Office of Science
Financial Assistance
Funding Opportunity Announcement

DE-FOA-0000523
Terabit Networking for Extreme-Scale Science

Office of Advanced Scientific Computing Research (ASCR)

SUMMARY: The Office of Advanced Scientific Computing Research (ASCR) in the Office of Science (SC) at the U.S. Department of Energy (DOE) hereby invites grant applications to address key challenges in developing, exploiting, or operating federated end-to-end terabit networks that support distributed extreme-scale science. ASCR contributes to the DOEs science mission by supporting leading-edge high-performance networking facilities, which provides DOE scientists and their national and international collaborators with unfettered access to scientific instruments and supercomputing facilities, and by supporting research into tools and services that enhance the use of these facilities.

A new generation of science facilities (e.g., National Synchrotron Light Source II - NSLS-II, International Thermonuclear Experimental Reactor - ITER, Large Hadron Collider - LHC, Linac Coherent Light Source - LCLS) scientific research communities using globally distributed tera/petascale class computing environments, and leading edge researchers exploiting exascale class supercomputers to simulate physical processes, will all produce and/or consume large amounts of data. The common element that enables these activities is a federated collection of high-performance networks with unprecedented end-to-end capabilities. Projections show that DOE's Energy Science Network (ESnet) will need to support Tb/sec transmission rates by the 2015-2016. While industry will supply the underlying optical technologies to build the network, DOE will need to develop and deploy the tools and services that will allow scientists to exploit this advanced infrastructure.

This Funding Opportunity Announcement (FOA) calls for innovative approaches to develop federated terabit network tools and services that address DOE's emerging network challenges. The major priorities in addressing these challenges include mechanisms that: allow hosts to create/terminate a dynamic circuit; isolate high-impact science flows from normal traffic flows; allow flows to seamlessly move between shared Internet Protocol (IP) and dynamic circuit infrastructures; allow network operators to effectively manage their part of the end-to-end path; perform fault diagnosis and performance prediction; allow flows to operate across domain boundaries; co-schedule components/resources needed by an application; and predict application behavior notifying users/administrators when it falls below a threshold. Projects supported by

this FOA may be a combination of algorithms, hardware, software, and/or radical concepts that scale beyond what can be achieved over today's infrastructure. Applications should also address how their solutions could be deployed, tested, and integrated into DOE network infrastructure.

SUPPLEMENTARY INFORMATION: The focus of this FOA is to build upon the optical network industry standards and deployed optical network infrastructure in DOE to address emerging terabit network challenges summarized above and detailed in workshop reports [1], [2], and [3]. The ultimate goal of the research activities generated by this FOA are to: 1) develop mechanisms and frameworks to develop, deploy, and operate federated multi-domain Tbps networks; 2) remove performance bottlenecks in hosts and other network attached devices; and 3) enable distributed high-end science application to fully exploit terabit networks. Although a wide range of technical issues exist in end-to-end terabit networks, current program priorities are in the following critical technical areas: a) federated terabit network services and tools, b) terabit end system technologies, and c) scalable tools and services for terabit network-aware applications.

A)   Federated terabit network services and tools – This technical topic deals with research and development of system-level tools and services that can be deployed over multi-domain terabit networks built with industry standard optical components. Research activities which make significant changes to industry standards and vendor's equipments are beyond the scope of this FOA. The current priorities for this topic include but are not limited to:

- Novel traffic engineering concepts and security frameworks that will enhance and secure DOE's On-demand Secure Circuits and Advance Reservation System (OSCARS) to support on-demand and guaranteed end-to-end circuits across federated research and education network domains.
- Advanced multi-layer and multi-domain services and tools to enable dynamic hybrid networking capabilities based on the emerging 100 Gbps link technologies.

Advanced services and tools for measuring, monitoring, modeling, and validating end-to-end performance and fault diagnosis capabilities that scale effectively to Tbps rates.

B) Terabit end system technologies – Hosts and end systems have historically introduced their own set of performance bottlenecks into end-to-end paths. Today's end systems built with multi-core technologies and parallel Input/Output (I/O) sub-systems offer a high-degree of parallelism that can be explored in solving these problems. This topic addresses the technical challenges of Local Area Networks (LANs) and end systems hosting extreme-scale science applications. Specific issues of interest include, but are not limited to:

Composable high-speed (Terabit/sec) transport protocols that can be dynamically re-configured for Storage Area Network (SANS): Remote Direct Memory Access (RDMA), Fiber Channel (FC), Internet Small Computer System Interface (iSCSI), on-demand circuits, best-effort IP, or a hybrid combination in federated networking environments,

Scalable and secure APIs (Application Programming Interfaces) and services to extend dynamic network provisioning capabilities, (e.g., OSCARS, Multi-protocol Label Switching (MPLS)/ Generalized Multi-Protocol Lambda Switching (GMPLS), OpenFlow) to end host systems or storage systems and high-end science applications),

Innovative protocols or services that hide network complexity from applications while exposing enough information to support end-to-end performance monitoring and faults diagnosis

C) Scalable tools and services for terabit network-aware applications – this technical topic addresses the fundamental challenges in tools and services that enable high-end science applications to take full advantage of terabit network capabilities. Potential technical topics of interest include, but are not limited to:

Advanced tools or services that enable distributed high-end science applications to effectively exploit terabits network capabilities, perform monitoring, fault diagnosis, or measure end-to-end performance,

Network-aware resource brokers that can discover and co-schedule network, storage, and related resources to enable the transfer of massive data sets,

Innovative performance models that can accurately describe or predict how high-end science applications perform over advanced network infrastructures.

