March 10-12, 2020, the Office of Science (SC) organized a three-day workshop to deliver a community-based report highlighting 5G and beyond basic research, development, applications, technology transition, infrastructure, and demonstration opportunities in support of the U.S. DOE mission. The brochure and report will help the DOE Office of Science understand both the challenges and the opportunities offered by 5G and emerging advanced wireless technologies in the areas of basic research, development, and integration into scientific user facility operations.

[Cover](#) | [Brochure](#)  | [Workshop Report](#) 

<https://science.osti.gov/ascr/Community-Resources/Program-Documents>



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# Some Other Past ASCR Workshops and Roundtables

## Data and Models: A Framework for Advancing AI in Science

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[View Technical Report](#)



## ASCR Workshop on In Situ Data Management

In January 2019, ASCR convened a workshop on In Situ Data Management (ISDM). The goal was to identify priority research directions (PRDs) to support current and future scientific computing needs, which will increasingly incorporate a number of different tasks that need to be managed along with the main simulation or data analysis tasks. The workshop identified six PRDs that highlight the components and capabilities needed for ISDM to facilitate scientific discovery from a variety of different data sources.

[Cover](#) | [Brochure](#)  | [Report](#)

<https://science.osti.gov/ascr/Community-Resources/Program-Documents>



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# Some Other Past ASCR Workshops and Roundtables



## Report on Basic Research Needs for Scientific Machine Learning: Core Technologies for Artificial Intelligence

Scientific Machine Learning (SciML) and Artificial Intelligence (AI) will have broad use and transformative effects across the Department of Energy. Accordingly, the ASCR January 2018 Basic Research Needs workshop report identifies six Priority Research Directions (PRDs) as viewed through the lens of applied mathematics and scientific computing. The six PRDs provide a sound basis for a coherent, long-term research and development strategy in SciML and AI.

[Cover](#) | [Workshop Report](#) | [Brochure](#)



## STREAM2016: Streaming Requirements, Experience, Applications and Middleware Workshop

This report describes the discussions, outcomes, and conclusions from STREAM2016: Streaming Requirements, Experience, Applications and Middleware Workshop – the second workshop in the STREAM series, held on March 22-23, 2016 in Tysons, VA. STREAM2016 focused on DOE applications, computational and experimental facilities, as well as software systems. The role of streaming and steering as a critical aspect of the linkage between experimental and computing facilities was pervasive throughout the workshop. Given the overlap in interests and challenges faced by industry, the workshop had significant presence from several major companies in this area.

[Workshop Report](#) 

<https://science.osti.gov/ascr/Community-Resources/Program-Documents>



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## ASCR Software-Stewardship Request for Information (RFI)

- On October 29<sup>th</sup>, 2021, ASCR released an RFI on the stewardship of software for scientific and high-performance computing.
- Responses were due by December 13<sup>th</sup>, 2021.
- The RFI details the potential scope of stewardship activities, including but not limited to:
  - Training on software development and use
  - Workforce support
  - Infrastructure for common development needs
  - Curation and governance processes
  - Maintaining situational awareness
  - Shared engineering resources
  - Project support
- ASCR received 37 independent responses\*, quality of most was very high
  - ECP responses from the ECP ST leadership team, the ECP task force on broader engagement, NWChemEx Project.
  - 11 responses from DOE national laboratories.
  - Responses from non-profit organizations: HDF5 Group and NumFOCUS.
  - Response from the US Research Software Engineer Association
  - 6 responses from small businesses.
  - Responses from medium/large businesses: CloudBees, HPE, NVIDIA, Google.
- Responses available:  
<https://doi.org/10.2172/1843576> – over 360 pages of text were provided.

(\*) Counting the two independently-authored submissions from SNL separately.

## ASCR Software-Stewardship RFI: Summary

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**Note:** The following slides summarize themes noted in the RFI responses, and they are ***not*** comprehensive. Their purpose is to inspire interest in reading the RFI responses, available at <https://doi.org/10.2172/1843576>. No endorsement, recommendation, or favoring is intended or implied.

DOE thanks all of the respondents for their considerable collective effort and hopes that the RFI responses will serve as a resource for the entire community.

