

Towards a Leadership-Class Computing Facility - Phase 1

PROGRAM SOLICITATION

NSF 17-558



National Science Foundation

Directorate for Computer & Information Science & Engineering
Office of Advanced Cyberinfrastructure

Letter of Intent Due Date(s) (required) (due by 5 p.m. submitter's local time):

July 14, 2017

Full Proposal Deadline(s) (due by 5 p.m. submitter's local time):

November 20, 2017

IMPORTANT INFORMATION AND REVISION NOTES

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 17-1), which is effective for proposals submitted, or due, on or after January 30, 2017.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Towards a Leadership-Class Computing Facility - Phase 1

Synopsis of Program:

NSF invites proposals for the acquisition and deployment of a High Performance Computing (HPC) system, called the Phase 1 system, with the option of a possible future upgrade to a leadership-class computing facility. The Phase 1 system will serve two important and complementary purposes:

1. It will serve as a robust, well-balanced, and forward-looking computational asset for a broad range of research topics for which advances in fundamental understanding require the most extreme computational and data analysis capabilities; and
2. It will serve as an evaluation platform for testing and demonstrating the feasibility of an upgrade to a leadership-class facility five years following deployment.

A competitive proposal in response to this solicitation will have the following five characteristics:

1. A detailed acquisition plan for deploying a reliable and well-balanced HPC system with at least two- to three-fold time-to-solution performance improvement over the current state of the art, the University of Illinois at Urbana-Champaign's (UIUC) [Blue Waters](#) system, for a broad range of existing and emerging computational and data intensive applications;
2. A thorough operations plan for the Phase 1 system to ensure that it will serve as an effective computational tool for the broad scientific and engineering community, and for the Nation at large;
3. A detailed three- to five-year project plan for scientific and technical evaluation of the Phase 1 system that will lead to an upgrade design of a leadership-class system, called the Phase 2 system, as well as the physical facility that will host it: the Phase 2 system is expected to have a ten-fold or more time-to-solution performance improvement over the Phase 1 system;
4. Clear and compelling science and engineering use cases, as well as detailed strategic project goals for a leadership-class computing facility; and
5. A persuasive articulation of educational and industry outreach, and the achievement of other broader societal impact goals, in the long-term strategic plan for the leadership-class computing facility.

Note that the award of a Phase 1 system does not imply any commitment beyond support for beginning the initial planning process for a leadership-class computing facility. The facility planning process may be terminated at any

time if satisfactory progress is not demonstrated through annual reviews.

Cognizant Program Officer(s):

Please note that the following information is current at the time of publishing. See program website for any updates to the points of contact.

- Edward Walker, Program Director, CISE/ACI, 1160, telephone: (703) 292-4863, email: edwalker@nsf.gov

Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.070 --- Computer and Information Science and Engineering

Award Information

Anticipated Type of Award: Cooperative Agreement

Estimated Number of Awards: 1

Anticipated Funding Amount: \$60,000,000

A total of \$60,000,000 in FY 2018 will be used to fund one award, subject to the availability of funds. At least 95% of the proposal amount should be for the system acquisition cost.

Following system acceptance, user support and operating costs are *expected* to be an additional 20% of the acquisition cost annually and, if approved, are anticipated to be made available as a separate funding action. Should the proposed resource require *additional* user and operating funds, an additional 5% of the acquisition cost can be requested but the proposal must provide strong justification for such a request. Again, if approved, these costs will be provided as a separate funding action.

Up to \$2,000,000 in additional funds are anticipated to be available in FY 2019 as a separate funding action for the planning activities associated with the *conceptual design phase* for Phase 2 of the award.

Note that this solicitation requests proposals for the acquisition and operation of a Phase 1 system as well as a project plan for the design of a potential upgrade or replacement to a leadership-class computing facility at the end of the five-year deployment period, subject to the availability of funds. Support for subsequent *preliminary design* and *final design* phases for Phase 2 will be provided in separate funding actions.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in, the US acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.

Who May Serve as PI:

No specific eligibility description

Limit on Number of Proposals per Organization: 1

An organization may submit only one proposal but may be identified as sub-awardee on other proposals responding to this solicitation. The restriction to no more than one submitted proposal as lead institution is to help ensure that there is appropriate institutional commitment necessary for responsible oversight, by the potential awardee institution, of a national resource.

Collaborative projects may **only** be submitted as a single proposal in which a single award is being requested. The involvement of partner organizations should be supported through sub-awards administered by the submitting organization.

Limit on Number of Proposals per PI or Co-PI: 1

An individual may be the PI or co-PI on no more than one proposal that responds to this solicitation. There is no limit on the number of proposals with which an individual may be associated in other capacities.

These eligibility constraints will be strictly enforced in order to treat all proposers fairly and consistently. In the event that an individual proposal submission exceeds the above limits, the proposal received within the limits will be accepted based on the earliest date and time of proposal submission (i.e., the first proposal received will be accepted and the remainder will be returned without review). **No exceptions will be made.**

Additionally, PIs or co-PIs are expected to commit at least 50% time to this activity.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Submission of Letters of Intent is required. Please see the full text of this solicitation for further information.
- **Preliminary Proposal Submission:** Not required
- **Full Proposals:**
 - Full Proposals submitted via FastLane: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
 - Full Proposals submitted via Grants.gov: *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov* guidelines apply (Note: The *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide).

B. Budgetary Information

- **Cost Sharing Requirements:**

Inclusion of voluntary committed cost sharing is prohibited.
- **Indirect Cost (F&A) Limitations:**

Not Applicable
- **Other Budgetary Limitations:**

Other budgetary limitations apply. Please see the full text of this solicitation for further information.

C. Due Dates

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. submitter's local time):

July 14, 2017
- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

November 20, 2017

Proposal Review Information Criteria

Merit Review Criteria:

National Science Board approved criteria. Additional merit review considerations apply. Please see the full text of this solicitation for further information.

