Call for Position Papers: Workshop on Reimagining Codesign

Important Dates

- 16th February 2021: Deadline for position paper submission
- 2nd March 2021: Notification of position acceptance
- 16–18th March 2021: Workshop
- SUBMISSION URL: ASCR Workshop on Co-Design - Position Papers
- WORKSHOP URL: https://www.orau.gov/ASCR-CoDesign/

Motivation

On behalf of the Advanced Scientific Computing Research (ASCR) program in the US Department of Energy (DOE) Office of Science, we are organizing a Workshop on Reimagining Codesign (ReCoDe). Codesign is the process of jointly designing interoperating components of a computing system—in particular: applications, algorithms, system software, programming models, and the hardware on which they run. The goal is to maximize the overall performance, efficiency, and other desirable qualities of the system as a whole. Codesign is a standard methodology in the embedded-systems community, where space, power, and cost constraints are commonly pitted against execution speed for a tightly constrained feature set. Over the last decade, the DOE has invested in codesign efforts to foster the development of exascale computing systems for broad classes of scientific and engineering applications. The ReCoDe workshop hopes to explore how scientific applications of interest to the DOE can be accelerated through close interactions with hardware designers and software-stack developers, in which all components adapt to each other's requirements and constraints. We want to answer the question of what are the key tools and methodologies for accomplishing codesign in today's computing landscape, and what will be the highest impact targets for meeting DOE's emerging mission requirements.

This workshop aims to bring together DOE, industry, and academia to identify opportunities to build on past codesign successes and identify new areas that are either emerging or that may need reimagining for the future. We want to continue to find opportunities that can be pursued as a joint effort and continue to break down the traditional customer/vendor dichotomy with true partnerships. From this work, DOE will benefit from increased application performance relative to what stock hardware or existing general-purpose roadmaps can provide, and vendors will benefit from expanding their hardware's capabilities to address needs they might have not otherwise anticipated and thereby create more widespread interest in their products.

The workshop will be structured around a set of breakout sessions, with every attendee expected to participate actively in the discussions. Afterward, workshop attendees—from DOE, industry, and academia—will produce a report for ASCR that summarizes the findings made during the workshop.

Invitation

We invite community input in the form of two-page position papers that identify and discuss key challenges and opportunities in the area of hardware/software codesign for scientific computing. In addition to providing an avenue for identifying workshop participants, these position papers will be used to shape the workshop agenda, identify panelists, and contribute to the workshop report. Position papers should not describe the authors' current or planned research, contain material that should not be disclosed to the public, nor should they recommend specific solutions or discuss narrowly focused research topics. Rather, they should aim to improve the community's shared understanding of the problem space, identify challenging research directions, and help to stimulate discussion.

One author of each selected submission will be invited to participate in the workshop.

By submitting a position paper, authors consent to have their position paper published publicly.

Authors are not required to have a history of funding by the ASCR Computer Science program.

Submission Guidelines

Position Paper Structure and Format

Position papers should follow the following format:

- Title
- Authors (with affiliations and email addresses)
- Topic: one or more of the following: architectures, applications, modeling and simulation, programming systems, emerging technologies, codesign methodologies
- Challenge: Identify aspects of current codesign that show the limitations of state-of-the-art practice with examples
- Opportunity: Describe how the identified challenges may be addressed, whether it is through new tools and techniques, new technologies, or new groups collaborating in the codesign process
- Timeliness or maturity: Why now? What breakthrough or change makes progress possible now where it wasn't possible before? What will be the impact of success?
- References

Each position paper must be no more than two pages including figures and references. The paper may include any number of authors but contact information for a single author who can

represent the position paper at the workshop must be provided with the submission. There is no limit to the number of position papers that an individual or group can submit. Authors are strongly encouraged to follow the structure previously outlined. Papers should be submitted in PDF format using the designated page on the workshop website.

Areas of Emphasis

We are seeking submissions along the following general directions:

- Key aspects of codesign across the entire hardware/software stack to include applications, algorithms, system software, and system architecture
- Insights into codesign for workflows arising from scientific experiments, on supercomputers, or to support large-scale scientific instruments
- Methods and tools for quantitative codesign, including both those that inform high-level decision-making and those impacting low-level aspects of the codesign process.
- New codesign challenges anticipated over the next decade

Notional Questions

Position papers should present a view on how hardware, firmware, the software stack, and scientific applications can be codesigned for maximal effectiveness, perhaps taking inspiration from some of the following:

- How to balance breadth of applications versus customization benefit? Does this vary by system type?
- What are the tools and techniques that enable successful codesign interactions and where are the gaps?
- With artificial intelligence and machine learning becoming more widely used in scientific workflows and applications, what new challenges and opportunities does this present?
- New accelerator technologies and chiplets are increasing the possible design space. What is the potential of these new technologies and how can codesign be used to take maximum advantage of them?
- How can we further the state of the art in efficient and flexible open-source hardware, modeling, and simulation tools that can underpin hardware codesign activities?
- Is there a performance benefit to codesigning scientific applications and the computer systems (hardware and software) they run on, or will the additional time and cost outweigh the benefits observed relative to more-or-less portable applications running on stock supercomputers?
- How do scientific applications and supercomputer codesign differ fundamentally from the codesign employed regularly for embedded systems (such as in automobiles and home appliances)? Can either area learn from the other?

- What are the lessons learned from DOE's last decade of exascale codesign collaborations among national laboratories, industry, and universities? What should be continued? What should be avoided?
- What are the roles that academia can play in codesign benefiting DOE systems?
- What do application developers and hardware designers need to do differently when beginning to think about codesign?
- What is the basic timeline for the constituent activities in a scientific-application codesign process? How can it be improved?
- What emerging hardware or software technologies will facilitate rapid development of both scientific applications and hardware platforms with sufficiently-flexible components to help produce successful outcomes?
- If codesign of scientific applications and hardware platforms becomes the norm, what new skills will be required of application/hardware developers? How will this future workforce be trained?
- What role does system software play in a codesign process?
- Open Source Software is supported by long-standing DOE policy. How can Open Source Hardware support codesign?
- What is the role of DOE in codesign for edge computing?
- What programming systems concepts facilitate effective codesign and why?

Selection

Submissions will be reviewed by the workshop's organizing committee using criteria of overall quality, relevance, likelihood of stimulating constructive discussion, and ability to contribute to an informative workshop report. Unique positions that are well presented and emphasize potentially-transformative research directions will be given preference.