Program Announcement To DOE National Laboratories
LAB 01-06
Scientific Discovery through Advanced Computing (SciDAC): National Collaboratories and High Performance Networks

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 proposals in support of the National Collaboratories and High Performance Networks Programs which include scope supportive of the Scientific Discovery through Advanced Computing Initiative. Collaboratories link geographically dispersed researchers, data, and tools via high performance networks to enable remote access to facilities, access to large datasets, shared environments, and ease of collaboration. This announcement is focused on research and development to support DOE-specific activities in three areas: 1) high performance middleware services that include, but are not limited to, software to allow applications to adapt to changing network conditions and software that provides ease of collaboration for distributed teams; 2) innovative, high performance network research that includes, but is not limited to, high performance transport protocols, network measurement and analysis, and traffic engineering tools and services which are focused on improving the end-to-end performance for data intensive scientific applications; and 3) collaboratories to test and validate the enabling technologies for discipline-specific applications. Collaborations across organizations that include networking researchers, middleware developers and discipline-specific scientists are encouraged.

Background: Scientific Discovery Through Advanced Computing

Advanced scientific computing will be a key contributor to scientific research in the 21st Century. Within the Office of Science (SC), scientific computing programs and facilities are already essential to progress in many areas of research critical to the nation. Major scientific challenges exist in all SC research programs that can best be addressed through advances in scientific supercomputing-designing materials with selected properties, elucidating the structure and function of proteins, understanding and controlling plasma turbulence, and designing new particle accelerators. To help ensure its missions are met, SC is bringing together advanced scientific computing and scientific research in an integrated program entitled "Scientific Discovery Through Advanced Computing."

The Opportunity and the Challenge

Extraordinary advances in computing technology in the past decade have set the stage for a major advance in scientific computing. Within the next five to ten years,

computers 1,000 times faster than today's computers will become available. These advances herald a new era in scientific computing. Using such computers, it will be possible to dramatically extend our exploration of the fundamental processes of nature (e.g., the structure of matter from the most elementary particles to the building blocks of life) as well as advance our ability to predict the behavior of a broad range of complex natural and engineered systems (e.g., the earth's climate or an automobile engine).

To exploit this opportunity, these computing advances must be translated into corresponding increases in the performance of the scientific codes used to model physical, chemical, and biological systems. *This is a daunting problem.* Current advances in computing technology are being driven by market forces in the commercial sector, not by scientific computing. Harnessing commercial computing technology for scientific research poses problems unlike those encountered in previous supercomputers, in magnitude as well as in kind. As noted in the 1998 report (See Footnote Number 1) from the NSF/DOE "National Workshop on Advanced Scientific Computing" and the 1999 report (See Footnote Number 2) from the President's Information Technology Advisory Committee, this problem will only be solved by increasing investments in *computer software* - in research and development on scientific simulation codes as well as on the mathematical and computing systems software that underlie these codes.

Investment Plan of the Office of Science

To meet the challenge posed by the new generation of terascale computers, SC will fund a set of coordinated investments in the long plan for scientific computing, *Scientific Discovery through Advanced Computing*, (See Footnote Number 3) submitted to Congress on March 30, 2000. First, it will create a *Scientific Computing Software Infrastructure* that bridges the gap between the advanced computing technologies being developed by the computer industry and the scientific research programs sponsored by the Office of Science. Specifically, the SC effort proposes to:

- Create a new generation of *Scientific Simulation Codes* that take full advantage of the extraordinary computing capabilities of terascale computers.
- Create the *Mathematical and Computing Systems Software* to enable the Scientific Simulation Codes to effectively and efficiently use terascale computers.
- Create a *Collaboratory Software Environment* to enable geographically separated scientists to effectively work together as a team and to facilitate remote access to both facilities and data.

These activities are supported by a *Scientific Computing Hardware Infrastructure* that has been tailored to meet the needs of its research programs. The *Hardware*

Infrastructure is *robust*, to provide the stable computing resources needed by the scientific applications; *agile*, to respond to innovative advances in computer technology that impact scientific computing; and *flexible*, to allow the most appropriate and economical resources to be used to solve each class of problems. Specifically, the SC proposes to support:

- A *Flagship Computing Facility*, the National Energy Research Scientific Computing Center (NERSC), to provide the robust, high-end computing resources needed by a broad range of scientific research programs.
- *Topical Computing Facilities* to provide computing resources tailored for specific scientific applications and to serve as the focal point for an application community as it strives to optimize its use of terascale computers.
- *Experimental Computing Facilities* to assess the promise of new computing technologies being developed by the computer industry for scientific applications.

