ADVANCED WIRELESS RESEARCH

Advanced Wireless Funding[1]

(Dollars in Millions)

	FY 2022 Actual[2]	FY 2023 Estimate Base	Disaster Relief Supplemental		FY 2023 Estimate Total	FY 2024 Request
			Base	CHIPS and Science		
CISE	$89.45	$88.76	-	-	$88.76	$93.26
ENG	26.00	25.00	-	-	25.00	27.75
MPS	17.00	17.00	-	-	17.00	17.00
TIP	30.00	15.62	7.64	7.29	30.55	41.16
Total	**$162.45**	**$146.38**	**$7.64**	**$7.29**	**$161.31**	**$179.17**

[1] Funding displayed may have overlap with other topics and programs.

[2] FY 2022 Actual may be greater than future fiscal years due to the receipt of more meritorious proposals than expected.

Overview

Advanced 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. For example, today's fifth-generation ("5G") wireless networks and systems have been enabled by ground-breaking NSF-funded research on millimeter-wave capabilities, advanced antenna systems, and other novel algorithms and protocols dating back to 2004. NSF partners with other federal agencies and industry on such research. Looking forward, NSF-supported research will innovate in areas critical to future generations of wireless networks and systems, such as 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; and fine-grained and real-time dynamic spectrum allocation and sharing. This research will offer new insights capable of making wireless communication faster, smarter, resilient, more affordable, more robust and secure and integrated with efficient sensing (e.g., forming radio images based on the reflections from wireless signals).

NSF co-chaired the formulation of a 2021 *National Strategy to Secure 5G Implementation Plan*[1], which noted that fifth-generation ("5G") wireless networks will drive our Nation's prosperity and security in the 21st century. Next-generation wireless networking will spur innovation and enable the development of new markets, products, and services, thereby contributing to economic growth. Of particular importance in the 5G Implementation Plan was the need to invest in the security and resiliency of these networks. NSF's Resilient and Intelligent Next-Generation Systems (RINGS) program, in collaboration with two other federal agencies and nine companies, is directly aligned with this emphasis. In addition, by deepening public and private partnerships through programs like RINGS and Platforms for Advanced Wireless Research (PAWR), NSF will accelerate the lab-to-market translation of innovative research outcomes in academic and government labs to successful products and services for the benefit of society.

[1]www.ntia.gov/files/ntia/publications/2021-1-12_115445_national_strategy_to_secure_5g_implementation_plan_and_annexes_a_f_final.pdf

Goals

NSF's leadership in wireless research has three intertwined components:

1. *Fundamental Research on Advanced Wireless:* Support fundamental research enabling the conception, exploration, and development of advanced wireless technologies.
2. *Advanced Wireless Research Testing Platforms:* Establish advanced wireless research testing platforms, in collaboration with industry, to experiment with new technologies at scale and to generate data sets that can be used by the research community to validate proposed methods and techniques at earlier stages of development.
3. *Education and Workforce Development:* Catalyze academic, industry, and community leaders to work together to nurture the next generation of the wireless and spectrum workforce, including researchers, engineers, technicians, and practitioners, as well as to increase public awareness of advanced wireless.

