Office of Science
Financial Assistance
Funding Opportunity Announcement
DE-FOA-0000264

High-Capacity Optical Networking and Deeply Integrated Middleware Services for Distributed Petascale Science

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 for research to address the end-to-end challenges of terabits (Tbits/s) networks and middleware based on the emerging 100 GigE (Gigabits Ethernet) technologies. The emergence of 100 GigE has opened the terabits networking era, making it possible for the aggregate capacity of backbone networks to reach Tbits/s and beyond. Innovative networking technologies will be needed to enable networks to operate efficiently Tbits/s speeds. Existing protocols, host systems stacks, network interface cards, protection and recovery mechanism, data transfer protocols, cyber security systems, network provisioning schemes, etc., may not easily scale to deliver terabits networking performance critical for DOE science mission.

Respondents will be required to address technology transfer plans to deploy and test the proposed technologies on DOE's ESnet (http://www.es.net/), and related infrastructures in national laboratories. Prospective applications are further encouraged to leverage DOE's ESnet networking resources such as the newly deployed 100 Gbits/s network demonstration in their proposed research activities.

APPLICATION DUE DATE: April 23, 2010, 11:59 p.m. Eastern Time

Formal applications submitted in response to this FOA must be received by April 23, 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-0000264&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 "High-Capacity Optical Networking and Deeply Integrated Services for Distributed Petascale

Science", 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 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.

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:

A) High-Capacity Optical Networks
Dr. Thomas Ndousse-Fetter, Program Manager
U. S. Department of Energy
Office of Advanced Scientific Computing Research

Phone: 301-903-5800
E-Mail: network_research@ascr.doe.gov

B) Deeply Integrated Middleware Services
Susan Turnbull, Program Manager
U. S. Department of Energy
Office of Advanced Scientific Computing Research
Phone: 301-903-6139
E-Mail: network_research@ascr.doe.gov

Richard Carlson, Program Manager
U. S. Department of Energy
Office of Advanced Scientific Computing Research
Phone: 301-903-9486
E-Mail: network_research@ascr.doe.gov

SUPPLEMENTARY INFORMATION:

Background:

The Office of Advanced Scientific Computing Research in DOE provides world-class leadership in developing and deploying computational and networking capabilities to analyze, model, simulate, and predict complex phenomena important to the nation. A particular challenge of ASCR is providing state-of-the-art networking technologies and novel middleware software to support extreme-scale distributed computing and large-scale experiments that generate massive data sets. DOE scientists continuously push the limits of today's Internet and are ready to explore the realm of advanced networks that can deliver a 1000 fold increase in end-to-end throughput to distribute massive data sets. Advanced network infrastructures with these capabilities will be expected to be 1) agile - to support dynamic reconfiguration needed to support a wide range of high-end applications with unique end-to-end performance requirement; 2) intelligent - to facilitate automation of middleware services to enable ease-of-use of advanced network capabilities for scientists; 3) observable and controllable - to advance end-to-end performance and fault monitoring; and 4) ultra fast - by exploring the emerging 100 Gbits/s link technologies to deliver multi-gigabit throughput to high-end data intensive applications.

A) High-Capacity Networks

High-capacity networks have emerged as critical components of modern scientific infrastructures. High-capacity networks are used to collect, store, and share the massive science data sets generated by extreme-scale computing and large-scale science experiments such the Large Hadron Collider. As these trends continue and massive science data becomes critical to scientific discoveries, networks with unprecedented end-to-end performance and agility will be needed support distributed data-intensive science activities. The current priorities that address the development, deployment, and operation of high-capacity networks for distributed data-intensive science are summarized in four technical areas described below: 1) hybrid packet/circuit-switched networks, 2) multi-

layer multi-domain dynamic provisioning, 3) 100 Gbps system-level network components and services, and 4) multi-layer multi-domain network Measurement and Monitoring. Potentials applicants interested in addressing the above networking challenging must ensure that the proposed solutions work efficiently at 100 Gbps speeds with a plan to test and validate the resulting work on DOE experimental networking infrastructures.

B) Deeply Integrated Middleware Services

Deeply integrated middleware services provide a suite of functional libraries and API's that simplify the task of creating and operating complex multi-domain network environments, and reduce the need for scientists to understand those operational details. For example, network measurement services need a mechanism to discover, and align with, the monitoring components of the intelligent network infrastructure; similarly, analysis services need to locate archived datasets. Both researchers and code developers need simple API's to build the agile services needed in these multi-domain environments. Agile middleware libraries and API's built on an appropriate abstraction framework, in turn, simplify the creation of application-specific tools and services.

To develop networks with these advanced capabilities, DOE intends to build on its advanced network demonstration prototype based on 100 Gbits/s links funded through the American Recovery and Re-investment Act (ARRA) of 2009.

