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Request for Information on the National Spectrum Research and Development Plan

AT&T

Before the
NATIONAL SCIENCE FOUNDATION
Alexandria, VA 22134

In the Matter of	)	
	)	Docket No. 2024-03400
Request for Information on the National Spectrum Research and Development Plan	)	

COMMENTS OF AT&T, INC. ON THE NATIONAL SPECTRUM RESEARCH AND DEVELOPMENT PLAN

INTRODUCTION

AT&T appreciates the opportunity to provide input to the development of the National Spectrum Research and Development Plan (R&D Plan) in support of the National Spectrum Strategy (NSS) and its implementation. Given the many technical challenges facing the nation in optimizing its spectrum allocations and use to meet a wide range of needs, R&D will play a vital role in achieving the strategic objectives articulated in the NSS. R&D is also crucial to advancing the United States' leadership in spectrum dependent technologies across multiple domains—including in the global competition for leadership in deploying 5G and Next G networks.

In what follows, AT&T provides responses to topics 1, 2, and 7 of those posed in the Request for Information issued by the Networking and Information Technology Research and Development (NITRD) National Coordination Office (NCO) within the National Science Foundation (NSF), on behalf of the White House's Office of Science and Technology Policy.[1] We hope the NITRD Wireless Spectrum Research and Development Interagency Working Group (WSRD IWG) finds this information helpful toward its development of the R&D Plan and we look forward to continued collaboration with the NSF, other agencies, and other stakeholders in support of both the R&D Plan and NSS.

[1] Networking and Information Technology Research and Development (NITRD) National Coordination Office (NCO), National Science Foundation, "Request for Information on the National Spectrum Research and Development Plan," 89 FR 12871, February 20, 2024. https://www.federalregister.gov/documents/2024/02/20/2024-03400/request-for-information-on-the-national-spectrum-research-and-development-plan.

I. Topic 1: Strategies for Spectrum Research

The RFI seeks recommendations on spectrum research strategies that minimize duplication, provide sufficient research coverage of needed issues, and advance the state of spectrum science and engineering.[2] Several ways to achieve these ends are offered below.

Coordinated R&D Investment. The R&D Plan should encourage and provide guidance on mechanisms to facilitate joint research efforts and information sharing across the R&D communities resident in academia, government, and the private sector. Two existing mechanisms that could be leveraged more extensively include:

1. **Enhanced and Expanded use of Cooperative Research and Development Agreements (CRADAs) and Other Transaction Authority (OTA).**
   CRADAs are instruments frequently used to facilitate joint research work between federal and non-federal parties.[3] OTAs are another instrument authorized for the Department of Defense (DoD) to engage non-federal parties for research, prototype, or production work outside of the standard defense acquisitions requirements.[4] Both instruments already play important roles in spectrum R&D.[5] The R&D Plan should enhance this by coordinating, consolidating, and clarifying the use of both CRADAs and Research OTAs in support of the National Spectrum Strategy. For example, the R&D Plan could provide a playbook for the relevant agencies to use to align the right instruments to the right spectrum research projects and partners—both linked to specific NSS Implementation Plan activities and more generally—and streamline the process for the federal and non-federal parties.

2. **Expanded funding opportunities for private sector researchers.**
   For better or worse, in the modern, highly competitive telecommunications industry, industry's privately funded R&D efforts will be oriented on topics and issues expected to have a sufficient financial return on investment. Much of the research of greatest importance

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[2] RFI Topic 1. https://www.federalregister.gov/d/2024-03400/p-15.

[3] 15 USC §3710a.

[4] 10 USC §4021-4022.

