

Japan-U.S. Network Opportunity 3 (JUNO3)

R&D for Programmable Networking for next generation core and beyond 5G/6G networks

PROGRAM SOLICITATION

NSF 21-624

REPLACES DOCUMENT(S):

NSF 17-586



National Science Foundation

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

Submission Window Date(s) (due by 5 p.m. submitter's local time):

September 20, 2021 - December 13, 2021

IMPORTANT INFORMATION AND REVISION NOTES

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

The theme of the solicitation has been changed from "R&D for trustworthy networking for smart and connected communities" to "R&D for programmable networking for next generation core and beyond 5G/6G networks."

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

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Japan-U.S. Network Opportunity (JUNO)
R&D for Programmable Networking for next generation core and beyond 5G/6G networks

Synopsis of Program:

The Division of Computer and Network Systems (CNS) within the National Science Foundation's (NSF) Directorate for Computer and Information Science and Engineering (CISE) supports research and education activities that develop a better understanding of the fundamental properties of computer and network systems and create better abstractions and tools for designing, building, analyzing, and measuring future systems.

In this program, NSF and the National Institute of Information and Communications Technology (NICT) of Japan have agreed to embark on a collaborative research program to address compelling research challenges associated with programmable networks for next generation core and beyond 5th Generation/6th Generation mobile networks (beyond 5G/6G). Software-Defined Networking (SDN) has been a particularly successful area of research interest and commercial innovation over the last decade. SDN increases the flexibility of networks, providing greater control of network behavior, performance, monitoring and problem diagnosis. SDN is thus one of the essential technologies for ensuring robust, flexible and high performing wired and wireless beyond 5G/6G networks. The first generation of SDN focused primarily on the implications of control and data plane separation, and control plane programmability. Today the networking research community focus also includes the second generation of SDN – data plane programmability – as enabled at transmission line rates through the relatively recent introduction of programmable layer 2/3 switches, programmable Network Interface Cards (NICs), and increasingly flexible physical layer transmission technologies such as software defined radios and optical transceivers. This program focuses on enabling flexible and scalable programmable networks for next generation core and beyond 5G/6G networks. This calls for creative and innovative ways of approaching the associated challenges and experimental demonstration and verification on research testbeds where appropriate. This program seeks joint Japanese-US research projects that leverage each nation's expertise and address the following topic areas:

- Network architectures/In-network intelligence and programmable network functionality

- o Develop the foundation for next-generation programmable functionality for enhanced core, optical and beyond 5G/6G networks
- Smart services, applications, and experimentation on research testbeds
 - o Develop experimental demonstrations of novel future services and essential networking applications on campus, Japan and/or US testbeds

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.

- Ann C. Von Lehmen, Program Director, CISE/CNS, telephone: (703) 292-4756, email: avonlehm@nsf.gov
- Deepankar Medhi, Program Director, CISE/CNS, telephone: (703) 292-2935, email: dmedhi@nsf.gov
- Alexander Sprintson, Program Director, CISE/CNS, telephone: (703) 292-8950, email: asprints@nsf.gov

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

- 47.070 --- Computer and Information Science and Engineering

Award Information

Anticipated Type of Award: Standard Grant

Estimated Number of Awards: 5

Anticipated Funding Amount: \$2,250,000

Each award may be up to \$450,000 over three years, and will be made to US organizations, pending availability of funds.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

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

Who May Serve as PI:

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: 1

In the event that an individual exceeds this limit, proposals received within the limit will be accepted based on earliest date and time of proposal submission (i.e., the first proposal received will be accepted and the remainder will be returned without review). **No exceptions will be made.**

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

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

B. Budgetary Information

- **Cost Sharing Requirements:**

Inclusion of voluntary committed cost sharing is prohibited.