Both sets of investments will create exciting opportunities for teams of researchers from laboratories and universities to create new revolutionary computing capabilities for scientific discovery.

The Benefits

The *Scientific Computing Software Infrastructure*, along with the upgrades to the hardware infrastructure, will enable laboratory and university researchers to solve the most challenging scientific problems faced by the Office of Science at a level of accuracy and detail never before achieved. These developments will have significant benefit to all of the government agencies who rely on high-performance scientific computing to achieve their mission goals as well as to the U.S. high-performance computing industry.

Background: National Collaboratories and High Performance Networks

The current core programs in ASCR are intended to enhance the Department's ability to satisfy mission requirements through advanced technologies such as distributed computing, national collaboratories, high performance networks, remote access to facilities, and remote access to petabyte-scale datasets with complex internal structure. Within this context, the National Collaboratories and High Performance Networks Programs provide a coordinated program of technology research and development that leverages the strengths of computer and computational science research programs and partners with science application pilot projects. Likewise, these programs support the Scientific Discovery through Advanced Computing by enabling integration of multi-institutional, geographically-dispersed researcher into effective, efficient teams and by

providing distributed computing environments and tools to support the use of remote computers and access to data and facilities.

Advances in high performance network capabilities and collaboration technologies are making it easier for large geographically dispersed teams to collaborate effectively. This is especially important for the teams using the major computational resources, data resources, and experimental facilities supported by DOE. With leadership from DOE, these geographically distributed laboratories or collaboratories have begun to play an important role in the Nation's scientific enterprise. The importance of collaboratories is expected to increase in the future. However, significant research questions must be addressed if collaboratories are to achieve their potential: namely, to enable remote access facilities that produce petabytes/year; to provide remote users an experience that approaches the same as "being there;" to provide remote visualization of terabyte to petabyte data sets from computational simulation; and to enable effective remote access to advanced scientific computers.

Solving the challenging network and distributed computing problems calls for new modalities of scientific research. Many scientific applications when deployed on existing networks fail to meet the end-to-end expectations for performance. This is especially true for distributed high-end applications such as remote visualization and high capacity data transfer. Recent advances in optical networks brought about by Dense Wave Division Multiplexing (DWDM) is resulting in unprecedented increases for bandwidth in the core networks. However, many challenging protocol engineering, traffic engineering, and high-performance middleware problems must be addressed before complex scientific high-end applications and collaboratories can benefit from this increase in bandwidth. Harnessing this bandwidth at the application level poses some important and challenging problems

Research is needed to understand what services collaboratories require and how these services should be integrated with the large number of network devices and network-attached devices that must work together. Examples of the components and services that need to be integrated include: data archives on tape, high performance disk caches, visualization and data analysis servers, authentication and security services, directory services, network resources, and computational systems including the computer on a scientist's desk. All of these physical and software services must be tied together by common software framework building blocks or "middleware" to enable the collaboratories of the future to succeed.

Further, at the network level, research is needed for advanced services to develop advanced network services and tools to deliver high end-to-end performance to distributed scientific applications. There are several areas that can contribute to improving the end-to-end performance for secure multi-gigabits/sec transport that

some of DOE's advanced scientific applications require. These include enhancement of existing transport protocols, the development of accurate measurement and analysis techniques and the network services that can provide online performance predictions.

These challenges will be addressed through an integrated program of fundamental research in high performance networking and collaboratory technologies in partnership with key scientific disciplines that provide the applications--the research may be focused for short-term results (within three years) or long term (five-years and greater). This announcement seeks applications in three areas:

1. Middleware: research and development projects that will address individual technology elements to enable universal, ubiquitous, easy access to remote resources or that will contribute to the ease with which distributed teams work together. Enabling high performance for scientific applications is an important consideration.
2. Collaboratory Pilots: research and development of enabling technologies that is integrated with and required by distributed scientific applications. An example of such a distributed application is the real-time data acquisition, reduction and visualization for macromolecular crystallography using a high intensity X-ray light source facility remotely. Another distributed application could be an extensive network measurement and analysis infrastructure employed to diagnose and predict end-to-end performance.
3. High Performance Network Engineering: research, development, and testing of advanced network protocols, traffic engineering, and network services that can significantly improve capabilities, end-to-end performance, and controllability of networks infrastructures designed to support distributed scientific applications.

