NSF 25-539: Verticals-enabling Intelligent Network Systems (VINES)

Introduction to NSF VINES - Track 2

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NSF VINES Informational Webinar

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NSF VINES Goals and Objectives

Goal:
To enhance U.S. competitiveness in advanced telecommunications technologies, to establish the U.S as a global leader in both NextG wireless telecommunications and emerging potential NextG vertical industries, as well as address the need for skilled workforce and expertise in these technology areas.

Support both fundamental research and verticals-driven technology development, demonstration, and translation activities that will lead to leaps in performance and capabilities of next generation (NextG) advanced intelligent network systems that span the user-edge-core-cloud continuum.

NSF VINES Objectives

- Support use-inspired fundamental research and vertical-driven technology development that will drastically improve and shape the future generations of advanced wireless and intelligent networked systems.
- Focus on innovations across various disciplines that lead to leaps in performance and capabilities of future networks and networked systems.
- Accelerate the lab-to-market translation of innovative research outcomes leading to global technology leadership and successful products and services for the benefit of society
- Enable formation of U.S. and international collaborations with like-minded countries to speed up the rate of innovations towards open, global, interoperable, reliable, resilient, and secure networks.
- Focus on emerging topics potentially critical to future generations of wireless networks and networked systems, such as cloud, AI & machine learning native designs, dynamic spectrum sharing and integrated sensing and communications.

NSF VINES Program Structure

- Track 1 (Use-inspired Fundamental Research) will support activities focused on use-inspired fundamental research to develop novel networking techniques and solutions.

- Track 2 (Verticals-Driven Technology Development, Demonstration, and Translation) will support activities focused on technology development, maturation, demonstration, integration, and translation of solutions with higher technology readiness levels (TRLs), with the goal of producing adoption-ready technologies. Industry contributions will not be used to fund Track 2.

NSF VINES Track 2 Focus: Technology Development, Demonstration & Translation

Support development, demonstration and translation of potential NextG technologies that will result in performance or capabilities critical to enabling emerging vertical application industries.

Accelerate the flow of technologies derived from use-inspired research to proofs of concept, including prototype development and testing, to product/solution development, to market creation and to ultimately the desired societal, national security and economic impacts.

NSF VINES: Track 2 Objectives (1/2)

- Bring telecommunications and wireless vertical applications teams together to develop NextG networking solutions that deliver performance required by emerging vertical industries.
- Support verticals-driven technology development, demonstration and/or translation that will shape the future generations of advanced wireless and intelligent networked systems.
- Encourage academic and industry collaborations that will lead to effective development, maturation and demonstration of novel NextG technologies.
- Accelerate the flow of novel and emerging technologies derived from use-inspired research to proofs of concept, including prototype development and testing, to product/solution development, to market creation and to ultimately the desired societal and economic impacts.

NSF VINES Track 2 Objectives (2/2)

- Establish global technology leadership in NextG wireless telecommunications via partnerships with industry, academia and international collaborators.
- Lead in emerging NextG wireless vertical industries via partnerships with industry, academia and international collaborators.
- Train future technical experts and entrepreneurs in NextG telecommunications and emerging wireless vertical technologies.
- Focus on relatively mature, yet still novel in terms of adoption, emerging technologies (current TRL level of at least 3) with the potential for translation and adoption in NextG networks.
- Enable formation of U.S. and international collaborations to speed up the rate of innovation towards open, global, interoperable, multi-functional, reliable, resilient, and secure networks.

Aside: Technology Readiness Levels (TRL)

- TRL 9: Actual system proven through successful operation in a commercial setting
- TRL 8: Actual system completed and qualified through testing and demonstration in a commercial setting
- TRL 7: System/subsystem prototype demonstrated in a commercial environment
- TRL 6: Pilot-scale system/subsystem prototype demonstrated in a relevant laboratory environment
- TRL 5: Component and/or system/sub- system validated in a relevant commercial environment
- TRL 4: Component and/or system/sub- system validated in a relevant laboratory environment
- TRL 3: Proof-of-concept validated through experiment or analysis
- TRL 2: Technology concept and/or application formulated
- TRL 1: Basic principles observed and reported

TRL 8-9: Product certifications and commercialization

TRL 6-8: Product development

TRL 5-7: Technology demonstration

TRL 3-5: Technology development

TRL 2-4: Proof of technology feasibility

TRL 1-2: Basic technology research

https://www.eda.gov/sites/default/files/filebase/archives/2021/files/performance/EDA-Technology-Readiness-Levels-Guidelines.xlsm

