Building the Prototype Open Knowledge Network (Proto-OKN)

PROGRAM SOLICITATION
NSF 23-571

National Science Foundation

Directorate for Technology, Innovation and Partnerships
   Innovation and Technology Ecosystems

National Aeronautics and Space Administration

   Biological and Physical Sciences Division

National Institutes of Health

   Office of Data Science Strategy

National Institute of Justice

National Oceanic and Atmospheric Administration

   National Centers for Environmental Information

US Geological Survey

   National Geospatial Technical Operations Center

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

   June 20, 2023

IMPORTANT INFORMATION AND REVISION NOTES

This muti-agency translational research solicitation seeks to build a prototype version of an integrated data and knowledge infrastructure called the Open Knowledge Network (OKN). The solicitation identifies three themes associated with building the Prototype-OKN (Proto-OKN). Theme 1 focuses on the development of knowledge graphs to provide data-centric solutions to various societal challenges. Theme 2 focuses on the development of the interconnecting technical "fabric" needed to link the knowledge graphs developed by Theme 1 teams. Theme 3 focuses on the creation of educational materials and tools for a wide range of constituents who are expected to be interested in engaging with the Proto-OKN.

Proposals may optionally include requests for cloud computing resources through an external cloud access entity supported by NSF's Enabling Access to Cloud Computing Resources for the Directorate for Computer and Information Science and Engineering (CISE) Research and Education (Cloud Access) Program.

Any proposal submitted in response to this solicitation should be submitted in accordance with the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) that is in effect for the relevant due date to which the proposal is being submitted. The NSF PAPPG is regularly revised and it is the responsibility of the proposer to ensure that the proposal meets the requirements specified in this solicitation and the applicable version of the PAPPG. Submitting a proposal prior to a specified deadline does not negate this requirement.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

   Building the Prototype Open Knowledge Network (Proto-OKN)

Synopsis of Program:

This program supports the creation of a prototype Open Knowledge Network — an interconnected network of knowledge graphs supporting a very broad range of application domains. Open access to shared information is essential for the development and evolution of artificial intelligence (AI) and AI-powered solutions needed to address the complex challenges facing the nation and the world. Knowledge graphs, which represent relationships among real-world entities, provide a powerful approach for organizing, representing, integrating, reusing, and accessing data from multiple structured and unstructured sources using ontologies and ontology alignment. Currently, private-sector investments in knowledge graphs power numerous consumer applications including web search, e-commerce, banking, drug discovery, advertising, etc. Undertaking a similar but inclusive, open, and community-driven effort and making use of publicly available data holds the potential to create a platform that would empower government and non-government users — fueling evidence-based policymaking, continued strong economic growth, game-changing scientific breakthroughs, while addressing complex societal challenges from climate change to social equity.

Projects funded by this program will provide an essential public-data infrastructure to power the next information revolution similar to the Internet — transforming our ability to unlock actionable insights from data by semantically linking information about related entities.

This Proto-OKN solicitation will support research projects in the following categories:

Theme 1 – Proto-OKN Use Cases: Projects in this category will develop a knowledge graph or "node" of the Proto-OKN that will address specific use-case challenges using well-identified data sets and a user-centric design process to help ensure usability and sustainability of the effort. Theme 1 Use Case projects will work in close collaboration with Theme 2 OKN Fabric projects to deploy their use cases on a common implementation fabric.

Theme 1 proposals may request budgets up to $1.5 million with durations up to three years. The estimated number of awards is 8 to 10, subject to availability of funds.

Theme 2 – Proto-OKN Fabric: Projects in this category will develop and deploy the necessary technologies to provide an "interconnecting fabric" for the Proto-OKN, to help link knowledge graphs developed across Theme 1 projects. Theme 2 teams will possess a strong track record of successful collaborations with technical as well as non-technical partners and will have the technical expertise necessary for successful execution. Theme 2 projects will work in close collaboration with Theme 1 Use Case projects to facilitate use of the OKN interconnecting fabric that will be created.

Theme 2 proposals may request budgets up to $1.5 million with durations up to two years. The estimated number of awards is 1 to 2, subject to availability of funds. One or both Theme 2 projects can be potentially renewed for an additional two years for a budget up to $2 million, with a goal of creating one overarching OKN fabric.

Theme 3 – Proto-OKN Education and Public Engagement: A single award will be made in this category for creating educational materials and tools targeted to the range of constituents who are expected to be engaged with the Proto-OKN. This includes end-users, senior executives/decision-makers, technical developers, students at the graduate, undergraduate, and middle and high school levels, and the public at large. The Theme 3 team will possess the breadth of expertise and experience necessary to produce education and training materials and public engagement content for a broad spectrum of partners. The Theme 3 grantee will work in close collaboration with Theme 1 and Theme 2 grantees to develop the educational, training, and outreach materials.

Theme 3 proposals may request budgets up to $1.5 million with durations up to three years. The estimated number of awards is 1, subject to availability of funds.

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.

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

- 15.808 --- US Geological Survey
- 43.001 --- National Aeronautics and Space Administration (Science)
- 47.084 --- NSF Technology, Innovation and Partnerships

Award Information

Anticipated Type of Award: Cooperative Agreement

Estimated Number of Awards: 10 to 13

Estimated number of awards for Theme 1 is 8 to 10 awards at $1.5 million for three years, for Theme 2 is 1 to 2 awards at $1.5 million for 2 years, and for Theme 3 is 1 award at $1.5 million for three years 3. Theme 2 projects can be potentially renewed for an additional two years for a budget up to $2 million. The number of awards is dependent upon available funding, quality of proposals received, and the degree to which proposals meet the solicitation goals, NSF merit review criteria, and solicitation-specific review criteria.

Anticipated Funding Amount: $20,000,000

The anticipated funding amount indicated above is for a given fiscal year and is subject to the quality of proposals received and 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 laboratories, professional societies and similar organizations located in the U.S. that are directly associated with educational or research activities.
- For-profit organizations: U.S.-based commercial organizations, including small businesses, with strong capabilities in scientific or engineering research or education and a passion for innovation.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization: 1

An organization may serve as the *lead organization* on at most one proposal to this solicitation. If an organization exceeds this limit, the proposal with the earliest date and time will be accepted, and the remainder will be returned without review.

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

There are no restrictions or limits.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not required

- **Preliminary Proposal Submission:** Not required

- **Full Proposals:**

  - Full Proposals submitted via Research.gov: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
  - Full Proposals submitted via Grants.gov: *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov* guidelines apply (Note: The *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide).

B. Budgetary Information

- **Cost Sharing Requirements:**

  Inclusion of voluntary committed cost sharing is prohibited.

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

  Not Applicable

- **Other Budgetary Limitations:**

  Not Applicable

C. Due Dates

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

  June 20, 2023

Proposal Review Information Criteria

Merit Review Criteria:

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

Award Administration Information

Award Conditions:

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

Harnessing the vast amounts of data generated in every sphere of life and transforming them into useful, actionable information and knowledge is crucial to the efficient functioning of a modern society. An Open Knowledge Network (OKN) that links together disparate, heterogeneous information from diverse and varied sources was called for by the Federal Big Data Interagency Working Group (NITRD OKN workshop) in 2018 and recognized in NSF's vision for Harnessing the Data Revolution Big Idea. As a first step to address this need, the NSF's Convergence Accelerator Track A on OKN funded a set of projects beginning in 2019. The imperative for an OKN to support the Artificial Intelligence research environment was also noted in the final report of the National Security Commission on Artificial Intelligence. Knowledge graphs consisting of *nodes* and *edges* — where *nodes* represent real-world entities (e.g., a city, a neighborhood, a court case, a gene, a chemical compound) and *edges* represent different types of relationships among nodes — can enable integration of diverse data to address a broad range of societal challenges.

