Designing Accountable Software Systems (DASS)

PROGRAM SOLICITATION
NSF 22-512

REPLACES DOCUMENT(S):
NSF 21-554

National Science Foundation

Directorate for Computer and Information Science and Engineering
    Division of Computing and Communication Foundations
    Division of Information and Intelligent Systems
    Division of Computer and Network Systems

Directorate for Social, Behavioral and Economic Sciences
    Division of Behavioral and Cognitive Sciences
    Division of Social and Economic Sciences

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

    January 28, 2022

    January 27, 2023

IMPORTANT INFORMATION AND REVISION NOTES

- The deadline dates have been updated.
- There is a new requirement: all proposals must have a separate section in the Project Description titled "Relevance to DASS" that defines the proposal's notion of accountability in the social and legal context in which it is being studied and how an understanding of these contexts will be used in the design of accountable software.
- The notion of accountability has been refined.

Important Information

Innovating and migrating proposal preparation and submission capabilities from FastLane to Research.gov is part of the ongoing NSF information technology modernization efforts, as described in Important Notice No. 147 . In support of these efforts, research proposals submitted in response to this program solicitation must be prepared and submitted via Research.gov or via Grants.gov, and may not be prepared or submitted via FastLane.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 22-1), which is effective for proposals submitted, or due, on or after October 4, 2021.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

    Designing Accountable Software Systems (DASS)

Synopsis of Program:

    Society is becoming highly dependent on software applications, systems, and platforms, as functionality in all aspects of business, government, and everyday life is increasingly implemented through software. At the same time, there has been an increase in the laws and regulations whose implementation and effectiveness depend on software. Whereas organizations and individuals throughout our history have been expected to comply with laws and regulations, now software systems also must be accountable and comply with them. Software systems need to be designed with legal and regulatory compliance in mind, and should be adaptable to changing laws and regulations, which themselves evolve with changing citizen expectations and social norms.

    The Designing Accountable Software Systems (DASS) program solicits foundational research aimed towards a deeper understanding and formalization of the bi-directional relationship between software systems and the complex social and legal contexts within which software systems must be designed and operate. The DASS program aims to bring researchers in computer and information science and engineering together with researchers in law and social, behavioral, and economic sciences to jointly develop rigorous and reproducible methodologies for understanding the drivers of social goals for software and for designing, implementing, and validating accountable software systems. DASS

will support well-conceived collaborations between these two groups of researchers. The first group consists of researchers in software design, which, for the purposes of this solicitation, is broadly defined as formal methods, programming languages, software engineering, requirements engineering, and human-centered computing. The second group consists of researchers in law and the social, behavioral, and economic sciences, who study social systems and networks, culture, social norms and beliefs, rules, canons, precedents, legal code, and routine procedures that govern the conduct of people, organizations, and countries.

Proposals for this program must create general advances in both (1) understanding the social, behavioral, economic and/or legal context of accountable software design; and (2) improving the methodology for designing accountable software beyond specific use cases. Each proposal must have at least one Principal Investigator (PI) or co-PI with expertise in software design and at least one PI or co-PI with expertise in law or a social, behavioral, or economic science. All proposals must contain a detailed collaboration plan that leverages the complementary expertise of the PIs/co-PIs in the designated areas and describes the mechanisms for continuous bi-directional collaboration. Projects are limited to $750,000 in total budget, with durations of up to three years.

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.

- Nina Amla, Program Director, CISE/CCF, telephone: (703) 292-7991, email: dass@nsf.gov

- Anindya Banerjee, Program Director, CISE/CCF, telephone: (703) 292-7885, email: dass@nsf.gov

- Sara Kiesler, Program Director, SBE/SES, telephone: (703) 292-8643, email: dass@nsf.gov

- Sol J. Greenspan, Program Director, CISE/CCF, telephone: (703) 292-8910, email: dass@nsf.gov

- Reggie S. Sheehan, Program Director, SBE/SES, telephone: (703) 292-5389, email: dass@nsf.gov

- Jeremy J. Epstein, Program Director, CISE/CNS, telephone: (703) 292-8338, email: dass@nsf.gov

- Daniel R. Cosley, Program Director, CISE/IIS, telephone: (703) 292-8832, email: dass@nsf.gov

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

- 47.070 --- Computer and Information Science and Engineering
- 47.075 --- Social Behavioral and Economic Sciences

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 10

Anticipated Funding Amount: $7,500,000

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

Who May Serve as PI:

By the submission deadline, any PI, co-PI, or other senior project personnel must hold either:

- a tenured or tenure-track position, *or*
- a primary, full-time, paid appointment in a research or teaching position

at a U.S.-based campus of an organization eligible to submit to this solicitation (see above), with exceptions granted for family or medical leave, as determined by the submitting organization. Individuals with *primary* appointments at for-profit non-academic organizations or at overseas branch campuses of U.S. institutions of higher education are not eligible.