Award Administration Information

Award Conditions:

Additional award conditions apply. Please see the full text of this solicitation for further information.

Reporting Requirements:

Additional reporting requirements apply. Please see the full text of this solicitation for further information.

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I. INTRODUCTION

Today's research discoveries are enabled by computer simulation and data analysis. Traditional empirical and theoretical paradigms in the scientific discovery process are frequently augmented by the use of computers at all scales. In addition, computer simulation and data analysis are increasingly embedded in dynamic workflows incorporating voluminous information from instruments and sensors to facilitate new scientific and engineering insights. From understanding the formation of the early universe to the atomic-scale exploration of biomolecular processes, the use of computer simulation and data analysis is now an integral part of a scientist's and/or engineer's toolkit for exploration and discovery.

With wide adoption of this new modality of scientific and engineering discovery, the demand for computational resources at all scales has increased exponentially over the past two decades – both in terms of capability and capacity. This demand has been satisfied by increasingly powerful device technologies following “Moore's Law” as well as by continually evolving processor architecture, memory, interconnect, and input/output (I/O) technologies. Scientists and engineers demanding the highest computational capabilities explore new methods and algorithms, while constantly adapting to rapid technological evolution. Visibility into NSF's plans for large-scale computational support can reduce uncertainty for researcher investments in algorithm development allowing confidence that the required resources will be available at the needed scale.

The deployment of a leadership-class facility can provide this visibility into longer-range plans for large-scale computing, enabling science teams to confidently adapt, evolve, and create new approaches in their computational techniques to push the frontiers of science and engineering. Additionally, as detailed in The National Academies report [Future Directions for NSF Advanced Computing Infrastructure to Support U.S. Science and Engineering in 2017-2020](#), human expertise and physical infrastructure, such as building, power, and cooling, are equally essential investments in maintaining a robust national cyberinfrastructure, but have much longer lifetimes than a single computational system acquisition. A sustained long-term facility deployment will allow computational investments to be made to match the lifetime of such long-lived assets (i.e. human expertise and physical facilities), and allow synergistic partnerships to develop with other long-lived experimental and observational scientific and engineering facilities.

Therefore, a goal of this solicitation is to begin planning a facility that will house a leadership-class system, and sustain a long-term investment in both computing and physical infrastructure. This facility will in turn serve as a national resource for providing predictable and sustained long-term leadership computing capabilities for science and engineering to push the frontiers of knowledge, and ultimately promote the health, prosperity and welfare of the Nation.

This solicitation represents the first step towards establishing a leadership-class computing facility. The solicitation requires the deployment of a Phase 1 system with at least two to three-fold **time-to-solution** performance improvement over the UIUC's [Blue Waters](#) system for a broad range of computational and data-intensive workflows that require the highest capabilities in terms of scale, throughput, and data analytics. This first phase will serve the dual purpose of providing 1) a production high-capability resource for science and engineering; and 2) a system for scientific and engineering evaluation that will inform the design of a Phase 2 leadership-class system.

The present solicitation requests proposals for the acquisition and operation of a Phase 1 system as well as a project plan for the design of a potential upgrade or replacement to a leadership-class computing facility at the end of the five-year deployment period, subject to the availability of funds.

II. PROGRAM DESCRIPTION

The purpose of this solicitation is to generate proposals from organizations that are committed to the delivery of a HPC Phase 1 system with the goals described in Section I. This competition emphasizes the characteristics of a well-balanced, forward-looking, production HPC system that will deliver a high level of sustained performance in terms of computation and data analysis for science and engineering. In addition, the competition places importance on the potential upgradability of the Phase 1 system to a possible leadership-class system five years after deployment, subject to the availability of funds.

Competitive proposals will provide a detailed acquisition plan for a Phase 1 system with performance analysis that demonstrate its utility for both the current [workload](#) of the UIUC [Blue Waters](#) system and anticipated future innovative applications.

The submitted performance analysis must include a broad range of applications and workflows requiring the highest capabilities in terms of scale (massive number of processors used in a single tightly-coupled application), high throughput (massive number of processors used by ensembles), and data analytics (large scale-out workloads for massive data analysis). Performance analysis must include projected time-to-solution improvement for all applications running on the proposed Phase 1 system over the existing Blue Waters system. The selected applications to demonstrate the utility of the proposed Phase 1 system should encompass the following three categories:

1. The [Sustained Petascale Performance \(SPP\)](#) benchmark, representing part of the current Blue Waters workload profile. Proposers must include the application benchmarks in the suite, or provide justification if an application is not used. SPP time-to-solution numbers on the current Blue Waters system are provided by the SPP benchmark documentation and will not need to be reproduced. The use of the aggregate SPP metric is not required. Benchmark results or projections must be provided for all applications and for all data sets.
2. Additional applications over the current Blue Waters [workload](#) profile as needed by the proposing team to make the case for the Phase 1 system. Time-to-solution numbers for these applications will need to be obtained through Blue Waters runs or, if not feasible, analytically.
3. Anticipated future innovative applications and workflows as needed to make the case for the proposed Phase 1 system. Where possible, and if appropriate, the motivation for using an innovative application may be substantiated by analyzed trends obtained from the current Blue Waters [workload](#) profile. Time-to-solution numbers for these applications will need to be obtained through Blue Waters runs or, if not feasible, analytically.

Proposers should include micro-benchmark results to the extent needed to demonstrate the capabilities of the components and sub-systems of the proposed Phase 1 system.

Benchmarks used, including optimizations made to SPP, with detailed documentation must be made available to NSF as described in Section V. All performance models used for projecting benchmark results from the current Blue Waters system to the proposed Phase 1 system must be described in sufficient detail for evaluation. In the required Letter of Intent, proposers may request an allocation of up to 100,000 node hours for three months on the Blue Waters system. All allocation requests will be reviewed by NSF for appropriateness of the use of the resource for this solicitation.

