NSF/Intel Partnership on Visual and Experiential Computing (VEC)

PROGRAM SOLICITATION
NSF 15-518

National Science Foundation

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

Intel Labs University Collaboration Office

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

February 20, 2015

IMPORTANT INFORMATION AND REVISION NOTES

This joint solicitation from NSF and Intel seeks proposals to be considered for both NSF Grants and Intel Agreements (i.e., Contracts, Grants or Gifts). Intel Agreements contain provisions for possible direct, on-site participation in research by Intel researchers-in-residence (RinRs).

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised NSF Proposal & Award Policies & Procedures Guide (PAPPG) (NSF 15-1), which is effective for proposals submitted, or due, on or after December 26, 2014. The PAPPG is consistent with, and, implements the new Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards (Uniform Guidance) (2 CFR § 200).

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

NSF/Intel Partnership on Visual and Experiential Computing (VEC)

Synopsis of Program:

The advancement of sensing technology such as RGBD (Red Green Blue Depth), multi-camera and light field imaging systems, networks of sensors, advanced visual analytics and cloud computing will challenge the longstanding paradigms of capturing, creating, analyzing and utilizing visual information. Advances in Visual and Experiential Computing (VEC) will enable capability, adaptability, scalability, and usability that will far exceed the simple information systems of today. VEC technology will transform the way people interact with visual information through, for example, the realization of new mobile and wearable devices and the emergence of autonomous machines and semantically aware spaces. VEC research will drive innovation and competition in many industrial sectors as well as enhance the quality of life for ordinary people.

Fast growing visual data has become a bottleneck in human decision processes in several emergent situations. New VEC technology is crucial to extracting information from complex visual and related data sets, combining this information with intuitive modes of human perception, and generating actionable information.

The goal of this joint solicitation between NSF and Intel is to foster novel, transformative, multidisciplinary approaches that promote research in VEC technologies, taking into consideration the various challenges present in this field. This solicitation aims to foster a research community committed to advancing research and education at the confluence of VEC technologies, and to transitioning its findings into practice. NSF and Intel will support three types of projects, each three years in duration: Small projects with funding from $500,000 to $1,000,000 per project; Medium projects with funding from $1,000,001 to $2,000,000 per project; and Large projects with funding from $2,000,001 to $3,000,000. It is intended that NSF and Intel will cofund each project in equal amounts.

This NSF/Intel partnership combines CISE's experience in developing and managing successful large, diverse research portfolios with Intel's long history of building research communities in emerging technology areas through programs such as its Science and Technology Center Program.

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.

- Jie Yang, Program Director, NSF CISE/IIS, telephone: (703) 292-4768, email: jyang@nsf.gov
- Weisong Shi, Program Director, NSF CISE/CNS, telephone: (703) 292-7096, email: wshi@nsf.gov
- Dmitry Maslov, Program Director, NSF CISE/CCF, telephone: (703) 292-8910, email: dmaslov@nsf.gov
- Greg Leeming, Program Manager, Intel Labs, telephone: (425) 281 2649, email: greg.p.leeming@intel.com

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

- 47.070 --- Computer and Information Science and Engineering

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant or Intel Agreement (i.e., Contract, Grant or Gift)

Estimated Number of Awards: 6

Subject to the availability of funds.

Anticipated Funding Amount: $6,000,000

Subject to the availability of funds.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

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

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 2

An individual may submit **only one proposal to each project class** (Small, Medium, and Large) in which he/she is the PI at the lead institution. In total, an individual may participate as PI, co-PI, or senior personnel in **no more than two proposals** submitted in response to this solicitation. In the event that an individual exceeds these limits, proposals received within the limits will be accepted based on the earliest date and time of proposal submission. **No exceptions will be made.**

This limit on the number of proposals per PI, co-PI or Senior Personnel applies only to this NSF/Intel VEC program solicitation.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not required
- **Preliminary Proposal Submission:** Not required
- **Full Proposals:**
  - Full Proposals submitted via 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:** Not Applicable

C. Due Dates

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

  February 20, 2015

Proposal Review Information Criteria

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

Award Administration Information

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

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

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I. INTRODUCTION

Visual Computing technologies have evolved to a level of sophistication at which one can now imagine systems that will perceive our everyday environments with near-human sophistication and allow us to effortlessly engage with visual representations that blur the boundaries between the real and virtual world. These advances promise a new, exciting class of systems and applications that will fundamentally change the way we interface with our devices and data, simplifying the ways we carry out day-to-day activities and extending our perception and understanding of the world in compelling and intuitive ways.

