Partnerships for Innovation: Building Innovation Capacity (PFI:BIC)

PROGRAM SOLICITATION
NSF 15-610

REPLACES DOCUMENT(S):
NSF 14-610

National Science Foundation

Directorate for Engineering
Industrial Innovation and Partnerships

Directorate for Computer & Information Science & Engineering
Division of Computer and Network Systems
Division of Information & Intelligent Systems

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

December 02, 2015

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

January 27, 2016

IMPORTANT INFORMATION AND REVISION NOTES

Partnerships for Innovation: Building Innovation Capacity (PFI:BIC) supports academe-industry partnerships, which are led by an interdisciplinary academic research team collaborating with at least one industry partner in order to carry out research to advance, adapt, and integrate **technology(ies)** into a **specified, human-centered smart service system**. The selected service system should function as a technology test bed.

Partnership projects are unrestricted as to domain knowledge and application areas and should be in the translational, pre-commercialization space, building on fundamental research discoveries with the objective of creating or transforming a “smart(er)” service system that has the potential for significant social and economic impact.

This program solicitation is pursuant to program solicitation NSF 14-610. Proposers should review all solicitation requirements carefully before submitting a proposal. Only major revisions to this solicitation are noted below.

Minimum partnership requirement. One **primary partner** that is either a for-profit or a not-for profit industrial partner (also known as a corporate or a business partner) **that has commercial revenues**. It is essential that a designated minimally-qualifying industrial partner have experience with having brought a product, process, service, or system to the marketplace, thereby providing an informed business perspective to the academe-industry team.

Research plan. In the Project Description, the description of the research plan now must include a discussion of the synergies and new knowledge expected from the interdisciplinary and cross-organizational research involved in the PFI:BIC partnership project.

Project framework. The Project Framework, formerly Supplementary Document (1), has been embedded in the Project Description.

Preliminary patent search (optional). The Preliminary Patent Search, formerly Supplementary Document (6), is now optional. For some projects, it may serve as a partial demonstration of knowledge of the competitive landscape and state-of-the-art. (See Project Description, Part 1A).

Additional merit review criteria. See the "Other Additional Review Criteria" section for changes. Examine these criteria carefully.

Important Information

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised NSF Proposal & Award Policies & Procedures Guide (PAPPG) (NSF 16-1). NSF anticipates release of the PAPPG in the Fall of 2015 and it will be effective for proposals submitted, or due, on or after January 25, 2016. Please be advised that proposers who opt to submit prior to January 25, 2016, must also follow the guidelines contained in NSF 16-1.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Partnerships for Innovation: Building Innovation Capacity (PFI:BIC)

Synopsis of Program:

The Partnerships for Innovation: Building Innovation Capacity (PFI:BIC) program supports academe-industry partnerships which are led by an interdisciplinary academic research team collaborating with a least one industry partner. In this program, there is a heavy emphasis on the quality, composition, and participation of the partners, including the appropriate contributions for each role. These partnerships focus on the integration of technologies into a specified human-centered service system with the potential to achieve transformational change, satisfying a real need by making an existing service system smart(er) or by spurring the creation of an entirely new smart service system. The selected service system should function as a test bed.

Service systems are socio-technical configurations of people, technologies, organizations, and information [1] designed to create value by fulfilling the needs of those participating in the system. A **"smart" service system** is a system that amplifies or augments human capabilities [2] to identify, learn, adapt, monitor and make decisions. The system utilizes data received, transmitted, or processed in a timely manner, thus improving its response to future situations. These capabilities are the result of the incorporation of technologies for sensing, actuation, coordination, communication, control, etc.

PFI:BIC funds research partnerships working on projects that operate in the post-fundamental/translational space; the proposers must be mindful of the state of the art and the competitive landscape, yet recognize that it is not a central task in this proposal to carve out, or be on, a clear path to commercialization. These projects require additional effort to integrate the technology into a real service system, incorporating human factors considerations to assure the system's efficacy. The research tasks in turn might spawn additional discoveries inspired by this interaction of humans with the technology.

Partnership activities that drive sustained innovation include the targeted allocation of resources such as capital, time, and facilities; and sharing of knowledge in a cross-organizational and interdisciplinary context. The research tasks of the project must demonstrate a highly collaborative research plan involving participation of the primary industrial partner(s) as well as of any other primary partners with the academic researcher during the life of the award.

NSF recognizes that a highly interdisciplinary collaboration involving many areas of expertise beyond those related to the technology is needed to achieve successful integration into a smart service system. The research components to be included in this project are: 1) engineered system design and integration; 2) computing, sensing, and information technologies; and 3) human factors, behavioral sciences, and cognitive engineering. **The proposer must show how these components will be integrated in the context of the project as part of the research plan in the Project Description.**

WEBINARS: Webinars will be held to answer questions about the solicitation. Register on the PFI:BIC website where details will be posted (http://www.nsf.gov/eng/iip/pfi/bic.jsp). Potential proposers and their partners are encouraged to attend. Also encouraged to attend are the following stakeholders in the successful review of PFI:BIC proposals: Vice Presidents for Research, Vice Presidents for Research and Innovation, and academic personnel concerned with the review of their respective institution's selection of candidates for submission, individuals from Sponsored Research Offices, and those focused on the identification and understanding of limited application submissions.

[1] Spohrer, J., Maglio, P., Bailey, J., Gruhl, D. (2007). Steps towards a science of service systems. Computer 40(1):71-77. doi:10.1109/MC.2007.33.

[2] Ng, I. (2015). The Internet of Everything and the Future of Service. Speech, 2015 Frontiers in Service Conference in San Jose, CA. Accessible online at: http://hubofallthings.com/hat-in-the-usa/.

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.