All projects must have at least one PI or co-PI with expertise in software design and at least one PI or co-PI with expertise in law or the social, behavior or economic sciences.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

>   **These eligibility constraints will be strictly enforced in order to treat everyone fairly and consistently**. In the event that an individual exceeds this limit, only the first proposal received before the deadline will be considered, and the other proposals will be returned without review. **No exceptions will be made.**

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not required

- **Preliminary Proposal Submission:** Not required

- **Full Proposals:**

    - Full Proposals submitted via Research.gov: *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:**

    Not Applicable

C. Due Dates

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

    January 28, 2022

    January 27, 2023

Proposal Review Information Criteria

Merit Review Criteria:

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

Award Administration Information

Award Conditions:

Standard NSF award conditions apply.

Reporting Requirements:

Standard NSF reporting requirements apply.

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I. INTRODUCTION

Society is becoming highly dependent on software applications, systems, and platforms. Software systems constitute not just a computational basis for the operation of commerce and government but have become integral to a social infrastructure that affects large and small communities and organizations, and nearly all aspects of daily life, including financial transactions, health care, criminal justice, transportation, education, social services, and many others. Software programs can have significant physical, personal, social, economic, and environmental consequences. Recently, efforts to regulate software and make organizations and individuals more accountable for its consequences have increased, and all indications seem to suggest that more of these efforts are on the way.

Regulation[1] is defined as "a rule of order having the force of law, prescribed by a superior or competent authority, relating to the actions of those under the authority's control." Well-known examples include the European Union General Data Protection Regulation (GDPR) and the California Consumer Privacy Act (CCPA), which require more transparency in how consumer data are collected, shared, and used. Such regulations are meant to hold organizations and individuals accountable, and software designed to implement such laws, regulations, or policies must be accountable as well. For the purpose of this solicitation, accountability is defined as having an obligation or responsibility for compliance with law, regulation, or public policy, or its intent or operation. Accountable software systems are those that comply with laws, regulations, or public policies. These systems also will have to be adaptable so that they comply with changing laws, regulations, and public policies.

Unfortunately, the context and design of accountable software is imperfectly understood; developers of software may interpret the social intent of regulations and associated governance structures in an unprincipled and *ad hoc* manner. Further, software systems often must comply with regulations that are written with obscure, complex, or dynamic legal and social intent, and it is not clear how such intent should be interpreted and implemented in a software system. It is also not clear what being compliant means in the context of unclear law or social context, and how to provide evidence of compliance or explain non-compliance to stakeholders. Further, policies intended for societal benefit, along with citizen expectations and social norms, may change, leading to revised law, regulation, or policy and further demands on the software systems that implement them.

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[1] https://law.jrank.org/pages/9734/Regulation.html

II. PROGRAM DESCRIPTION

Laws and regulations are formal governance structures with goals and consequences intended to have beneficial impacts on society. Accountability and compliance are societal concepts that reflect how well society's institutions, routine practices, and governance structures, including laws and regulations implemented in software, reflect citizen preferences and function consistent with society's norms and values. When law and regulation become embedded in software, their accountability and compliance become of central importance in the design of these systems.

State-of-the-art software design methodologies treat regulations as a requirement that the system must satisfy, but this approach fails to capture either the intricacies of underlying legal requirements or the dynamic nature of social norms and expectations. Moreover, there is no mechanism, beyond the actual software code itself, to measure whether a software system is compliant with respect to one or more regulations or policies. It is clear that, with respect to accountability, current software development approaches are deficient in several areas: they are not flexible enough to handle evolving and context-sensitive requirements or social expectations; not expressive enough to be able to capture the intent and consequences of policies; not capable of providing provable and certifiable compliance guarantees; and not transparent or auditable with respect to the regulatory processes and practices of their stakeholders.