- **Indirect Cost (F&A) Limitations:**

Not Applicable

- **Other Budgetary Limitations:**

Not Applicable

C. Due Dates

- **Submission Window Date(s)** (due by 5 p.m. submitter's local time):

September 20, 2021 - December 13, 2021

Proposal Review Information Criteria

Merit Review Criteria:

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

Award Administration Information

Award Conditions:

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

Reporting Requirements:

Standard NSF reporting requirements apply.

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I. INTRODUCTION

NSF and the National Institute of Information and Communications Technology (NICT) of Japan have a history of collaboration that extends back over a decade. In 2010, the NICT and NSF jointly funded a set of Japan/US proposals in the area of future Internet design. In 2013, NSF and NICT established a second Japan-U.S. joint research and development program, JUNO, to support advanced Internet architectures, and in particular support an Internet where trillions of objects are connected to, and accessed from, a mobile world. This program ended in 2016. In 2017, NSF and NICT established a third Japan-U.S. joint research and development program, JUNO2, that seeks novel approaches for network architectures, design, protocols and management that span wired and wireless networks, closely integrated with edge compute resources to provide high availability services, all with the goal of supporting smart and connected communities. This program ends in 2021. The projects funded under these programs have helped establish strong collaborations between researchers from both countries.

In November 2020, NSF/NICT jointly sponsored a virtual workshop on Programmable Networking to identify further research topics of mutual interest. The areas that emerged from the workshop were programmable networking for next generation core and beyond 5G/6G networks (<https://sites.google.com/view/us-japan-workshop/workshop-report>). Building on the rich history of prior collaboration and the findings from this workshop, NSF and NICT have moved forward to

establish this solicitation. This Japan-U.S. joint research and development program seeks transformative ideas on programmable networks to address critical performance and robustness issues in next-generation wired and wireless networks and services.

II. PROGRAM DESCRIPTION

Proposals are solicited for joint Japan-U.S. foundational and transformative research consistent with the theme of "Programmable Networking for next generation core and beyond 5G/6G networks". Network programmability offers the potential to address major long-standing network control and management challenges, including those associated with emerging applications such as distributed big data computation, augmented and virtual reality and IoT, and more stringent requirements on resiliency and robustness. Proposals are solicited in the following areas:

1) Network architectures/In-network intelligence and programmable network functionality

This solicitation seeks fundamental systems research that investigates novel network architectures with in-network intelligence and advanced programmable network functionality to enable robust, high performance next-generation core, optical and wireless networks. In-network intelligence and programmability drive the need to make network, server and storage resources available when and how much they are needed. This solicitation covers a wide range of reference networks, including but not limited to core, access and IoT networks, and wired and wireless networks towards beyond 5G/6G era. Topics of interest include but are not limited to:

- Programmable data plane architectures, hardware platforms, software execution environments, and protocols;
- Architectures exploring in-network compute and storage elements;
- Methods and tools for validating control and data plane operation;
- Framework for creating easy-to-program, end-to-end policies and abstractions across heterogeneous programmable networks;
- Development of a novel data plane programmability and a pilot use case experiment for beyond 5G/6G;
- Dynamic, real time resource management, mobility management, and spectrum/interference management using network programmability in beyond 5G/6G networks, as well as for an integrated edge-core-cloud environment;
- Virtualization and isolation mechanisms on programmable data planes on NICs and/or switches;
- Physical layer programmability, including optical and/or wireless communications systems;
- Programmable converged wireless and optical networks for beyond 5G/6G networks; and
- Integrated cross-layer programmability, including the physical layer.

2) Smart services, applications and experimentation on research testbeds

This solicitation seeks proposals that include implementation and demonstration of smart services and future applications using network programmability on campus, Japan JGN (<https://testbed.nict.go.jp/jgn/>) and/or US FABRIC (<https://fabric-testbed.net/>) and PAWR (<https://advancedwireless.org/>) testbeds. Projects are encouraged to provide open-source software developed for experimentation where possible. Topics of interest include but are not limited to:

- Distributed service monitoring for big data and IoT applications (e.g., monitoring interrelated flows for congestion or failure that could impact large-scale distributed computation, optionally with spatially diverse data);
- Enabling performance, robustness, scalability, and security for smart services;
- Applications including monitoring, telemetry and measurement, load balancing, control plane acceleration and programs that solve practical problems related to traffic engineering, measurement, and time synchronization;
- New methods for achieving low latency/high QoE, energy efficiency, scalability, mobility or routing for beyond 5G/6G networks;
- Machine learning/AI for data collection and fusion to integrate information and control across network layers; and
- Experiments related to research on Area (1) above.