To the extent that software and/or infrastructure development is involved, all proposals in response to this announcement should address the issues that characterize a successful research lifecycle. That is, technology transfer strategies should be provided for the transition of research code and/or infrastructure into robust production. Long term software evolution and maintenance and end user support should also be considered.

Integration of work efforts across all projects funded under this notice will occur following the awards, to preclude duplication of effort and to maximize leveraging and coordination. Projects are expected to work closely with other SciDAC teams, where identified during this integration. Coordination through a participatory management process will continue for the life of the projects.

(See http://doecollaboratory.pnl.gov/ for a list of currently funded projects in National Collaboratories and background of the program that began as the DOE 2000 Initiative. See http://www.er.doe.gov/production/octr/mics/network_research for background on the High Performance Networks Program.)

Solicitation Emphasis Areas

1. Middleware technology research and development projects are to have certain characteristics. Products of this research and development are expected to provide services that interoperate and feature common interfaces. It should be easy to learn and use the tools. Proposals in response to this announcement should delineate an effective strategy for coupling with requirements from the scientific applications of the potential collaboratories. Proposals in response to this announcement should also provide a plan for software maintenance and support.

Middleware technology research and development projects that enable collaboration may focus on providing a broad set of tools or toolkits to support, but are not limited to, the following areas of interest

- Collaborative Visualization
- Collaborative Problem Solving Environments
- Real-time Analysis
- Group Collaboration
- Data Management
- Science Portals
- On-line Instrumentation
- Data Grids

In addition, middleware technology research and development projects may address standard services and protocols that are needed to enable persistent, universal, and ubiquitous access to networked resources, such as, but are not limited to the following:

- Directory Services
- Authentication/Authorization Services
- Co-scheduling Distributed Resources
- Multicast and efficient broadcast capabilities
- Automatic resource discovery protocols
- Remote data access services
- Network-attached memory and storage systems
- Communications services

For middleware technology research and development projects, it is estimated that between four and eight awards could be made in FY 2001, contingent upon the availability of appropriated funds. The scope of a single-focus project is expected to range from $150K to $500K.

2. Collaboratory pilots should have certain characteristics. The project should

- address a problem of national scientific or engineering significance clearly related to the mission of DOE and have high visibility.
- involve geographically separated groups of personnel and/or facilities that are inherently required to collaborate or be used remotely for success of the project. The project may
- focus on developing and providing a set of middleware services needed by a broad set of applications requiring distributed computing capabilities.
- focus solely on advanced network development and testing such as a measurement and analysis infrastructure to accurately measure, calibrate, diagnose performance related problems, and predict the end-to-end performance of operational high-speed networks.

All responses to this notice must provide a plan for transition to sustaining activities and services for end users on completion of the project. The scope of a collaboratory pilot is expected to be about $0.5M to $2.5M total per year. This is the total for all the institutions participating and it is expected that a single institution would be funded at a level of no more than $600K. It is estimated that three to five awards will be made for this area during FY 2001.

It is also possible for middleware technology research and development projects and/or collaboratory pilots to address an element for evaluating systems and their impact on the process of science, namely identifying factors that facilitate or impede the adoption of technology.

3. High Performance Network Engineering is key to the DOE vision of collaborative scientific research environments in which geographically distributed research teams and computing resources are interconnected to form a virtual computing research environment. Emerging high-end scientific applications, when deployed on existing networks, fail to meet the expected end-to-end performance, latency, security, and guaranteed quality of service required for complex scientific investigations. The high-performance network program addresses these challenges in the current announcement by focusing in three major research areas of high performance network engineering:

- Network Measurement and Analysis: Focuses on the fundamental issues of end-to-end performance through measurement and analysis.
- High-performance Transport Protocols: Addresses the performance and security enhancement issues of traditional protocols operating in high-speed, high-performance networks.

- Advanced Traffic Engineering Tools And Services: Deals with advanced tools and service for managing, differentiating, and controlling network traffic in order to satisfy the end-to-end performance objectives.