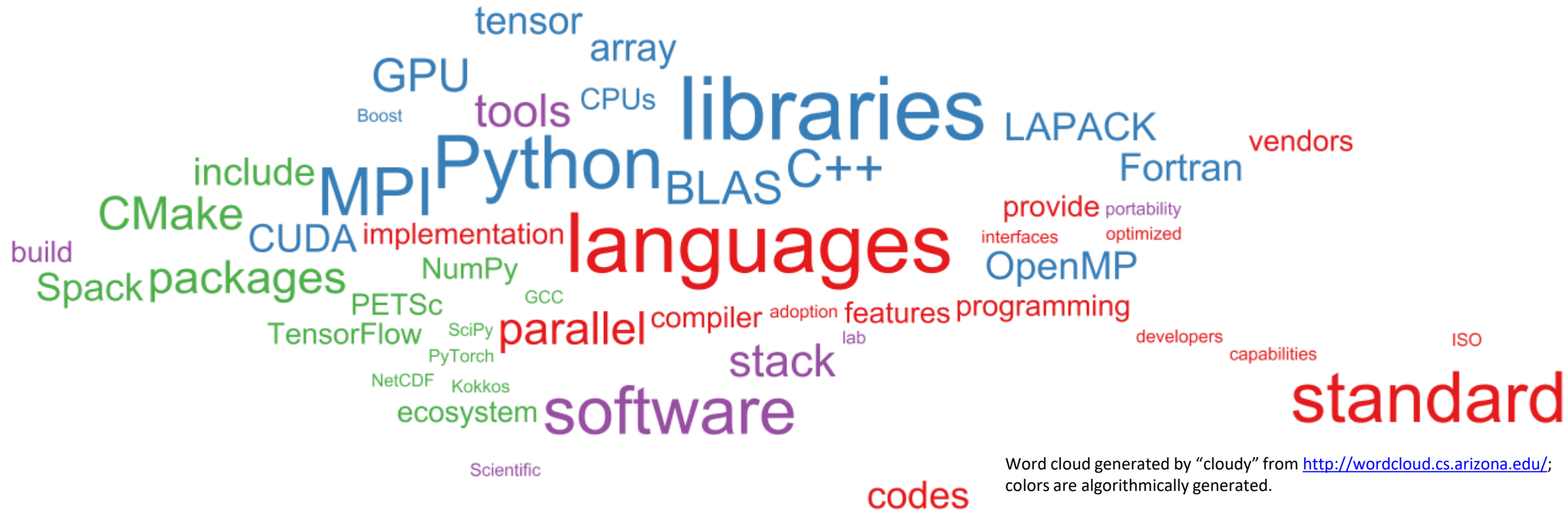
ASCR Software-Sustainability Task Force:

Ben Brown, Hal Finkel, Saswata Hier-Majumder, Robinson Pino, Bill Spotz

**Note:** For the full set of slides on the RFI responses, please see: [https://science.osti.gov/-/media/ascr/ascac/pdf/meetings/202203/ASCAC\\_202203\\_Finkel-RFI-Codesign-PDES.pdf](https://science.osti.gov/-/media/ascr/ascac/pdf/meetings/202203/ASCAC_202203_Finkel-RFI-Codesign-PDES.pdf) – This presentation contains only a subset of the slides.

# ASCR Software-Stewardship RFI: Software Dependencies

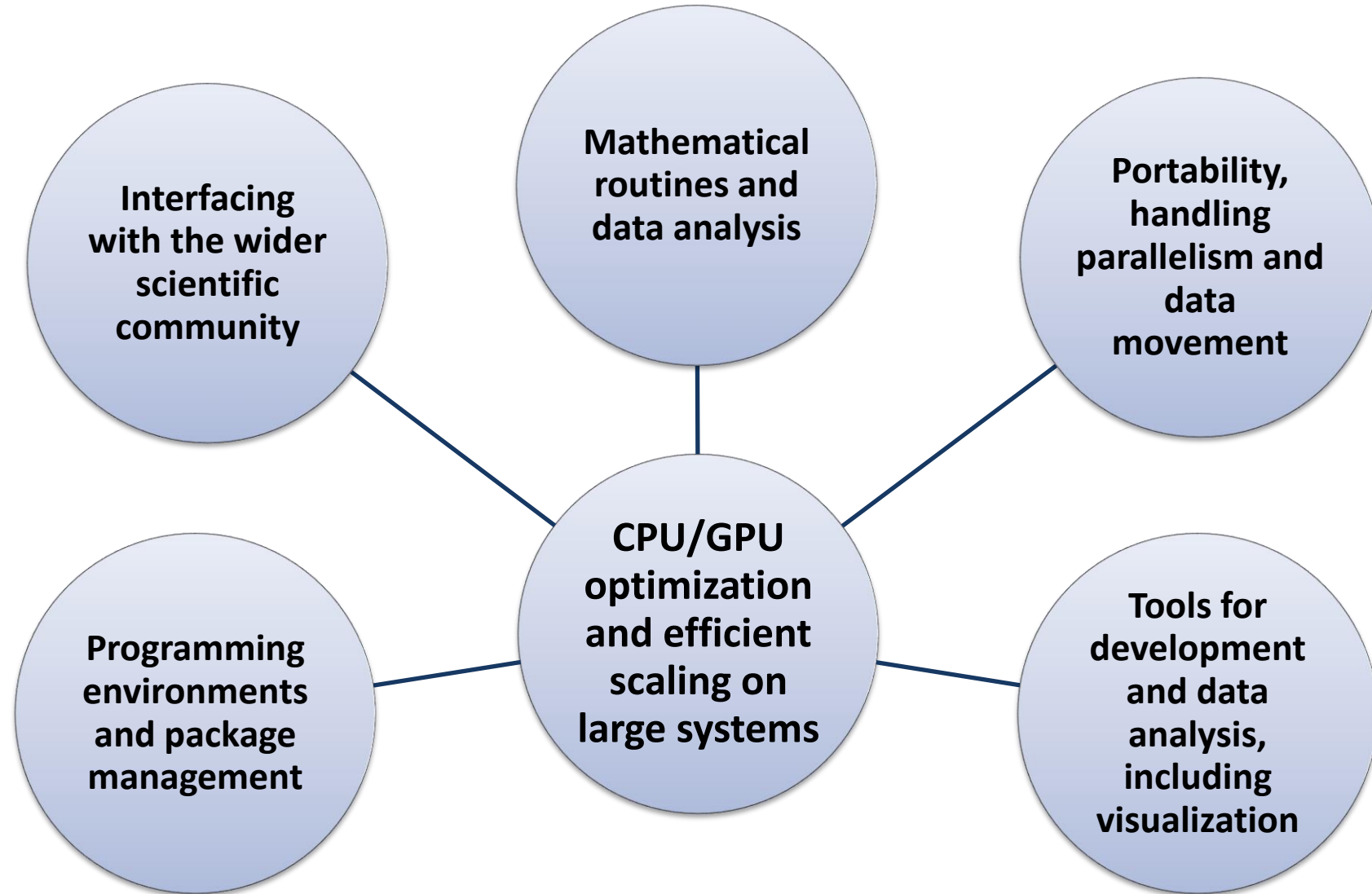
**Software dependencies and requirements:** What software packages and standardized languages or Application Programming Interfaces (APIs) are current or likely future dependencies for your relevant research and development activities?