- Sara B. Nerlove,ENG/IIP/PFI:BIC, Program Director, telephone: (703) 292-7077, email: snerlove@nsf.gov
- Alexandra Medina-Borja,ENG/OAD, telephone: (703) 292-7557, email: amedinab@nsf.gov
- Gurdip Singh,CISE/CNS, telephone: (703) 292-8950, email: gsingh@nsf.gov
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Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.041 --- Engineering
- 47.070 --- Computer and Information Science and Engineering

Award Information

Anticipated Type of Award: Standard Grant

Estimated Number of Awards: 10

Anticipated Funding Amount: $10,000,000

- Anticipated Funding Amount is subject to the availability of funds and the quality of proposals received.
- Awards may be up to $1,000,000 with an award duration of three (3) years.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- U.S. universities and two-and four-year colleges (including community and technical colleges) accredited in, and having a campus located in the U.S., acting on behalf of their faculty members. Such organizations are also referred to as academic institutions. The lead (submitting) organization must be an academic institution.

  For a single project, only one proposal should be submitted, and the lead academic institution should be the submitter. Additional partners that will be compensated via the grant should participate as subawardees in the proposal (rather than submitting a separate proposal); i.e., no separately submitted collaborative proposals will be accepted.

Who May Serve as PI:

The PI cannot concurrently be a PI on more than one active PFI:BIC award.

Limit on Number of Proposals per Organization: 2

Academic institutions are limited to participation on two (2) proposals as a lead institution, preferably involving distinct application areas.

A lead academic institution that has submitted a proposal has the option to participate as a subawardee on additional proposals submitted under this solicitation. Lead academic institutions that have submitted a proposal may also provide consultants to other proposals submitted under this solicitation.

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

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, Part I: Grant Proposal Guide (GPG) Guidelines apply. The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg.
  - 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: http://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. proposer's local time)***:***

  December 02, 2015

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

  January 27, 2016

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: Standard NSF award conditions apply.

Reporting Requirements: Standard NSF reporting requirements apply.

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I. INTRODUCTION

National economic and societal well-being is dependent upon research and technology-based innovation. NSF's role of supporting fundamental research across all fields of science and engineering has become ever more relevant to economic competitiveness and value creation. The Partnerships for Innovation: Building Innovation Capacity (PFI:BIC) program establishes and expands partnerships, providing the motivation and foundation to build on fundamental research discoveries in technological areas with high potential for effective integration into service systems. These strategic partnerships, which create an academe-industry collaborative culture, are in a position to advance and adapt technologies elucidated by human factors research in the context of a specified human-centered, smart service system.

Other federal programs also contribute to the goal of innovation. Internal to NSF, there are the following programs: Partnerships for Innovation: Accelerating Innovation Research (PFI:AIR), Innovation Corps (I-Corps™), Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR), Grant Opportunities for Academic Liaison with Industry (GOALI), and Industry University Cooperative Research Centers (I/UCRC). For more information on these programs, go to the Division of Industrial Innovation and Partnerships website: http://www.nsf.gov/div/index.jsp?org=IIP.

II. PROGRAM DESCRIPTION

The National Science Foundation invites requests for funding in the area of smart service systems under this Partnerships for Innovation: Building Innovation Capacity (PFI:BIC) solicitation. The hallmark of PFI:BIC is an academe-industry partnership crafted to collaborate on research to advance and adapt key technology(ies) for integration into a specified human-centered smart service system. Sensing, actuating, and computational and communication technologies and their integration into smart service systems have the potential for abundant societal and economic benefits.

The perspectives, competencies, and commitments of both academe and industry are needed to address the central issue of advancing and adapting technology to interact with humans in order to create or add value in a service system. Knowledge gained in the course of the integration process may generate additional research activities and additional discoveries that will become essential part(s) of the system. A clear understanding of the state of the art of the technologies and the competitive landscape of the proposed service system should help not only to guide project activities, but also to act as a filter when a proposer and his/her institution is deciding whether a project is a viable candidate for submission.

Service systems are socio-technical configurations of people, technologies, organizations, and information [1] designed to create value by fulfilling the needs of those participating in the system. A **"smart" service system** is a system that amplifies or augments human capabilities [2] to identify, to learn, to adapt, to monitor and to make decisions. The system does so through self-detection, self-diagnosing, self-correcting, self-monitoring, self-organizing, self-replicating, or self-controlled functions. The system utilizes data received, transmitted, or processed in a timely manner, thus improving its response to a future situation. These capabilities are the result of the incorporation of technologies for sensing, actuation, coordination, communication, control, etc.

These technologies are inspired by fundamental research discoveries and should have the potential to achieve transformational change in an existing service system or to spur the creation of entirely new systems. The technologies themselves may or may not be considered “smart”; however, the creative way in which they are designed, configured, and integrated into a service system makes the system exhibit smart behavior. For example, research in cyber-physical systems (CPS), has enabled creation of systems that collect large amounts of data, analyze them in conjunction with historical data, and control/actuate the physical components in real-time. CPS research can be effectively leveraged in the creation of smart services in PFI:BIC partnership projects. **Proposals must specify a service system to function as a technology test bed and include activities for testing and evaluating the system’s efficacy in this real life service environment.**

First and foremost, a signature characteristic of service systems in the NSF context is a smart service system that is human-

centered. Human interaction with technologies and with physical and virtual realities can produce and deliver service(s) never before imagined. A human-centered service system involves stakeholders (e.g., users, recipients, beneficiaries, providers, and/or decision makers) utilizing the information and capability provided by the service system. Additionally, the interactions need to add value to a human or group(s) of humans who ultimately benefit from the interactions.

Smart cities, smart transportation, precision agriculture, smart healthcare, and smart infrastructure are all examples of service systems with the potential to improve quality of life. Solutions to improve government services, including self-service and customized service technologies, are also likely to improve efficacy and quality. Examples of other service systems where smart technologies could make a difference include disaster mitigation and humanitarian services, communication services, and utilities, to name a few [3]. In addition, with more frequent and ubiquitous use of networks that link information, people, processes, and products, manufacturing firms are increasingly developing service solutions [4][5]. Smart technology will undoubtedly be needed to adapt supply chains to this new manufacturing paradigm shift where again, the human element will be central [6].