In 2022, NSF and the White House Office of Science and Technology Policy (OSTP) engaged roughly 150 subject matter experts, end-users, and constituents from government, industry, academia, nonprofits and other communities in an *Open Knowledge Network Innovation Sprint*. Harnessing the collective insights of these experts, the Sprint resulted in an Open Knowledge Network Roadmap outlining a path to a OKN. The OKN is envisioned as an open, interconnected network of knowledge graphs that serves as public, accessible infrastructure and enables development of a variety of solutions for a broad set of societal challenges using open, public data.

Led by the NSF Directorate for Technology, Innovation and Partnerships (TIP), which is charged with inclusively and equitably supporting use-inspired and translational research spanning a set of key technology focus areas, this program aims to make the OKN vision a reality by developing a *Proto-OKN* that embraces state-of-the-art technologies and leverages various extant related efforts. The program invites proposals in one of three categories/themes:

- **Theme 1 – Proto-OKN Use Cases**: Theme 1 focuses on the creation of knowledge graphs, in collaboration with other federal agencies, to address specific societal challenges. Theme 1 projects will be required to work in mutual collaboration with the Theme 2 project(s) to integrate their use case and knowledge graph to create the larger Proto-OKN.
- **Theme 2 – Proto-OKN Fabric**: Theme 2 focuses on the development and deployment of the platform/framework to interconnect the knowledge graphs to create the Proto-OKN and implement it on cloud-based infrastructure.
- **Theme 3 – Proto-OKN Education and Outreach**: Theme 3 focuses on building education, training, and outreach materials for Proto-OKN users, developers, and other constituents. The Theme 3 grantee will work closely with both Theme 1 and Theme 2 grantees to develop educational and training materials, and also coordinate Proto-OKN outreach efforts.

Considering that the creation of the Proto-OKN is fundamentally a *sociotechnical effort,* proposals should demonstrate consideration of human, social, and organizational factors, as well as being technical efforts. User-centered design approaches, user involvement and alignment, and customer engagement are essential to ensuring an impactful and sustainable outcome. Therefore, projects must address both the technological and social dimensions of the Proto-OKN and describe how those dimensions are integrated together. Deep engagement is necessary among domain knowledge experts and a host of other constituents including data owners, decision makers, various end-user communities, tool builders, and knowledge representation experts. Proposals may integrate information from a range of domains of interest to NSF and other federal government agencies including, but not limited to: agriculture, civil infrastructure, disaster mitigation and response, crime and justice, energy, environmental quality, learning environments, health and wellness including healthcare, human services, accessibility and inclusivity, workforce development, resiliency, safety, social services, telecommunications, transportation and mobility, urban and rural planning, and water resources.

Additional details on individual themes are provided in Section II Program Description.

II. PROGRAM DESCRIPTION

A. Overview

This muti-agency translational research Solicitation seeks to build an integrated data and knowledge infrastructure called the *Proto-OKN*. The Proto-OKN is envisioned as an essential public-data infrastructure consisting of an interconnected network of easily accessible and query-able knowledge graphs. It would transform our ability to unlock actionable insights from data by semantically linking information about related entities — powering the next data revolution.

Proto-OKN projects should involve multidisciplinary teams consisting of key constituents, e.g., end-users, data providers, industry leaders, technical experts, leading to the creation of an *ethical, impactful* and, ultimately, *sustainable* Proto-OKN. *Identification of and engagement with end-users and key partners should have occurred prior to applying to this program — and not as a part of the project activity.* The solicitation especially seeks proposals that align with partnering US federal agency priorities as described in Section II.C.2.

Technologies to support knowledge graph implementations at scale can be diverse and are evolving. To ensure a basic level of interoperability and the ability to integrate all efforts into a single Proto-OKN, proposals must describe how the following technical requirements will be met:

- Common representation of all information using the Resource Description Framework (RDF), or similar format.
- Public/open access (e.g., GitHub) to software/code developed for data ingestion, enrichment, query, and other key functions.
- Use of a standards-based approach for describing graph data, e.g., Web Ontology Language (OWL), Resource Description Framework Schema (RDFS), Shapes Constraint Language (SHACL) schema. Publicly documented schema including an actionable serialization (e.g., RDF/Extensible Markup Language (XML), Terse RDF Triple Language (TTL), JavaScript Object Notation for Linked Data (JSON-LD)) for transmission or storage.
- Wherever possible, simple (1-1) mappings of classes and properties within the graph data to entities in open systems like Wikidata, DBpedia, public graph data from the NSF's Convergence Accelerator Track A efforts (KnowWhereGraph, SCALES OKN, SPOKE and UF OKN), Google Data Commons, and other similar publicly accessible graph data sources. Where necessary, projects should provide entity disambiguation, to resolve two or more terms that refer to the same entity, utilizing entities from the publicly accessible graph data sources, e.g., such as those mentioned above. The results should be provided in open, documented form using, for example, OWL or RDF (e.g., owl:sameAs or skos:exactMatch), or other common mechanisms.
- Where applicable, complex mappings to large publicly accessible graph data sources using OWL or Semantic Web Rule Language (SWRL).
- Quality assurance of both the schema and entity mappings at increasing levels of complexity, with open access to the methods and results.
- Ability to query the graph, e.g., using the public Simple Protocol and RDF Query Language (SPARQL) endpoint or similar capability.
- Federated querying using data from other Proto-OKN projects based on simple (1-1) mappings of classes and properties.

Proposals responding to this solicitation should cover the following elements at a minimum, to be considered competitive:

- Theme 1 proposals should **have already identified key public datasets** that will be used to create underlying knowledge graphs. Data must come from more than one source (e.g., government agency or site) and may include multiple types of data (e.g., structured, unstructured, numerical, categorical). Projects may also propose to incorporate non-public data with access controls, aggregation, and/or anonymization; however, the end tool or resource must be publicly accessible.
- **The ethical implications of using these data, and related data governance.** Describe how the proposed project will adhere to data and AI ethics standards including Executive Order 13960 Promoting the Use of Trustworthy AI in the Federal Government and OSTP Blueprint for an AI Bill of Rights, as well as ethics guidance appropriate to the use-case (e.g. VA Ethics Principles for Access to and Use of Veteran Data or DOD ethics principles for AI).
- **How, and in which areas, would collaborations occur with other projects in this program?**
- **The roles and responsibilities of various constituents engaged in the project**, and how they will ensure that the overall information infrastructure (data, data workflows, knowledge graph structures, software, interfaces, applications) of the project will be maintained in the long run.
- **The data and software artifacts,** including software tools, data workflows, ontology and knowledge design and implementation methods, that would be employed to create the underlying knowledge graph infrastructure in order to semantically link data sets.

Proposers are strongly encouraged to focus their multi-disciplinary, use-inspired research on areas of interest to NSF and other government agencies participating in the program, as listed below in Section II.C.2.

B. Proposal Categories

Research Project Proposals

Proposals for research projects must fall into **only one** of the following themes, which should be clearly identified in the project title.

