Office of Science
Financial Assistance
Funding Opportunity Announcement
DE-PS02-08ER08-27

High-Performance Networks for Distributed Petascale Science

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 grant applications for research and development projects in high-capacity and high-performance networks to support distributed petascale science. Awards for this solicitation will be made in FY 2009, subject to the availability of funds.

LETTER OF INTENT DUE DATE: October 31, 2008, 5:00 p.m., Eastern Time

A one-page Letter of Intent (LOI) is **REQUIRED** and must be received by **October 31, 2008**, 5:00 p.m., Eastern Time. The Letter of Intent should be submitted by e-mail as a PDF file attachment to: network_research@ascr.doe.gov. Please use "Letter of Intent for Announcement **DE-PS02-08ER08-27**" in the subject line of the email.

The purpose of the Letter of Intent (LOI) is to facilitate the planning of the peer review process and the selection of reviewers, including identifying any potential conflicts of interest. The one-page LOI must include the following information: the announcement number **DE-PS02-08ER08-27**; name, institutional affiliation, and contact information of the Principal Investigator (PI); names and institutional affiliations of other PIs and senior personnel; projected funding request (if possible); title of the proposed effort; and an abstract of the proposed research. For collaborations involving multiple institutions, a single Letter of Intent should be submitted by the PI of the lead institution. An example of the format for the one-page Letter of Intent can be viewed at: http://www.sc.doe.gov/ascr/Research/NextGen/Solicitation.html.

A response to the Letters of Intent encouraging or discouraging formal applications will be communicated to the applicants by **November 14, 2008. Formal applications will be accepted only from those encouraged to submit. No other formal applications will be considered.**

APPLICATION DUE DATE: December 17, 2008, 8:00 p.m., Eastern Time

Applications must be submitted using Grants.gov, the Funding Opportunity Announcement can be found using the CFDA Number, 81.049 or the Funding Opportunity Announcement number, **DE-PS02-08ER08-27**. Applicants must follow the instructions and use the forms provided on Grants.gov.

FOR FUTHER INFORMATION CONTACT:

The technical contact/program manager for this program is:

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SUPPLEMENTARY INFORMATION:

The emergence of distributed petascale science in DOE, characterized by supercomputers that perform quadrillions of mathematical operations per second; large science experiments that generate petabyte-scale data; and large-scale scientific collaborations that are of National and International scale, have generated the need for a new generation of networks with unprecedented capabilities. The core capabilities of these networks include: 1) the ability to deliver multi-gigabits/sec - terabits/sec throughputs to high-end science applications; 2) the capability to dynamically provision on-demand bandwidth and circuit services to a variety of science applications across federated networks; and 3) the ability to diagnose faults, and to measure, monitor, and predict end-to-end performance of federated networks.

This Notice solicits innovative basic and applied research to develop and deploy terabits network technologies in existing and new DOE network infrastructures to meet the short- and long-term needs of the emerging distributed petascale science. Prospective researchers should observe that:

- Proposed research activities should be relevant to DOE networking infrastructures by focusing on technologies that are directly applicable to the following networking infrastructures: 1) Energy Science Network (ESnet - http://www.es.net) core IP backbone network and the Science Data Network (SDN); 2) DOE laboratories LANs; and 3) end systems hosting DOE high-end applications. Applicants are strongly encouraged to contact the engineering teams of these facilities for information on using them to enhance, validate, or test concepts and technologies proposed in their applications.
- Collaborative applications involving multiple institutions, which may include: universities, laboratories, and/or private institutions, are encouraged but not required. Collaborative applications should be developed as a single unified and complete application. However, each participating institution is required to submit a formal copy of the same application. Subcontracting will not be allowed through the lead institution in a collaborative application. Additional information on preparing and submitting multi-institution applications can obtained at: http://www.sc.doe.gov/ascr/Research/NextGen.html
- No funds will be provided to Federal Laboratories and Federally Funded Research and Development Centers (FFRDCs), including the DOE National Laboratories, under this Notice. Laboratories should respond to the **LAB 08-27 Announcement** posted at: http://www.science.doe.gov/grants/grants.html.
- Researchers may request a period of performance of up to a maximum of three (3) years, subject to the availability of funds.

Technical Areas

The emerging distributed petascale science environment in DOE will require a new generation of networks with unprecedented capabilities. Achieving such capabilities will require scaling existing network technologies and developing revolutionary new protocols, tools, and services that will make end-to-end terabit networks possible. In contrast to today's networks that use best-effort IP network concepts to provide conventional networking services, it is anticipated that the next-generation of terabit networks for science will use federated hybrid (packet and circuit-switched) networking concepts to support the diverse needs of DOE science applications. In addition, it is expected that alternatives or enhanced versions of protocols, such as TCP, UDP, and IP will be needed to achieve terabits/sec throughputs. Also, new provisioning techniques that offer on-demand switched circuit services will be needed to overcome the limitations of best-effort IP networks where guaranteed bandwidths and quality of services are critical. The ability to diagnose faults and monitor and predict network performance across federated networks will also be critical. This announcement focuses on innovative and revolutionary technologies that address these challenges, especially at the terabits/sec end-to-end performance level. Particular technical areas of interest include, but are not limited to, the following:

1. ***Terabit data transfer protocols, tools, and services*****.** Advanced technologies capable of providing secure and rapid data transfers will be needed to support the distribution of petabyte-scale data generated by scientific experiments and petascale simulation. Such technologies must be easily deployable and deal effectively with the end-to-end issues of data transfers over very long distances, and securely provide terabit throughputs in a variety of scientific data transfer settings, including peer-to-peer and real-time data transfers. Other highly desirable features include: 1) dynamic reconfiguration capabilities to support different data transfer objectives such as bath, scheduled, streaming, and reservation data delivery; 2) automatic detection and use of appropriate and available transport protocols, such as (TCP-variants, UDP-variants, Fiber Channel, Infiniband, SCSI, etc.) in different data transfer scenarios; 4) data transfer utilities such as fault recovery, optional authentication services, real-time throughput monitoring, etc.; and 5) APIs to integrate data transfer protocols with host applications and workflows, including network control and management applications.