Academe-Industry Partnerships

Strong PFI:BIC partnerships are characterized by the partners' expertise, experience, and significant measurable commitment to the project, with clear contributions as well as technical and/or economic "takeaways" [7] for all parties involved. The partnership should be crafted to achieve research accomplishments that would not have been possible without the interdisciplinary expertise and the joint perspectives of academe and industry at a formative stage. Moreover, it should be clear how the partners specifically complement each other in the context of the project. It follows that **it is very important that the partners (each and every one of them) have vetted the proposal and are clear about where they each fit in the larger collaborative research effort.**

The primary members of a partnership are an academic research team and at least one industry partner. At least one industry partner or appropriate entity in a support role is expected to contribute understanding of the state of the art and the competitive landscape. Individual projects might require different configurations of partners, depending on the position of potential partners with regard to the final users, and the nature of the service system. Therefore, variation in the numbers and types of partners is anticipated. For the purposes of submitting a proposal to this solicitation, partners can be placed in the following broad categories.

- **Minimally qualifying primary partner.** A minimum of one (1) industry partner of any size is required. This partner (i.e., either a for-profit or not-for-profit entity that fulfills the minimum requirement) must be U.S.-based and have commercial revenues that include sales, services, or licensing. Grants and government contracts may contribute to its revenues but may not constitute the entirety of its revenues. It is essential that the minimally qualifying industrial partner has experience with bringing a product, process, service or system to the marketplace in order to ensure that the team incorporates an “empirically-based” business perspective. **Note:** In regard to industrial partners, subawards can only be allocated to small businesses that meet the SBIR program eligibility requirements: (http://sbir.gov/sites/default/files/elig_size_compliance_guide.pdf). See the Additional Eligibility Information section for details. Note also that in regard to academic partners, subawards may be allocated to other academic institutions.

- **Additional primary partner(s).** When the requirement of a minimum of one (1) primary industrial partner has been met, other partners, such as academic institutions, non-profit organizations including foundations, public sector organizations, and additional industry partners, including start-ups as well as other “qualifying” partners, can be selected as additional primary partners at the discretion of the PI. In short, the choice of other partners is essentially wide open. Partners should be chosen with care so as to include explicit knowledge about “smart” service systems and/or to cover the areas of expertise required in addition to those related to the technology to be included in the project.

- **Broader context partner(s).** Broader context partners belong to all of the same categories as primary partners. They are unlikely to appear as participating in the project tasks as presented in the Project Description. Nonetheless, each broader context partner has a role and is **required to supply a Partner Letter with a statement of explicit commitment.** The role of a **broader context partner**, while meaningful, is not as central as the role of a primary partner, and no Cooperative Research Agreement may be needed.

To facilitate the partners' collaboration in an open innovation context, NSF will require signed written **cooperative research agreements (CRAs)** between the lead institution and the primary industrial partner(s) and other applicable partners **at the time of the PFI:BIC Program's *consideration for recommendation* for an award.** It is anticipated that PI typically will be notified that he/she is being considered for an award within one to two months after the last panel of the cycle has been convened. Note that the lead institution and all partners must understand that this event occurs prior to the NSF grants office issuing an award letter. See the Supplementary Documents section for more details.

[1] Spohrer, J., Maglio, P., Bailey, J., Gruhl, D. (2007). Steps towards a science of service systems. Computer 40(1):71-77. doi:10.1109/MC.2007.33.

[2] Ng, I. (2015). The Internet of Everything and the Future of Service. Speech, 2015 Frontiers in Service Conference in San Jose, CA. Accessible online at: http://hubofallthings.com/hat-in-the-usa/.

[3] Note that examples have been provided in this solicitation to offer a sense of the variety of possibilities across types of service systems and the forefront technologies that would allow them to achieve their apex of effectiveness and efficiency, but they are not intended to represent program emphases or priorities.

[4] Vandermerwe, S. and Rada, J. (1988). Servitization of business: Adding value by adding services, European Management Journal, Volume 6, Issue 4, Winter, pp. 314-324.

[5] Turunen, T. (2013). Organizing Service Operations in Manufacturing. Aalto University publication series, Doctoral dissertations, 4/2013. Permanent link: http://urn.fi/URN:ISBN:978-952-60-4962-5

[6] Georgia Tech. "Research @ Tech." *Supply chains and logistics make room for 3D printing.* December 11, 2013. http://www.research.gatech.edu/news/supply-chains-and-logistics-make-room-3d-printing (accessed June 11, 2014).

[7] "Takeaways" are defined as capabilities, competencies, or more tangible items that one can take possession of and can move forward with (versus a benefit that may be merely received and enjoyed). Takeaways are for the primary partners--academe, business, and other--and also include the strategy that has the potential to build innovation capacity. The growth and development of students in the context of being integral to the PFI:BIC partnership project are also considered to have the potential to build innovation capacity.

III. AWARD INFORMATION

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

NSF will make awards subject to the availability of funds and quality of proposals. Awards may be up to $1,000,000, with an award duration of three (3) years. *In other words, the **total** budget request to NSF for the lead institution and all others participating in the project cannot exceed $1,000,000. Ten awards of $1,000,000 each are anticipated.*

As appropriate, awardees have the option to allocate funds for the participation of those primary industrial partners that are small businesses and meet the SBIR program eligibility requirements: (http://sbir.gov/sites/default/files/elig_size_compliance_guide.pdf) as well as for academic partners in the project research activities in the form of subawards. Whether or not the option to allocate funds to the partners is exercised, it should be clear how the funds and other resources of the project (e.g., special facilities, equipment, and students) are shared by the partnership.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

- U.S. universities and two-and four-year colleges (including community and technical colleges) accredited in, and having a campus located in the U.S., acting on behalf of their faculty members. Such organizations are also referred to as academic institutions. The lead (submitting) organization must be an academic institution.

  For a single project, only one proposal should be submitted, and the lead academic institution should be the submitter. Additional partners that will be compensated via the grant should participate as subawardees in the proposal (rather than submitting a separate proposal); i.e., no separately submitted collaborative proposals will be accepted.

Who May Serve as PI:

The PI cannot concurrently be a PI on more than one active PFI:BIC award.