- **Theme 1 – Proto-OKN Use Cases**

    Proposals in this category will focus on the challenges posed by specific application(s)/use-case(s) and the relevant data sources for the respective use-case(s). Proposals should describe the software tools, data workflows, ontology, and knowledge design and implementation methods that would be employed to create the knowledge graph infrastructure from underlying data.

Key constituents including end-users and data providers should already have been identified and should be engaged in and committed to this effort. Proposals should explain how the overall information infrastructure, including the data, software, and knowledge graph structures will be maintained including roles and responsibilities of the various constituents engaged in the project. This solicitation especially seeks Theme 1 proposals that align with the priorities from the partnering agencies, as listed below in Section II.C.2.

Theme 1 proposals should clearly describe the data governance procedures that will be in place to ensure transparency and fair use of all the data. Proposals should also describe the essential data and AI ethics issues relevant to the use-case(s) and the ethics standards that will be used to guide the effort.

As mentioned, Theme 1 projects should be prepared to work in collaboration with Theme 2 projects for interoperable technical implementation at scale, following the timeline(s) of the Theme 2 award(s). Theme 1 projects should plan for their deliverables to be available and used by Theme 2 projects in demo, alpha, or beta mode during the duration of this 2-year effort as discussed in the Deliverables and Management Plan in subsection II.C.4 below. Also, Theme 1 projects should be prepared to work with the Theme 3 project to help prepare appropriate education/training materials. Proposals should identify the specific personnel who will be engaged in such collaborations with Theme 2 and Theme 3 projects, respectively.

Theme 1 proposals may request budgets up to $1.5 million with durations up to three years.

Estimated number of awards is 8 to 10, subject to availability of funds.

- **Theme 2 – Proto-OKN Fabric**

  Proposals in this category must focus on development and prototyping of robust, scalable, cloud-based technical infrastructure for Proto-OKN based on leading-edge technologies. Theme 2 projects will be expected to support and demonstrate use of the prototype infrastructure by Theme 1 projects in Year 2 of the program. At that time, Theme 2 projects will need to deploy and run "production systems" and support Theme 1 users. Theme 2 projects are strongly encouraged to include industry partners as leads, co-PIs, or collaborators, or ensure that the project is able to adopt a production systems approach in their efforts.

  Theme 2 proposals should clearly describe the proposed technical architecture and implementation considerations. Implementations are expected to be open and cloud-based, to enable future OKN efforts to continue to link to the overall Proto-OKN fabric. Adequate explanations should be provided in case the implementation has any closed/proprietary aspects, and in case it employs private cloud infrastructure.

  Theme 2 proposals should be able to demonstrate:

  - *Technical skill*, i.e., technical expertise and experience in implementing large-scale data projects and systems;
  - *Technical support capability*, i.e., the ability and willingness to provide technical support to assist Theme 1 projects; and
  - *Open and collaborative approach*, i.e., the experience and ability to develop open systems and the ability to collaborate with other teams as peers.

  Theme 2 projects will provide the technical expertise needed to help link together Theme 1 data/knowledge graphs to create an overall linked Proto-OKN fabric. Theme 2 projects will plan for their infrastructure to be available for use by Theme 1 projects in *alpha* mode in 9 months and in *beta* mode in 18 months, as described in the Deliverables and Management Plan in subsection II.C.4 below. Collaboration between Theme 1 and Theme 2 projects should be on a peer-to-peer basis rather than one side dictating to the other, with adequate time and personnel effort dedicated for this interfacing effort. Theme 2 projects are also expected to collaborate with the Theme 3 effort to help develop the relevant educational and training materials.

  This program seeks to fund up to two Theme 2 projects via this solicitation. The two projects will be required to merge their efforts together to create a single, common OKN Fabric to be deployed prior to the end of Year 2. Details of the merged effort will be worked out in Year 1 in collaboration with NSF. Subject to availability of funds, the merged OKN Fabric effort will be funded for an additional 2-year period in order to provide on-going support to Theme 1 efforts as well as any other OKN-related efforts from partner agencies.

  Theme 2 proposals may request budgets up to $1.5 million with durations up to two years. Theme 2 projects can be potentially renewed for an additional two years for a budget up to $2 million.

  Estimated number of awards is 1 to 2, subject to availability of funds.

- **Theme 3 – Proto-OKN Education and Public Engagement**

  A single award will be made in this category for creating educational and training materials and tools addressing the broad range of users of the Proto-OKN — from data providers to expert end users, technical developers, senior managers, non-expert users/citizens, and students at graduate, undergraduate, high school and middle school levels. For each distinct end-user community, the goal of the education and training materials is to help explain how the Proto-OKN impacts society and help prospective users understand how to engage. Proposals should describe how they would develop materials to help:

  Explain the underlying concepts and techniques of the Proto-OKN and, more broadly, the concepts of *knowledge representation* and *knowledge graphs* and the importance of that approach to a broad range of end-users;

  - Provide the conceptual information and functional details necessary for users to effectively use the system; and
  - Provide the conceptual information and functional details necessary for content and technology contributors to effectively contribute to the system.
  - As mentioned earlier, Theme 1 and Theme 2 projects will collaborate with the Theme 3 effort in order to help develop the relevant educational and training materials.

  Proposals are encouraged to consider novel approaches and activities for effectively engaging with the broad range of end-users to facilitate effective user engagement.

  Theme 3 proposals may request budgets up to $1.5 million with durations up to three years.

  Estimated number of awards is 1, subject to availability of funds.

C. Project Description Components

Each proposal is required to address the seven components described below.

1. Integrative Sociotechnical Research and Development

As a sociotechnical effort, the creation of Proto-OKN should consider both the *technological* and *social* dimensions in concert, in order to develop a tool that is both useful in the short term and also likely to be adaptable for the long term. Proposal should describe the social aspects relevant to their respective efforts using the following guidelines and considerations:

○ *Participatory Design*: does the effort employ human-centered design principles to engage the broad range of partners and end-users?
○ *Open Contributions*: is the system being designed to be as open as possible, to avoid the risk of a closed, proprietary system that may benefit only a few?
○ *Transparency:* is the system design — including the processes employed for data ingestion, enrichment, and consumption — open, accessible, and transparent to help foster the creation of a trustworthy system?
○ *Ethics*: is the project working directly with effected and cognizant communities to ensure inclusivity in the data, users, and communities engaged and protection of privacy, civil rights, and civil liberties of individuals to facilitate the creation of an ethical, responsible Proto-OKN?
○ *Sustainability*: is the project taking sustainability into consideration from the start, for example, by interconnecting use-cases of clear value to specific government agencies and/or other organizations, and/or connecting to existing open science efforts, data library initiatives, or other shared research computing structures.
○ *Extensibility*: is the system being designed and architected with existing standards but with an eye toward the future. New data, use cases, users, and partners should be able to connect to and use the Proto-OKN in the future.
○ *Connective Fabric*: is the project cognizant of the connective nature of the Proto-OKN and the need to facilitate linkages, as opposed to creating disconnected fragments of information?