[5] For example, the DoD and the National Spectrum Consortium have established a structure and process around OTA for connecting a broad range of private sector companies engaged in spectrum research and engineering to DoD solicitations. However, the primary orientation of the NSC's activities and DoD's solicitations through it have, naturally, been on serving DoD's requirements rather than the broader national spectrum objectives delineated in the National Spectrum Strategy.

to the National Spectrum Strategy lacks a clear business case for the private sector to fund with shareholders' money but falls in research areas where the private sector has the greatest relevant practical knowledge and expertise. This leads to potential misalignments in R&D activity, funding, and execution that could be redressed by providing increased access to federal funding for private corporations to engage in research aligned to the National Spectrum Strategy. And, while some federally funded research proposals are open to for-profit corporations, most crucial programs are not. For example, for-profit corporations are eligible for NSF's recent "Ideas Lab: Breaking the Low Latency Barrier for Verticals in Next-G Wireless Networks" (NSF 24-545) solicitation but they are *not* eligible for NSF's "Next Era of Wireless and Spectrum" (NSF 24-549) solicitation.[6] Of note, solicitation 24-549 is explicitly linked to the National Spectrum Strategy and encompasses research into topics in which private, licensed-spectrum holders are key stakeholders—though there is not necessarily a compelling business case to warrant significant private investment into the kinds of research called for by this solicitation. Conversely, solicitation 24-545—which, again, *is open* to for-profit corporations—falls in a research area in which a clearer potential business case can be made, and it is more plausible that private sector research would be (or is being) pursued for commercial purposes. The R&D Plan should rationalize the determination of eligibility for federally funded research projects of for-profit corporations to assure better coordination of public and private spectrum research.

Structural and Process Improvements. Information sharing across research communities is core to both advancing R&D and ensuring sufficient and non-duplicative research efforts. Given the significance of the role of the DoD as both the dominant federal spectrum user and conducting and in funding significant R&D work, the R&D Plan should lay out means by which an expanded set of private sector and academic researchers can access spectrum-relevant research findings and reports controlled by DoD, while still appropriately protecting Controlled Unclassified Information, Controlled Technical Information, and other categorizations of unclassified research. This would help improve national R&D coordination and reduce duplicative research by bridging the information asymmetry that often exists between the

[6] NSF 24-545: https://new.nsf.gov/funding/opportunities/ideas-lab-breaking-low-latency-barrier-verticals/nsf24-545/solicitation; NSF 24-549: https://new.nsf.gov/funding/opportunities/next-era-wireless-spectrum-newspectrum/nsf24-549/solicitation.

military spectrum research community and the academic and private sector spectrum research communities.

For example, the Defense Technical Information Center (DTIC) is a large repository of research conducted or funded by the DoD that is available to:

- "Authorized U.S. DoD/military employees
- "Authorized U.S. Government employees
- "Authorized U.S. Government Contractors and Subcontractors"[7]

While some limited portion of relevant spectrum related research and/or reports available in the DTIC repository may also be available to the public in the National Technical Information Service's (NTIS) National Technical Reports Library (NTRL) or other publicly available sources, certainly not all of it is. Per DoD policy, only reports categorized and marked as "Distribution Statement A. Approved for public release: distribution is unlimited" may be released to the public, as is the case for research reports in the NTRL. DoD documents, including DoD or DoD-contracted R&D with other distribution statements are increasingly restricted as to whom those documents can be released—even for unclassified information.[8] DoD policy for distribution of technical information states that "The DoD will pursue a coordinated and comprehensive program to promote *sharing technical information to the maximum extent possible to facilitate the efficient use of resources* in accordance with safeguarding requirements as specified in national and DoD information and operations security policies, procurement regulations, policies, and procedures…"[9] (*emphasis added*). While that policy is specifically applicable only to DoD, the objective of facilitating "efficient use of resources" is equally important in the context of the National Spectrum Strategy that has as one of its key objectives assuring sufficient federal and DoD access to spectrum domestically. Accordingly, the R&D Plan should identify ways to make unclassified DoD research available to a broader set of spectrum R&D entities and researchers while comporting with both DoD requirements and policy and the requirements of 42 USC Subchapter III, Part D.

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[7] Department of Defense, Defense Technical Information Center (DTIC), DTIC Registration Information, available at: https://discover.dtic.mil/dtic-registration-benefits/dtic-registration/.

[8] Department of Defense, DoD Instruction 5230.24, "Distribution Statement on DoD Technical Information," January 10, 2023. Distribution Statement A is only applicable to unclassified information; Distribution Statements B, C, D, E, and F can be applied to both unclassified and classified information. The discussion here only pertains to unclassified research.

[9] *Ibid*.