There are many challenges in designing accountable software in these regulation-aware environments. (1) Accountable software systems will have to be designed for adaptability in the context of social paradigms and legislative, regulatory, or contractual obligations that may evolve over time. These obligations may be specific to a geographic location, government, or organization; may be underspecified or intentionally ambiguous; and may be inconsistent, or consistent only under a probabilistic setting. (2) Software has the potential to impact future policy and regulations. As concepts of ethical responsibility, authority, autonomy, compliance, approval, consequences, causality, equity, and fairness become operationalized by software, their definitions and implications become critical concerns in the software design process. (3) Regulations and policies that hold software accountable are often written for multiple purposes and audiences, which can make it difficult to implement policy in software, check for compliance, and explain non-compliance. Ideally such regulations should be written in such a way to serve multiple audiences, and yet not impact these different audiences differentially.

The DASS program solicits research proposals that will make fundamental contributions towards understanding and formalizing the bi-directional relationship between software systems and the complex legal and social environment in which they arise and must operate, with an emphasis on designing software systems that are demonstrably accountable to law, regulation, and/or public policy. The DASS program aims to bring researchers in computer and information sciences and engineering together with researchers in law, and social, behavioral, and economic sciences to jointly develop rigorous and reproducible methodologies for understanding the drivers of social goals for software and for designing, implementing, and validating accountable software systems. DASS encourages strong collaboration between these two groups of researchers. The first group consists of researchers in software design, which, for the purposes of this solicitation, is broadly defined as formal methods, programming languages, software engineering, requirements engineering, and human-centered

computing. The second group consists of researchers in law and the social, behavioral, and economic sciences, who study social systems and networks, culture, social norms and beliefs, rules, canons, precedents, legal code, and routine procedures that govern the conduct of people, organizations, and countries.

DASS seeks proposals that contribute to both technical and legal or social, behavioral or economic aspects of designing software accountable to law and regulation. A non-exhaustive list of possible research questions is included below as examples:

- What are the implications for accountable software design of variations across jurisdictions or social institutions in the intent, consequences, policy goals, or enforcement of laws or regulations, or of differences in societal expectations of laws, regulation, or policy?
- How do we specify, develop, and reason about software compliance and accountability in the presence of ambiguity, uncertainty, and contradiction?
- How do we incorporate design rationale and requirements tradeoffs into the implementation of accountable software systems?
- Can regulations be written in a manner that leads to formal functional or security specifications that can be implemented in the software?
- What are the (clean slate) methodologies needed for software requirements, design, development, testing, and maintenance of accountable software?
- How can evolution in regulation lead to principled approaches to regulation-compliant software evolution?
- How can languages for expressing and implementing policies best manage tradeoffs between expressibility and analyzability?
- What specialized domain- and regulation-specific programming languages are needed to develop these programs?
- What are the novel formal verification and validation techniques needed to ensure and/or demonstrate compliance to stakeholders?
- Can formal methods identify and suggest reasonable alternatives/repairs to sets of interacting regulations that are inconsistent across stakeholders, contexts, or time?
- How can methods provide for meaningful involvement of policy stakeholders in software development processes throughout the software lifecycle?
- How might methods designed to allow flexible policy implementation support rapid prototyping of more and less likely intended consequences of proposed regulation, as well as unintended consequences and harms?
- What methodologies can be used to predict and understand how changes in regulation affect software and its consequences?

Projects are limited to $750,000 in total budget, with durations of up to three years.

Proposals should lead to novel advances in both (1) understanding the social, behavioral, economic, and/or legal context of software design and (2) improving the methodology for designing accountable software beyond specific use cases. These contributions do not have to be equal, but proposals where one side is primarily in service of the other are not in scope. Further, PIs considering proposals in domain areas aligned with existing NSF solicitations (for instance, but not limited to, Fairness in AI, Secure and Trustworthy Cyberspace, and Future of Work at the Human-Technology Frontier) should justify how the contributions being proposed will impact the design of accountable software systems, not just the specific domain area, and are encouraged to choose the solicitation that best fits the intended contributions.