The technological dimensions of Theme 1 and Theme 2 efforts (along with corresponding educational/training materials from Theme 3)include, but are not limited to:

○ Gathering *requirements* for capabilities needed for the specific domain of each use-case, aggregating those capabilities as general categories of requirements, understanding which of these capabilities are immediately available versus which would require research advances, and identifying the types of linkage approaches required among data from different domains (e.g., health and environment, natural resources, or judicial records).
○ Identifying relevant data sources and assessing their utility for each use-case requirement.
○ Establishing quality schemas in the form of *ontologies* while taking existing ontologies into account and identifying any gaps, compiling inventories of relevant ontologies, services, and frameworks across different domains, and adopting common or shared representations.
○ Encouraging existing repositories to provide *easy communication* among the elements of the Proto-OKN, by identifying shared ontologies, using NIEM vocabularies, and extending the schema.org framework wherever possible. Identifying and addressing any ontological barriers to access would help the Proto-OKN create more robust data access to various domain repositories, including private and sensitive data.
○ *Fostering interconnection* of information across domains, with particular emphasis on any particularly valuable datasets and information that may currently be largely disconnected and/or difficult to integrate.
○ Developing highly effective *prototypes for querying and accessing* data and, where applicable, performing reasoning tasks with the data.
○ Prototyping various *user-friendly interfaces* with different data access modalities for a broad range of users including, for example, graph technology experts, domain science experts, and lay users. For example, interfaces may be required to engage domain/subject matter experts, who may not necessarily be familiar with knowledge graph technologies, in order to assist with the verification/validation/curation of the knowledge base.
○ Developing *metrics* to objectively measure the use and the impact of Proto-OKN use by different constituents.
○ Ensuring that it is possible to *incorporate data* from a wide variety of resources including unstructured, semi-structured, and structured sources and, importantly, data with varying levels of quality and fidelity.
○ Developing approaches to *incorporate private and access-controlled data* within the open system design of the Proto-OKN using established governance principles and procedures.
○ Use cases considering the use of large language models should discuss the relationship and complementarity between such models and the knowledge graph as well as the various issues and challenges associated with using such models.

2. Partnerships and Engagement

All proposals should clearly identify participating constituents (e.g., from government, industry, academia, non-profits, citizen groups, and others) and describe activities that reflect their meaningful engagement. Projects are encouraged to engage with government constituents as integral members of the project team, including government decision makers who could potentially act on the results of the knowledge derived from the Proto-OKN. Other examples of user communities include neighborhood or community groups, nonprofit or philanthropic organizations, businesses, municipal organizations such as libraries, museums, public works departments, educational institutions, and health and social services agencies. local, county, and state governments and departments as well as regional cooperative initiatives. All partners are expected to work closely together to develop, pilot, and evaluate creative approaches to accomplish the goals of the proposed effort.

While participation by government constituents is strongly encouraged, please note that employees of the US federal government may not receive funding through NSF proposals.

Theme 1 proposals must demonstrate that they **have already identified and engaged with end users and other partners prior to applying to this program** (and not as a part of the project activity). This includes engaging with end-users to identify application needs and data availability and characteristics, identifying and articulating the translational research challenges, and specifying the steps required to use/reuse the data to create the Proto-OKN environment.

This solicitation especially seeks proposals that align with the following priorities from the partnering agencies including NASA, NIH, NIJ, NOAA and USGS:

○ **(NASA) Space biology**: Space biology research characterizes the effects of spaceflight on living systems. This Priority is interested in integrating diverse data by creating a knowledge graph that would connect space biology terminology with the terminology used by the larger biological/biomedical research community (including existing knowledge graphs such as SPOKE: spoke.ucsf.edu), supported by the spaceflight and space-relevant Open Science Data Repositories at NASA Ames: https://genelab.nasa.gov/.
○ **(NIH) Proto-OKN Fabric**: NIH anticipates partnering with NSF on the Theme 2 Proto-OKN Fabric (NIH supports several Knowledge Network

efforts; a full list can be found on RePORT).

- **(NIJ) Tracking nonfatal firearm injuries:** The NIJ is interested in creating a single source of information for nonfatal, interpersonal, and intentional firearm (i.e., gunshot) injuries to support the development of evidence-based firearm violence prevention policy that depends upon timely, accurate, and microlevel data. Currently, there is no single database that contains information about firearm injuries that do not result in fatalities to allow for calculating the frequency and understanding the circumstances surrounding such shootings. Various relevant databases exist at the national, state, and local levels that contain critical elements related to injury and firearm use, such as the National Incident Based Reporting System (NIBRS), and public health data, among others. Validated through descriptive information from law enforcement's incident reports, merged data from NIBRS and public health data could be linked with local-level data describing socioeconomic characteristics, features of the built environment, and other community-relevant information to better understand why nonfatal shootings occur — where and when they do — which in turn can inform strategic violent crime prevention efforts in the community.
- **(NIJ) Mining criminal justice insights from existing data:** The National Archive of Criminal Justice Data (NACJD), supported by the Bureau of Justice Statistics (BJS), the National Institute of Justice (NIJ), and the Office of Juvenile Justice and Delinquency Prevention (OJJDP) of the Office of Justice Programs, United States Department of Justice, is located at the Inter-University Consortium for Political and Social Research (ICPSR) and contains data from over 3,200 studies on topics of crime, justice, and the criminal justice system. ICPSR also houses a Federal Statistical Data Center for the access of sensitive data. This priority is interested in linking the data sets in NACJD to support the exploration of cross-cutting questions, the provision of new insights, and the promotion of knowledge development across the criminal justice system.
- **(NOAA) Environmental Data**: NOAA is interested in use-cases that leverage NOAA data to address challenges in areas related to climate and the Blue Economy, with an emphasis on **ensuring equitable distribution and use of data**. A general priority for NOAA is to improve the findability, accessibility, interoperability, and reusability of its data and furthering use-cases that help connect NOAA data with other related data across Federal agencies.
- **(USGS) Topographic Data Integration**: USGS is interested in integrating topographic data from the USGS National Map and other related distributed datasets to serve a range of user needs including publishing Findable, Accessible, Interoperable, Reusable (FAIR) data, making linkages among diverse USGS programs and helping initiate new collaborative efforts with the data. The activity should also consider data integration workflows capable of dealing with sensitive geospatial data throughout the various stages of data handling.

In addition to the above, agencies including the Defense Advanced Research Projects Agency (DARPA), U.S. Department of Transportation (DOT), U.S. Army, and the U.S. Department of Veterans Affairs (VA) have also provided use cases.

- *(DARPA) Supply-and-Demand Networks* : This use case focuses on the relationship between efficiency and fragility (anti-resilience) in supply-and-demand networks (SDNs). Specifically, the use-case is interested in developing a knowledge graph that would help (i) identify blind spots in our awareness of an SDN structure and its vulnerabilities, (ii) quantify the fragilities in an SDN that emerge at system (network) scale/scope, (iii) stress test the SDN to assess system response to external stress events, and (iv) analyze the critical risks and uncertainties in SDNs based on procurement relationships. Potential deliverables include techniques for SDN information fusion, including reconciliation of bottom-up details and top-down aggregates, protocols for design of disruption scenarios for stress-testing analytics, and tested algorithm(s) for SDN fragility identification and assessment.
- *(DoT) Transportation Equity* : This use-case is interested in tackling a variety of transportation equity challenges using the National Transportation Atlas Database (NTAD) (https://data-usdot.opendata.arcgis.com/) and other transportation-related datasets housed at the U.S. Department of Transportation. Transportation equity has many dimensions ranging from supply-chain flows to accessibility to transportation for healthcare and wellbeing, education, and employment.
- *(U.S. Army) DoD Innovation Ecosystem* : This use-case is about creating an information resource, in the form of a Knowledge Graph (KG), of the various innovation programs currently funded by the US Army and other DoD agencies to enable the US Army to better link various programs, initiate new collaborative efforts among participants to yield outcomes greater than the sum of their parts, and eliminate duplication of efforts.
- *(VA) Social Determinants of Health* : This use-case requires bringing together a number of geographically distributed sources for data on social determinants of health, ingesting these into a knowledge graph form, and facilitating successful integration with other existing knowledge graphs such as the ones generated by the NSF-funded KnowWhereGraph OKN project and also other Proto-OKN efforts.