This FOA solicits research and development projects to address the above challenges in four critical and high priority technical areas:

- ***Hybrid packet/circuit-switched networks*** *- A hybrid networking paradigm combines traditional packet and circuit switching concepts over a single integrated backbone network to provide differentiated network services to high-end science applications with different end-to-end networking performance requirements. Applications are sought to address (a) networking challenges of hybrid networks. These include but are not limited to the following: dynamic allocation of resources across multiple networking modes, hybrid networking traffic engineering services and inter-domain peering services, and protection and recovery mechanisms for hybrid networks. (b) middleware challenges of creating hybrid networks. These include but are not limited to the following: functions to allow the provisioning, optimization, and management of hybrid networks by science applications, functions to expose network capabilities, and functions to securely access the network control plane.*
- ***Multi-Layer Multi-Domain Dynamic Provisioning****. Recent advances in transport network technologies offers new opportunities to develop novel network services such as on-demand circuits, scheduled circuits, guaranteed end-to-end bandwidth, and network virtualization at different layers using VLANs. The realization of these capabilities will require new end-to-end network signaling and provisioning schemes beyond traditional MPLS and GMPLS. These new schemes must work effectively across multiples network layers and across different autonomous network domains. Applications are sought to (a) develop dynamic provisioning of on-demand bandwidth and circuits at different network layers, including but not limited to advanced tools for managing and monitoring network provisioning services; automated services to co-schedule application resources with*

network provisioning; technologies to extend backbone provisioning capabilities to site/campus LANs; and techniques to provide network restoration and protection to provisioned bandwidth/circuits; (b) authentication and authorization (AA) services, functions to simplify application access to higher level AA services, functions to expose provisioning capabilities, functions to allow applications to request these services, and mechanisms to automate the creation of these services.

- ***100 GE System-Level Network Components and Services***. *The deployment of the 100 GigE-based network demonstration prototype provides network researchers new opportunities to address Tbits/sec networking challenges and to support the distribution of massive science data in DOE. At these speeds, conventional networking hardware, network management tools and services, security systems, network-aware middleware, and host system stacks may not scale efficiently. Applications are sought in this technical area to develop or scale existing system-level network technologies to work efficiently with 100 GigE technologies. These include but are not limited to SANs and WANs 100 GigE- based data transfer protocols; 100GigE IDS and DPI systems, programmable network interface, host provisioning software for packets/circuit services, network-application APIs, etc. Respondents are encouraged to leverage DOE's 100 GigE network demonstration prototype in formulating their proposed research along with a plan to use the testbed for performance testing and validation.*
- ***Multi-Layer Multi-Domain Network Measurement and Monitoring***. *The ability to monitor and predict the end-to-end performance and faults in high-performance networks is critical to high-end science applications. Applications with innovative approaches to fault diagnostics, performance measurement and prediction, and related network management are sought to provide services that enable scientists to make effective use of network resources, especially at 100 Gbits/s speeds. These include but are not limited to (a) scalable and secure tools and services for end-to-end circuit monitoring; end system host software stack application environment monitoring tools; services for multi-layer inter-domain network monitoring; and services to co-schedule end-to end network monitoring with network-aware data-intensive applications; (b) statistical techniques for analyzing and visualizing network measurement data, functions to simplify access to higher level AA services, and functions to expose measurement/monitoring tools, data, and services. Respondents are encouraged to leverage the PerfSONAR framework and the DOE's 100 GigE network demonstration prototype to formulate their proposed research and to develop a plan to use these facilities for performance testing and validation.*

Additional Information

DOE operates a high-performance wide area best-effort IP backbone called ESnet (http://www.es.net/) and a switched Science Data Network (SDN) (http://www.nitrd.gov/subcommittee/lsn/jet/material/ESnet4-JET.pdf) network both operated by Lawrence Berkeley National Laboratory (http://www.lbl.gov/). The goal of this FOA is to develop advanced networking technologies that will enable the integration of ESnet and SDN capabilities into a unified backbone network infrastructure optimized for end-to-end high-throughput and operating in dual networking mode, offering best-efforts IP services and on-demand circuit services. In addition, DOE operates high-performance LANs in national

laboratories to provide scientists with access to ESnet and SDN. These state-of-the-art networking facilities, along with the recently deployed nation-wide network demonstration prototype based on the emerging 100 GigE links technologies, provide a rich environment for researchers to develop and test new networking concepts. Potential applicants are encouraged to leverage the capabilities of networking resources in ESnet and national laboratories in developing and executing their proposed research.

Reference Information:

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

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

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. Additional information on developing and submitting collaborative grant applications can be found: http://www.sc.doe.gov/ascr/Research/NextGen/guidelines.html.

Program Funding

It is anticipated that up to **$3,500,000** total will be available for awards in Fiscal Years 2010 and 2011, contingent on the availability of appropriated funds. It is expected that awards will be at most **$750,000** per year for multi-institution applications and **$175,000** per year for single investigator applications. The funding period for all projects will be three years, subject to availability of funds, progress of the research, and programmatic needs. It is anticipated that up to **three multi-institution** and **eight single** awards will be made for this.

DOE is under no obligation to pay for any costs associated with preparation or submission of pre- applications and applications. 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
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