NSF VINES Track 2 Partners: The Magnificent Seven

- U.S National Science Foundation (NSF)
- Department of Homeland Security (DHS) - Science & Technology Directorate
- U.S. Department of Defense (DOD) – Office of the Under Secretary of Defense for Research and Engineering (OUSD) (R&E)
- National Institute for Standards and Technology (NIST)
- Business Finland (BF)
- National Institute of Information and Communications Technology (NICT), Japan
- Ministry of Electronics & Information Technology, India (MeitY)

Definition of NSF VINES Track 2 Projects

- Each Track 2 project must identify:
  - A novel emerging networking technology that has potential for translation and adoption in NextG mobile telecommunications networks (including 6G cellular and WiFi);

  and
  - A vertical industry/application for which the performance/capability enabled by the identified networking technology would be critically important.
- Selected vertical must be an industry/application whose connectivity requirements cannot reasonably (i.e. cost-effectively, reliably, efficiently, securely etc.) be met by today's networks (5G, WiFi, etc.).

Each project must develop and implement the proposed networking technology solution in an at-scale test bed in the context of the relevant vertical application and demonstrate that the performance/capability achieved indeed will enable the selected vertical application.

NSF VINES Track 2 Project Requirements

1. An emerging translation/adoption-ready NextG networking technology applicable to any part/parts of the end-to-end system. Examples include, but are not limited to, RAN, Core, Transport, Cloud or Edge technologies.
2. A wireless vertical for which the performance or capability offered through identified networking technology advancement will be critical for its success.
3. Maturation, implementation, and integration of the proposed networking technology within the context of the identified vertical application.
4. At-scale demonstration of the integrated system enabling the selected vertical in an end-to-end network (testbeds/platforms or in partnership with MNOs/CSPs etc).

NSF VINES Track 2 Team Requirements

A. Identified primary networking technology expertise (competency A)
B. Selected vertical application expertise (competency B)
C. Integrated end-to-end system/network expertise

Teams must submit a concept outline (CO) before submitting the full proposal

- To determine the appropriateness of the work & the team (see NSF PAPPG Chapter 1.D.1)
- Proposers must include the email from the NSF VINES Program Director Team encouraging submission in the Program Officer Concurrence Email(s) section of the Full Proposal.

NSF VINES Track 2 Technical Scope: Potential Emerging Technologies of Interest

1. Integrated Sensing and Communications (ISAC)
2. Mobile/Multi-access Edge Computing (MEC)
3. Open & integrated networks (open standards and interfaces-based space-air-ground integration)
4. Semantic communications and networking (SC)
5. Advanced spectrum technologies such as Dynamic Spectrum Sharing (DSS), operation at higher frequencies, Multi-band, Multi-mode Radios (MBMMR) and low-power & spectrum-agile radios
6. High-performance data transport (e.g., fiber, WDM), transport layer, and automation technologies for various network environments, including software-defined wide area networks (SD-WAN) and data center and cloud networks
7. Reconfigurable Intelligent Surfaces (RIS)

NSF VINES Track 2 Technical Scope: Potential Emerging Vertical Applications

- Smart manufacturing, Industrial IoT (IIoT)
- Immersive applications, AR/VR/MR/XR
- Smart/precision agriculture
- Connected autonomous vehicles (CAVs), intelligent transportation
- Tele-medicine, remote healthcare, remote surgery
- Advanced Air Mobility (AAM), UAV networks
- Smart-grid
- Entertainment industry, gaming
- Disaster response
- Education, training

This is not an exhaustive list.

Emerging Networking Technologies: Requirements

- These are the candidates for primary networking technology competency (competency A).
  - While each Track 2 project must identify one of the above listed networking technologies as the primary networking technology focus of the project and the primary enabling technology for the selected vertical, a team's overall solution may incorporate aspects of other networking technologies (either from the above list or something not in it) as appropriate.
- The starting maturity level of the proposed primary technology solution is expected to be at least at Technology Readiness Level (TRL) 3 or higher while being novel and innovative in terms of translation and adoption.
- The scope of each of the above emerging technologies is intended to be broadly defined to allow for new ideas that are important for novel NextG vertical industries with potential for success and impact.

NSF VINES Track 2 Proposal Content Requirements

- The proposal must provide strong justification, backed by sufficient evidence, for the choice of the primary networking technology area and the vertical application by addressing the following:
  1. The identified primary networking technology area is relatively mature (at least TRL 3) and has the potential to be adopted in NextG networks,
  2. The performance or capability enabled by the selected primary networking technology is critical to meeting the requirements of the identified vertical application, and
  3. The identified vertical application has the potential to be of societal and/or economic importance.
- Must be provided in both the concept outline and the full proposal

Proposers are strongly encouraged to be thoughtful in selecting an emerging vertical application with the highest potential for commercialization, market adoption and economic and/or societal impact.