2. ***Composable transport protocols*****.** The vast majority of today's network services revolve around TCP and UDP stacks. These two widely deployed stacks converge on the use of a single IP stack. While a single IP stack simplifies network usage, it makes it difficult to develop and deploy advanced capabilities needed to support distributed petascale science applications in terabits/sec networks. Transport protocols envisioned for next-generation networks should preferably be component-based to enable different types of networking scenarios achieved by dynamically assembling protocol components that are optimized for different types of applications and layer 1-3 transport network technologies. The goal is to have composable transport protocols that can effectively deliver terabit throughput and can be dynamically reconfigured to take full advantage of today's rich variety of transport media (circuit-based DWDM, VLANs, SONET, guaranteed bandwidth, etc.). Other desired features for composable transport protocol frameworks include the following: 1) user-space and kernel-level instrumentation to collect real-time performance data; 2) modular design to facilitate composability; 3) selectable congestion control to be used only when needed; 4) variable packet lengths

with corresponding error correction capabilities; and 5) the ability to handle real-time applications.

3. *Advanced network provisioning technologies*. Innovative techniques will be needed to enable secure dynamic multi-layer end-to-end circuit-based services across federated networks. Particular network provisioning technologies of current interest are those that will use out-of-band signaling and control plane technologies to implement on-demand, reservation, and scheduled services to offer coarse- and fine-grain federated switched services. Applicants interested in this topic are encouraged to focus on technologies that are directly applicable to DOE's ESnet and Science Data Networks (http://www.es.net). The current technical areas of interest include the following: 1) extensions of existing control plane technologies such as GMPLS, MPLS, etc., to accommodate advanced scheduling, reservation, and authentication; 2) techniques to secure federated control plane networks; 3) mathematical modeling of unified control plane technologies, path computations, and traffic engineering for multi-layer and multi-domain networks offering hybrid best-effort IP and switched circuit services; and 4) secure APIs to integrated control plane and signaling systems with user applications and network monitoring systems.

4. *High-performance network interfaces*. Providing secure access and coupling distributed high-end applications to next-generation networking for science will require robust distributed systems software. Specific areas of interest include, but are not limited to, the following: 1) network-storage system interfaces to enable petascale storage systems to take full advantage of terabit network capabilities; 2) network-application interfaces to facilitate the deployment and usage of network-enabled applications; 3) network-file system services for mapping data from networks onto storage systems; 4) host systems stack enhancements that hide network complexities from users.

5. *Federated network management and monitoring*. Advanced network instrumentation services and tools will be needed to efficiently and effectively measure and predict the performance of terabit networks. These include multi-layer, end-to-end network management tools and services such as end-to-end performance prediction, fault location and diagnosis, and dynamic circuit monitoring of heterogeneous multi-domain networks. Particular technical issues of critical importance in the area include, but are not limited to, the following: 1) robust techniques based on sound principles to collect, store, analyze, and correlate network monitoring data in multi-domain networks; 2) scalable frameworks for coordinating different network monitoring policies and network measurement standards across multiple networks; 3) advanced tools and services for diagnosing faults and monitoring the performance of dynamic circuits across multiple domains; and 4) discovery services network measurement in peer networks.

More information on DOE's Next-Generation Networking for Science can found at this Website: http://www.sc.doe.gov/ascr/Research/NextGen.html.

Additional Information

As a mission-oriented agency, DOE conducts network research to support its mission objectives. As part of the application development, applicants are required to justify that their proposed research is relevant to DOE's science mission by including in the technical narrative of their application a plan to transfer the research results to DOE's network and computing infrastructure should they be successful. A network testbed facility operated by DOE's Energy Science Network (http://www.es.net) will be made available to assist researchers to develop and test prototypes resulting from successful network research projects funded under this announcement. Other arrangements to validate research prototypes not directly applicable to DOE's ESnet will be possible in National Laboratories and collaborating science facilities. Additional information on DOE networking requirement can be obtained in the following DOE networking workshop reports:

a) Workshop on Advanced Networking for Distributed Petascale Science: R&D Challenges and Opportunities. April 8-9, 2008. Report in PDF

b) Workshop on Science-Driven R&D Requirements for ESnet,
April 23-24, 2007. Report in PDF

Collaboration

Applicants are encouraged to collaborate with researchers in other institutions, such as universities, industry, non-profit organizations, federal laboratories and Federally Funded Research and Development Centers (FFRDCs), including the DOE National Laboratories, where appropriate. Additional information on collaboration is available in the Application Guide for the Office of Science Financial Assistance Program that is available via the Internet at: http://www.sc.doe.gov/production/grants/Colab.html.

Program Funding

Awards are expected to be at most $500,000 per year for multi-institution applications and $150,000 per year for single investigator applications. The funding period for all projects will be three years, subject to availability of funds. Grant applications funded under this announcement will be handled as cooperative agreements. It is anticipated that up to six multi-institution and ten single awards will be made for this announcement contingent on availability of appropriated funds in Fiscal Year 2009. 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 part, any, all, or none of the applications submitted in response to this Notice.

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
September 30, 2008.