The Phase 1 system must offer 1) a robust, well-balanced, and forward-looking computational asset with an expected operational life of at least five years and delivering at least two- to three-fold time-to-solution performance improvement over the UIUC's Blue Waters system for advancing a broad range of research frontiers requiring the most extreme computational and data analysis capabilities; and 2) a system for scientific and engineering evaluation that will inform the design of a Phase 2 leadership-class system. Proposers are required to describe the Phase 1 system's operation and support for the known portfolio of scientific applications and workflows requiring leadership-class computing capabilities, as well as for future frontier applications exploiting the confluence of simulation and data analysis. A description of how the system can be incorporated into existing and emerging scientific discovery workflows, is desired. Strategic plans for supporting the computational requirements of long-lived scientific facilities are also encouraged.

Consequently, proposers are requested to identify elements of integration for the Phase 1 system with other complementary activities in the HPC ecosystem, such as, but not limited to, those supported by NSF, the U.S. Department Of Energy (DOE), the U.S. Department of Defense (DOD) and other federal agencies. As appropriate, proposers should provide plans for leveraging services that complement and enhance the education, outreach, user support and other activities within the national cyberinfrastructure ecosystem for science and engineering research.

At least 80 percent of the capacity of the Phase 1 system will be allocated to scientists and engineers through NSF's [Petascale Computing Resource Allocation \(PRAC\) program](#), or a follow-on program as determined by NSF. Proposers are also requested to detail allocation plans for the remainder of the Phase 1 system, specifically addressing broadening participation goals through education and industry outreach, as well as other partnerships that will potentially further this goal. Interagency and international collaborations are encouraged if possible.

Furthermore, the proposing organization must be committed to engaging in a three- to five-year process for developing a design for a leadership-class computing facility. This design process will involve three distinct phases: *conceptual design*, *preliminary design*, and *final design*. Exit from each design phase will be evaluated by an external review panel with the assumption that design activities will be terminated if satisfactory progress is not demonstrated.

The *conceptual design phase* will be an approximate 12- to 18-month process entailing the creation of an initial design of a leadership computing facility. The end of this phase will produce the following at a minimum:

- A description of the research infrastructure and technical requirements needed to meet the science objectives. The description may be site-independent, but must incorporate lessons learned through **engagement with science and engineering teams** in deploying the Phase 1 system.
- A system-level design, including definition of all functional requirements and major sub-systems, and any sub-system gaps identified through the operation of the Phase 1 system.
- A risk analysis and mitigation strategy for construction, identifying high-risk or long-lead items needed to reduce the risk to acceptable levels.
- Identification and evaluation of enabling technologies for scientific productivity of the Phase 2 system. Teams are encouraged to use the Phase 1 system as a platform for assisting in technology evaluation and insertion into the Phase 2 system.
- A description of potential environment and safety impacts to be considered in site selection.
- A description of the proposed performance baseline (scope of work, budget, application performance benchmarks, and schedules) needed to evaluate readiness for the next design phase.
- A description of proposed education and industry outreach, as well as other broader societal impact activities for the future facility. This should include tight integration with existing broader outreach activities where possible.
- A conceptualization of operating governance and management for the leadership-class computing facility, including plans for enabling management entity transition at 10-year intervals during the operational life of the facility. This conceptualization should include preliminary cost estimates.

Upon satisfactory external review and recommendation by NSF, the project may then proceed with the *preliminary design phase*. This phase is expected to take between 12 and 24 months. The goal of this phase is to continue to refine the concepts developed in the conceptual design phase to a level of maturity in which there is at a minimum:

- A fully-elaborated definition of the scientific goals and technical requirements for the Phase 2 system through engagement with science teams.
- A detailed site-specific infrastructure design, both system and physical, which will effectively address the scientific goals. This design may include creative public-private partnerships to leverage existing data center facilities using a “facilities-as-a-service” model if necessary.
- A detailed Project Execution Plan (PEP) that fully addresses major anticipated risks in the completion of design and development activities and in undertaking facility construction.
- A detailed bottom-up budget and contingency estimates for the proposed facility that can be presented with high confidence to NSF. NSF expects a no-cost-overrun policy to be in effect with this project.
- An environment assessment or impact statement.
- Demonstration of key technologies that have been evaluated through the Phase 1 system that will be used in the proposed upgrade.
- Plans for the management of the project during construction, including the implementation of a Project Management Control System (PMCS).
- Estimates of future operating and management costs, and anticipated future upgrades. This should also include updated plans for governance and management of the future facility, incorporating processes for enabling management entity transition at 10-year intervals during the operational life of the facility.

Upon satisfactory external review and approval by NSF, the project may then proceed to the *final design phase*. This phase is expected to take between 12 and 18 months. This final design phase will require the following key deliverables at the minimum:

- Delivery of final design and scope for build contract agreements with vendor partners.
- Refined bottom-up cost and contingency estimates, including detailed vendor estimates and quotes, for construction. This should include risk analysis, presented in detailed Work Breakdown Structure (WBS) format and accompanied by a dictionary defining the scope of all entities.
- Implementation of PMCS, including a final version of the resource-loaded schedule and mechanisms to generate reports.
- Hardening and demonstration of the scientific utility of tools and other enabling technologies needed for deployment of the Phase 2 system.
- Finalized commitments to any partnerships, public or private, and signing of Memoranda of Understanding (MOUs).
- Completion of recruitment of key staff needed to undertake construction.
- Finalized PEP for construction. This will include performance baselines for the phased delivery and acceptance of the construction activities. This must also include plans for quality assurance and safety.
- Updated description and plans for education and industry outreach, as well as other broader societal impact activities for the future facility.
- Finalization of operating and management cost estimates, as well as detailed governance and management processes for the future facility.