III. AWARD INFORMATION

For each project, the U.S. and Japanese teams will be funded by NSF and the NICT, respectively, through separate NSF and NICT funding instruments. For each project, NSF support will be provided via an NSF grant, and NICT support will be provided either via a contract entered between NICT and a research institute under NICT's extramural Commissioned ICT Research and Development Program or via a new opportunity under NICT's intramural R&D funding program for NICT researchers.

It is anticipated that approximately 5 projects, each up to \$450,000 over three years, will be made to U.S. organizations, pending the availability of funds.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

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

Who May Serve as PI:

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: 1

In the event that an individual exceeds this limit, proposals received within the limit will be accepted based on earliest date and time of proposal submission (i.e., the first proposal received will be accepted and the remainder will be returned without review). **No exceptions will be made.**

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

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

- Full Proposals submitted via Research.gov: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal and Award Policies and Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov. The Prepare New Proposal setup will prompt you for the program solicitation number.
- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov*. The complete text of the *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: (https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

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

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

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

In addition to the guidelines in the PAPPG or NSF Grants.gov Application Guide, proposal preparation instructions specific to the preparation of proposals submitted in response to this solicitation are provided below:

It is expected that the Japanese researchers taking part in the joint research project will submit proposals separately to NICT in accordance with NICT's guidelines and procedures. U.S. researchers will submit to NSF in accordance with NSF's guidelines and procedures. Proposals must be coordinated; it is required that the Project Summary and Project Description should be identical in the US proposal and the NICT proposal. Japanese personnel should be listed as "non-NSF funded collaborators." This listing is for administrative purposes and is not intended to characterize the level or value of the contribution of Japanese personnel to the project. Guidance on information to provide for "non-NSF funded collaborators" is below:

- Biographical Sketch - Required. The biographical information must be clearly identified as "non-NSF funded collaborators" biographical information and uploaded as a single PDF file in the Other Supplementary Documents section of the proposal. Use of a specific format is not required.
- Collaborators and Other Affiliations (COA) Information - Optional but requested. The COA information should be provided through the use of the COA template, identified as "non-NSF funded collaborators" information, and uploaded as a PDF file in the Single Copy Documents section of the proposal.
- Current and Pending Support - Not required.
- Results from Prior NSF Support - Not required.

U.S. Principal Investigators taking part in a joint research project are expected to coordinate their NSF submissions with their Japanese counterparts' NICT submissions.

The following information supplements the guidelines provided in the NSF Proposal and Award Policies and Procedures Guide (PAPPG):

Proposal Titles: Proposals for this solicitation should have titles that begin with "NeTS: JUNO3:" followed by project-specific text.

Project Description: The Project Description is limited to 15 pages. **Please note that per guidance in the PAPPG, the Project Description must contain, as a separate section within the narrative, a section labeled "Broader Impacts" that discusses the broader impacts of the proposed activities.**

Required Supplementary Documents: In the Supplementary Documents Section, the lead institution should upload the following information (not part of the project description and need only be submitted by the lead institution):