The advancement of sensing technology such as RGBD (Red Green Blue Depth), multi-camera and light field imaging systems, networks of sensors, advanced visual analytics and cloud computing will challenge the longstanding paradigms of capturing, creating, analyzing and utilizing data. This plethora of data sources has given rise to information diversity. However, most data are unstructured and distributed across spatial and temporal scales that are hard to natively observe but instead require sophisticated analytics to understand. We envision a new era in computing in which sensing, analytics and visualization enable the realization of powerful systems that provide both expert and non-expert users with intuitive access to, and insightful analysis of, data in ways that are seamlessly embedded into their daily lives.

II. PROGRAM DESCRIPTION

For the purposes of this program, visual computing deals with the acquisition, analysis, and synthesis of visual information through the use of computational resources and tools. Experiential computing involves the use of computing architectures and applications to enable and/or enhance compelling human experiences.

Visual and experiential computing can translate the information contained in complex visual and non-visual data sets into intuitive modes of human perception and interaction and create accessible platforms for information capture, retrieval, analysis and knowledge discovery that enhance human decision making. Real-time access to this information can create capabilities that are akin to "super-human senses" and will enable the perception of our world in new and exciting ways, highlighted by the following select examples:

- Real-time recognition of events and activities that extend human perception, profoundly improving our understanding of the

world around us and simplifying the complexities of our interactions.
- Immersive reconstructions of events and/or locations that provide revealing insight and mimic the ability of the human visual system to perceive the world.
- Trusted autonomous navigation of large-scale environments using visual-based localization and mapping.
- The expansion of one's vision by being able to "see" over a hill or around a corner while driving or walking, enabled by ubiquitous cameras capturing images and providing a computational composite from any perspective of what is forthcoming.
- The creation of perspectives that are not visible to existing optical instruments, such as scattered micro-cameras around a surgery location or distributed instruments around a laboratory.

Exploring and harnessing technology to deliver the full potential of visual and experiential computing requires an interdisciplinary approach. NSF and Intel seek disruptive, yet pragmatic proposals for research that will drive game-changing advancement in this emerging field through tight collaboration between researchers in adjacent disciplines.

Proposals responsive to this solicitation should seek to improve core capabilities in this emerging field and make advances to relevant areas. Suggested focus areas include but are not limited to:

- **Computational Photography:** Advances in imaging technology and computation that will enable new modes of visual data capture and new processing features. More specifically, hardware and software techniques that will contribute broadly to the effectiveness of computer vision solutions by providing: better-quality imaging (e.g., increased dynamic range, reduced motion blur, deghosting); advanced sensing (e.g., the ability to see through partial occlusions, extract depth, and accurately capture material properties); and sensor technology (e.g., array cameras, light field imaging).
- **Simultaneous Localization and Mapping (SLAM):** New approaches to real-time visual-based localization and mapping of large-scale environments (e.g., building complexes, shopping malls, city blocks) for indoor and outdoor autonomous navigation under any lighting conditions and accounting for dynamic scenes (e.g., independently moving objects) with articulated and non-rigid objects. The deployment of other non-visual sensors (e.g., GPS, IMU, etc.) should be considered to improve performance, reduce power consumption and/or reduce thermal requirements. Distributed computing options (e.g., algorithm partitioning across the local device and cloud and/or utilization of large-scale cloud-based 3D data) should be considered where they can improve end-user experience. Further, solutions that can fully execute on low-power devices without external computing support should be considered (in particular for autonomous machines).
- **Augmented Reality:** Photo-realistic virtual content insertion into real scenes and the application of this rendering to mobile and wearable platforms (e.g., virtual content presented to the user through a “see-through” display). Of particular interest is high-fidelity global illumination, accurate registration of the virtual content and convincing physics-based modeling, all with lower power. Example applications include “task assistance” and “task training” where the application guides the user through the execution of a task, tracks user performance, and adapts as required (e.g., one-time tasks like building a table from its parts).
- **Image and Video Understanding:** With the explosion of visual data, the detection of salient content in video clips or imagery is growing in importance for various uses. These include: video indexing, summarization, new methods for large-scale face, object and activity recognition, large vocabulary gesture recognition and the integration of multiple sensing modalities (e.g., video and sound).
- **3D Scene Understanding:** Parse reconstructed 3D scenes derived from visual imagery (e.g., RGB, RGBD or multi-camera) to enable dense category labeling of 3D points, extrapolation of occluded parts of the scene, photorealistic object removal, and the recovery and reasoning about functional properties of objects in the scene (e.g., how can an autonomous system use an object?). This effort may include the collection and utilization of novel annotated data sets.