To these ends, all proposals must have:

a. at least one PI or co-PI with expertise in software design and at least one PI or co-PI with expertise in law or a social, behavioral, or economic science;
b. a detailed collaboration plan (included as a supplementary document) that leverages the complementary expertise of the PIs/co-PIs in the designated areas and describes the mechanisms for continuous bi-directional interaction; and
c. a separate section in the project description titled "Relevance to DASS" that defines the proposal's notion of accountability in the social and legal context in which it is being studied and how an understanding of these contexts will be used in the design of accountable software. This section should also discuss the specific research contributions to both general principles of software design beyond implementing specific systems, and to law and/or a social, behavioral, or economic science, as well as the potential broader impact with respect to the goals of the DASS program.

DASS PI Meetings

The DASS program is aiming to grow a new research community. In this spirit, the program plans to host a PI meeting in the fall of 2022, to be held in the U.S., with participation from funded investigators (at least one collaborating PI/co-PI focusing on software design and at least one PI/co-PI focusing on law or a social, behavioral or economic science must attend this PI meeting), along with other representatives from the research community, government, and industry.

III. AWARD INFORMATION

Anticipated Type of Award: Continuing Grant or Standard Grant

Estimated Number of Awards: 10

Anticipated Funding Amount: $7,500,000

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

Who May Serve as PI:

By the submission deadline, any PI, co-PI, or other senior project personnel must hold either:

- a tenured or tenure-track position, *or*
- a primary, full-time, paid appointment in a research or teaching position

at a U.S.-based campus of an organization eligible to submit to this solicitation (see above), with exceptions granted for family or medical leave, as determined by the submitting organization. Individuals with *primary* appointments at for-profit non-academic organizations or at overseas branch campuses of U.S. institutions of higher education are not eligible.

All projects must have at least one PI or co-PI with expertise in software design and at least one PI or co-PI with expertise in law or the social, behavior or economic sciences.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

These eligibility constraints will be strictly enforced in order to treat everyone fairly and consistently. In the event that an individual exceeds this limit, only the first proposal received before the deadline will be considered, and the other proposals will be returned without review. **No exceptions will be made.**

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

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

- Full Proposals submitted via Research.gov: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal and Award Policies and 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) 292-8134 or by e-mail from nsfpubs@nsf.gov. The Prepare New Proposal setup will prompt you for the program solicitation number.
- 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) 292-8134 or by e-mail from nsfpubs@nsf.gov.

In determining which method to utilize in the electronic preparation and submission of the proposal, please note the following:

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via Research.gov. PAPPG Chapter II.D.3 provides additional information on collaborative proposals.

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.

The following information supplements the guidelines and requirements in the NSF PAPPG and NSF Grants.gov Application Guide:

Titles:
Proposal titles must indicate the **DASS** program, followed by a colon and the title of the project. For a collaborative proposal (that is, one submitted as separate submissions from multiple organizations), all participating organizations should use the same title, which should begin with **Collaborative Research** followed by a colon. Thus, a single-organization proposal would have a title of the form **DASS: Title**, and a collaborative proposal would use the form **Collaborative Research: DASS: Title**.

Project Summary:

All proposals are encouraged to include a short list of keywords describing the research to be undertaken. The keywords should be entered at the end of the Broader Impacts section and should begin with "Keywords:" and be separated by ";".

Project Description:

Proposals should have a separate section in the project description titled "Relevance to DASS" that defines the proposal's notion of accountability in the social and legal context in which it is being studied and how an understanding of these contexts will be used in the design of accountable software. This section should also discuss the specific research contributions to both general principles of software design beyond implementing specific systems, and to law and/or a social, behavioral, or economic science, as well as the potential broader impact with respect to the goals of the DASS program.

Budget:
Each proposal must include the costs of attending the DASS PI meeting as part of the budget for the first year of the project. The budget should cover

participation by the PIs and co-PIs, as described above under "DASS PI Meeting".

Supplementary Documents:

1. **Collaboration Plan**: All projects are required to include a Collaboration Plan submitted by the lead organization as a separate Supplementary Document (limited to 2 pages). This plan must clearly describe the distinct expertise provided by the PIs as required above under "Who May Serve as PI" as well as plans for working together to advance knowledge in both software design, and law or social, behavioral, and economic sciences. Joint supervision of students and postdoctoral researchers is strongly encouraged. The collaboration plan must also describe clear measures of success for all aspects of the project and a plan for evaluating success. **Projects without this document will be returned without review.**

2. **Data Management Plan**: All proposals are required to include a Data Management Plan as a separate Supplementary Document (limited to 2 pages). This plan must address the dissemination of the algorithmic contributions and resulting applications, tools, languages, compilers, libraries, architectures, systems, software, architectures, data, etc. Open-source release of these artifacts is strongly encouraged. **Proposals without this document will not be accepted or will be returned without review.**

Submission Checklist:

In an effort to assist proposal preparation, the following checklist is provided as a reminder of the items that should be checked before submitting a DASS proposal to this solicitation. This list is a summary of the requirements described above. For the items marked with (RWR), the proposal will be returned without review if the required item is non-compliant as of the date of proposal submission.