- *Collaboration and Management Plan:* In a supplemental document (up to 3 pages), describe a comprehensive collaboration and management plan: identify the project manager who will take responsibility for overall project coordination and management and who will serve as the contact PI for the

project; describe management and research responsibilities for the project; define the expected contributions of each of the PIs and provide a convincing case that the collaborative contributions of the project team members will be greater than the sum of each of their individual contributions; describe mechanisms for integrating and managing all organizations and individuals involved in the project and for exposing students or junior faculty to their counterparts in Japan; and provide a timeline for the proposed effort and identify the parties responsible for each major task. The length of, and degree of, detail provided in the Collaboration and Management Plan should be commensurate with the complexity of the proposed project but must be sufficient to ensure that the U.S. and Japan project elements will work together as an integrated project. **If a proposal does not include a Collaboration and Management Plan, of up to 3 pages, that proposal will be returned without review.**

- **A list of Project Personnel and Partner Institutions** (Note: In collaborative proposals, the lead institution should provide this information for all participants): 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 reviewer selection. The list should include all PIs, co-PIs, Senior Personnel, paid/unpaid Consultants or Collaborators, Subawardees, Postdocs, and project-level advisory committee members, include both U.S. and Japanese personnel. 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:
 - Mary Smith; XYZ University; PI
 - John Jones; University of PQR; Senior Personnel
 - Jane Brown; XYZ University; Postdoc
 - Bob Adams; ABC Community College; Paid Consultant
 - Susan White; DEF Corporation; Unpaid Collaborator
 - Tim Green; ZZZ University; Subawardee
- **Biographical sketches:** The biographical information for Japanese researchers must be clearly identified as "non-NSF funded collaborators" biographical information and uploaded as a single PDF file in the Other Supplementary Documents section of the proposal. Use of a specific format is not required.
- **Letters of Collaboration:** These should be included only if they document collaboration or contributions of resources, data, or other assistance necessary to carry out this project.

Required Single Copy Documents:

- For this solicitation, the Collaborators & Other Affiliations (COA) is required for U.S. senior personnel. Proposers should follow the guidance specified in Chapter II.C.1.e of the NSF PAPPG. The COA information for Japanese researchers can be optional, and if desired, should be provided through the use of the COA template, identified as "non-NSF funded collaborators" information, and uploaded as a PDF file in the Single Copy Documents section of the proposal.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Budget Preparation Instructions:

Grantees of this program will be expected to attend, and should budget for, annual review meetings for the purpose of sharing research progress with representatives of other projects funded under this solicitation as well as other NSF/NICT-designated individuals. For budgetary purposes, proposers should assume that two of these meetings will be held in Japan and one will be held in the U.S.

C. Due Dates

- **Submission Window Date(s)** (due by 5 p.m. submitter's local time):

September 20, 2021 - December 13, 2021

D. Research.gov/Grants.gov Requirements

For Proposals Submitted Via Research.gov:

To prepare and submit a proposal via Research.gov, see detailed technical instructions available at: https://www.research.gov/research-portal/appmanager/base/desktop?_nfpb=true&_pageLabel=research_node_display&_nodePath=/researchGov/Service/Desktop/ProposalPreparationandSubmission.html. For Research.gov user support, call the Research.gov Help Desk at 1-800-673-6188 or e-mail rgov@nsf.gov. The Research.gov Help Desk answers general technical questions related to the use of the Research.gov system. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: <https://www.grants.gov/web/grants/applicants.html>. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

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

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

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

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

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

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Building the Future: Investing in Discovery and Innovation - NSF Strategic Plan for Fiscal Years (FY) 2018 – 2022*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

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

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

A. Merit Review Principles and Criteria

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

1. Merit Review Principles

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

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

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

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

2. Merit Review Criteria

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

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (PAPPG Chapter II.C.2.d(i). contains additional information

for use by proposers in development of the Project Description section of the proposal). Reviewers are strongly encouraged to review the criteria, including PAPPG Chapter II.C.2.d(i), prior to the review of a proposal.

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

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

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

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

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

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

Additional Solicitation Specific Review Criteria

In addition to the merit review principles and criteria described above, JUNO3 proposals will also be evaluated by:

- The extent to which the proposed work supports the solicitation theme of "R&D for Programmable Networking for next generation core and beyond 5G/6G networks"; and
- The extent to which the work and collaboration plans describe a unified project between the U.S. and Japanese participants.