Exit from the final design phase is subject to external review and approval by NSF, and is subject to the availability of funds. If approved by NSF, the project may then proceed with the construction of the leadership computing facility subject to NSF cooperative agreement oversight.

III. AWARD INFORMATION

Anticipated Funding Amount: A total of \$60,000,000 is available for this solicitation, subject to availability of funds.

The project duration will be for up to five years. An acquisition associated with the upgrade of an existing system is permissible. The award will support the acquisition and deployment of hardware, software, and the personnel costs associated with the acquisition and deployment of the proposed system, including acceptance testing.

Although there are no NSF-provided benchmarks that need to be met, proposals must clearly project the capability of the proposed system by providing information about the benchmarks used, the projected performance results, and details of the performance model used. A successful proposal should provide compelling evidence that the resource will deliver a two- to three-fold time-to-solution improvement for a comprehensive set of representative applications and workflows in the current UIUC Blue Waters [workload](#) profile.

Demonstrated ability to achieve any of the benchmark results, or other performance measures provided in the proposal, whether actual or projected, will be subsequently required as a performance metric for acceptance of the delivered system in an award.

Furthermore, early operations of no less than 90 days to empirically demonstrate and confirm the capabilities of the proposed Phase 1 system are expected. This activity will be supported as a separate funding action.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in, the US acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.

Who May Serve as PI:

No specific eligibility description

Limit on Number of Proposals per Organization: 1

An organization may submit only one proposal but may be identified as sub-awardee on other proposals responding to this solicitation. The restriction to no more than one submitted proposal as lead institution is to help ensure that there is appropriate institutional commitment necessary for responsible oversight, by the potential awardee institution, of a national resource.

Collaborative projects may **only** be submitted as a single proposal in which a single award is being requested. The involvement of partner organizations should be supported through sub-awards administered by the submitting organization.

Limit on Number of Proposals per PI or Co-PI: 1

An individual may be the PI or co-PI on no more than one proposal that responds to this solicitation. There is no limit on the number of proposals with which an individual may be associated in other capacities.

These eligibility constraints will be strictly enforced in order to treat all proposers fairly and consistently. In the event that an individual proposal submission exceeds the above limits, the proposal received within the limits will be accepted based on the earliest date and time of proposal submission (i.e., the first proposal received will be accepted and the remainder will be returned without review). **No exceptions will be made.**

Additionally, PIs or co-PIs are expected to commit at least 50% time to this activity.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Letters of Intent (required):

The Letter of Intent is a statement of the proposer's preliminary plans. It must contain the names of all senior personnel, a proposed title, a list of participating organizations, and a synopsis that describes the proposed resource in sufficient detail to permit an appropriate selection of reviewers.

Additionally, if required, include in the synopsis a short justification for an allocation request on the UIUC Blue Waters system for NSF to evaluate. The allocation request must not exceed 100,000 node hours for up to three months.

Please use the "Other Comments" box (which has a 2,500-character limit) to provide additional names and institutional affiliations of Senior Personnel who will be involved in the project and are not otherwise specified in the "Add Other Senior Project Personnel Section".

Use the "Allocation Request" data field (which has a 255-character limit) to specify the node hour request on Blue Waters for three months. Up to 100,000 node hours may be requested. If no allocation request is required, enter "0" in this text box.

Use the "Contact Information" data field (which has a 255-character limit) to specify the email contact information to which the allocation access information will be sent if granted by NSF. If no allocation request is required, enter "None" in this text box.

All Letters of Intent must be submitted by the proposing organization's Authorized Organizational Representative via FastLane (<http://www.fastlane.nsf.gov/fastlane.jsp>).

Letter of Intent Preparation Instructions:

When submitting a Letter of Intent through FastLane in response to this Program Solicitation please note the conditions outlined below:

- Submission by an Authorized Organizational Representative (AOR) is required when submitting Letters of Intent.
- A Minimum of 0 and Maximum of 4 Other Senior Project Personnel are permitted
- A Minimum of 0 and Maximum of 10 Other Participating Organizations are permitted
- Allocation Request is required when submitting Letters of Intent
- Contact Information is required when submitting Letters of Intent
- Submission of multiple Letters of Intent is not permitted

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via Grants.gov or via the NSF FastLane system.

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.
- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov*. The complete text of the *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: (https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

See PAPPG Chapter II.C.2 for guidance on the required sections of a full research proposal submitted to NSF. Please note that the proposal preparation instructions provided in this program solicitation may deviate from the PAPPG instructions.

Exceptions to guidelines in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) or NSF Grants.gov Application Guide follow.

- The page limit for the Project Description section of the proposal is **40 pages**. (see Note below)
- The Budget Justification section is limited to **5 pages**. (see Note below)
- Only personnel directly connected to the project should be listed as collaborators.
- Certain information other than that described in the PAPPG should be submitted as Supplementary Documents (see below for details).
- Collaborative efforts may **only** be submitted as a single proposal, in which a single award is being requested. The involvement of partner organizations should be supported through sub-awards administered by the proposing organization.

NOTE: FastLane performs an automated compliance check when you run "Check Proposal," "Forward to SPO," and "Submit Proposal." A warning message will display when the Project Description and the Budget Justification exceed the normal page allocations. For this solicitation only, the Project Description may be up to 40 pages, and the Budget Justification may be up to 5 pages; assuming you are within these page limits, the warning can be ignored for these two sections.