For more information, please see the following workshop and conference reports:

[1]   Terabit networks for extreme scale science, February 16-17, 2011, Rockville, Maryland, Report (PDF)
http://science.energy.gov/ascr/~/media/ascr/pdf/programdocuments/docs/Terabit_Networks_Workshop_Report.pdf

[2]   Workshop Report on Advanced Networking for Distributed Petascale Sciences: R&D Challenges and Opportunities, April 8-9, 2008, Report (pdf)

[3]   Science Driven R&D Requirements for ESnet Workshop, April 23-24, 2007 - Report (pdf)

[4]   Networking Requirements Workshop- Office of Biological and Environmental Research, April 29-30, 2010- Report (pdf)

[5]   Networking Requirements Workshop- Office of Basic Energy Sciences - Report (pdf)

[6]   Networking Requirements Workshop- Report: Office of Fusion Energy, Conducted March 13 and 14, 2008 - Report (pdf)

[7]   ESnet Future Technology Assessment and Requirements Dynamic Bandwidth and Circuit Provisioning - Report (pdf)

[8]   ESnet On-Demand Secure Circuits and Advanced Reservation Systems Federation Networking, Report (ppt)

[9]   Multi-Layer Networking -- An Architecture Framework, Report to download (pdf)

DOE Networking Facilities Awareness

The ultimate goal of this FOA is to develop advanced networking technologies that can be integrated into DOE's network infrastructures that include ESnet (http://www.es.net/) and related supporting systems in DOE national laboratory systems. Grant applications should therefore address how they plan to collaborate with related research efforts or DOE production facilities to facilitate the adoption of their proposed technology. To facilitate this process, the DOE Advanced Network Initiative (ANI) network research testbed (https://sites.google.com/a/lbl.gov/ani-testbed/) is available to assist researchers to develop and test advanced disruptive technologies that cannot be directly deployed in production network facilities.

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 developing and submitting collaborative submissions can be found at http://www.sc.doe.gov/grants/colab.asp.

Funding

It is anticipated that up to a total of $3.7 million annually will be available for multiple awards for this program. Awards are planned to be made in Fiscal Year 2011 and may occur in FY12. The funding level for single investigator/institution is $175k and $750k for multi-institutional projects. All awards are contingent on the availability of funds 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 part, any, all, or none of the applications submitted in response to this Notice.

Merit review criteria

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 CFR 605.10(d):

a) Scientific and/or Technical Merit of the Project
b) Appropriateness of the Proposed Method or Approach
c) Competency of Applicant's Personnel and Adequacy of Proposed Resources; and
d) Reasonableness and Appropriateness of the Proposed Budget.

GENERAL INQUIRIES ABOUT THIS FOA SHOULD BE DIRECTED TO:

Technical/Scientific Program Contacts:

Dr. Thomas Ndousse-Fetter
Phone: (301) 903-9960
E-mail: Thomas.ndousse-fetter@science.doe.gov

Mr. Richard Carlson
Phone: 301-903-9486
E-mail: Richard.carlson@science.doe.gov

LETTER OF INTENT AND PREAPPLICATION.

1. **Letter of Intent.**

Letters of Intent are not required.

2. **Preapplication.**

Preapplications are not required.

APPLICATION DUE DATE: May 23, 2011, 11:59 PM Eastern Time

Formal applications submitted in response to this FOA must be received by May 23, 2011, 11:59 PM Eastern Time, to permit timely consideration of awards in Fiscal Year 2012. **You are encouraged to transmit your application well before the deadline. APPLICATIONS RECEIVED AFTER THE DEADLINE WILL NOT BE REVIEWED OR CONSIDERED FOR AWARD.**

<u>**IMPORTANT SUBMISSION INFORMATION:**</u>
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-0000523&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 "Theoretical Research in Magnetic Fusion Energy 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.

<u>Where to Submit:</u> 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.

<u>Registration Requirements:</u> 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.

Application Receipt Notices

After an application is submitted, the Authorized Organization Representative (AOR) will receive a series of four E-mails. It is extremely important that the AOR watch for and save each of the emails. It may take up to two (2) business days from application submission to receipt of email Number 2. The titles of the four E-mails are:

Number 1 - Grants.gov Submission Receipt Number
Number 2 - Grants.gov Submission Validation Receipt for Application Number
Number 3 - Grants.gov Grantor Agency Retrieval Receipt for Application Number
Number 4 - Grants.gov Agency Tracking Number Assignment for Application Number

Questions regarding the content of the Funding Opportunity Announcement (FOA) must be submitted through the FedConnect portal. You must register with FedConnect to respond as an interested party to submit questions, and to view responses to questions. It is recommended that you register as soon after release of the FOA as possible to have the benefit of all responses. More information is available at
https://www.fedconnect.net/FedConnect/PublicPages/FedConnect_Ready_Set_Go.pdf. DOE will try to respond to a question within 3 business days, unless a similar question and answer have already been posted on the website.

Modifications: Notices of any modifications to this Funding Opportunity Announcement will be posted on Grants.gov and the FedConnect portal. You can receive an email when a modification or an announcement message is posted by registering with FedConnect as an interested party for this FOA. It is recommended that you register as soon after release of the FOA as possible to ensure you receive timely notice of any modifications or other announcements. More information is available at http://www.fedconnect.net.

All applications should be in a single PDF file.