(a) *Network Measurement and Analysis:* Proposals may address innovative scalable network measurement and analysis infrastructures, tools, services, etc., that can be used to accurately measure, calibrate, diagnose performance related problems, and predict the end-to-end performance of operational high-speed network networks. This may involve passive and active measurement, SNMP derived data, or a combination and may include, but not be limited to, the following:

- Bandwidth estimation techniques for high-speed links (OC-12, OC-48)
- Measurement infrastructures to collect, store, and analyze traffic traces
- Distributed agent architecture for network measurement and analysis
- On-line analysis and data mining of measured data
- Dynamic end-to-end path selection based on online analysis
- Measurement and calibration of transport protocol performance

Proposals focusing on measurement and analysis infrastructures are expected to work in close collaboration with DOE's Energy Science Network (ESnet) in the deployment of measurement facilities. A network research testbed facility has been established, with the cooperation of ESnet, for experimental network research activities. Researchers requiring the use of this experimental facility are encouraged to work closely with the ESnet Research Support Subcommittee (ESRSC) chartered to coordinate the activities of the testbed. A complete description of this experimental facility can be found at http://www.es.net.

(b) *High-Performance Transport Protocols:* The performance expectation for the delivery of multi-gigabits/sec throughput to distributed scientific applications far exceeds the capability of current networks. This performance expectation raises some fundamental questions concerning the capability of conventional routing protocols optimized for low-speed, best-effort traffic. The current announcement addresses transport protocol performance issues by seeking innovative approaches that may include, but are not be limited to, the following:

- Transport protocol measurement, tuning, and calibration tools
- Adaptive extensions of transport protocols for high-speed networks
- High-performance network traffic characterization
- Transport protocol parallelization at high-speed

The objective is to reduce the contribution of transport protocol on end-to-end congestion. Potential applications must provide a sound mathematical analysis of the

proposed enhancements when subjected to high-end scientific applications that potentially exercise its important features.

(c) *Advanced Traffic Engineering Tools and Services:* Addresses the resource and performance optimization of high-performance and high-speed networks, including advanced traffic management and control strategies, services, and tools that can be used for traffic differentiation and for steering traffic. Applications may focus on, but are not limited to, the following:

- QoS-based routing and source routing
- Dynamic routing and traffic control
- Congestion notification and avoidance
- Bandwidth brokering services
- Advanced traffic management tools and services
- Simulation of large traffic flows

Proposals addressing these and other related issues should concentrate on those activities that lead to a significant improvement in end-to-end performance of applications running across high performance networks.

The high-performance network research program anticipates funding projects in these three areas in FY 2001. It should also be noted that a collaboratory pilot (as discussed under section 2.) may focus solely on advanced network development and testing such as a measurement and analysis infrastructure to accurately measure, calibrate, diagnose performance related problems, and predict the end-to-end performance of operational high-speed networks. The scope of a single project is expected to range from $150K to $500K.

Preproposals

Potential proposers are strongly encouraged to submit a brief preproposal that consists of two to three pages of narrative describing the research objectives and technical approach(s). Preproposals will be reviewed relative to the scope and research needs of the ASCR National Collaboratories and High Performance Networks Programs, as outlined above. The preproposal should identify, on the cover sheet, the title of the project, the institution, principal investigator name, telephone, fax, and e-mail address. The focus element (Middleware Technology, Collaboratory Pilots, or High Performance Network Engineering) for the preproposal should also be clearly identified. A response to each preproposal discussing the potential programmatic relevance of a formal proposal will be communicated to the Principal Investigator within 7 to 14 days of receipt.

Program Funding

It is anticipated that up to $9 million will be available for all National Collaboratories and High Performance Networks Programs awards in Fiscal Year 2001; from ten to as many as fifteen awards are anticipated, contingent on availability of appropriated funds in FY 2001 and the size of the awards. Multiple year funding is expected, also contingent on availability of funds and progress of the research.

Awards are expected to be at most $500,000 per year for individual middleware technology and network engineering R&D projects. Awards for collaboratory pilots are expected to be at most $2.5 million per year. Since pilots are expected to be multi-institution projects, awards under this notice would range from $200,000 to $600,000 for participation in a pilot. The term for projects can be from one to three years.

DATES: Preproposals referencing Program Announcement LAB 01-06 should be received by January 31, 2001. Formal proposals in response to this announcement should be received by 4:30 p.m., E.S.T., March 15, 2001, to be accepted for merit review and funding in FY 2001.

ADDRESSES: Preproposals referencing Program Announcement LAB 01-06 should be sent via e-mail using the following address: preapplications@er.doe.gov.