In addition to the required sections described in the PAPPG or NSF Grants.gov Application Guide, the Project Description must include the following 10 sections:

- **Project Goals for Leadership-Class Computing Facility;**
- **Phase 1 System Specification;**
- **Phase 1 Sustained Performance for Science and Engineering Applications;**
- **Phase 1 System Reliability and Usability;**
- **Phase 1 Implementation, Project Management, and Risk Mitigation;**
- **Phase 1 Quality of the Physical Infrastructure;**
- **Phase 1 Security;**
- **Phase 1 Plan for Operations, including User Support and Training;**
- **Project Plans for Construction of Leadership-Class Computing Facility; and**
- **Broader Impacts.**

Information to be provided in each section is described below. ***In the following descriptions, the term "system" is intended to refer to the entire resource being proposed.***

Project Goals for Leadership-Class Computing Facility

Articulate and justify the scientific goals and objectives for the proposed leadership-class computing facility. Identify specific research frontiers and advances that will be enabled. Describe the intended unique impact for U.S. academic research in science and engineering and how this project will enable this impact.

Articulate and justify the near-term and sustained benefit of the increased capacity and capability for the U.S. HPC ecosystem with emphasis on the contributions to the overall U.S. academic cyberinfrastructure.

Describe the scientific and project management qualifications of the senior personnel on the project, and why they are qualified to lead the successful design and construction of the proposed leadership computing facility. Justify any PI or co-PI time commitment less than 50%.

Describe any synergistic collaborations, public or private, and how this will serve the scientific goals and objectives of the proposed facility.

Phase 1 System Specification

Specify the detailed design of the Phase 1 system to be acquired and deployed. Include a detailed description of any aspects of the proposed system that are likely to influence the performance of science and engineering applications and workflows. Proposals should elaborate on the details of the Phase 1 system to be deployed. Relevant parameters to be considered may vary with the nature of the proposed resource but could include total number of processors, node and processor architecture, processor to memory architecture, amount of memory, cache architecture, inter-processor and inter-node bandwidth and latency, interconnect topology, amount of secondary storage, I/O sub-system, file system(s), operating system(s), compiler(s), debugging tools, performance measurement tools,

system administration tools, modes of parallelism available to users, and programming models and abstractions.

Clearly articulate the innovative and potentially transformative capabilities of the system, and how this will improve the usability, performance and reliability of science and engineering applications, as well as the potential for enabling new computational paradigms at the confluence of simulation and data analytics.

Describe how the entire system composed of compute, memory, I/O, and interconnect sub-systems will be integrated.

Describe and justify the proposed system balance, especially in the context of science and engineering applications and workflows.

Describe any vendor-supplied tools and technologies for enhancing the utility and capabilities of the system for science and engineering.

Describe visualization and data analysis aspects of the system, including capabilities that will support the entire scientific discovery workflow from ingestion of existing and emerging data sources to information assimilation and knowledge discovery.

Describe any anticipated risk and challenges associated with implementing the capabilities proposed.

Describe the potential upgradability to a Phase 2 system that will enable a ten-fold or more time-to-solution performance improvement over the Phase 1 system for a broad range of scientific and engineering applications and workflows requiring this capability.

Phase 1 Sustained Performance for Science and Engineering Applications

Clearly describe the types of science and engineering research challenges that drive the design choices of the Phase 1 system. Also clearly describe the expected impact of the system on science and engineering including on new science and engineering applications, and how this will push the frontiers of new science and engineering discoveries never before possible.

Provide a detailed performance analysis that demonstrate the utility of the proposed Phase 1 system to both the current [workload](#) of the UIUC Blue Waters system and anticipated future innovative applications. The submitted performance analysis must include a broad range of applications requiring the highest capabilities in terms of scale (massive number of cores used in a single tightly-coupled application), high throughput (very large core count used by ensembles), and data analytics (large scale-out workloads for massive data analysis). Performance analysis must include projected time-to-solution improvement for all applications running on the proposed Phase 1 system over the Blue Waters system. The selected applications to demonstrate the utility of the proposed Phase 1 system should encompass the following three categories:

1. The [Sustained Petascale Performance \(SPP\)](#) Benchmarks, representing part of the current Blue Waters workload profile. Proposers must include the applications benchmarks in the suite or provide justification if an application is not used. SPP time-to-solution numbers on the current Blue Waters system are provided by the SPP benchmark documentation and will not need to be reproduced. The use of the aggregate SPP metric is not required. Benchmark results or projections must be provided for all applications and for all data sets.
2. Additional applications over the current Blue Waters [workload](#) profile as needed by the proposing team to make the case for the Phase 1 system. Time-to-solution numbers for these applications will need to be obtained through Blue Waters runs or, if not feasible, analytically.
3. Anticipated future innovative applications and workflows as needed to make the case for the proposed Phase 1 system. Where possible, and if appropriate, the motivation for using an innovative application may be substantiated by analyzed trends obtained from the current Blue Waters [workload](#) profile. Time-to-solution numbers for these applications will need to be obtained through Blue Waters runs or, if not feasible, analytically.

Proposers should include micro-benchmark results to the extent needed to demonstrate the capabilities of the components and sub-systems of the proposed Phase 1 system.

All benchmarks used, including optimizations to SPP, must be posted to a secure web site hosted by the proposing organization and accessible to NSF staff on the day following the proposal deadline date. Detailed descriptions of the benchmark and/or specific code modifications or optimization made to any code, as well as execution scripts that were used in running the benchmark, must also be made available at the same secure web site on the day following the proposal deadline date. Any libraries with which the benchmarks were linked should be part of the proposed system specification.

Benchmarks may be run on existing or prototype systems of the same design as proposed, or estimated by **well-justified projections** from analogous systems.

Proposers may provide additional benchmarks that explicitly highlight any new innovative capability. The choice of applications should be justified in terms of their scientific merit and their ability to demonstrate the capability for extreme scale, high throughput or data analytics. The features of applications influencing the design and configuration of the proposed innovative capability should be fully explained with respect to how the innovation will push the frontiers of science and engineering discovery in ways that would not be possible otherwise.