Limit on Number of Proposals per Organization: 2

Academic institutions are limited to participation on two (2) proposals as a lead institution, preferably involving distinct application areas.

A lead academic institution that has submitted a proposal has the option to participate as a subawardee on additional proposals submitted under this solicitation. Lead academic institutions that have submitted a proposal may also provide consultants to other proposals submitted under this solicitation.

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

Additional Eligibility Info:

Minimally Qualifying Industrial Partner. A minimum of one (1) minimally qualifying U.S.-based industrial partner organization must participate on the PFI:BIC proposal. The partner must have commercial revenues that include sales, services, or licensing. Grants and government contracts may contribute to its revenues but may not constitute the entirety of its revenues.

Subawards or Direct Funds from the Grant. Only those industrial partners that are small businesses and meet the SBIR program eligibility requirements: (http://sbir.gov/sites/default/files/elig_size_compliance_guide.pdf) can receive subawards. Note that the lead institution may also allocate funds for subawards to academic institutional partners.

Project Team. Because service systems are socio-technical systems requiring understanding of people, organizations, and information, the team and the project must contain expertise and activity that reflect these requirements. Note that in addition to the discipline or disciplines related to the technology, there is also a range of other expertise based on multiple disciplines and comprising the three components needed to achieve successful integration into a smart service system that must be included in this project. They are as follows: 1) engineered service system design and integration; 2) computing, sensing, and information technologies; and 3) human factors, behavioral sciences, and cognitive engineering. **Teams not experienced with service engineering might benefit from consulting with an individual with expertise in service operations or service systems.** NSF recognizes that the labels for the aforementioned disciplines may vary in different institutions and organizations. Thus, it is important to demonstrate the equivalence of the representation of these disciplines to the required components of the project. NSF also recognizes that expertise and experience can be demonstrated in myriad ways, including teaching assignations, degrees, publications, and other professional activities and accomplishments. **The proposer will be asked to show how the three components will be integrated in the context of the project as part of the research plan in the Project Description.**

Human Subjects. Because of the necessity for the service system to be human-centered, research activities that focus on human beings are essential, while those that involve “Human Subjects” are likely to be necessary. PIs must consult with their Institutional Review Board (IRB) about their research in regard to human subjects, needed authorizations, and irrespective of the determined status, must provide documentation. See GPG, Chapter II.D.8 for more information. Note that Chapter II.D.8, Proposals Involving Human Subjects, has been supplemented to clarify that the only acceptable IRB approval documents are those that approve a human subjects research protocol, and approvals "in concept" or conditional IRB documents are not acceptable. Guidance also is provided on the procedure to follow if IRB approval cannot be obtained at the time of the award action because the development of a human subjects research protocol requires preliminary or other conceptual work to take place.

This includes cases where the research plan involves substantial allocation of time to device development before the design of the experimentation with humans can proceed. Additional guidance concerning research involving human subjects can be found here: https://www.nsf.gov/bfa/dias/policy/human.jsp.

Animal Studies. In some contexts, animal studies are an important prelude to, and/or may be needed in addition to, the involvement of human subjects. (See Human Subjects above.) PIs should be knowledgeable about whether they will need to seek Institutional Animal Care and Use Committee (IACUC) approval. See GPG, Chapter II.D.7. Any project proposing use of vertebrate animals for research or education shall comply with the Animal Welfare Act [7 U.S.C. 2131, et seq.] and the regulations promulgated thereunder by the Secretary of Agriculture [9 CFR 1.1-4.11] pertaining to the humane care, handling, and treatment of vertebrate animals held or used for research, teaching or other activities supported by Federal awards. In accordance with these requirements, proposed projects involving use of any vertebrate animal for research or education must be approved by the submitting organization's IACUC before an award can be made. For this approval to be accepted by NSF, the organization must have a current Public Health Service (PHS) Approved Assurance.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Letters of Intent *(required):*

To submit a proposal for this opportunity, the submission of a Letter of Intent (LOI) by the lead institution (i.e., the proposing institution) is required. LOIs are to be submitted via FastLane at http://fastlane.nsf.gov/.

PURPOSE

The LOI is a pre-requisite to proposal submission.

- LOIs are necessary to help NSF prepare and deliver the best review process possible, including assembling panels with appropriate reviewer expertise that encompasses all the research components of the project.
- LOIs provide the NSF with an opportunity to examine proposed projects with respect to some eligibility requirements and, in some instances, to identify correctible issues in terms of focus and eligibility.

The LOI will **NOT** be used as a screening device; that is, it will not be used to disallow the submission of a full proposal.

In the event that there are changes regarding the LOI prior to submission of the proposal, it is important to communicate those changes to the Program Director (Dr. Sara Nerlove, telephone: (703) 292-7077, email: snerlove@nsf.gov).

SUBMISSION.

Up to two (2) LOIs per institution can be submitted.

CONTENT/FORMAT

Letters of intent have length limitations. The first two sections, **Synopsis** and **Other Comments** (each 2500 characters maximum, including spaces), should be used to convey important aspects of the project, such as information about the areas of expertise that comprise the three required components of this project: 1) engineered service system design and integration; 2) computing, sensing, and information technologies; and 3) human factors, behavioral sciences, and cognitive engineering.

Under **Additional Information**, three (3) data fields are provided. Each data field can contain a maximum of 255 characters or approximately 30 words for each section. For PFI:BIC, these are as follows:

- **Test Bed for Technology Integration:** Briefly describe the technology-based “smart” service system and how the technology will contribute to its efficacy.
- **Primary Industrial Partner(s):** Provide for each: Name, Founding Date, Number of Employees, Location (City & State), Commercial Revenues for the preceding calendar year, and Project Role (s). Reasonable abbreviations can be used. If you cannot accommodate the information, include the rest of the information under Other Comments (see above).
- **Human Factors Research Tasks** to be carried out which are ***essential to the operation of the smart service system.*** List a few major research activities which illustrate inclusion of human-centered considerations

If the limited spaces designated for Primary Industrial Partners and/or Human Factors Research Tasks are not sufficient, the **Other Comments** section may be used to describe these aspects of the project.