The application of promising algorithmic approaches and design methodologies (e.g., deep learning and other machine learning methods, domain specific languages) is encouraged. Wherever possible, research should be focused on ultra-mobile/wearable technologies and consider system engineering issues such as performance and power tradeoffs between possible platform components (e.g., 2D vs RGB-D cameras) and interaction with the full spectrum of future computing platforms from the data center on down. The inclusion of significant prototyping efforts that demonstrate the viability of promising Center research and broadly involve Center researchers is encouraged in Medium proposals and expected in Large proposals.

PROJECT CLASSES

Proposals submitted to this solicitation must be consistent with one of three project classes defined below. Proposals will be considered for funding within their project classes.

- **Small VEC Projects**, with total budgets ranging from $500,000 to $1,000,000 for durations of three years, are well-suited to one or two investigators (PI and one co-PI or other Senior Personnel) and a small number of students and/or postdocs.
- **Medium VEC Projects**, with total budgets ranging from $1,000,001 to $2,000,000 for durations of three years, are well-suited to a small number of investigators (PI, co-PI and/or other Senior Personnel) and several students and/or postdocs. Medium projects are encouraged to be inclusive of a prototyping effort for the researched solutions.
- **Large VEC Projects**, with total budgets ranging from $2,000,001 to $3,000,000 for durations of three years, are well-suited to many investigators (PI, co-PI(s), or other Senior Personnel), and a team of students and/or postdocs. Large project proposals are expected to be inclusive of a functional prototype for the researched solutions. Large projects will typically integrate research from various areas, either within a cluster or across clusters, or tackle ambitious goals not feasible with smaller projects.

All proposals must explain why the size of the budget proposed is required to carry out the proposed work.

III. AWARD INFORMATION

Anticipated Type of Award: Continuing Grant or Standard Grant or Intel Agreement (i.e., Contract, Grant or Gift)

Estimated Number of Awards: 6

Anticipated Funding Amount: $6,000,000

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

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

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

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 2

An individual may submit **only one proposal to each project class** (Small, Medium, and Large) in which he/she is the PI at the lead institution. In total, an individual may participate as PI, co-PI, or senior personnel in **no more than two proposals** submitted in response to this solicitation. In the event that an individual exceeds these limits, proposals received within the limits will be accepted based on the earliest date and time of proposal submission. **No exceptions will be made.**

This limit on the number of proposals per PI, co-PI or Senior Personnel applies only to this NSF/Intel VEC program solicitation.

Additional Eligibility Info:

Subawardees may include universities and two-and four-year colleges (including community colleges) accredited in, and having a campus located in, the US acting on behalf of their faculty members; and non-profit, non-academic organizations such as independent museums, observatories, research laboratories, professional societies and similar organizations located in the US that are directly associated with educational or research activities in the computing and information sciences (and closely related fields). Other organizations such as US national laboratories may participate in the proposed activities if they have independent sources of support; they will not be supported by NSF or Intel.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

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

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

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via the NSF FastLane system. Chapter II, Section D.5 of the Grant Proposal Guide provides additional information on collaborative proposals.