Exceptions to the Emerging Networking Technologies

- In some circumstances, a concept outline proposing to use a primary networking technology area that is not in the above list may be allowed to submit a full proposal.
- In this special case, the proposer must provide strong justification backed by sufficient evidence to demonstrate that:
  1. The proposed primary networking technology is relatively mature (at least TRL 3) and has the potential to be in consideration for NextG networks,
  2. The performance or capability enabled by the proposed primary networking technology is critical to meeting the requirements of the identified vertical application,
  3. The identified vertical application has the potential to be of societal and/or economic importance, and
  4. The solution approach based on the proposed primary networking technology is potentially superior and more desirable to that based on any of the above suggested technologies.
- The above must be addressed in both the concept outline and the full proposal.

Everything being equal, the preference will be given to those projects that advance the technologies identified in the list provided in this solicitation.

NSF VINES Track 2 Projects: Technology Demonstration is a Must!

- Demonstration of developed technological solution in the context of the identified vertical application is a requirement for all Track 2 projects.
- Must provide sufficient details on how the team plans to develop, integrate and demonstrate the proposed networking solutions in an at-scale testbed/platform to validate successful vertical application operation.
- Specific success criteria and evaluation metrics must be identified.
- A phased demonstration approach (with a timeline) can be adopted to minimize risks, though it is not required.

Whenever possible, Track 2 teams are strongly encouraged to utilize existing national testbeds such as NSF Platforms for Advanced Wireless Research (PAWR), testbeds funded by other Federal agencies (e.g., DOD, NTIA (in particular, recently funded Open RAN Testing & Evaluation (T&E) centers), NIST) or partner with mobile network operators (MNOs) and/or cloud service providers (CSPs).

NSF VINES Track 2: Intellectual Property Rights

- Prior to award issuance, each Track 2 team must certify in writing the existence of either a finalized Intellectual Property (IP) Management Plan executed by, or a general framework for IP Sharing and Management agreed upon by, authorized representatives from all participating institutions.
- The provisions of the Bayh-Dole Act will apply.
- Recipients may defer the publication of data and software related to inventions to allow for the timely filing of patent applications. However, NSF's terms and conditions mandate the prompt publication of all research results, data, and software generated during the project.

NSF VINES Track 2: Who May Submit?

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the U.S., acting on behalf of their faculty members.
- 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.
- State and Local Governments: State educational offices or organizations and local school districts.
- Tribal Nations: An American Indian or Alaska Native tribe, band, nation, pueblo, village, or community that the Secretary of the Interior acknowledges as a federally recognized tribe pursuant to the Federally Recognized Indian Tribe List Act of 1994, 25 U.S.C. §§ 5130-5131.

NSF VINES Track 2: PI Eligibility & Limitations

- Individuals with primary appointments at overseas branch campuses of U.S. IHEs are not eligible.
- An individual may serve as PI or co-PI on only one Track 2 proposal in this competition but may serve as Senior/Key Personnel or Other Personnel on any number of Track 2 proposals.
  - This is independent from Track 1 proposals
- For international collaborative proposals, foreign collaborators should not be listed on the NSF proposal coversheet (they are not considered NSF Senior/Key Personnel).

A U.S. investigator can be the PI or co-PI in only one Track 2 proposal regardless of whether the proposal include foreign collaborations or not.

NSF VINES Industry Partners and Track 2

- VINES industry partners, as defined in NSF 25-539 VINES solicitation, are Ericsson, Intel and Qualcomm.
- An industry partner is permitted to participate in proposals to Track 2.
- Individuals affiliated with industry partners may participate in Track 2 proposals.

NSF VINES Track 2 International Collaborative Teams

- A Track 2 team may include a bi-lateral collaboration between the U.S. and one of the participating countries.
- In an international collaborative team, entities from the same country cannot be primarily responsible for both networking technology (competency A) and the vertical (competency B):
  - Must demonstrate that entities from one country are primarily responsible for the competency A while those from the other country are primarily responsible for the competency B.
  - Both in concept outline and the full proposal.
- Participants from each partner country should possess unique capabilities that increase the chance of project success and potential translational impact that justifies the collaboration between the two countries.

NSF VINES Track 2: Awards

- $6M per award. Each award is for 3 years
- 8 ~ 10 awards
- Potential co-funding from international and other federal agency partners
- Cooperative Agreements: Cost reimbursement awards

- International partnerships:
  - The budget for the U.S. team can range between $2 million to $4 million.
  - The total combined budget must not exceed $6 million.

