U.S. NATIONAL SCIENCE FOUNDATION
2415 EISENHOWER AVENUE
ALEXANDRIA, VIRGINIA 22314

NSF 24-041

Dear Colleague Letter: Funding Opportunities for Engineering Research in Advanced Wireless

December 22, 2023

Dear Colleagues:

With this Dear Colleague Letter, the U.S. National Science Foundation (NSF) Directorate for Engineering (ENG) encourages the submission of research and education proposals related to **Advanced Wireless as an Emerging Industry**.

Future wireless networks and systems will provide the backbone that connects users, devices, applications, and services that will continue to enrich America's economy. NSF has a proven track record of investing in fundamental research on wireless technologies and partners with other federal agencies and industry on such research.

Research supported by NSF and the Engineering Directorate will continue to innovate in areas critical to future generations of wireless networks and systems. These innovations will span new wireless devices, circuits, protocols, and systems for “6G” and beyond; security and resiliency; mobile edge computing; distributed machine learning, and inferences across mobile devices; fine-grained and real-time dynamic spectrum allocation and sharing; and other areas. New insights will make wireless communication faster, smarter, more affordable, and more resilient, robust, and secure, as well as integrated with efficient sensing.

NSF and the Engineering Directorate invest in research and education activities that align with the needs of the nation and support the CHIPS and Science Act of 2022, White House strategies (such as the 2023 *National Spectrum Strategy*), and other policy directives to enable secure, resilient, high-performance wireless technologies.

ENGINEERING DIRECTORATE INTERESTS

The Directorate for Engineering encourages the submission of all types of research and education proposals related to advanced wireless, including proposals in the following areas:

Novel devices and circuits for future wireless: High-frequency and high-speed device

technologies and circuit techniques to fully utilize wireless spectrum from microwave to millimeter-wave and terahertz (THz), and to enable future wireless systems with unprecedented bandwidth and speed for 6G and beyond.

Integrated wireless transceivers: High-performance wireless transceivers integrated on semiconductor chips or through heterogeneous integration of various device technologies for communications and sensing, such as radar and imaging; circuit-algorithm co-design and optimization for integrated wireless transceivers; ultralow-power wireless interconnects for intra-chip or inter-chip communications.

Integrated antennas: Antennas co-designed and integrated with other circuit components or integrated on a semiconductor chip or in its package to enhance wireless system performance while reducing overall hardware size, weight, and cost; reconfigurable/tunable antennas for dynamic spectrum access and sharing; electrically small antennas exploring unconventional modalities (for example, those involving interactions between photons and phonons, magnons, or plasmons) for embedded applications such as implants and wearables.

Electromagnetic engineering: Novel concepts and designs using engineered electromagnetic metamaterials or metasurfaces to control electromagnetic wave reflection, refraction, or diffraction to enhance wireless system and network performance. In addition, simulation and design of multi-scale multi-physics wireless systems, wireless signal propagation, and electromagnetic interference and compatibility leveraging computational electromagnetics or other advanced tools and methods.

Wireless technologies for healthcare: Noninvasive radio frequency (RF) sensing technologies from kilohertz (kHz) to THz for medical imaging, health monitoring, and early disease detection; wireless communication and wireless power transfer for implants; wireless therapies utilizing interactions between electromagnetic waves and biological tissues; and wireless technologies and protocols for connected medical and healthcare systems.

Wireless environmental sensing: Novel low-power, energy-efficient, and eco-friendly wireless sensor technologies that can operate in extreme conditions to monitor environments and climate change.

Quantum-inspired wireless technologies: Novel wireless communications and sensing systems exploring quantum devices and quantum information processing to overcome fundamental limits in classical physics.

AI-empowered wireless devices and systems: Signal processing and machine learning for wireless systems; dynamic spectrum access and sharing of wireless systems enabled by machine learning; dynamic data-enabled reconfigurable wireless devices and systems through sensing and machine learning.

Security and privacy of wireless systems: Enhancing wireless security and privacy through hardware, algorithms, or both.