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

Visual and Experiential Computing (VEC) Proposal Titles:

A proposal title must begin with “VEC:” followed by the project class to which the proposal is being submitted. For example, titles of Small proposals should take the form, **VEC: Small: Title**, and of Large Proposals, **VEC: Large: Title**. If you submit a proposal as part of a set of collaborative proposals, the title of the proposal should begin with "VEC:" followed by the project class to which the proposal is being submitted, followed by "Collaborative Research:". For example, if you are submitting a collaborative set of proposals for a Medium project, the title of each would be **VEC: Medium: Collaborative Research: Title**.

VEC Project Descriptions:

For all collaborative projects, project descriptions must be comprehensive and well-integrated, and should make a convincing case that the collaborative contributions of the project team will be greater than the sum of each of their individual contributions.

Supplementary Documents:

In the Supplementary Documents section, upload the following information where relevant:

(1) A list of Project Personnel and Partner Institutions (Note: In collaborative proposals, only the lead institution should provide this information):

Provide current, accurate information for all personnel and institutions involved in the project. NSF staff will use this information in the merit review process to manage conflicts of interest. The list **must** include all PIs, Co-PIs, Senior Personnel, paid/unpaid Consultants or Collaborators, Subawardees, Postdocs, project-level advisory committee members, and writers of letters of support. This list should be numbered and include (in this order) Full name, Organization(s), and Role in the project, with each item separated by a semi-colon. Each person listed should start a new numbered line. For example:

1. Mary Smith; XYZ University; PI
2. John Jones; University of PQR; Senior Personnel
3. Jane Brown; XYZ University; Postdoc
4. Bob Adams; ABC Community College; Paid Consultant
5. Mary White; Welldone Institution; Unpaid Collaborator
6. Tim Green; ZZZ University; Subawardee

(2) A list of Collaborators (Note: In collaborative proposals, only the lead institution should provide this information):

Provide current, accurate information for all active or recent collaborators of personnel and institutions involved in the project. NSF staff will use this information in the merit review process to manage conflicts of interest. **This list is distinct from (1) above in that it must include all active or recent Collaborators of all personnel involved with the proposed project.** Collaborators include any individual with whom any member of the project team -- including PIs, Co-PIs, Senior Personnel, paid/unpaid Consultants or Collaborators, Subawardees, Postdocs, and project-level advisory committee members -- has collaborated on a project, book, article, report, or paper within the preceding 48 months; or co-edited a journal, compendium, or conference proceedings within the preceding 24 months. This list should be numbered and include (in this order) Full name and Organization(s), with each item separated by a semi-colon. Each person listed should start a new numbered line.

1. Collaborators for Mary Smith; XYZ University; PI
    a. Helen Gupta; ABC University
    b. John Jones; University of PQR
    c. Fred Gonzales; DEF Corporation
    d. Susan White; DEF Corporation
2. Collaborators for John Jones; University of PQR; Senior Personnel
    a. Tim Green; ZZZ University
    b. Ping Chang, ZZZ University
    c. Mary Smith; XYZ University
3. Collaborators for Jane Brown; XYZ University; Postdoc
    a. Fred Gonzales; DEF Corporation
4. Collaborators for Bob Adams; ABC Community College; Paid Consultant
    a. None
5. Collaborators for Susan White; Welldone Institution; Unpaid Collaborator
    a. Mary Smith; XYZ University
    b. Harry Nguyen; Welldone Institution
6. Collaborators for Tim Green; ZZZ University; Subawardee
    a. John Jones; University of PQR

(3) Collaboration Plan (if applicable):

Since the success of collaborative research efforts are known to depend on thoughtful coordination mechanisms that regularly bring together the various participants of the project, a Collaboration Plan is required for all Small and Medium proposals with more than one investigator and all Large proposals. Up to 2 pages are allowed for Collaboration Plans. The length of, and level of, detail provided in the Collaboration Plan should be commensurate with the complexity of the proposed project. **If a Small or Medium proposal with more than one investigator or any Large Proposal does not include a Collaboration Plan, that proposal will be returned without review.**

(4) Postdoctoral Researcher Mentoring Plan (if applicable):

Each proposal that requests funding to support postdoctoral researchers must include, as a supplementary document, a description of the mentoring activities that will be provided for such individuals. In no more than one page, the mentoring plan must describe the mentoring that will be provided to all postdoctoral researchers supported by the project, irrespective of whether they reside at the submitting organization, any subawardee organization, or at any organization participating in a simultaneously submitted collaborative project. Please be advised that if required, FastLane will not permit submission of a proposal that is missing a Postdoctoral Researcher Mentoring Plan. See Chapter II.C.2.j of the GPG for further information about the implementation of this requirement.