Under **Point of Contact for NSF Inquiries**, place the name of the PI, a phone number (preferably a direct line to the PI, for further inquiry), his/her e-mail address, and the submitting department or unit.

Under **Submitter Information**, place the information for the Sponsored Research Office/Sponsored Program Offered (SRO/SPO) individual who submitted the LOI

Under **Senior Project Personnel**, list up to 4 official Co-PIs first. Note that the maximum number of individuals appearing on the NSF Cover Page is 5, which includes the PI; note that the PI has already been listed as the point of contact.

Instead of listing the department of these Senior Project Personnel, list their respective fields of science and engineering expertise represented on this project in order to convey the maximum amount of information about the areas of expertise to be included in the project.

There may be sufficient lines to accommodate additional (i.e., Non-Co-PI) Senior Project Personnel on the form. Note that official Co-PIs (those who will be listed on the Cover Page of the proposal) need not all be employed by the lead institution.

Under **Participating Organizations**, list up to 4. In order to **provide a maximum amount of non-redundant information**, include partner organizations other than the lead institution and the primary industrial partner(s), since the aforementioned organizations will

appear earlier on the LOI form; respectively, under **Project PI Information** and under **Additional Information**, second data field, **Primary Industrial Partner(s)**.

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:

- Sponsored Projects Office (SPO) Submission is required when submitting Letters of Intent
- A Minimum of 1 and Maximum of 4 Other Senior Project Personnel are allowed
- A Minimum of 1 and Maximum of 4 Other Participating Organizations are allowed
- Test Bed for Technology Integration is required when submitting Letters of Intent
- Primary Industrial Partner(s) is required when submitting Letters of Intent
- Human Factors Research Tasks is required when submitting Letters of Intent
- Submission of multiple Letters of Intent is not allowed

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 Grant Proposal Guide (GPG). The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg. Paper copies of the GPG 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: (http://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.

Guide to Submission of a Full Proposal

Note: the submission criteria outlined below are in addition to requirements contained within the NSF Grant Proposal Guide (GPG) or NSF Grants.gov Application Guide.

It is essential that the partners (each and every one of them) have vetted the proposal and are clear about where they each fit in the larger collaborative effort. Active and early collaboration among the primary project partners is highly encouraged, beginning with the LOI preparation stage, including a discussion about the content and requirements of a fully executed (signed and dated by all parties) Cooperative Research Agreement (CRA). Note CRAs are to be submitted only after notification that the program is considering a recommendation for award. Therefore, please do not submit draft CRAs with the proposal. Instead, the lead academic institution shall submit a promissory letter stating that the institution will submit fully executed (signed and dates by all parties) CRA(s), if the proposal is being considered for an award **within no more than 6 weeks after the notification that the PFI:BIC Program is considering the proposal for an award**. It is important that all the partners that will be participating as signatories on a CRA be fully aware that this is a requirement of participating in the PFI:BIC Program.

A. Cover Sheet

The Cover Sheet is automatically generated by FastLane or Grants.gov based on information entered into the "Cover Sheet" module. The title for each project should be preceded by PFI:BIC. If the project contains proprietary information, be sure that the box labelled Proprietary and Privileged Information is marked.

B. Project Summary

Proposals that do not contain the Project Summary, including an **overview** and separate statements on **intellectual merit** and **broader impacts**, will not be accepted by FastLane or will be returned without review. Additional instructions for preparation of the Project Summary are available in FastLane. The Project Summary should be written in the third person and shall begin as follows: "This Partnerships for Innovation: Building Innovation Capacity (PFI:BIC) project...." Provide the title of the proposed PFI:BIC project, the name of the PI, and the lead institution.

- Box 1: Overview including Naming the Primary Industry Partner(s), and Key Words: A summary paragraph describing the potential outcome(s) of the proposed activity. Provide a statement of objectives and methods to be employed. Provide a list of key words or phrases that identify the areas of expertise in science or engineering that are to be invoked in reviewing the proposal. Identify the application area to which the smart service system innovation is to be initially directed, i.e., the test bed.
- Box 2: Intellectual Merit: No proprietary information should be included in the summary. Describe the potential of the proposed activity to enhance scientific and technological understanding both at the level of the technology and of the smart service system.
- Box 3: Broader Impacts: Describe the potential of the proposed activity to contribute to economic impact and contribute to the achievement of specific, desired societal outcomes. Information on the potential commercial value can be included in this section.

The aggregate of the three text boxes cannot exceed 4,600 characters, including spaces.

C. Table of Contents

The table of contents is automatically generated by FastLane or Grants.gov.

D. Project Description

The project description cannot exceed 15 pages and must include the following parts:

Part 1. Narrative Description

1.A Project Framework

Proposers (primary academic and industrial partner(s) and other primary partners, if applicable) are encouraged to define the proposed smart service system and frame the proposal narrative to convey a convincing story. That is, rather than simply describing the potential of the technology, and the research plan, the proposers should first present a clearly articulated, compelling case as to why this partnership provides the best approach for achieving the greatest impact.

Proposers should address the following in separate subsections (use a two-page table format, template here).