Additional applications/use cases that emerged from the OKN Innovation Sprint are provided below. Again, these applications/use cases are merely exemplary and not meant to be exhaustive.

- *Equity, Social Care, and Justice Issues* : Use cases related to providing community care and community services that improve community health and well-being for all community members. Community care could be delivered through social services such as decarceration service planning and family reunification; addressing and preventing homelessness; and/or increasing transparency in the justice system.
- *Climate Change, Disaster Management, and Energy Systems* : Use cases focusing on climate change and its impact on (i) food systems, (ii) resources to support local community adaptation and community-level decision-making, (iii) resilience and improvement of energy systems, and (iv) preparing for natural disasters due to extreme weather events compounding with other factors.
- *Health Communications and Information Accuracy* : Use cases exploring use of bona fide public health information to help counter the significant amounts of misinformation on this topic in social media, especially focusing on vulnerable populations in this context.
- *Innovation and Research Ecosystems* : Use cases focusing on providing data-driven, insightful decision-making support for stakeholders of various research and innovation programs. Specifically, use cases may explore how to enable the system to support researchers seeking to assess current research gaps, and use predictive methods to identify future areas of scientific research opportunities.
- *Supply Chain, Decision Support, and Financial Risk Analysis* : Use cases addressing macro-scale issues in supply chain management, decision support, and financial risk assessment that promote the use of data-driven insights, decisions, and predictions for use by public and private agents to tackle a range of issues related to supply chain, government decision making, and financial risk analyses.

3. Collaboration Plan

Strong collaboration among the cohort of Proto-OKN projects will be a hallmark of the Proto-OKN program — to help build the connective fabric of the Proto-OKN and prevent fragmentation. To that end, all projects are required to provide a collaboration plan that articulates how they will collaborate with the other projects funded in this program. Projects must account for the collaboration activity in their timelines and their budgets. Since the cohort of funded projects will not be known at the time of writing the proposals, the collaboration plans will necessarily have to be relatively "open-ended".

Projects in Theme 1 and Theme 2 are expected to collaborate in order to realize Theme 1 implementations using platforms created by Theme 2 efforts.

As mentioned earlier, Theme 1 and Theme 2 projects are expected to collaborate with the Theme 3 effort in order to develop education and training materials.

There may also be opportunities for projects in Theme 1 to collaborate with each other, depending upon their respective topic(s), goals and objectives, and the end-users involved.

4. Deliverables and Management Plan

Deliverables

All projects will start on the same date, October 2023.

Proto-OKN projects will be driven by alpha, beta, and final project deliverables, with regular tracking and measurement of project progress every quarter.

All Proto-OKN Project Timeline must include the following milestones:

- Definition of alpha-level deliverables by the end of *first quarter (3 months)*
- Presentation of the concept for alpha-level deliverables by the end of *second quarter (6 months)*
- Demonstration of alpha version of product at the end of Y*ear 1 PI meeting (12 months)*
- Presentation of the concept for beta-level deliverables by the end of *fifth quarter (15 months)*
- Demonstration of beta version of product at the end of Year 2 (24 months)
- Deployment of product for general use by the end of *tenth quarter* (30 months)
- Project closeout presentations at the end of Year 3 (36 months)

All Teams are expected to define the alpha and beta level deliverables in coordination with rest of the Proto-OKN program participants and the government partners.

Proposals should clearly identify project deliverables and describe how they will be achieved in a quarterly timeline. The Project Timeline should include intermediate milestones associated with data access and ingestion, development and deployment of knowledge graphs, related curation and analytical tools, and training materials. Testing, validation, evaluation plan — where the beta *v*ersion is able to ingest/process/analyze/visualize significantly more data than the alpha — should be part of the Project Timeline. The timeline provided should be realistic — accounting for possible contingencies — rather than an optimistic view of activities. The activities included should cover the effort for standing-up a demo/alpha Proto-OKN, use of the same by the program participants, including data providers, end users, and other constituents.

Additional Deliverables for Theme 2

In addition to the deliverables described above, Theme 2 projects must also include a plan for testing the *system at scale*, as one of their deliverables. A reasonable plan should be adopted for testing at scale that may include, for example, testing with larger data volumes, more concurrent users, a diverse concurrent workload (e.g., small queries requiring fast response, long compute-intensive computations, etc.)

Management Plan

A strong management structure and plan is essential to ensure success of Proto-OKN projects. Given the relatively short project duration of 2 years, it will be essential for projects to ensure smooth functioning across a possibly distributed, multi-sector, transdisciplinary team. The management plan should demonstrate awareness of the issues involved in coordinating across the range of disciplines, institutions, and organizations engaged in the effort. It should identify specific mechanisms to enable cross-discipline and cross-sector integration of teams. The plan should describe how tasks will be integrated over the course of the project and provide a timeline with principal tasks, milestones, and associated interactions.

The Plan should describe the specific roles and responsibilities of the collaborating PI, co-PIs, other Senior Personnel, staff, paid consultants, and constituent participants in ensuring that the deliverables are delivered on time, while keeping in mind the technical as well as social sciences dimensions of the project.

All projects must designate a C*ollaboration Lead* and an *Integration Lead* — which could be two different individuals or the same person in two roles. The Collaboration Lead will be responsible for ensuring effective communications and collaboration among all participants in the project. The Integration Lead will ensure effective integration of components at a technical level.

5. Evaluation Plan

All proposals must include an *Evaluation Plan* that defines the metrics for success for the proposed research and development goals, pilot activities and societal impact, from the perspective of both researchers and government and other constituents. Proposals should identify the key time points and/or milestones at which they will assess progress towards achieving the project goals and the specific evaluation metrics, methodologies and criteria that will be employed. Proposals to all Themes should describe the roles of constituents in evaluating progress and outcomes to ensure that project goals continue to align with user needs.

Evaluation using mixed methods is encouraged and may employ any of a variety of systematic methodologies and criteria such as: qualitative and/or quantitative methods, public participation, periodic and/or longitudinal analyses, experiments, or other approaches required to iteratively improve and successfully evaluate the project.

6. Scalability, Extensibility and Sustainability Plan

While all proposals will focus on their specific objectives, proposals should also consider that the Proto-OKN should be architected with an eye toward the future — new data, use cases, and partnerships must be able to connect to and use the Proto-OKN to provide increased value and impact. As such, proposals should describe the potential for their approaches to be scaled and extended to other use cases, end-users, and/or government agencies, Proposals should also be able to articulate a clearly identified sustainable path beyond the performance period of the program.

The Proto-OKN will require a committed community of users and partners to ensure sustainability of the purpose, data and the network. Basing the initial effort on interconnected use-cases with clear value to specific agencies and other organizations can help build that community, as will connecting the Proto-OKN to existing open knowledge graph efforts, open data efforts, data library initiatives, and shared research computing structures.