Proposals that include Postdoctoral Mentoring Plans exceeding one page in length will be returned without review.

(5) Data Management Plan (required):

Proposals must include a supplementary document of no more than two pages labeled "Data Management Plan." This supplementary document should describe how the proposal will conform to NSF policy on the dissemination and sharing of research results.

See Chapter II.C.2.j of the GPG for full policy implementation.

For additional information see: http://www.nsf.gov/bfa/dias/policy/dmp.jsp.

For specific guidance for proposals submitted to the Directorate for Computer and Information Science and Engineering (CISE) see: http://www.nsf.gov/cise/cise_dmp.jsp.

Proposals that include Data Management Plans exceeding two pages in length will be returned without review.

B. Budgetary Information

Cost Sharing: Inclusion of voluntary committed cost sharing is prohibited.

Budget Preparation Instructions:

Budgets for projects should include funding for one or more project representatives (PI/co-PI/senior researcher or NSF-approved replacement) to attend Annual Retreats held after the beginning of the award.

The budget submitted with the proposal should include all necessary project funds without regard to the two funding organizations; NSF and Intel will inform selected PIs of the breakdown in funding between the two organizations, and will request revised budgets at that point.

C. Due Dates

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

  February 20, 2015

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://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

NSF engages in Partnership Programs with companies in order to increase the potential for research discoveries to become innovations with societal impact through market mechanisms.

In this light, selected specific Broader Impacts that will be examined include:

- The degree to which the project's technical research is likely to inform the realization of compelling human experiences enabled by Visual and Experiential Computing technologies.
- The degree to which the project's plans both pursue the development of a systems perspective and implement demonstrations of interrelated component research ideas. These demonstrations, along with the research outcomes, should serve as a call to action by the Visual and Experiential Computing innovation ecosystem, specifically but not limited to Intel.

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review, Internal NSF Review, or Internal Review by Intel Corporation.

Intel and NSF will each conduct separate proposal reviews. For Intel, internal review will be conducted. Proposals and other relevant information about proposals including reviews will be shared between the participating organizations as appropriate. Upon conclusion of the separate reviews award recommendations will be coordinated by a Joint NSF and Intel Working Group (hereafter referred to as JWG) comprising personnel from both NSF and Intel. The JWG will recommend meritorious proposals for award.

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.

Special Award Conditions:

Each awarded project will be jointly funded by the NSF and Intel through separate NSF and Intel funding instruments. NSF awards will be made as continuing or standard grants. Intel awards will be made as Intel agreements (i.e., Contracts, Grants or Gifts). NSF and Intel will manage their respective awards/agreements in accordance with their own guidelines and regulations.

1. **Site visits, meetings, and annual retreats**

   Intel and NSF will organize annual retreats for awardees which will bring together the academic community involved in the VEC program, along with NSF and Intel personnel who have interest in the programs. Intel and NSF will work with academic leadership to organize these events. They will involve reviews of the research underway in each project along with presentations from NSF and Intel on technical areas of interest related to each awarded project. Ample time will be provided for face to face interaction between participants in these retreats.

2. **Intellectual property, publishing, and licensing**

   Awardees will be required to include appropriate acknowledgment of NSF and Intel support in reports and/or publications on work performed under the award. An example of such an acknowledgement would be: "This material is based upon work supported by NSF/Intel Partnership on Visual and Experiential Computing Program under Award Title and No. [Recipient enters project title and awards number(s)]."

   All projects agree to distribute all source code that has been authored while working on an NSF/Intel award under a BSD, Apache or other equivalent open source license. Software licenses that require as a condition of use, modification and/or distribution that the software or other software incorporated into, derived from or distributed with the software be licensed by the user to third-parties for the purpose of making and/or distributing derivative works are not permitted. Licenses not appropriate thus include any version of GNU's General Public License (GPL) or Lesser/Library GPL (LGPL), the Artistic License (e.g., PERL), and the Mozilla Public License.