- **Broader Impacts of the Proposed Work.**PFI projects must address a need or gap driven by social and/or economic factors. Include the economic rationale and market needs that might be addressed. Frame the focus of the project research as a problem, addressing the need (broader impact)—point to potential setbacks due to economic limitations and discuss the risk-reward ratio of the research.
- **Solution:** Describe how this problem could be solved by the systems integration of the proposed technology into a smart(er) service system —Describe: (1) the test bed, (2) the design architecture of the service system (systems level composition of the services and data flows), (3) the value delivered by the "smart" service system to the stakeholders. Answer the following questions: What makes your system smart? What evidence supports the efficacy of your proposed system?
- **Competitive Landscape.** Demonstrate the team's knowledge about the competitive landscape for the proposed service system featured as the test bed and the state of the art for the technology(ies) by describing how the particular solution proposed is distinct from what exists. A detailed market analysis is premature and not necessary, but proposers should address the following question: What makes your system original or unique? Evidence that all of the primary partners have assessed the potential barriers or limitations to the eventual implementation of the outcome(s) of this effort, including technical, economic, social (e.g. security and privacy issues), legal, and environmental barriers, etc. A Letter of Support from participant(s) in the market may lend credibility to this assessment (see Supplementary Document 6).
- **Partners.** Describe the primary project partners and how they were selected. Why is this partnership the appropriate partnership to carry out this project?
- **Contributions.** Describe the specific contributions (facilities, resources, know-how, expertise, etc.) of each partner and how the partnership might evolve if the project is successful.
- **Objectives.** Describe the objectives or takeaways for each partner. If the project is successful, how will these takeaways be implemented following the term of the award? How will the outcomes of the collaboration across organizations and disciplines be greater than the sum of the outcomes of the primary individual partners alone?

1.B Research Plan

Discuss the scientific context of the research discovery, the importance of the technology; and the way that the technology can be further advanced and adapted to allow integration into a service system. The ingenuity of composition and synthesis into a viable system is important.

Proposers should ensure they address the following:

- **Interdisciplinary and Cross-Organizational Research.** Highlight the major synergies and the new knowledge that is expected to be gained from the merging and blending of the following research areas: 1) engineered service system design and integration, 2) computing, sensing, and information technologies; and 3) human factors, behavioral sciences, and cognitive engineering.
- **Defining User Requirements.** Often, paradigm-shifting innovation in service systems requires having the user in mind as potential co-creator of the service. Discuss how the team will articulate and define user requirements. Proposals are expected to include research tasks performed by experts in human factors, behavioral sciences, or cognitive engineering to study human interaction with the system to assure optimal integration of the technology and the achievement of pre-defined system efficacy objectives. Discuss how students and post-doctoral researchers (if applicable) will be immersed in the above interdisciplinary and cross-organizational environment and cross-reference their mentoring plans (see Supplementary Documents 7 and 10).
- **Test and Evaluation Plan.** Provide a description of the system performance measures that will be tested to evaluate whether the integration of the technology was successful and the smart service system achieved its efficacy objectives. Identify human subject testing protocols so that it is clear how this test bed will be validated, including user testing. These evaluation tasks should **"yield design principles and ultimately improve human-system interfaces and sociotechnical systems that lead to safer and more effective outcomes."** [8]

Part 2. Project Management Plan and Schedule

Provide a description of the respective roles, responsibilities, resources, and partner relationships with respect to the tasks (see Supplementary Document 2). Proposers must address how the project will be managed across institutions and disciplines and identify the specific coordination mechanisms that will enable cross-institution and/or cross-discipline scientific integration, e.g., graduate student exchange, project meetings, use of videoconferencing and other communication tools, etc. Include specific references to the budget line items that support these coordination mechanisms. Are there enough opportunities provided for interaction?

Provide a table of the research tasks to be conducted, the designated partners to accomplish each task, and a detailed timeline associated with each task.

Part 3. Intellectual Property (if applicable)

Include a discussion of any relevant background intellectual property held by the proposing institution and/or the industry partner(s).

Part 4. Results from Prior NSF Support.

If any PI or Co-PI identified on the project has received NSF funding in the past five years, information on the award(s) is required. Each PI and Co-PI who has received more than one award (excluding amendments) must report on the award most closely related to the proposal. The following information must be provided (consistent with the GPG Guidelines). For all citations, provide the numbers cross-referenced to the full references which can appear under E. References Cited.

Part 5. Lineage of the Proposed Research

Include, **if applicable**, the lineage relating to research discoveries in past NSF awards that are relevant to this project. For each previously funded project, include the directorate name, division name, and award number. If there is an award that qualifies both as Lineage as well as Results from Prior Support (Part 3), cross-reference to Results from Prior Support.

E. References Cited

Provide a comprehensive listing of relevant reference sources, including patent citations. Use this section to put the full references cited by number in Part 4. Results from Prior NSF Support and Part 5. Lineage of the Proposed Research above.

F. Biographical Sketches

All participating personnel from industry and other (types of) primary partners (if applicable) as well as from academe who are not PIs or Co-PIs should be classified as "Non-Co-PI/Senior Personnel". Note that “Non-Co-PI/Senior Personnel” may or may not appear on the NSF proposal budget forms. Provide relevant biographical information for the Principal Investigator (PI), Co-Principal Investigators (Co-PIs), and Senior Personnel (including any consultant(s), and/or key member(s) on each subaward) as well as those who are participating in the partnership but do not appear on the NSF proposal budget forms. This information should take the form of short "Biographical Sketch" documents (two pages maximum per person). Within each document, include at the top of the first page: the person's name, category of participation (PI, Co-PI, Industry/Other Organization Consultant, Academic Consultant, Industry Subawardee, Academic Subawardee, Industry/Other Organization Participant), and affiliation. Biographical sketches of industry participants need not conform to the standard academic format. Providing information about the backgrounds of the participating industry partners and other partners will provide a fuller picture of the expertise included in the partnership.

G. Budget, Subaward Budgets, and Consultants

The NSF Summary Proposal Budget is generated in FastLane or Grants.gov. Prepare a budget for each year. The system will automatically generate a cumulative budget for the entire project. All PIs, Co-PIs, and at least one named individual designated as responsible for the leadership of each subaward--this individual(s) must be listed under "A. Senior Personnel" on the subaward budget-- must spend time for which he/she receives salary. The amount of time may be limited, as deemed appropriate; but there must be a formal commitment.

In the budget justification, clarify how many individual participants there are under each of the categories of "B. Other Personnel" (e.g., 2 students per year sums to a total of 6 students on the cumulative budget, which in turn may actually mean that, e.g., there are 2 students on the project for 3 years each, or 6 students, for one year each; it is useful to be able to count heads as well as person years.