As part of the Scalability, Extensibility, and Sustainability Plan, teams should identify which community/government constituents on the project team have the capability (e.g., influence, experience and networks) to develop pathways to sustain successful project outcomes in the long-term. Teams should discuss how they envision sustainability and scalability? What could be done in the short term (1-3 years)? and what efforts and resources are needed in the longer term (4-15 years)?

7. Data/AI Ethics Standards and Guidance

The OKN should be a trustworthy resource, and the Proto-OKN should embrace and incorporate ethical approaches and standards to help build this trust. Projects must clearly describe how they will protect privacy, civil rights, and civil liberties and adhere to prevailing/emerging data and AI ethics standards and guidelines, such as Executive Order 13960 Promoting the Use of Trustworthy AI in the Federal Government and OSTP Blueprint for an AI Bill of Rights, as well as ethics guidance appropriate to the use-case (e.g. VA Ethics Principles for access to and use of veteran data (https://www.oit.va.gov/about/ethical-data-use/index.cfm?) or DOD ethics principles for AI, and other relevant standards/guidelines).

Ensuring an ethical, responsible Proto-OKN requires an intentional, community-centric approach and careful design, along with ongoing monitoring. Many factors will contribute to the success of this objective, including working directly with government constituents, various other end-user communities and ensuring inclusivity in the data, users, and communities engaged.

Proposals must include their plan to address concerns regarding ethics risks and social implications. In doing so, teams are encouraged to consider the potential limitations of their data sources, potential biases in collection, inclusion, and the gaps or omissions in the data. Teams are also encouraged to consider who has rights over the data, what permissions are needed (legally), or should be requested (ethically), before using these data? Does the data incorporated serve the core purpose of the effort? Teams may consider how their efforts may negatively impact a community or a cause, could the manner in which the data is collected, shared, or used cause harm? Could groups or individuals experience prejudice or profiling? Would only some groups have access to the tools/data? Additionally, is there a mechanism for those who may be impacted to engage? If problems are identified, how could the tool/resource be changed to address those concerns?

D. Proto-OKN Kick-off and Team Meetings

The Proto-OKN program requires a regular schedule of meetings among participants to (a) enable enhanced integration of efforts among the funded projects, (b) build a committed community of users to ensure sustainability; and (c) accelerate the rate of dissemination of ideas among researchers, end-users, and government constituents. All projects must plan for at least the following meetings, which should be factored into the respective project plans, timelines, and budgets.

1. Proto-OKN Year 1 Project Kickoff meeting. In-person and/or remote. To be held soon after project awards have been announced.
2. Quarterly meetings (every 3 months). In-person and/or remote. The goal of these meetings is to monitor progress and make adjustments if/where needed. These meetings could be held among subgroups of projects, based on topics of interest. Subgroups may change between meetings.
3. Year 2 and Year 3 Kickoff meeting. In-person and/or remote. PIs or their designees must participate in the entirety of each meeting throughout the duration of their awards. Lead investigators from each subaward institution and various community users are expected to participate.

A substitute project representative may be designated to attend a PI meeting, but only with prior approval from a cognizant NSF Program Officer. As noted in Section V.B, Budget Preparation Instructions, budgets for all projects must include funding for one or more designated project representatives (PI/co-PI/Senior Personnel or NSF-approved replacement) to attend each PI meeting during the proposed lifetime of the award. It is also strongly encouraged for at least one community partners to attend the PI meeting and for the budget to include funding to support the participation of the attending partners(s).

E. Cloud Computing Resources

Proposals may request cloud computing resources to use public clouds such as Amazon Web Services (AWS), Google Cloud Platform (GCP), IBM Cloud, and Microsoft Azure. Cloud computing resources described in proposals may be obtained through an external cloud access entity (CloudBank) supported by NSF's Enabling Access to Cloud Computing Resources for CISE Research and Education (Cloud Access) program.

Proposers should describe this request in a Supplementary Document including: (a) which public cloud providers will be used; (b) anticipated annual and total costs for accessing the desired cloud computing resources, based on pricing currently available from the public cloud computing providers; and (c) a technical description of, and justification for, the requested cloud computing resources. The proposal budget should not include the costs for accessing public cloud computing resources via CloudBank. Also, the total cost of the project, including the cloud computing resource request, may not exceed the budget limit described in this solicitation.

If incorporating this request into the proposal, a proposer should include "CloudAccess" (one word without spaces) as a keyword on the Project Summary page, at the end of the Overview section (before the section on Intellectual Merit).

Proposers seeking CloudBank funds should include "CloudAccess" (one word without space) at the end of the list of keywords in the project summary (before the section on Intellectual Merit). Proposers may contact CloudBank (see https://www.cloudbank.org/faq) for consultation on estimating the costs for using cloud computing resources.

See Section V.A. Proposal Preparation Instructions, Supplementary Documents, for more information on how to describe the cloud computing resource request as well as the associated budget.

III. AWARD INFORMATION

Anticipated Type of Award: Cooperative Agreement

Estimated Number of Awards: 10 to 13

Estimated number of awards for Theme 1 is 8 to 10 awards at $1.5 million for three years, for Theme 2 is 1 to 2 awards at $1.5 million for 2 years, and for Theme 3 is 1 award at $1.5 million for three years 3. Theme 2 projects can be potentially renewed for an additional two years for a budget up to $2 million. The number of awards is dependent upon available funding, quality of proposals received, and the degree to which proposals meet the solicitation goals, NSF merit

review criteria, and solicitation-specific review criteria.

Anticipated Funding Amount: $20,000,000

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:

- 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 laboratories, professional societies and similar organizations located in the U.S. that are directly associated with educational or research activities.
- For-profit organizations: U.S.-based commercial organizations, including small businesses, with strong capabilities in scientific or engineering research or education and a passion for innovation.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization: 1

An organization may serve as the *lead organization* on at most one proposal to this solicitation. If an organization exceeds this limit, the proposal with the earliest date and time will be accepted, and the remainder will be returned without review.

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

There are no restrictions or limits.

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.

See PAPPG Chapter II.D.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.

Organizations that are new to NSF proposal submission and funding are encouraged to review the Prospective New Awardee Guide**.**

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

Multi-Institutional Proposals: For collaborative proposals involving multiple institutions, the proposal must be submitted by one lead institution with funding for all other **participating institutions made through subawards**. See PAPPG Chapter II.E.3.a for additional information. **Proposals submitted as separately submitted collaborative proposals (as described under PAPPG Chapter II.E.3.b) will be returned without review.**

Proposal Title: The title of the proposal **must** begin with **"Proto-OKN Theme 1", "Proto-OKN Theme 2"** or **"Proto-OKN Theme 3".**

The rest of the title of the proposal should describe the project in concise, informative language so that a scientifically- or technically literate reader can

understand what the project is about. The title should emphasize the scientific work to be undertaken and be suitable for use in public press.