Hybrid wireless technologies: Wireless systems and protocols exploring optical or acoustic frequencies and techniques for communications and sensing.

Wireless power and energy harvesting: Future wireless power transfer technologies for multi-scale applications, ranging from a micro-scale wirelessly powered semiconductor chip with wireless interconnects to a macro-scale safe and resilient wireless power grid; wireless energy harvesting technologies to recycle vast, unutilized ambient wireless signals; and systems and protocols of simultaneous wireless power, sensing, and communication sharing the same spectrum.

Wireless connectivity for power systems: Wireless systems and networks connecting power systems to enable dynamic data-enabled learning, decision, and control; secured wireless technologies for monitoring, protection, and resilient operation of power grid.

Wireless technologies for future smart transportation: Wireless sensing, communication, and control for autonomous vehicles; secured wireless technologies for vehicle-to-vehicle communication; next-generation automobile radar and lidar; and wireless charging of electric vehicles.

Wireless technologies for manufacturing: Research to overcome barriers to adoption of wireless networking and communications in manufacturing, including latency, reliability, and security issues that are specific to industrial environments; in addition, wireless communication and coordination between operators, machinery, and the cloud, and ways to leverage mobile connectivity for operation, troubleshooting and maintenance.

PROGRAMS AND CONTACTS

The Engineering Directorate encourages the submission of proposals related to advanced wireless to the ENG core programs listed below, and to other relevant programs. To determine which program best fits a project idea, Principal Investigators are encouraged to read the program descriptions and reach out to program contacts with questions.

- **Advanced Manufacturing**: AdvancedManufacturing@nsf.gov
- **Civil Infrastructure Systems**: Siqian Shen, siqshen@nsf.gov
- **Communications, Circuits, and Sensing-Systems**: Jenshan Lin, jenlin@nsf.gov; Rosa (Ale) Lukaszew, rlukasze@nsf.gov
- **Electronics, Photonics and Magnetic Devices**: Dominique Dagenais, ddagenai@nsf.gov; Usha Varshney, uvarshne@nsf.gov
- **Energy, Power, Control and Networks**: Eyad Abed, eabed@nsf.gov; Anthony Kuh, akuh@nsf.gov

The Engineering Directorate also encourages proposals for research centers, which tackle grand challenges and spur industrial innovation, and for workforce development, which provides experiential learning opportunities and opens new career paths.

- **Engineering Research Centers (ERC)**: nsferc@nsf.gov
- **Industry–University Cooperative Research Centers (IUCRC)**: Prakash Balan, pbalan@nsf.gov
- **Non-Academic Research Internships for Graduate Students (INTERN)**: Prakash Balan, pbalan@nsf.gov
- **Research Experiences for Teachers (RET)**: Amelia Greer, agreer@nsf.gov
- **Research Experiences for Undergraduates (REU)**: reu.eng@nsf.gov (REU for ERCs: reu.eng.erc@nsf.gov)

SUBMISSION GUIDANCE

Proposals submitted in response to this DCL should focus on scientific research and education relevant to the topical area of advanced wireless. Proposal titles should begin with "**ENG-ADVWIRE:**" followed by any other relevant prefixes and the project name.

For consideration during fiscal year 2024, proposals to programs without deadlines should be submitted by April 30, 2024; proposals submitted later will be considered for fiscal year 2025.

NSF welcomes proposals that broaden geographic and demographic participation to engage the full spectrum of diverse talent in STEM. Proposals from minority-serving institutions, emerging research institutions, primarily undergraduate institutions, two-year colleges, and institutions in EPSCoR-eligible jurisdictions, along with collaborations between these institutions and those in non-EPSCoR jurisdictions, are encouraged.

This DCL does not constitute a new competition or program. Proposals submitted in response to this DCL should be prepared and submitted in accordance with guidelines in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) and instructions found in relevant program descriptions.

Sincerely,

Susan Margulies
Assistant Director, Engineering