B. Review and Selection Process

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

NSF will manage and conduct the review process of proposals submitted in accordance with NSF standards and procedures. Reviewers will be asked to formulate a recommendation to either support or decline each proposal. Following, and based upon the results of, independent and parallel review processes by NSF and NICT, program managers at the two agencies will discuss recommendations. During this discussion, NSF and NICT program managers may share unattributed reviews (i.e., the reviews will not include reviewer identities) with one another. The NSF Program Officer assigned to manage the proposal's review will consider the advice of both the U.S. and Japanese review processes and the results of the discussions with NICT program managers and will formulate a recommendation.

It is expected that the U.S. and Japanese researchers taking part in the joint research project will submit proposals separately to NSF and NICT, respectively, in accordance with each agency's guidelines and procedures. Proposals received at NSF will be evaluated in accordance with the standard NSF merit review criteria of intellectual merit and broader impacts, plus additional review criteria assessing the quality of the Japan-U.S. collaboration and extent to which the proposal advances the solicitation theme, as specified in this solicitation. The review will be conducted using standard NSF merit review processes, rules, and procedures.

NSF will evaluate for compliance all proposals that it receives. Those proposals that are deemed non-compliant (because they do not follow the PAPPG) will be returned without review. In addition, proposals that lack a Collaboration and Management Plan will be returned without review. Because JUNO3 is co-funding collaborative projects between NSF and NICT applicants, any proposal returned without review by NSF will similarly be returned without review by NICT, and vice-versa.

NSF plans to organize and conduct the peer review process in compliance with the Federal Advisory Committee Act (FACA), as amended (5 USC App. 2). Following this, and based upon the results of, independent and parallel review processes by NSF and NICT, program managers at the two agencies will discuss recommendations. Through this joint selection meeting, NSF and NICT will select proposals to be funded. A comprehensive description of the Foundation's merit review process is available on the NSF website at: https://www.nsf.gov/bfa/dias/policy/merit_review/.

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

After programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications. After an administrative review has occurred, Grants and Agreements Officers perform the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF

Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

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

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

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

B. Award Conditions

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

*These documents may be accessed electronically on NSF's Website at https://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

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

Special Award Conditions:

NSF intends to make awards to the U.S. collaborators named in the recommended proposals. NICT intends to make awards to the Japanese collaborators named in the recommended proposals. Both NSF and NICT awardees will acknowledge the collaboration in their award notices. The awards will be made for three-year periods.

Grantees of this program will be expected to attend, and should budget for, annual grantee review meetings for the purpose of sharing research progress with representatives of other projects funded under this solicitation as well as NSF and NICT representatives and other persons designated by NSF and NICT. The first such meeting will be held approximately 9 months after the awards are made and succeeding meetings will be held approximately every 12 months thereafter.

C. Reporting Requirements

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

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

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

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

VIII. AGENCY CONTACTS

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

General inquiries regarding this program should be made to:

- Ann C. Von Lehmen, Program Director, CISE/CNS, telephone: (703) 292-4756, email: avonlehman@nsf.gov
- Deepankar Medhi, Program Director, CISE/CNS, telephone: (703) 292-2935, email: dmedhi@nsf.gov
- Alexander Sprintson, Program Director, CISE/CNS, telephone: (703) 292-8950, email: asprints@nsf.gov

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

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

For questions relating to Grants.gov contact:

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

IX. OTHER INFORMATION

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

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

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

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

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

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

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

- **Location:** 2415 Eisenhower Avenue, Alexandria, VA 22314
- **For General Information** (NSF Information Center): (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**

Send an e-mail to: nsfpubs@nsf.gov

or telephone: (703) 292-8134

- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

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

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

Suzanne H. Plimpton
Reports Clearance Officer
Policy Office, Division of Institution and Award Support
Office of Budget, Finance, and Award Management
National Science Foundation
Alexandria, VA 22314

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