Project Description:

Project Descriptions for Proto-OKN Theme 1, Theme 2 and Theme 3 proposals are limited to 15 pages in length and must be prepared as follows:

- **Proto-OKN Theme 1 Proposals** (15-page limit): Theme 1 proposals must describe the compelling Proto-OKN use case how it will serve the public good. The Project Description must provide details on an integrative sociotechnical approach and describe how the community/constituent engagement components infuse and support the proposed research. As described in Section II.C above, the Project Description should include separate sections labeled **Integrative Sociotechnical Research and Development, Partnerships and Engagement, Collaboration Plan, Deliverables and Management Plan, Evaluation Plan, Scalability, Extensibility and Sustainability Plan,** and **Data/AI Ethics Standards and Guidance**. Additionally, a separate section labeled **Broader Impacts** must be included, as described in the PAPPG. **Proposals lacking one or more of these sections or subsections will be returned without review.**

- **Proto-OKN Theme 2 Proposals** (15-page limit): Theme 2 proposals must describe how they would create a process and architecture that will integrate Theme 1 projects and operate a federated system for queries across Theme 1 use cases. Significant time and personnel effort is expected to be dedicated to interfacing with the Theme 1 grantees, including facilitated approaches for effective dialogue with different scientific disciplines, end-users, and overall goals. Proposals should describe how the overall Proto-OKN created would connect with cloud-based infrastructures. Proposal must include a discussion of where the final integrated Proto-OKN would reside. As described in Section II.C above, the Project Description should include separate sections labeled **Integrative Sociotechnical Research and Development**, **Partnerships and Engagement**, **Collaboration Plan**, **Deliverables and Management Plan**, **Additional Deliverables for Theme 2**, **Evaluation Plan, Scalability**, **Extensibility and Sustainability Plan**, and **Data/AI Ethics Standards and Guidance**. Additionally, a separate section labeled **Broader Impacts** must be included, as described in the PAPPG. **Proposals lacking one or more of these sections or subsections will be returned without review.**

- **Proto-OKN Theme 3 Proposals** (15-page limit): Proposals in Theme 3 should discuss their plans to create educational materials and tools that help explain how the Proto-OKN impacts society and help prospective users understand how to engage. As described in Section II.C above, the Project Description should include separate sections labeled **Integrative Sociotechnical Research and Development, Partnerships and Engagement, Collaboration Plan, Deliverables and Management Plan, Evaluation Plan, Scalability, Extensibility and Sustainability Plan, and Data/AI Ethics Standards and Guidance**. Additionally, a separate section labeled **Broader Impacts** must be included, as described in the PAPPG. **Proposals lacking one or more of these sections or subsections will be returned without review.**

Supplementary Documents:

1. Project Personnel and Partner Institutions: 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 must include all PIs, co-PIs, Senior Personnel, paid/unpaid Consultants or Collaborators, Subawardees, Postdocs, and project-level advisory committee members. 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:

- Keisha Johnson; XYZ University; PI
- Neil Gupta; University of PQR; Senior Personnel Xavier Brown; XYZ University; Postdoc
- Marc Garcia; ABC Inc.; Paid Consultant
- Cosmo Cramer: HHH Community organization, Paid Consultant
- Maria White; XYX Govt organization; Unpaid Collaborator
- Lucy Wang; ZZZ University; Subawardee

2. Letters of Collaboration: For all substantial collaborations and engagements (included or not included in the budget) with partner institutions including communities and federal agencies mentioned in the Project Description, Letters of Collaboration are strongly encouraged. These should be provided in the Supplementary Documents section of the proposal and follow the format instructions specified in the NSF PAPPG. **Letters of Collaboration should not contain endorsements or evaluation of the proposed project**. One format for a letter of collaboration is as follows:

"If the proposal submitted by Dr. [insert the full name of the Principal Investigator] entitled [insert the proposal title] is selected for funding by NSF, it is my intent to collaborate and/or commit resources as detailed in the Project Description or the Facilities, Equipment or Other Resources section of the proposal."

Collaborative activities that are identified in the budget should follow the instructions in the NSF PAPPG. Any substantial collaboration with individuals not included in the budget should also be described in the Facilities, Equipment and Other Resources section of the proposal and documented in a Letter of Collaboration from each collaborator.

3. Cloud Computing Resources: Proto-OKN Theme 1, Theme 2, or Theme 3 proposals may request cloud computing access through Cloudbank.org (as described in Section II.B). The request must include a description that is not to exceed two pages and must include: (a) title of the proposal; (b) anticipated annual and total costs for accessing the desired cloud computing resources; (c) which public cloud providers will be used; and (d) a technical description of, and justification for, the requested cloud computing resources, along with how the cost was estimated.

The NSF Budget should not include any costs for accessing public cloud computing resources via Cloudbank.org. **Note that the total cost of the project, including this cloud computing resource request from Cloudbank.org, may not exceed the budget limit described in this solicitation.** Proposers may contact Cloudbank.org (see https://www.cloudbank.org/faq) for consultation on determining the budget estimate for using cloud computing resources.

Furthermore, **proposals requesting Cloud Computing Resources should include "CloudAccess" (one word without space) on the Project Summary page at the end of the Overview section** (before the section on Intellectual Merit).

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Budget Preparation Instructions:

- Theme 1 proposals may request budgets up to $1.5 million with durations up to three years.
- Theme 2 proposals may request budgets up to $1.5 million with durations up to two years. Theme 2 projects can be potentially renewed for an additional two years for a budget up to $2 million.
- Theme 3 proposals may request budgets up to $1.5 million with durations up to three years.

Budgets for all projects must include funding for one or more designated project representatives (PI/co-PI/Senior Personnel or NSF-approved replacement) to attend annual PI meetings during the proposed lifetime of the award and are encouraged to include funding for attendance of one community user (see Section II of this program solicitation).

Theme 1 proposers are also encouraged to consider including funding for community end-user participation in the project as part of the project budget or explain why this does not make sense or is not possible. Theme 1 proposals must include funding for one or more designated integration lead, responsible for ensuring close interaction between Theme 1 team and the Theme 2, Proto-OKN fabric team.

Though for-profit organizations are eligible to submit proposals in response to this solicitation, no fees are allowed.

C. Due Dates

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

    June 20, 2023

D. Research.gov/Grants.gov Requirements

For Proposals Submitted Via Research.gov:

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

For Proposals Submitted Via Grants.gov:

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

Submitting the Proposal: Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to Research.gov 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 *Leading the World in Discovery and Innovation, STEM Talent Development and the Delivery of Benefits from Research - NSF Strategic Plan for Fiscal Years (FY) 2022 - 2026* . 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.D.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.D.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

Data Management Plan: The Data Management Plan must not exceed two (2) pages. It should summarize how all the data and software products associated with the final deployed product, including the knowledge graph and other related data/software products, will be made available for continued access after the end of the project duration. While it is expected that all the aspects related to data and software access would already have been introduced and described throughout the main Project Description section, the Data Management Plan provides the opportunity to summarize the key issues related to persistence and access in a single location.

Postdoctoral Researcher Mentoring Plan: The Postdoctoral Researcher Mentoring Plan should reflect the goals and objectives of this translational research effort and, as such, what is expected to be different from a typical mentoring plan for a basic research effort.

In addition to the National Science Board merit review criteria, reviewers will be asked to apply the following criteria when reviewing proposals submitted to this solicitation:

1. Impact on identified user community/ies

- What is the potential for the proposed effort to profoundly impact one or more end user community/ies?
- Will the activity provide a specific benefit(s) to the user community/ies and help them achieve their desired outcomes?

2. Partnership

- Does the Project Description make a strong case that partners and end users from multiple sectors are poised to form a deep and diverse partnership that supports the use-inspired research proposed?
- Does the proposed use case support and contribute to the mission of at least one identified end user federal agency?

3. Deliverables

- Does the overall effort, as described in the Project Description, Collaboration Plan, and Deliverables and Management Plan indicate a high probability of deliverables within a 36-month period that will ultimately benefit society?
- Are there clear, achievable goals and objectives provided for the 12-month alpha release, the 24-month beta release, and the final release at the end of the effort?