   Projects that generate data or software in performing the work under an award agree not to incorporate any third-party code or background intellectual property, except by separate prearrangement with NSF and Intel, into this data or software that would limit or restrict its ability to be distributed under an open source license.

   Awardees may file patent applications, providing that they grant to Intel a non-exclusive, worldwide, royalty-free, sub-licensable license to all intellectual property rights in any inventions or works of authorship resulting from research conducted under the joint award.

3. **Intel participation in research**

   Intel may separately fund its own personnel to directly participate in NSF/Intel Partnership research, part-time or full-time, with the universities awarded NSF/Intel Partnership projects. Proposals do not need to budget for the cost of such personnel. These Intel researchers will work alongside the academic researchers, identifying opportunities for tech transfer, and being involved with the projects as advisors or as fellow researchers. Optional deployment of Intel Researchers in Residence (RinR) on campuses will require mutual consent by the Parties and respective awardees in the Project Management Plan for each NSF/Intel Partnership award. Further, Intel may designate one of its more senior, separately funded researchers to work alongside NSF/Intel Partnership academic lead PIs. The Intel VEC Program Director and the lead Intel researcher may work with the academic PI of each project to collaboratively oversee the project, manage Intel's participation in each project, champion considerations related to innovation – the translation of discoveries into industry impact – and to manage the center on a day-by-day basis. He/she would inject a perspective on commercial aspects and help with the day-to-day leadership of the center. He/she would also be responsible for working with the Intel Program Director to oversee the engagement of all other Intel researchers.

4. **Program management**

   The Intel VEC Program Director overseeing funded projects may become a member of the Project Management Team for the Intel award. Intel will conduct annual retreats and may require deliverable reports to monitor project progress. Annual on-site reviews may be conducted jointly by NSF and Intel. Intel may lead the organization of quarterly or more frequent phone calls with project teams; NSF may participate in these calls at its discretion. NSF and Intel may request visits to the research institutions or may ask PIs to visit NSF or Intel.

5. **Funding Support and Budget Revisions**

   Individual awards selected for joint funding by NSF and Intel will be funded through separate NSF and Intel funding instruments. For each such project, NSF support will be provided via an NSF grant and Intel support will be provided via an Intel agreement (i.e., Contract, Grant or Gift). Either organization may supplement a project without requiring the other party to provide any additional funds.

   The budget submitted with the proposal should include all necessary project funds without regard to the two funding organizations; NSF and Intel will inform selected PIs of the breakdown in funding between the two organizations, and will request revised budgets at that point.

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.

In addition, Intel may require deliverable reports to monitor project progress.

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:

- Jie Yang, Program Director, NSF CISE/IIS, telephone: (703) 292-4768, email: jyang@nsf.gov
- Weisong Shi, Program Director, NSF CISE/CNS, telephone: (703) 292-7096, email: wshi@nsf.gov
- Dmitry Maslov, Program Director, NSF CISE/CCF, telephone: (703) 292-8910, email: dmaslov@nsf.gov
- Greg Leeming, Program Manager, Intel Labs, telephone: (425) 281 2649, email: greg.p.leeming@intel.com

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.

ABOUT INTEL LABS

Intel Labs delivers breakthrough innovations to fuel Intel’s growth and technology leadership. We focus our research in the areas of architecture and design, software and systems, security, integrated computing and user experience. Intel Labs is comprised of a worldwide network of research centers in nine countries including the U.S., China, India, Ireland, Russia, Egypt, Germany, Spain and Mexico. Our research has led to important Intel products and tech leadership including Xeon Phi, vPro, Atom, Thunderbolt and Quark.

Intel Labs collaborates with industry partners, government and academia throughout the world to leverage the brightest minds in

research. We encourage open and collaborative innovation with researchers through our network of university-centered Intel Science and Technology Centers (ISTCs) in the U.S. and Intel Collaborative Research Institutes (ICRIs) abroad focused on projects aligned with Intel Labs' overall research agenda.

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
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