FY 2024 Investments

<u>Fundamental Advanced Wireless Research</u>

- Through foundational research programs in CISE and ENG, outcomes from NSF investments in advanced wireless over the last decade have enabled 5G deployments capable of delivering multi-gigabit-per-second (Gbps) bandwidth to individual wireless users. Continued investments in advancing these frontiers are focused on developing advanced technologies to support ultra-low latencies of the order of sub-milliseconds while simultaneously connecting hundreds of millions of devices. Moreover, NSF foundational research programs coupled with investments by TIP in use-inspired and translational research are also investing in technologies beyond 5G systems, developing more efficient uses of spectrum bands, higher-order spectrum, spectrum sharing, sensing using wireless communications, and novel codes for highly-efficient device-to-device communications as well as improving resilience and security of wireless networks. These investments will continue to support the foundations of U.S. leadership in advanced wireless R&D.
- In FY 2024, in partnership with the Department of Defense (DOD) Undersecretary of Defense for Research and Engineering (OUSD (R&E)), the National Institute of Standards and Technology (NIST), and nine industry partners, NSF will continue to support the RINGS program, laying the groundwork for next-generation wireless connections that will enable faster service; resiliency to natural disasters, malicious attacks, and service interruptions; and broader access to wireless connectivity for people across the U.S.
- In FY 2024, NSF will support, in collaboration with DOD OUSD (R&E), use-inspired research on 5G security through a track of the Convergence Accelerator, Securely Operating Through 5G Infrastructure. The goal of this track is to enhance end devices and/or augment 5G infrastructure to enable military, government, and critical infrastructure operators to have the capability to operate through public 5G networks, while meeting security and resilience requirements.
- In FY 2024 NSF will continue its support for the NSF AI Institute for Edge Computing Leveraging Next-generation Networks (Athena) and the NSF AI Institute for Future Edge Networks and Distributed Intelligence (AI-Edge). Athena focuses on developing edge computing with groundbreaking AI functionality while keeping complexity and costs under control. AI-Edge leverages the synergies between networking and AI to design future generations of wireless edge networks that are highly efficient, reliable, robust, and secure.
- NSF investments in fundamental advanced wireless research will be in synergy with the National Center for Wireless Spectrum Research (SII-Center) program under the Spectrum Innovation

Initiative (SII) which also invests in the National Radio Dynamic Zones (SII-NRDZ) program. SII-NRDZ is an interdisciplinary program that seeks to foster collaborations among stakeholders to advance the use of dynamic spectrum sharing for the enhancement of active electromagnetic spectrum management efforts at NSF's major research facilities and platforms.

Advanced Wireless Research Testing Platforms

- NSF is pursuing a convergent approach to validate advanced wireless research through its PAWR program, a $100.0 million public-private partnership comprising $50.0 million of NSF investment paired with $50.0 million in funding and in-kind contributions from a wireless consortium of 35 companies. With oversight from the NSF-funded PAWR Project Office hosted at US Ignite, Inc., and Northeastern University, PAWR platforms in Salt Lake City, UT; West Harlem, NY; Research Triangle, NC; and Ames, IA, are helping to build core wireless capabilities through creative university partnerships, attracting government and corporate research funding as well as local wireless jobs, and using advanced wireless capabilities to enhance community services and economic development. FY 2024 will be the third year when all four PAWR testbeds are fully operational and generally available simultaneously to the research community, unleashing the full potential of translational opportunities for advanced wireless R&D. Moreover, NSF investments through TIP will allow federation of an open-access plane across the four PAWR testbeds, creating an interconnected national network for testing and validation of emerging wireless concepts.
- The PAWR testbeds will continue to benefit from NSF investments in the NSF National Radio Dynamic Zone program under the SII. In FY 2024, the PAWR testbeds will support proofs of concept for dynamic spectrum sharing across diverse geographic and spectrum use cases.
- In FY 2024, NSF will support multiple cross-directorate programs (potentially as public-private partnerships) to support research in advanced networking systems. The programs built through these partnerships will seek innovations in networking for connected medical systems, machine learning for high-performance, next-generation networks, airborne and satellite networking, and novel radio frequency spectrum uses. The programs are expected to fund collaborative team research that transcends the traditional boundaries of individual disciplines to achieve the program goals.

Education and Workforce Development

- In FY 2024, NSF will continue emphasizing the need to develop a workforce trained in advanced wireless technologies, which is critical to maintaining U.S. leadership in advanced wireless. Through ongoing investments in programs such as Research Experiences for Undergraduates, Research Experiences for Teachers in Engineering and Computer Science, Computer Science for All: Researcher Practitioner Partnerships, Improving Undergraduate STEM Education: Computing in Undergraduate Education, Experiential Learning for Emerging and Novel Technologies (ExLENT), NRT, and GRFP as well as the SII-Center, NSF will continue to train future generations of scientists, engineers, and practitioners to pursue careers in this domain.