4. Use Case Integration

- Is the proposed project appropriate, i.e., is there a close match to one of the Themes in this solicitation?
- Is there convincing evidence of how the effort will contribute to the success of the Proto-OKN effort and support potential use case integration efforts?

5. Adherence to Data/AI Ethics Standards and Guidance

- Does the Project Description clearly identify how the project will adhere to data/AI ethics standards and guidance such as
  - 2021 Executive Order 13960: Trustworthy AI Principles;
  - VA Ethics Principles for Access to and Use of Veteran Data (Regulations.gov);
  - OSTP Blueprint for an AI Bill of Rights?

B. Review and Selection Process

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

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

Partner agency program managers will be assisting NSF with the proposal review and selection process. Partner agency program managers may suggest reviewers/panelists and act as observers during panels. Agency observers may not submit reviews either in writing or verbally to the merit review process. Partner agency program managers will be given access to proposals, reviews, and panel summaries. NSF and partner agency program managers will meet as soon as possible after the proposals have been reviewed, to discuss panel outcomes and formulate a set of funding recommendations consistent with the goals of the program. NSF and partner agency program managers will reach a coordinated recommendation for the awards. Coordinated recommendations will take into account individual reviews, panel recommendations, the goals of the program, and portfolio considerations. Final award recommendations are subject to availability of funds and all awards will be made by NSF.

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 or the Division of Acquisition and Cooperative Support 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 an NSF Grants and Agreements Officer. 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.

Administrative and National Policy Requirements

Build America, Buy America

As expressed in Executive Order 14005, Ensuring the Future is Made in All of America by All of America's Workers (86 FR 7475), it is the policy of the executive branch to use terms and conditions of Federal financial assistance awards to maximize, consistent with law, the use of goods, products, and materials produced in, and services offered in, the United States.

Consistent with the requirements of the Build America, Buy America Act (Pub. L. 117-58, Division G, Title IX, Subtitle A, November 15, 2021), no funding made available through this funding opportunity may be obligated for an award unless all iron, steel, manufactured products, and construction materials used in the project are produced in the United States. For additional information, visit NSF's Build America, Buy America webpage.

Special Award Conditions:

The Proto-OKN cooperative agreements will include Special Conditions relating to the period of performance, statement of work, awardee responsibilities, NSF responsibilities, NSF-awardee responsibilities, funding and funding schedule, reporting requirements, Senior Personnel, and other conditions. Within the first approximately 30 days of the award, all Senior Personnel will be required to participate in an approximately two-day meeting at NSF or virtually, as part of the Proto-OKN Project Kickoff. In addition, PIs and other key project members are required to attend Quarterly meetings as described in Section II.D.

The Proto-OKN program also requires all PIs and other key project personnel to attend an evaluation meeting for approximately two days at NSF or virtually, near the end of year one. The purpose of the evaluation meeting is to assess progress the awardees have made towards project deliverables and advancing project goals. Each awardee team will prepare briefing material (expected to be 10 pages or less) describing its accomplishments and make a short presentation which will be followed by questions and answers. The reviewers will evaluate the team's progress towards its stated goals and, in particular, progress towards creating deliverables. Considering reviewers' input, NSF will decide whether the team will receive funding for the second year.

Failure to meet the deliverables within the timeline agreed upon in the cooperative agreement can result in the early termination of the award.

Attribution of support in publications must acknowledge the National Science Foundation, partnering federal agencies, the award number, and the program, by including the phrase, "as part of the NSF Proto-OKN Program." Precise wording of the acknowledgement may change based on the partners funding the work and will be stipulated in the award letter or award-specific programmatic terms and conditions.

Ensuring Adequate COVID-19 Safety Protocols

Any cooperative agreement awarded in response to this solicitation will contain the following term and condition:

(a) This clause implements Section 3(b) of Executive Order 14042, Ensuring Adequate COVID Safety Protocols for Federal Contractors, dated September 9, 2021 (published in the Federal Register on September 14, 2021, 86 FR 50985). Note that the Department of Labor has included "cooperative agreements" within the definition of "contract-like instrument" in its rule referenced at Section 2(e) of this Executive Order, which provides:

For purposes of this order, the term "contract or contract-like instrument" shall have the meaning set forth in the Department of Labor's proposed rule, "Increasing the Minimum Wage for Federal Contractors, " 86 Fed. Reg. 38816, 38887 (July 22, 2021). If the Department of Labor issues a final rule relating to that proposed rule, that term shall have the meaning set forth in that final rule.

(b) The awardee must comply with all guidance, including guidance conveyed through Frequently Asked Questions, as amended during the performance of this award, for awardee workplace locations published by the Safer Federal Workforce Task Force (Task Force Guidance) at

https://www.saferfederalworkforce.gov/contractors/

(c) *Subawards*. The awardee must include the substance of this clause, including this paragraph (c), in subawards at any tier that exceed the simplified acquisition threshold, as defined in Federal Acquisition Regulation 2.101 on the date of subaward, and are for services, including construction, performed in whole or in part within the United States or its outlying areas. That threshold is presently $250,000.

(d) *Definition*. As used in this clause, *United States or its outlying areas* means:

(1) The fifty States;

(2) The District of Columbia;

(3) The commonwealths of Puerto Rico and the Northern Mariana Islands;

(4) The territories of American Samoa, Guam, and the United States Virgin Islands; and

(5) The minor outlying islands of Baker Island, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Midway Islands, Navassa Island, Palmyra Atoll, and Wake Atoll.

(e) The Foundation will take no action to enforce this article, where the place of performance identified in the award is in a U.S. state or outlying area subject to a court order prohibiting the application of requirements pursuant to the Executive Order (hereinafter, "Excluded State or Outlying Area". A current list of such Excluded States and Outlying Areas is maintained at https://www.saferfederalworkforce.gov/contractors/.

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:

- Chaitanya K. Baru, Senior Advisor, TIP/OAD, telephone: (703) 292-4596, email: okn@nsf.gov

- Jemin George, Program Director, TIP/ITE, telephone: (703) 292-2251, email: okn@nsf.gov

- Samrawit Gebre, Deputy Project Manager, NASA GeneLab, telephone: (650) 604-5399, email: samrawit.g.gebre@nasa.gov

- Lauren Sanders, Project Scientist, NASA Ames GeneLab, telephone: (530) 409-2174, email: lauren.m.sanders@nasa.gov

- Haluk Resat, Program Director, Office of Strategic Coordination, NIH, telephone: (301) 827-6671, email: haluk.resat@nih.gov

- Elizabeth Groff, Senior Advisor, Office of the Director, National Institute of Justice, telephone: (202) 598-3021, email: elizabeth.groff@usdoj.gov

- Ryan Berkhiemer, Physical Scientist, NOAA, telephone: (828) 350-2024, email: ryan.berkheimer@noaa.gov

- Dalia Varanka, Research Physical Scientist, USGS National Geospatial Technical Operations Center (NGTOC), Center of Excellence for Geospatial Science (CEGIS), telephone: (303) 202-4351, email: dvaranka@usgs.gov

For questions related to the use of NSF systems contact:

- NSF Help Desk: 1-800-673-6188
- 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 (FASED) provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See the *NSF Proposal & Award Policies & Procedures Guide* Chapter II.F.7 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**   (703) 292-5111
>   (NSF Information Center)**:**
>
> - **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:

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