All projected benchmark performance results should be based on well-justified projection models from analogous systems. Clearly describe the performance model at a level of detail such that it can be reviewed for validity. The demonstrated ability to achieve any benchmark results or other performance measures provided in the proposal, whether actual or projected, will be subsequently required as a performance metric for acceptance of the delivered system.

All actual and/or projected benchmark results should be included in the Supplementary Documents section.

Phase 1 System Reliability and Usability

Describe the availability of system software and tools to effectively use the capabilities of the Phase 1 system. Depending on the type of resource being proposed, system software features of particular importance may include the operating system(s), file system or other storage metadata system, compilers, message-passing libraries, other libraries (including standard system and mathematical libraries),

and debugging, application tuning, performance monitoring, system administration and resource management, job scheduling and accounting, networking software, programming environment, data management and workflow orchestration tools. For the types of science and engineering research workflows that drive the choice of system design, describe usability aspects of the system from the perspective of both new and existing researchers and educators. In particular, describe how the proposed system will effectively execute the UIUC Blue Waters [workload](#) profile. Additionally, describe how the system will be deployed to support the entire end-to-end pipeline for new and emerging scientific workflows, incorporating potentially new data sources.

It is anticipated that one of the performance requirements included in the award document will be that, in production mode, when averaged over one month, 96% of jobs submitted to the system should complete without having to be resubmitted as a result of a failure in the hardware or system software, including failures as a result of a compiler failing to correctly implement code that complies with the relevant language standard. Include an analysis of the reliability of the proposed production resource and the reasons that the proposed system can be expected to meet this performance requirement.

The award will include a performance requirement on the availability of the system. NSF requires that, when averaged over a month, production resources should be unavailable as a result of scheduled and unscheduled maintenance no more than 5% of the time. Provide an analysis of the reasons that the proposed system can be expected to meet this performance requirement.

Phase 1 Implementation, Project Management, and Risk Mitigation

Provide a detailed implementation plan and corresponding metrics for developing and/or acquiring and deploying the proposed Phase 1 system. A detailed month-by-month schedule must be provided. This schedule must include an early operations phase period of not less than 90 consecutive days. This early operations period will be part of the acquisition phase of the proposed resource and must be used to empirically demonstrate and confirm the capabilities of the proposed Phase 1 system. The early operations phase will be funded through a separate funding action.

Describe which elements of the proposed resource will be integrated into complementary HPC or large-scale data analytics projects.

Provide details on any sub-contract(s) with relevant vendor(s) that describe the contractual terms of any substantial acquisition of hardware, software or services.

Describe the availability of experts to address any system integration problems that arise as the system is deployed. This expertise may be provided by the proposer and/or by other vendor, academic or government partners. Proposers should make clear their previous associations, if any, with these partners. The breadth of knowledge, depth of interaction, and technical abilities of partners will be considered in the review process. This knowledge and expertise is particularly important in supporting advanced programming or usage paradigms (e.g., compilers for parallel environments, problem-solving environments, distributed computing), tools (e.g., performance visualization, parallel debuggers) and system elements (e.g., parallel file systems).

Describe user access to the system during the deployment phase and prior to system acceptance, including during testing.

Describe the experience of the proposing organization in the management of awards of this scale and the resources that would be available to manage such an award. If the proposal involves a substantial acquisition, describe the experience of the proposing organization in the management of large sub-contracts to vendors for the acquisition of HPC systems. Describe the resources that would be available to manage any such sub-contract issued under an award made as a result of this solicitation.

Provide a detailed risk mitigation plan, identifying both technical and management risks as well as strategies to mitigate such risks.

Phase 1 Quality of the Physical Infrastructure

Describe the physical facility or facilities that will house the proposed Phase 1 system and any schedule implications of the provision of computer-ready space, including floor space, power, cooling, fire suppression, and any other emergency equipment, for the system and its supporting hardware. Include a description of the physical security that will be provided. Include a description of the expected power and heat budgets of the proposed system and explain how they will be managed. Describe the expected impacts of power interruptions and how they will be managed. Provide an analysis of the implications of a sudden loss of power to, or catastrophic failure of, either the computing, storage or primary cooling systems and describe what emergency systems will be required to minimize damage to personnel and equipment.

Describe the external network connectivity between the proposed resource and national networks.

High-performance applications are expected to produce many terabytes of data. Describe how these data will be handled, how data integrity will be maintained, and any backup and contingency procedures and schedules, including how they will be provided and implemented.

Phase 1 Security

Both physical and operational security of cyberinfrastructure resources are important considerations. Describe project roles and responsibilities with respect to cybersecurity for the facility. In addition, describe how will security risks be assessed, and what technical, administrative, and physical safeguards will be in place. Explain how policies and procedures for cybersecurity will be established and maintained, and the associated plans for awareness and training. Describe the procedures in the event of a security incident for notification to NSF, the user community, the wider cyberinfrastructure communities, and relevant authorities [local police, the Federal Bureau of Investigation (FBI), etc.] Describe how would the effectiveness of the proposed cybersecurity program would be evaluated and assessed, and what approach would be taken to implement the cybersecurity plan.

Phase 1 Plan for Operations, including User Support and Training

Provide a plan for user support that includes a description of the anticipated requirements of the science and engineering research community, a description of how resources will be allocated beyond those allocated through the NSF [Petascale Computing Resource Allocation \(PRAC\)](#) program, and any other operational details likely to have an impact on user access or usage of the proposed system.

Describe the number and anticipated qualifications of the types of personnel who will be involved with the provision of user support. In addition, describe the user training opportunities that will be made available. Describe the expected availability of dedicated time on the

system for both science and engineering applications and systems testing, and what fraction of system resources will be consumed in moving users on and off the system, or reconfiguring it for dedicated use, if applicable.