Formal proposals referencing Program Announcement LAB 01-06, should be forwarded to: U.S. Department of Energy, Office of Science, Office of Advanced Scientific Computational Research, ATTN: Program Announcement LAB 01-06, 19901 Germantown Road, Germantown, MD 20874-1290. This address must be used when submitting proposals by U.S. Postal Service Express Mail or any commercial mail delivery service, or when hand-carried by the proposer.

FOR FURTHER INFORMATION CONTACT:

For further information on this announcement contact:

National Collaboratories: Dr. Mary Anne Scott, Office of Advanced Scientific Computing Research, SC-31, Office of Science, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874-1290, telephone: (301) 903-6368, e-mail: scott@er.doe.gov.

High Performance Networks: Dr. Thomas D. Ndousse, Office of Advanced Scientific Computing Research, SC-31, Office of Science, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874-1290, telephone: (301) 903-9960, e-mail: tndousse@er.doe.gov.

Submission Information

The Project Description must be 20 pages or less, exclusive of attachments. It must contain an abstract or project summary on a separate page with the name of the proposer, mailing address, phone FAX and E-mail listed. The proposal must include letters of intent from collaborators (briefly describing the intended contribution of each to the research), and short curriculum vitaes for the proposer and any co-PIs.

The instructions and format described below should be followed. Reference Program Announcement LAB 01-06 on all submissions and inquiries about this program.

OFFICE OF SCIENCE
GUIDE FOR PREPARATION OF SCIENTIFIC/TECHNICAL PROPOSALS TO BE SUBMITTED BY NATIONAL LABORATORIES

Proposals from National Laboratories submitted to the Office of Science (SC) as a result of this program announcement will follow the Department of Energy Field Work Proposal process with additional information requested to allow for scientific/technical merit review. The following guidelines for content and format are intended to facilitate an understanding of the requirements necessary for SC to conduct a merit review of a proposal. Please follow the guidelines carefully, as deviations could be cause for declination of a proposal without merit review.

1. Evaluation Criteria

Proposals will be subjected to formal merit review (peer review) and will be evaluated against the following criteria which are listed in descending order of importance:

Scientific and/or technical merit of the project
Appropriateness of the proposed method or approach
Competency of the personnel and adequacy of the proposed resources
Reasonableness and appropriateness of the proposed budget

The evaluation under the first item, Scientific and/or Technical Merit of the Project, will also consider the following elements:
a) The potential of the proposed project to make a significant impact in the effectiveness of SciDAC applications researchers.
b) The degree to which an application area can benefit from collaborative technology.
c) The extent to which the project will test important collaborative technologies.
d) The extent to which the results of the project are extensible to other program or discipline areas.
The evaluation under the second item, Appropriateness of the Proposed Method or Approach, will also consider the following elements:

a) The degree to which the project adheres to the management philosophy of incorporating collaboration into the project execution.
b) The quality of the plan for ensuring interoperability and integration with software produced by other SciDAC efforts.
c) The extent to which the project incorporates broad community (industry/academia/other federal programs) interaction.
d) Quality and clarity of proposed work schedule and deliverables.
e) Knowledge of and coupling to previous efforts for collaborative technologies such as DOE 2000.
The evaluation will include program policy factors such as the relevance of the proposed research to the terms of the announcement, the uniqueness of the proposer's capabilities, and demonstrated usefulness of the research for proposals in other DOE Program Offices as evidenced by a history of programmatic support directly related to the proposed work.

2. Summary of Proposal Contents

Field Work Proposal (FWP) Format (Reference DOE Order 5700.7C)
Proposal Cover Page
Table of Contents
Abstract
Narrative
Literature Cited
Budget and Budget Explanation
Other support of investigators
Biographical Sketches
Description of facilities and resources
Appendix

2.1 Number of Copies to Submit

An original and seven copies of the formal proposal/FWP must be submitted.

3. Detailed Contents of the Proposal

Proposals must be readily legible, when photocopied, and must conform to the following three requirements: the height of the letters must be no smaller than 10 point with at least 2 points of spacing between lines (leading); the type density must average no more than 17 characters per inch; the margins must be at least one-half inch on all sides. Figures, charts, tables, figure legends, etc., may include type smaller than these requirements so long as they are still fully legible.

3.1 Field Work Proposal Format (Reference DOE Order 5700.7C)

The Field Work Proposal (FWP) is to be prepared and submitted consistent with policies of the investigator's laboratory and the local DOE Operations Office. Additional information is also requested to allow for scientific/technical merit review. Laboratories may submit proposals directly to the SC Program office listed above. A copy should also be provided to the appropriate DOE operations office.

