

**Office of Science
Financial Assistance
Funding Opportunity Announcement
DE-FOA-0000257**

X-Stack Software Research

SUMMARY:

The Office of Advanced Scientific Computing Research (ASCR) of the Office of Science (SC), U.S. Department of Energy (DOE), hereby announces its interest in receiving applications from Computer Science (CS) researchers in the area of **X-Stack Software Research**. The X-Stack refers to the scientific software stack that supports extreme scale scientific computing, from operating systems to development environments. Multi-Institutional proposals with cohesive emphasis on transformational computer science discoveries that address key challenges on the path to exascale computing are encouraged. In addition to other topics, this FOA continues and extends topics of research addressed under the ASCR program on *Operating and Runtime Systems for Extreme Scale Scientific Computation*, http://www.sc.doe.gov/grants/LAB07_23.html and <http://www.sc.doe.gov/grants/FAPN07-23.html>.

Exascale computer systems will be comprised of as many as a billion cores. Such systems will be capable of 10 billion-way concurrency in simultaneous operations. Industry reports indicate that data movement will be the limiting factor for exascale systems, rather than processors and computational operations, especially when power constraints are considered. At the same time, memory per core is expected to decline sharply for exaflop systems, and the performance of storage systems continues to lag far behind. Multi-level storage architectures that span multiple types of hardware are anticipated and will require new approaches to run-time data management and analysis.

This Funding Opportunity Announcement invites basic computer science research proposals to address a variety of challenges in creating the software stack for extreme scale computing systems, the X-Stack, including operating and run-time systems, programming models and environments, and scientific workflow systems. Awards will not be made for design or development of applications for discipline-specific science.

APPLICATION DUE DATE: April 2, 2010, 11:59 p.m. Eastern Time

Formal applications submitted in response to this FOA must be received by April 2, 2010, 11:59 p.m. Eastern time, to permit timely consideration of awards. **APPLICATIONS RECEIVED AFTER THE DEADLINE WILL NOT BE REVIEWED OR CONSIDERED FOR AWARD.**

IMPORTANT SUBMISSION INFORMATION:

The full text of the Funding Opportunity Announcement (FOA) is located on FedConnect. Instructions for completing the Grant Application Package are contained in the full text of the FOA which can be obtained at: <https://www.fedconnect.net/FedConnect/?doc=DE-FOA-0000257&agency=DOE>. To search for the FOA in FedConnect click on "Search Public Opportunities". Under "Search Criteria", select "Advanced Options", enter a portion of the title "X-Stack Software Research", then click on "Search". Once the screen comes up, locate the appropriate Announcement.

In order to be considered for award, Applicants must follow the instructions contained in the Funding Opportunity Announcement.

WHERE TO SUBMIT: Applications must be submitted through [Grants.gov](https://www.grants.gov) to be considered for award.

You cannot submit an application through Grants.gov unless you are registered. Please read the registration requirements carefully and start the process immediately. Remember you have to update your CCR registration annually. If you have any questions about your registration, you should contact the Grants.gov Helpdesk at 1-800-518-4726 to verify that you are still registered in [Grants.gov](https://www.grants.gov).

Registration Requirements: There are several one-time actions you must complete in order to submit an application through Grants.gov (e.g., obtain a Dun and Bradstreet Data Universal Numbering System (DUNS) number, register with the Central Contract Registry (CCR), register with the credential provider, and register with Grants.gov). See <http://www.grants.gov/GetStarted>. Use the Grants.gov Organization Registration Checklist at <http://www.grants.gov/assets/OrganizationRegCheck.pdf> to guide you through the process. Designating an E-Business Point of Contact (EBiz POC) and obtaining a special password called an MPIN are important steps in the CCR registration process. Applicants, who are not registered with CCR and Grants.gov, should allow at least 21 days to complete these requirements. It is suggested that the process be started as soon as possible.

IMPORTANT NOTICE TO POTENTIAL APPLICANTS:

When you have completed the process, you should call the Grants.gov Helpdesk at 1-800-518-4726 to verify that you have completed the final step (i.e. Grants.gov registration).

Questions: Questions relating to the registration process, system requirements, how an application form works, or the submittal process must be directed to Grants.gov at 1-800-518-4726 or support@grants.gov. Part VII of the FOA explains how to submit other questions to the Department of Energy (DOE).

All applications should be in a single PDF file.

GENERAL INQUIRIES ABOUT THIS FOA SHOULD BE DIRECTED TO:

Technical/Scientific Program Contact:

Program Manager: Dr. Daniel Hitchcock
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SUPPLEMENTARY INFORMATION:

Critical challenges in developing the X-Stack include concurrency, energy efficiency and resiliency, among others. Solving these problems may call for new approaches to system design, such as hardware-software co-design.

The complexity of exascale systems presents significant challenges to human understanding which must be addressed. A fundamental need is for ways to express concurrency and locality in ways that are comprehensible to scientists, who must be able to understand how codes relate to theory and experimentation in their disciplines. Burdens of managing the memory hierarchy, synchronization, resource scheduling and communication, utilizing heterogeneous processors, etc., must not fall to programmers.