Describe the experience of the proposing organization in operating production systems, including any experience in operating in a physical and distributed environment. Include a description of whether operational support was provided on a 24/7 or more limited basis. Describe the number and type of users, the types of computation performed, and the nature of the user support provided. Describe the processes used to evaluate management performance, determine user needs, and evaluate user satisfaction.

Describe the qualifications of the PIs and co-PIs with regard to their ability to manage a project of this size and complexity, and, in proposals for production resources, to manage a resource with a large number of external users.

Describe elements of integration with other national programs if any, specifically addressing what services are being leveraged.

Provide an analysis of the annual operating costs of the proposed system for the duration of the award, including the cost of providing user support. Detailed operating cost estimates may include any necessary maintenance contracts. Operating cost estimates may also include, if applicable, the cost of power and physical security, external network connectivity, and co-location.

Provide an estimate of the costs associated with the number of full-time equivalent (FTE) staff necessary to maintain 24/7 operations and security of the proposed system. Also provide an estimate of the costs associated with the number of FTE staff necessary to provide effective user support.

Include a more detailed explanation of the budget for user support and operating costs in the Supplementary Documents section of the proposal. Information provided will be used by NSF assess the operating cost-performance attributes of the proposed system.

Describe any other factors that are anticipated to have an impact on the Total Cost of Ownership of the proposed system.

Project Plans for Construction of Leadership-Class Computing Facility

Describe a detailed preliminary month-to-month project plan for the three design phases described in Section II, Program Description. The total duration of the accumulative design phases must not exceed 5 years.

Describe how the design activities will be conducted, how the science drivers will be solicited, how enabling technologies will be evaluated, and how the Phase 1 system will be used in this design process.

Describe the expertise and qualifications of key senior personnel who will be involved in this process.

Develop a comprehensive risk analysis and mitigation plan for the planned design activities.

Provide preliminary cost estimates, with justification, for each design phase.

Proposers may provide up to 5 pages of supporting project plan illustrations, such as preliminary Work Breakdown Structure (WBS) and Gantt Charts, in the **Supplementary Documents section**.

Broader Impacts

The Project Description must contain, as a **separate section within the narrative**, a discussion of the broader impacts of the proposed activities. In addition, as part of this discussion, clearly articulate a plan for outreach to educational institutions and to industry. Also describe any complementary and leveraged aspects of other research infrastructure projects and facilities, particularly those that are supported by NSF.

Proprietary information

Proposals containing patentable ideas, trade secrets, privileged or confidential commercial or financial information, disclosure of which may harm the proposer, should be clearly marked where appropriate in the proposal and labeled with the following legend:

"The following is (proprietary or confidential) information that (name of proposing organization) requests not be released to persons outside the Federal Government, except for purposes of review and evaluation."

For further information, please refer to the PAPPG ([NSF 17-1](#)).

Supplementary Documents

In addition to other required supplementary documents described in the PAPPG, proposals should include the following sections as Supplementary Documents:

- Actual or estimated performance benchmark results as described in Section V.A, *Phase 1 Sustained Performance for Science and Engineering Applications*, of this solicitation; this supplementary document **may not be used to continue discussion or analysis of the merits of the awardee or sub-awardees, vendor(s), or system**;
- Detailed Projected Operating Costs as described in Section V.A, *Phase 1 Plan for Operations, including User Support and Training* of this solicitation. This supplementary document **may not exceed five pages**;
- A list of all organizations and companies involved in the project, together with their roles within the project and the levels of funding;
- A plan for user support that includes a description of the anticipated requirements of the science and engineering research community, and any other operational details likely to have an impact on user access or usage of the proposed system (see Section V.A, *Phase 1 Plan for Operations, including User Support and Training* above);
- Project plan illustrations as described in Section V.A, *Project Plans for Construction of Leadership Computing Facility*; this supplementary document **may not exceed 5 pages** and may not include discussion about the merits of the project plan; and
- Letters of collaboration from individuals who are described in the Project Description as involved in the project in a senior capacity but who are not members of the lead proposing organization, or from representatives of institutions or organizations collaborating with the lead institution, are allowable. As described in the PAPPG, such letters of collaboration should be

included in the Supplementary Documents section and do not count toward overall page limits. **Note that letters of support may not be included in proposals; if letters of support are included, NSF may choose to return the proposal without review.**

Collaborators & Other Affiliations Information

For this solicitation, the *Collaborators & Other Affiliations* information specified in the *PAPPG* should be submitted using the spreadsheet template found at <https://www.nsf.gov/cise/collab/>. For each proposal, a completed spreadsheet for each PI, co-PI, or senior personnel must be uploaded directly into Fastlane in .xls or .xlsx format as a "Collaborator and Other Affiliations" Single Copy Document. NSF staff use this information in the merit review process to help manage reviewer selection; the spreadsheet will ensure the Collaborator and Other Affiliations information has a common, searchable format.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Other Budgetary Limitations:

Each proposal should be for the development phase including any acquisition costs as well as the deployment phase of the project. The proposal amount cannot exceed \$60,000,000 for a single award. At least 95% of the proposal amount should be for the system acquisition cost.

NSF expects the full Phase 1 system will be deployed and available for production operations by the end of FY 2019. NSF understands that the deployment of the system into production operations may under extenuating circumstances extend past FY 2019. NSF is prepared to consider these plans if they are in the interest of NSF and the wider research community.

The number of years that the Phase 1 system will be deployed is anticipated to be at least 5 years.

An acquisition associated with the upgrade of an existing system is permissible. The award will support the acquisition and deployment of hardware, software and associated personnel costs, including acceptance testing. Detailed budgetary information should be provided in the Budget Justification section of the proposal.

Early operations of no less than 90 days to empirically demonstrate and confirm the capabilities of the proposed Phase 1 system will be supported with a separate funding action.