NS VINES Track 2: Concept Outlines

- Must submit a Concept Outline to aid in determining the appropriateness of the scope and work for consideration under this opportunity.
  - *Concept outline length limit is 2 pages*
- NSF PD Email with CO Concurrence must be included in Full Proposal Package submitted to NSF.
- Deadline to submit your CO to vines-track2@nsf.gov is August 25, 2025.
- NSF VINES Team will provide feedback/approval as they are received.

Do not wait till August 25! Submit your Concept Outline ASAP!

NSF VINES Track 2: Eligibility Letter (Only Required for International Collaborative Proposals)

- International collaborative proposals: involve at least one US-based organization and at least one organization based in, and seeking funding from, one of the international partner agencies
- International Collaborative Proposals must include a "PI(s) Eligibility Letter", issued by the applicable international partner agency to the foreign collaborators, in the full proposal submission to NSF.
  - Finland: BF
  - India: MeitY
  - Japan: NICT
- To obtain the Eligibility Letter, foreign collaborators must follow the country-specific instructions provided by the relevant international partner agency
  - Each VINES international partner agency may require country-specific documentation to assess to what extent the proposed activities align with their priority topics and missions
  - Refer to their website for how, what, when and where to apply
- The eligibility letter is not needed to be submitted with the Concept Outline, but must be included in Full Proposals

- Make sure international collaborators submit their request for Eligibility Letter to the relevant International Partner Agency ASAP!
- Do not wait till the last minute!

NSF VINES Track 2: Full Proposals

- When initiating a new proposal on Research.gov or Grants.gov:
  - Proposals submitting to **Track 1** need to choose the **CISE** directorate.
  - Proposals submitting to **Track 2** need to choose the **TIP** directorate.
- Both collaborative proposals from a single organization with sub recipient collaborators and separately submitted collaborative proposals from multiple organizations are allowed.
  - Sub recipient institutions must follow the same eligibility rules.

NSF VINES Track 2 Full Proposals: Demonstration and Evaluation Plan

- **Project Description** of VINES Track 2 full proposals must have a section titled "Demonstration and Evaluation Plan"
- Provide sufficient details on the technology integration, demonstration, evaluation (including success criteria and metrics to be used) and validation plan
  - About 1 - 2 pages
- Though not required, a phased demonstration approach (with a timeline) is preferred

- International collaborative proposals:
  - Project Description must represent an integrated collaborative effort

NSF VINES Track 2 Full Proposals: Solicitation-Specific Review Criteria

- **Project Description** of VINES Track 2 full proposals must have a section titled "Addressing VINES Solicitation-Specific Review Criteria"
  - Explain how the proposal meets the solicitation-specific review criteria for Track 2 by answering Q1 through Q6 (provided under the Additional Solicitation-Specific Review Criteria section) and refer to other sections for further details.
  - About 1 page

Track 2 Solicitation-Specific Review Criteria (1/2)

Q1. Can the performance or the capability enabled by the proposed NextG networking technology solution be expected to meet the requirements of the target vertical application and, if so, what is the economic viability and the associated timeframe?

Q2. Does the selected vertical application have the potential to drive demand for NextG networks offering the proposed technological solution and the performance/capability enabled from it?

Q3. Does the proposal justify that (1) the identified primary networking technology area is relatively mature (at least TRL 3) and has the potential to be adopted in future NextG networks, (2) the performance or the capability enabled by the selected primary networking technology is critical to meeting the requirements of the identified vertical application, and (3) the identified vertical application has the potential to be of societal and/or economic importance?

Q4. Are the project schedule of milestones and matching demonstrations/deliverables sound and consistent with program and project objectives?

Track 2 Solicitation-Specific Review Criteria (2/2)

Q5. **Only for proposals proposing a primary networking technology area not in the suggested list for Track 2**: Does the proposal demonstrate that (1) the proposed primary networking technology is relatively mature (at least TRL 3) and has the potential to be in consideration for NextG networks, (2) the performance enabled by the proposed primary networking technology is critical to meeting the requirements of the identified vertical application, (3) the identified vertical application has the potential to be of societal and economic importance, and (4) the solution approach based on the proposed primary networking technology is potentially superior and more desirable to that based on any of the above suggested technologies?

Q6. **Only for teams with foreign collaborations**: Does the proposal demonstrate that (i) entities from one country are primarily responsible for competency A, while those from the other country are primarily responsible for competency B, and (ii) participants from each partner country bring unique capabilities to the team that increase the chance of project success justifying the collaboration between the two countries?