3.2 Proposal Cover Page

The following proposal cover page information may be placed on plain paper. No form is required.

Title of proposed project
SC Program announcement title
Name of laboratory
Name of principal investigator (PI)
Position title of PI
Mailing address of PI
Telephone of PI
Fax number of PI
Electronic mail address of PI
Name of official signing for laboratory*
Title of official
Fax number of official
Telephone of official
Electronic mail address of official
Requested funding for each year; total request
Use of human subjects in proposed project:
If activities involving human subjects are not planned at any time during the proposed project period, state "No"; otherwise state "Yes", provide the IRB Approval date and Assurance of Compliance Number and include all necessary information with the proposal should human subjects be involved.
Use of vertebrate animals in proposed project:
If activities involving vertebrate animals are not planned at any time during this project, state "No"; otherwise state "Yes" and provide the IACUC Approval date and Animal Welfare Assurance number from NIH and include all necessary information with the proposal.
Signature of PI, date of signature
Signature of official, date of signature*
*The signature certifies that personnel and facilities are available as stated in the proposal, if the project is funded.

3.3 Table of Contents

Provide the initial page number for each of the sections of the proposal. Number pages consecutively at the bottom of each page throughout the proposal. Start each major section at the top of a new page. Do not use unnumbered pages and do not use suffices, such as 5a, 5b.

3.4 Abstract

Provide an abstract of no more than 250 words. Give the broad, long-term objectives and what the specific research proposed is intended to accomplish. State the hypotheses to be tested. Indicate how the proposed research addresses the SC scientific/technical area specifically described in this announcement.

3.5 Narrative

The narrative comprises the research plan for the project and is limited to 25 pages. It should contain the following subsections:

Background and Significance: Briefly sketch the background leading to the present proposal, critically evaluate existing knowledge, and specifically identify the gaps which the project is intended to fill. State concisely the importance of the research described in the proposal. Explain the relevance of the project to the research needs identified by the Office of Science. Include references to relevant published literature, both to work of the investigators and to work done by other researchers.

Preliminary Studies: Use this section to provide an account of any preliminary studies that may be pertinent to the proposal. Include any other information that will help to establish the experience and competence of the investigators to pursue the proposed project. References to appropriate publications and manuscripts submitted or accepted for publication may be included.

Research Design and Methods: Describe the research design and the procedures to be used to accomplish the specific aims of the project. Describe new techniques and methodologies and explain the advantages over existing techniques and methodologies. As part of this section, provide a tentative sequence or timetable for the project.

Subcontract or Consortium Arrangements: If any portion of the project described under "Research Design and Methods" is to be done in collaboration with another institution, provide information on the institution and why it is to do the specific component of the project. Further information on any such arrangements is to be given in the sections "Budget and Budget Explanation", "Biographical Sketches", and "Description of Facilities and Resources".

3.6 Literature Cited

List all references cited in the narrative. Limit citations to current literature relevant to the proposed research. Information about each reference should be sufficient for it to be located by a reviewer of the proposal.

3.7 Budget and Budget Explanation

A detailed budget is required for the entire project period, which normally will be three years, and for each fiscal year. It is preferred that DOE's budget page, Form 4620.1 be used for providing budget information*. Modifications of categories are permissible to comply with institutional practices, for example with regard to overhead costs.

A written justification of each budget item is to follow the budget pages. For personnel this should take the form of a one-sentence statement of the role of the person in the project. Provide a detailed justification of the need for each item of permanent equipment. Explain each of the other direct costs in sufficient detail for reviewers to be able to judge the appropriateness of the amount requested.

Further instructions regarding the budget are given in section 4 of this guide.
* Form 4620.1 is available at web site:
http://www.sc.doe.gov/production/grants/forms.html

3.8 Other Support of Investigators

Other support is defined as all financial resources, whether Federal, non-Federal, commercial or institutional, available in direct support of an individual's research endeavors. Information on active and pending other support is required for all senior personnel, including investigators at collaborating institutions to be funded by a subcontract. For each item of other support, give the organization or agency, inclusive dates of the project or proposed project, annual funding, and level of effort devoted to the project.

3.9 Biographical Sketches

This information is required for senior personnel at the laboratory submitting the proposal and at all subcontracting institutions. The biographical sketch is limited to a maximum of two pages for each investigator.