# ASCR Software-Stewardship RFI: Key Capabilities Provided by Dependencies

## Software dependencies and requirements:

What key capabilities are provided by these software packages?





# ASCR Software-Stewardship RFI: Anticipated Key Capability Requirements

**Software dependencies and requirements:** What key capabilities, which are not already present, do you anticipate requiring within the foreseeable future?

Common themes included various technical capabilities and increased alignment with community best practices:

Data management

Modern  
development tools

Workflows and  
integration

Community-aligned  
processes

Machine learning

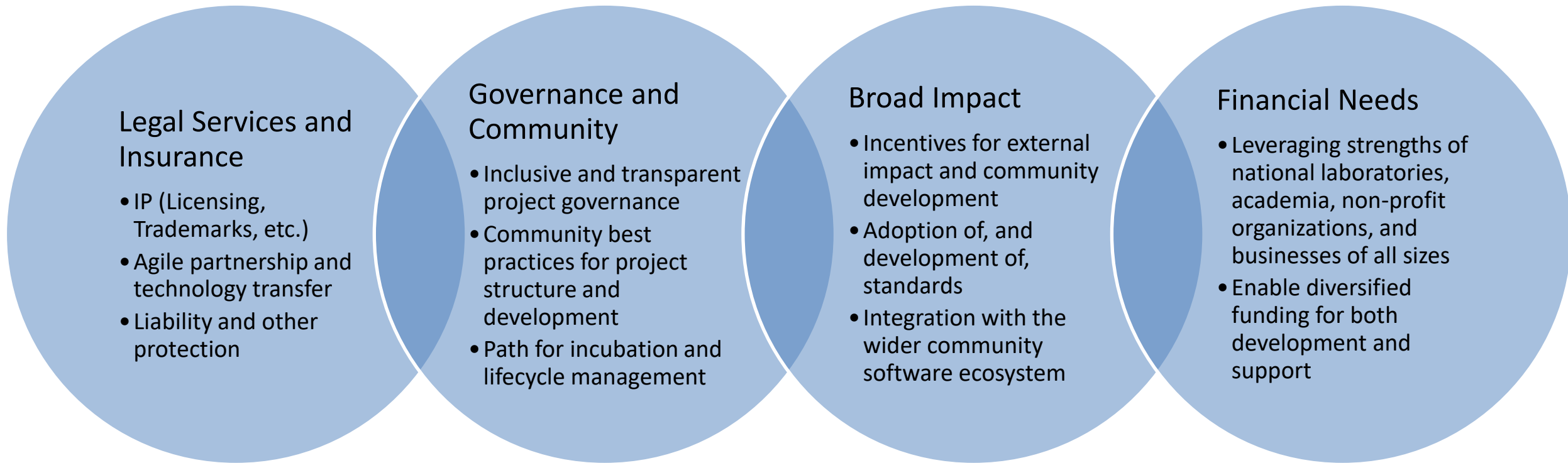
Sparsity support

Accelerator  
optimization



# ASCR Software-Stewardship RFI: Components of Sustainable Models

**Requirements, barriers, and challenges to technology transfer, and building communities around software projects, including forming consortia and other non-profit organizations:** How to encourage sustainable, resilient, and diversified funding and development models for the already-successful software within the ecosystem. What are the important characteristics and components of sustainable models for software for scientific and high-performance computing?



# ASCR Software-Stewardship RFI: Factors Leading to Successful Models

**Requirements, barriers, and challenges to technology transfer, and building communities around software projects, including forming consortia and other non-profit organizations:** What development practices and other factors tend to facilitate successful establishment of these models?