Topics of interest include but are not limited to:

- System software, including operating systems, runtime systems, adaptable operating and runtime systems, I/O systems, systems management/administration, resource management and means of exposing resources, and external environments
- Fault management, both by the operating and runtime systems and by applications
- Development environments, including programming models, frameworks, compilers, and debugging tools
- Application frameworks
- Crosscutting dimensions, including resilience, power management, performance optimization, and programmability
- Design and/or development of high-performance scientific workflow systems that incorporate data management and analysis capabilities

These example research topics represent only a portion of the research challenges in developing the X-Stack that are of interest to ASCR. All interested proposers are encouraged to study the following references for additional discussion and insight:

- *The International Exascale Software Project Roadmap*, http://www.exascale.org/iesp/Main_Page
- *Operating and Runtime Systems for Extreme Scale Scientific Computation (a.k.a. FAST OS)*, http://www.sc.doe.gov/grants/LAB07_23.html and <http://www.sc.doe.gov/grants/FAPN07-23.html>
- *ExaScale Software Study: Software Challenges in Extreme Scale System*, report for the DARPA Information Processing Techniques Office (IPTO), September 2009, <http://users.ece.gatech.edu/mrichard/ExascaleComputingStudyReports/ECSS%20report%20101909.pdf>
- *System Resilience at Extreme Scale*, <http://institutes.lanl.gov/resilience/docs/IBM%20Mootaz%20White%20Paper%20System%20Resilience.pdf>
- "Software Challenges in Extreme Scale Systems," Sarkar, Vivek; Harrod, William; and Snavely, Allan E., SciDAC 2009, <http://www.cs.rice.edu/~vs3/PDF/Sarkar-Harrod-Snavely-SciDAC-2009.pdf>

Interested proposers should also be aware that ASCR anticipates related Funding Opportunity Announcements on **Scientific Data Management and Analysis at Extreme Scale** and on **Advanced Architectures and Critical Technologies for Exascale Computing**. When available, additional information may be found on the ASCR Funding Opportunities web site at <http://science.doe.gov/ascr/Misc/Funding.html>. Existing ASCR programs of likely interest to proposers include the following:

- *Mathematics for Complex, Distributed, Interconnected Systems*, http://www.science.doe.gov/grants/LAB09_23.html
- *Joint Mathematics/Computer Science Institute*, http://www.sc.doe.gov/grants/LAB09_22.html
- *Mathematics for Analysis of Petascale Data*, http://www.science.doe.gov/grants/LAB09_10.html

COMMUNITY BUILDING

An important goal of this notice is to foster an active, integrated research community of versatile researchers who are committed to the common goal of achieving exascale computation for advancing scientific discovery. Accordingly,

- Each research team should plan to send representatives to a kick-off meeting and an annual PI meeting, where they will give presentations on the status and promise of their research and engage in working sessions to address shared problems. Meeting attendees will include invited participants from other relevant research communities. The objectives of these meetings include fostering a sense of community and serving as a venue for exchange of information with complementary programs.

The application will need to include plans for the dissemination of research results, such as:

- Publications, conferences, and educational activities for the science user community: what mechanisms will the project employ to present its work to a broader community to ensure sustained activities in the research area and promote adoption by communities of scientists?
- Code release: how will the codes be released to allow other researchers to continue building and expanding on the knowledge gained?
- Testing at scale: Will the project perform software testing at scale? If so, what are the requirements for this testing (for example, hardware, specific architecture, specific test bed, etc)?

This program requires open source software development. Applications should identify the open source license to be used.

Program Funding

It is anticipated that up to \$10,000,000 annually will be available for multiple awards for this program, contingent on the availability of appropriated funds. Multiple (10-15) awards are planned to be made in Fiscal Year 2010, and applications may request project support for up to three years. All awards are contingent on the availability of funds, progress of the research, and programmatic needs.

DOE is under no obligation to pay for any costs associated with the preparation or submission of an application. DOE reserves the right to fund, in whole or in part, any, all, or none of the applications submitted in response to this FOA.

Merit Review

Applications will be subjected to scientific merit review (peer review) and will be evaluated against the following evaluation criteria which are listed in descending order of importance codified at 10 CFR 605.10(d):

1. Scientific and/or Technical Merit of the Project;
2. Appropriateness of the Proposed Method or Approach;
3. Competency of Applicant's Personnel and Adequacy of Proposed Resources; and
4. Reasonableness and Appropriateness of the Proposed Budget.

The evaluation process will include program policy factors such as the relevance of the proposed research to the terms of the announcement and the agency's programmatic needs. Note that external peer reviewers are selected with regard to both their scientific expertise and the absence of conflict-of-interest issues. Both Federal and non-Federal reviewers may be used, and submission of an application constitutes agreement that this is acceptable to the investigator(s) and the submitting institution.

The Catalog of Federal Domestic Assistance (CFDA) number for this program is 81.049, and the solicitation control number is ERFAP 10 CFR Part 605.

Posted on the Office of Science Grants and Contracts Web Site
January 29, 2010.