Travel costs can be included with careful justification, containing as much specificity as possible regarding the parties, locations/events, and purpose. Foreign travel is permitted. In addition, costs of one trip per year for the PI and Co-PIs to travel to the D.C. area to report on progress or participate in grantees workshops should be included in the requested budget (approximately $5000/year) and spelled out explicitly in the budget justification. Additional travel costs can be budgeted for a partner, a student, and/or other participants on the project to travel for the same or similar purposes.

The NSF does not intend to fund industrial or business research and development. Awarded funds may be allocated in the form of subawards for the participation of industry partners in the PFI:BIC project research activities only if the partner is a small business that meets the SBIR program eligibility requirements: (http://sbir.gov/sites/default/files/elig_size_compliance_guide.pdf). Note that subawards for small businesses or any other partners are optional.

It should be clear in the budget justification and narrative how the NSF funds will be shared by the partnership. In the "Facilities, Equipment, and Other Resources" section of the proposal, it should be clear how the other resources of the project (e.g., special facilities, equipment, and students) are shared by the partnership and where they are located.

If consultants will be used, consultant letter(s) must be provided. See Supplementary Document 4 for more information.

H. Current and Pending Support

The proposal should provide information regarding all research to which the Principal Investigator and other senior personnel either have committed time or have planned to commit time. For all ongoing and proposed projects, the following information should be provided for the Principal Investigator and anyone designated as Senior Personnel in the submitted budget.

Name of sponsoring organization and **add the award number as a reference (Note that the award number is not currently asked for on the form);**

- Title and performance period of the proposal;
- Person-months/calendar months (per year) devoted to the project by the Principal Investigator and each of the senior personnel.

The PFI:BIC proposal being submitted is considered "pending" for this purpose, and therefore MUST appear in the Current and Pending Support module.

I. Facilities, Equipment, and Other Resources

Discuss requirements for, and the availability of, facilities, equipment, and other resources for the proposed work provided by the lead academic institution and each of the partners.

J. Supplementary Documents

Proposals missing any of the required documents outlined below will be returned without review.

The following information must be provided as supplementary documents (unless otherwise indicated) and submitted to the

Supplementary Documents module in FastLane or Grants.gov. Place the documents 1-8 in the order in which they are listed.

1. **Partnership List.** Provide a list of all the partner entities (cross-reference: Supplementary Document 3) and all of the participating individuals from those entities, subdivided into the following categories:

    - Primary Partners
        - Lead institution
        - Industrial partner(s) those (one or more) that qualify for the minimum requirement , provide founding date, number of employees, location (City & State), commercial revenues (from the previous year or some other appropriate time period), and project role(s)
        - Other primary partners (if any, e.g., academic, other private sector organizations, public sector organizations, others)
    - Broader Context Partners
        - Academic institutions
        - Private sector organizations, including for-profit, non-profit businesses, foundations, etc.
        - Public sector organizations, including state and local governments, federal government laboratories
        - Other broader context partners (if any)

    In listing the personnel from each entity participating in the PFI:BIC project, provide the individual's title. For each of the individuals from an academic institution, include the department and/or school/college with which the individual is associated.

2. **Organizational/Role Diagram.** Provide an organizational chart that identifies the role(s) to be played by each of the partners. In addition to the areas of expertise beyond those related to the technology, include other areas of expertise are needed to achieve successful integration into a smart service system. The research components to be included in this project and denoted on the diagram are: 1) engineered system design and integration; 2) computing, sensing, and information technologies; and 3) human factors/behavioral sciences/cognitive engineering.

3. **Partnership Letter(s)**

    - **Primary Partners.** Provide partnership letters from the primary industrial partner(s). Each partner should explicitly describe the contributions to the collaboration. These letters must be provided on letterhead, signed by the appropriate institution or partner representative and **begin with a statement that confirms the partnership** between the academic team and the industrial partner.

      The partnership letter should address the following questions:

        - What do you stand to gain from participating in this partnership project?
        - What do you have to offer to this partnership project?

      And, in addition, the following is optional:

        - Briefly make any comments you wish to make about your relationship to any of the partners, how you came to join this partnership, past experience, etc.
        - **Broader Context Partners (s):** Provide letters from all other partners engaged in the proposed project, **including the nature of their respective contributions** to the partnership.

4. **Consultant Letters (if applicable).** If consultants are used, consultant letter(s) must be provided with the number of days, dollar amount per day, and the role of the consultant. Provide an explicit statement that the consultant's role is deemed reasonable and necessary for the project. If a consultant is also a partner, the letter must contain a statement of contribution over and above the consultant fees. Place that letter under 3. Partnership Letters (above) along with the other Partnership Letters. Be sure to indicate that consultants who are also partners are noted as such on the budget justification pages.

5. **Cooperative Research Agreements (CRAs).** A letter (not an official legal document at this point, but simply a brief promissory statement signed by an appropriate person at the lead institution) must be submitted with the proposal. The letter should state that fully executed CRAs will be provided within 6 weeks of notification that the program is considering a recommendation for award. Typically, such notification from the program occurs within a month or two after the last panel of the cycle has been convened. Partners (and their legal departments) on all proposals should be aware of this requirement and be prepared to comply within the required timeframe in the event of consideration of the proposal for an award. This may mean working out a draft CRA in advance. (However, please do not submit a draft CRA with the proposal.)

    The CRAs, which are specifically intended for this project and **solely for the benefit and mutual understanding of the primary partners**, outline any issues surrounding the intellectual property that each party may bring to the table or intellectual property that could be an outcome of the relationship. CRAs also cover other pertinent matters surrounding the conduct of the partnership. Typical "Articles" in CRAs might include the following: Research, Publication, Intellectual Property, Term and Termination, Proprietary Information, General, Appendix A (Research Project Title, Research Project Description, Collaborators, Investigators, Scope of Work). **NSF is not responsible for the type or content of agreement reached between the parties.** There is no template provided by the program. Should it be useful to adapt a CRA template from another source, please do so.