3.10 Description of Facilities and Resources

Describe briefly the facilities to be used for the conduct of the proposed research. Indicate the performance sites and describe pertinent capabilities, including support facilities (such as machine shops) that will be used during the project. List the most important equipment items already available for the project and their pertinent capabilities. Include this information for each subcontracting institution, if any.

3.11 Appendix

Include collated sets of all appendix materials with each copy of the proposal. Do not use the appendix to circumvent the page limitations of the proposal. Information should be included that may not be easily accessible to a reviewer. Reviewers are not required to consider information in the Appendix, only that in the body of the proposal. Reviewers may not have time to read extensive appendix materials with the same care as they will read the proposal proper. The appendix may contain the following items: up to five publications, manuscripts (accepted for publication), abstracts, patents, or other printed materials directly relevant to this project, but not generally available to the scientific community; and letters from investigators at other institutions stating their agreement to participate in the project (do not include letters of endorsement of the project).

4. Detailed Instructions for the Budget

(DOE Form 4620.1 "Budget Page" may be used)

4.1 Salaries and Wages List the names of the principal investigator and other key personnel and the estimated number of person-months for which DOE funding is requested. Proposers should list the number of postdoctoral associates and other professional positions included in the proposal and indicate the number of full-time-equivalent (FTE) person-months and rate of pay (hourly, monthly or annually). For graduate and undergraduate students and all other personnel categories such as secretarial, clerical, technical, etc., show the total number of people needed in each job title and total salaries needed. Salaries requested must be consistent with the institution's regular practices. The budget explanation should define concisely the role of each position in the overall project.

4.2 Equipment

DOE defines equipment as "an item of tangible personal property that has a useful life of more than two years and an acquisition cost of $5000 or more." Special purpose equipment means equipment which is used only for research, scientific or other technical activities. Items of needed equipment should be individually listed by description and estimated cost, including tax, and adequately justified. Allowable items ordinarily will be limited to scientific equipment that is not already available for

the conduct of the work. General purpose office equipment normally will not be considered eligible for support.

4.3 Domestic Travel

The type and extent of travel and its relation to the research should be specified. Funds may be requested for attendance at meetings and conferences, other travel associated with the work and subsistence. In order to qualify for support, attendance at meetings or conferences must enhance the investigator's capability to perform the research, plan extensions of it, or disseminate its results. Consultant's travel costs also may be requested.

4.4 Foreign Travel

Foreign travel is any travel outside Canada and the United States and its territories and possessions. Foreign travel may be approved only if it is directly related to project objectives.

4.5 Other Direct Costs

The budget should itemize other anticipated direct costs not included under the headings above, including materials and supplies, publication costs, computer services, and consultant services (which are discussed below). Other examples are: aircraft rental, space rental at research establishments away from the institution, minor building alterations, service charges, and fabrication of equipment or systems not available off-the-shelf. Reference books and periodicals may be charged to the project only if they are specifically related to the research.

a. Materials and Supplies

The budget should indicate in general terms the type of required expendable materials and supplies with their estimated costs. The breakdown should be more detailed when the cost is substantial.

b. Publication Costs/Page Charges

The budget may request funds for the costs of preparing and publishing the results of research, including costs of reports, reprints page charges, or other journal costs (except costs for prior or early publication), and necessary illustrations.

c. Consultant Services

Anticipated consultant services should be justified and information furnished on each individual's expertise, primary organizational affiliation, daily compensation rate and number of days expected service. Consultant's travel costs should be listed separately under travel in the budget.

d. Computer Services

The cost of computer services, including computer-based retrieval of scientific and technical information, may be requested. A justification based on the established computer service rates should be included.

e. Subcontracts

Subcontracts should be listed so that they can be properly evaluated. There should be an anticipated cost and an explanation of that cost for each subcontract. The total amount of each subcontract should also appear as a budget item.

4.6 Indirect Costs

Explain the basis for each overhead and indirect cost. Include the current rates.

FOOTNOTES:

1) This workshop was sponsored by the National Science Foundation and the Department of Energy and hosted by the National Academy of Sciences on July 30-31, 1998. Copies of the report may be obtained from: http://www.er.doe.gov/production/octr/mics/index.html

2) Copies of the PITAC report may be obtained from: http://www.ccic.gov/ac/report/.

3) Copies of the SC computing plan, Scientific Discovery through Advanced Computing, can be downloaded from the SC website at: http://www.sc.doe.gov/production/octr/index.html.