ADVANCED WIRELESS RESEARCH

Advanced Wireless Research Funding[1]
(Dollars in Millions)

	FY 2020 Actual	FY 2021 Estimate	FY 2022 Request
CISE	$88.76	$88.76	$93.26
ENG	24.36	23.45	25.80
MPS	17.00	17.00	17.00
TIP[2]	0.60	0.55	30.55
Total	**$130.72**	**$129.76**	**$166.61**

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

[2] FY 2020 and FY 2021 funding for TIP is shown for comparability across fiscal years.

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, including the Federal Communications Commission and National Institute of Standards and Technology, and collaborates extensively with 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; mobile edge computing; distributed machine learning, and inferences across mobile devices; and fine-grained and real-time dynamic spectrum allocation and sharing. The research will offer new insights capable of making wireless communication faster, smarter, more affordable, and more robust and secure—with profound implications for science and society.

In addition, by deepening public-private partnerships such as those enabling the 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 commercial products and services.

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.
3. *Education and Workforce Development:* Catalyze academic, industry, and community leaders to work together to nurture the next generation of the wireless networking workforce, including researchers, engineers, technicians, and practitioners, as well as to increase public awareness of advanced wireless.

FY 2022 Investments

<u>Fundamental Advanced Wireless Research</u>

- Through core 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. The core research programs are also investing in technologies beyond 5G systems, looking at more efficient uses of spectrum bands, higher-order spectrum, sensing using wireless communications, novel codes for highly-efficient device-to-device communications and self-healing of secure wireless networks. These investments will continue to support the foundations of U.S. leadership in advanced wireless R&D.

- In FY 2022, in partnership with other federal agencies and the private sector, NSF will support the Resilient and Intelligent Next-Generation Systems (RINGS) program, laying the groundwork for next-generation wireless connections that will enable faster service, networks more resilient to natural disasters and service interruptions, and broader access for people across the U.S.
- In FY 2022, NSF will continue to support the Spectrum and Wireless Innovation enabled by Future Technologies (SWIFT) program with emphasis on miniaturized efficient low-cost hardware, innovations on radio-frequency (RF)/analog and hardware security, improving access to underserved areas, distributed machine learning, intelligent transportation systems, wireless-enabled smart manufacturing, and beyond-5G wireless components and systems.
- In FY 2022, NSF will continue to support research in artificial intelligence and machine learning techniques that address the diverse, stringent quality-of-service requirements of future wireless applications such as learning from a continuous stream of new data in real time and enabling efficient operations with limited radio and network resources. Research integrating AI, machine learning, and advanced wireless will enable self-organizing, self-managing, scalable wireless networks that can support large numbers of people, devices and diverse applications.
- 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).

<u>Advanced Wireless Research Testing Platforms</u>

- 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 cash 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; and Research Triangle, NC, 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. A fourth platform in this program, expected to start in FY 2021, will support robust and rigorous experimentation on diverse ways to deliver affordable, high-speed broadband to the wide-spread rural regions of the country. FY 2022 will be the first year when all four PAWR testbeds are expected to be operational and generally available simultaneously to the research community, unleashing the full potential of translational opportunities for advanced wireless R&D.
- The PAWR testbeds will continue to benefit from NSF investments in the NSF National Radio Dynamic Zone program under the SII. In FY 2022, the PAWR testbeds will support proofs of concept for dynamic spectrum sharing across diverse geographic and spectrum use cases.

<u>Education and Workforce Development</u>

In FY 2022, 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, 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.