NSF VINES Track 2 Full Proposals: Supplementary Documents

- Proposers are strongly encouraged to include letters of collaboration from testbed/platform operators, MNOs/CSPs or other infrastructure providers critical to at-scale demonstrations indicating the scope of collaboration and that access is available to the facility and fits within the timeline of the proposed research.
- These letters may deviate from standard NSF template language suggested in Chapter II.D.2.i-(iii).
- Each letter must be limited to a single page and a proposal may not include more than 4 such letters.

- This information is not considered part of the 15-page project description or the 8-page Management Plan limitation but should not exceed a total of 4 pages.

NSF VINES Track 2 Full Proposals: Management Plan

- Management Plan must include the following numbered sections:
  1. a list of project personnel, including their affiliation, expertise and project roles.
  2. a plan for collaborative team coordination and project management: The complexity of the plan for collaborative team coordination and project management should match that of the project and should include: a.) How the project will be managed across investigators, organizations, and/or disciplines; b.) Personnel responsible for project management and execution of tasks; c.) Coordination mechanisms for cross-investigator, cross-organization, and cross-discipline integration (e.g., meetings, video conferencing, student exchanges, software repositories); d.) Budget line items supporting collaboration and coordination activities.
  3. a detailed project schedule identifying major tasks, inputs to each task, milestones with matching demonstrations/ deliverables (including a Gantt chart), associated risks and mitigation approaches. For Track 2 proposals, the schedule must also include planned demonstrations, where and when they will take place and who will be responsible.
  4. a brief plan for establishing and maintaining an up-to-date project website.
  5. Only for Track 2 proposals: an appropriately detailed initial draft of an IP management plan among team members indicating explicitly that all team members are in agreement of the initial draft and will be ready to sign either a finalized or a general framework agreement before an award is made.
  6. Only for Track 2 proposals: a sufficiently detailed roadmap (with a timeline) on plans for potential post-project (beyond the duration of 3 year project) follow-up activities such as partnerships, stakeholder engagement, commercialization and standardization of innovations resulting from Track 2 project.

- The management plan is not considered part of the 15-page project description limitation but should not exceed a total of 8 pages for track 2 proposals

NSF VINES Track 2 Full Proposals: Supplementary Documents – Program Office Concurrence Email

Track 2 full proposals must include a copy of the NSF "Program Officer Concurrence Email" allowing the submission of the Track 2 proposal based on the proposed Concept Outline

- Include it under the “Single Copy Documents”

Track 2 Full Proposals: Supplementary Documents for International Collaborative Proposals

- The international team's budget request and budget justification must be included in the NSF proposal as a Supplementary Document.
  - International proposers should indicate only the international research expenses on the international partner agency's budget form.
  - NSF proposers should indicate only the U.S. expenses in the NSF budget.
- The Budget Justification section of the NSF proposal should address the full project budget (U.S. and international teams).
  - The U.S. project budget must be fully justified and clearly differentiated from funds requested by the international team.
- Proposals that request duplicative funding may be returned without review.

- Remember to provide as a Supplementary Document, a 'Confirmation of Eligibility' letter obtained by the foreign collaborators from the respective international partner agency.

Track 2 Full Proposals: Additional instructions for International Collaborative proposals:

- Foreign collaborators must follow the guidelines provided in the respective international partner agency's instructions available at the links provided in the solicitation
  - Links also include instructions about how to obtain the required eligibility letter from the respective international partner agency
- For any questions, foreign collaborators are encouraged to contact the respective international partner agency listed in the international partner agency Contacts section of this solicitation.
- Foreign collaborators must submit documentation that may be required by the respective international partner agency directly to the relevant agency in accordance with their procedures, in addition to documentation submitted to NSF.

- It is the foreign collaborators responsibility to seek a "PI(s) Eligibility Letter" from the respective international partner agency, which must be included in the full proposal submission to NSF.

NSF VINES Deadlines

- Track 1
  - Full Proposals due August 25, 2025
- Track 2
  - Concept Outlines due August 25, 2025
  - Full Proposals due September 25, 2025

- Do not wait till August 25 to submit your Concept Outline for a potential Track 2 project! Submit it now!

NSF VINES Upcoming Events

- Webinar on Japan-U.S. collaborative proposals:
  - Date & Time: Jun 17, 2025 07:00 PM in Eastern Time (US and Canada)
  - Register here: https://nsf.zoomgov.com/webinar/register/WN_srTYdHJtTMKI9q-GIbAy4g#/registration
- U.S.-International collaborators networking event: Announcement coming

NSF VINES Track 2

Questions?

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