Up to \$2,000,000 is anticipated to be available as a separate funding action for the activities associated with the *conceptual design phase* for Phase 2. Support for subsequent *preliminary design* and *final design phases* in Phase 2 will be provided in separate funding actions.

User support and operating costs are *expected* to be 20% of the acquisition cost per year. Should the proposed resource require *additional* user and operating funds, an additional 5% of the acquisition cost can be requested but the proposal must provide very strong justification for such a request. These costs will be provided in a separate funding action.

C. Due Dates

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. submitter's local time):

July 14, 2017

- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

November 20, 2017

D. FastLane/Grants.gov Requirements

For Proposals Submitted Via FastLane:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: <https://www.fastlane.nsf.gov/a1/newstan.htm>. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov. The FastLane Help Desk answers general technical questions related to the use of the FastLane system. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: <https://www.grants.gov/web/grants/applicants.html>. In addition, the NSF Grants.gov Application Guide (see link in

Section V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

Submitting the Proposal: Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to the NSF FastLane system for further processing.

Proposers that submitted via FastLane are strongly encouraged to use FastLane to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program for acknowledgement and, if they meet NSF requirements, for review. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in PAPPG Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: https://www.nsf.gov/bfa/dias/policy/merit_review/.

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Investing in Science, Engineering, and Education for the Nation's Future: NSF Strategic Plan for 2014-2018*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

One of the strategic objectives in support of NSF's mission is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions must recruit, train, and prepare a diverse STEM workforce to advance the frontiers of science and participate in the U.S. technology-based economy. NSF's contribution to the national innovation ecosystem is to provide cutting-edge research under the guidance of the Nation's most creative scientists and engineers. NSF also supports development of a strong science, technology, engineering, and mathematics (STEM) workforce by investing in building the knowledge that informs improvements in STEM teaching and learning.

NSF's mission calls for the broadening of opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, which is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

A. Merit Review Principles and Criteria

The National Science Foundation strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs in understanding across all areas of science and engineering research and education. To identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF makes every effort to conduct a fair, competitive, transparent merit review process for the selection of projects.

1. Merit Review Principles

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the

likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities.

These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

2. Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (PAPPG Chapter II.C.2.d(i). contains additional information for use by proposers in development of the Project Description section of the proposal). Reviewers are strongly encouraged to review the criteria, including PAPPG Chapter II.C.2.d(i), prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to
 - a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
 - b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. NSF values the advancement of scientific knowledge and activities that contribute to achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

Proposers are reminded that reviewers will also be asked to review the Data Management Plan and the Postdoctoral Researcher Mentoring Plan, as appropriate.

Additional Solicitation Specific Review Criteria

Reviewers will be asked to assess the adequacy of the descriptions provided in the required sections of the Project Description (these are described in Section V.A. *Proposal Preparation Instructions* above):

- Project Goals for Leadership-Class Computing Facility;
- Phase 1 System Specification;
- Phase 1 Sustained Performance for Science and Engineering Applications;
- Phase 1 System Reliability and Usability;
- Phase 1 Implementation, Project Management, and Risk Mitigation;
- Phase 1 Quality of the Physical Infrastructure;
- Phase 1 Security;
- Phase 1 Plan for Operations, including User Support and Training;
- Project Plans for Construction of Leadership-Class Computing Facility; and
- Broader Impacts (including solicitation-specific aspects).

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review, or Site Visit Review.

Ad hoc Review and/or Panel Review, or Site Visit Review.

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will generally be completed and submitted by each reviewer and/or panel. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF strives to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

After programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications. After an administrative review has occurred, Grants and Agreements Officers perform the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any reviewer-identifying information, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

B. Award Conditions

An NSF award consists of: (1) the award notice, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award notice; (4) the applicable award conditions, such as Grant General Conditions (GC-1)*; or Research Terms and Conditions* and (5) any announcement or other NSF issuance that may be incorporated by reference in the award notice. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

*These documents may be accessed electronically on NSF's Website at https://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the NSF *Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

Special Award Conditions:

The award made as a result of this competition will include performance requirements and metrics for the proposed system. If appropriate, an awardee will include terms and conditions in any subcontract agreement to address schedule and performance expectations and the impact of delays in delivery.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer no later than 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). No later than 120 days following expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report, will delay NSF review and processing of any future funding increments as well as any pending proposals for all identified PIs and co-PIs on a given award. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

More comprehensive information on NSF Reporting Requirements and other important information on the administration of NSF awards is contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

Additional reporting requirements apply, will be negotiated with the awardee prior to award, and will be incorporated into the special terms and conditions of the award.

VIII. AGENCY CONTACTS

Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.

General inquiries regarding this program should be made to:

- Edward Walker, Program Director, CISE/ACI, 1160, telephone: (703) 292-4863, email: edwalker@nsf.gov

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: fastlane@nsf.gov.

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a confirmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: support@grants.gov.

IX. OTHER INFORMATION

The NSF website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this website by potential proposers is strongly encouraged. In addition, "NSF Update" is an information-delivery system designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF [Grants Conferences](#). Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on [NSF's website](#).

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this mechanism. Further information on Grants.gov may be obtained at <http://www.grants.gov>.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 55,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

Facilitation Awards for Scientists and Engineers with Disabilities (FASED) provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See the *NSF Proposal & Award Policies & Procedures Guide* Chapter II.E.6 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at <https://www.nsf.gov>

- **Location:** 2415 Eisenhower Avenue, Alexandria, VA 22314
- **For General Information** (NSF Information Center): (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**
 - Send an e-mail to: nspubs@nsf.gov
 - or telephone: (703) 292-7827
- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, [NSF-50](#), "Principal Investigator/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004), and [NSF-51](#), "Reviewer/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

Suzanne H. Plimpton
Reports Clearance Officer
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