- (RWR) Each proposal **must** have at least one Principal Investigator (PI) or co-PI with expertise in software design (broadly defined as research in formal methods, programming languages, software engineering, requirements engineering, and human-centered computing) and at least one PI or co-PI with expertise in law or a social, behavioral, or economic science (broadly defined as researchers who study social systems and networks, culture, social norms and beliefs, rules, canons, precedents, legal code, and routine procedures that govern the conduct of people, organizations, and countries.)
- (RWR) The Project Description **must** have a section labeled "Relevance to DASS" that defines "accountability" in the proposal's context and discusses the specific contribution of the research with respect to the goals of the DASS program.
- (RWR) A collaboration plan (up to 2 pages) **must** be provided as a Supplementary Document, even if all investigators are affiliated with the same organization.
- (RWR) Maximum budget shown on the Cover Sheet and on the budget sheets **must** not exceed $750,000.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

C. Due Dates

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

    January 28, 2022

    January 27, 2023

D. Research.gov/Grants.gov Requirements

For Proposals Submitted Via Research.gov:

To prepare and submit a proposal via Research.gov, see detailed technical instructions available at: https://www.research.gov/research-portal/appmanager/base/desktop?_nfpb=true&_pageLabel=research_node_display&_nodePath=/researchGov/Service/Desktop/ProposalPreparationandSubmission.html. For Research.gov user support, call the Research.gov Help Desk at 1-800-673-6188 or e-mail rgov@nsf.gov. The Research.gov Help Desk answers general technical questions related to the use of the Research.gov 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 Research.gov may use Research.gov 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 *Building the Future: Investing in Discovery and Innovation - NSF Strategic Plan for Fiscal Years (FY) 2018 – 2022*. 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 other underrepresented groups 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

Proposals will be evaluated on the basis of the following solicitation-specific review criteria:

1. the extent to which the proposal makes fundamental contributions towards understanding the social, behavioral, economic, and/or legal context of accountable software design and improving the methodology for designing accountable software beyond specific use cases, and
2. the extent to which the collaboration plan ensures the proposed collaboration will indeed deliver the expected results.

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel 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) 292-8134 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.

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.

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:

- Nina Amla, Program Director, CISE/CCF, telephone: (703) 292-7991, email: dass@nsf.gov

- Anindya Banerjee, Program Director, CISE/CCF, telephone: (703) 292-7885, email: dass@nsf.gov

- Sara Kiesler, Program Director, SBE/SES, telephone: (703) 292-8643, email: dass@nsf.gov

- Sol J. Greenspan, Program Director, CISE/CCF, telephone: (703) 292-8910, email: dass@nsf.gov

- Reggie S. Sheehan, Program Director, SBE/SES, telephone: (703) 292-5389, email: dass@nsf.gov

- Jeremy J. Epstein, Program Director, CISE/CNS, telephone: (703) 292-8338, email: dass@nsf.gov

- Daniel R. Cosley, Program Director, CISE/IIS, telephone: (703) 292-8832, email: dass@nsf.gov

For questions related to the use of FastLane or Research.gov, contact:

- FastLane and Research.gov Help Desk: 1-800-673-6188
- FastLane Help Desk e-mail: fastlane@nsf.gov.
- Research.gov Help Desk e-mail: rgov@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 https://www.grants.gov.

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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.

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>
> - **For General Information** (NSF Information Center)**:** (703) 292-5111
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> - **TDD (for the hearing-impaired):** (703) 292-5090
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> - **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 System of Record Notices, NSF-50, "Principal Investigator/Proposal File and Associated Records," and NSF-51, "Reviewer/Proposal File and Associated Records." 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
Policy Office, Division of Institution and Award Support
Office of Budget, Finance, and Award Management
National Science Foundation
Alexandria, VA 22314

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