6. **Support Letters.** Begin with "This letter of support...." Support letters are one mechanism for providing evidence of market validation and the potential value of the project. For example, a signed letter on letterhead from a credible individual holding a position in recognized entity(ies) in the market (potential future customer, potential licensee, large corporation, etc.) may be included in the supplementary documents to lend credibility to the proposer's assessment of the market and need for an intended application of the technology. Letters indicating potential investment upon the achievement of project milestones would also be appropriate. Make sure support letters are distinct from each other, and also **note that Support Letters are not to be confused with Partnership Letters, which describe the partners' contributions to the collaboration.**

7. **Student Mentoring Plans.** In addition to the NSF-wide required mentoring plan for Postdoctoral Researchers (see 10, below), a mentoring plan for each different level of students, Graduate Students and/or Undergraduate Students, receiving support from the budget of this proposal is required. It is also an option to provide mentoring plans individuals. Mentoring plans should be concise and specifically focused on the anticipated role of the students on the PFI:BIC academe-industry partnership project and how the students participating in this project will take advantage of this special interdisciplinary,

cross-organizational context by including relevant activities and checkpoints. For example, provide a description of their opportunity to work with the industrial partner and to benefit from real life interdisciplinary experiences that foster an innovation culture in the next generation of researchers.

These plans are essential for this program, which is concerned with students' entrepreneurial perspectives and careers as well as with STEM education. Note that there are no specific requirements for participation in any of these categories. The number and selection of undergraduates, graduates, and/or postdocs is left to the discretion of the proposers. Cross-reference these plans carefully in the body of the proposal so that reviewers do not overlook them and their importance in conveying the value of the project to students.

8. **Preliminary Patent Search (Optional).**

9. **Data Management Plan.** An NSF-wide requirement. A Data Management Plan is required for all proposals submitted to NSF. Please reference the data management requirements at this URL: http://www.nsf.gov/pubs/policydocs/pappguide/nsf15001/gpg_2.jsp#IIC2j.

10. **Postdoctoral Researcher Mentoring Plan** (if applicable, i.e., a postdoctoral researcher is listed on the budget). An NSF-wide requirement. If more than one postdoctoral researcher is supported on the proposal, the proposer may wish to provide a separate mentoring plan for each researcher. In any case, the mentoring plan for PFI:BIC should contain specific reference to role of each postdoctoral researcher on the PFI:BIC academe-industry partnership project. More is expected in this program than is covered in a typical plan for postdoctoral researchers, e.g., synergies and new knowledge expected from the interdisciplinary and cross-organizational research involved in the PFI:BIC partnership project and the exposure and participation in settings with researchers from different perspectives, different areas of expertise, disciplines, and organizations.

K. Single Copy Documents

Proposers have the option to supply an annotated list of suggested reviewers, complete with affiliation and contact information. Be particularly mindful about potential conflicts of interest. Avoid selecting any individuals who may have a conflict of interest, or an appearance of a conflict of interest, with the PI, Co-PIs or any of the senior personnel on the project (including personnel on any subawards) or with the industrial partner(s).

[8] Human Factors: The Journal of the Human Factors and Ergonomics Society (accessed online http://hfs.sagepub.com/ on August 12, 2014).

B. Budgetary Information

Cost Sharing: Inclusion of voluntary committed cost sharing is prohibited

Other Budgetary Limitations:

Limitations:

NSF will not provide salary support for personnel employed by Federal Agencies or Federally Funded Research and Development Centers.

Subawards can only be allocated to small businesses that meet the SBIR program eligibility requirements: (http://sbir.gov/sites/default/files/elig_size_compliance_guide.pdf).

Budget Limitations:

Proposers may request up to $1,000,000 from NSF for an award duration of three (3) years.

C. Due Dates

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

  December 02, 2015

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

  January 27, 2016

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: http://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 the GPG as Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: http://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. (GPG 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 GPG 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

Other additional review criteria are as follows:

- **Partnership.** The quality of the primary partnership (e.g., expertise, achievements, complementarities, contributions to the partnership and commitment to the project).
- **Technology.** The potential of the technology to be advanced, adapted, and integrated into a smart service system that in turn has the potential for societal and economic impact. Will this effort also have extensibility to other application areas or other entirely different service systems?
- **Test Bed.** The appropriateness of the test bed for the integration of the proposed technology into a smart service system.
- **Research Plan.** The value of the research tasks to be carried out, including the test and evaluation plan for human-system integration, and the existence of appropriate mechanisms in the research plan to bring feedback from the evaluation results to the engineered system design.
- **Mentoring Plans.** The likelihood that the nature of the participation and the quality of students' and/or postdoctoral researchers' exposure in this interdisciplinary and cross-organizational culture of collaboration will prepare them to be future innovators.

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 be completed and submitted by each reviewer. 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 http://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 *Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag.

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 at least 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). Within 90 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 *Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag.

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:

- Sara B. Nerlove, ENG/IIP/PFI:BIC, Program Director, telephone: (703) 292-7077, email: snerlove@nsf.gov
- Alexandra Medina-Borja, ENG/OAD, telephone: (703) 292-7557, email: amedinab@nsf.gov
- Gurdip Singh, CISE/CNS, telephone: (703) 292-8950, email: gsingh@nsf.gov
- Hector Munoz-Avila, CISE/IIS, telephone: (703) 292-7129, email: hmunoz@nsf.gov

- Alexander Leonessa, ENG/CBET, telephone: (703) 292-2678, email: aleoness@nsf.gov
- Leon Esterowitz, ENG/CBET, telephone: (703) 292-7942, email: lesterow@nsf.gov
- William J. Cooper, ENG/CBET, telephone: (703) 292-5356, email: wjcooper@nsf.gov
- Jordan M. Berg, ENG/CMMI, telephone: (703) 292-5365, email: jberg@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 at https://public.govdelivery.com/accounts/USNSF/subscriber/new?topic_id=USNSF_179.

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 provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See Grant Proposal Guide Chapter II, Section D.2 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 http://www.nsf.gov

- **Location:** 4201 Wilson Blvd. Arlington, VA 22230
- **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: nsfpubs@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
Office of the General Counsel
National Science Foundation
Arlington, VA 22230

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