One simple and specific way to do so would be to provide a streamlined means for enabling appropriate entities and individuals—both academic and private sector—to access the DTIC repository. The R&D Plan could designate a Government Approving Official to facilitate authorizing the issuance of the External Certification Authority or Personal Identity Verification cards to appropriately validated and relevant spectrum researchers not otherwise affiliated with DoD, whether in academia or the private sector. For the purposes of the R&D Plan, this Government Approving Official could be the NSF Chief of Research Security, or an appropriate designee.[10] At the very least, the R&D Plan could direct that all spectrum-relevant research published in DTIC's repository that has a Distribution A categorization, and that is not already included in the NTRL, be posted there as well.

In the classified information domain, improved means of enabling private sector access to relevant classified research would help support the objectives of the R&D Plan and the National Spectrum Strategy. Classified research is obviously even more challenging to share while protecting national security than unclassified research. The DoD's Partnership for Advancing Trusted and Holistic Spectrum Sharing-Classified (PATHSS-C) subgroup, formed under the auspices of the National Spectrum Consortium to inform DoD's Emerging Mid-Band Radar Spectrum Sharing (EMBRSS) study of the 3.1-3.45 GHz band took on this challenge and successfully demonstrated the viability of classified information sharing on spectrum topics with industry and academia outside of traditional mechanisms. To further the National Spectrum Strategy, this kind of classified information sharing, and particularly greater sharing of classified research work, needs to be sustained, routinized, and expanded. The R&D Plan should: (1) identify the kinds of classified research that are relevant to supporting the National Spectrum Strategy, (2) assess the relevant research communities that do not typically have access to these kinds of classified research, and (3) make recommendations on processes and forums for facilitating improved sharing of classified research across the relevant research community.

II. Topic 2: Recommended Priority Areas for Spectrum R&D

***Spectrum utilization efficiency*.** Commercial spectrum licensees have very strong financial incentives to maximize the efficient use of the spectrum in which they have invested

[10] 42 USC §19032.

significant capital through both auctions *and* purchase and deployment of network equipment. Much of the research leading to 3GPP standards has focused on maximizing spectral efficiency within communications channels. These research trends will persist through the industry's continued evolution and advancement of the standards. However, for many federal spectrum users, 'spectrum utilization efficiency' is a more challenging notion to define or quantify. For example, many federal systems are necessarily designed to prize flexibility, agility, and mission effectiveness across large bandwidths over "efficiency." Research into ways to characterize risk-based frameworks associated with federal spectrum users' missions would be fruitful for helping assess federal spectrum utilization and identifying ways to productively increase overall spectrum utilization. For example, there is spectrum inefficiency when spectrum is reserved solely for federal use, but that use is merely episodic and then only sometimes for what could accurately be characterized as a truly critical mission, in terms of time-sensitivity and severity of consequence to the nation of interference leading to mission failure. The R&D Plan should incorporate this as a key research issue to explore.

***Spectrum resilience and assured access for critical mission applications*.** This research area has the highest relevance to federal, and specifically military, systems and aligns well to the DoD's Electromagnetic Superiority Strategy's call for "revolutionary, leap-ahead technology and capabilities" for its electromagnetic systems that "should be flexible and access spectrum through frequency agility, frequency diversity, and wide tuning ranges."[11] It is reasonable to assume that DoD continues to pursue R&D into these capabilities, though likely that much of the most substantive research and findings will be controlled unclassified and classified. However, as part of the R&D Plan, DoD's research in this area should be coordinated through other federal agencies with parallel streams of research to determine how DoD's nascent spectral resilience and agility capabilities can be used to enhance coexistence with non-federal use of shared spectrum. Also, this issue is intimately related to the discussion above of federal users' spectrum utilization and the recommendation for research into risk-based frameworks and federal mission analysis.

For commercial licensed spectrum users, whose mobile networks represent important elements of the nation's critical infrastructure, the R&D Plan should support research efforts into

[11] Department of Defense, *Electromagnetic Superiority Strategy*, October 2020, p. 7.

resilience of spectrum dependent systems and networks from natural and manmade electromagnetic pulse (EMP) hazards. As has been repeatedly noted, there is a certain EMP risk posed by natural events (i.e., solar flares) and, in an era of increasing global instability and great power competition, there is a concomitant and renewed risk of manmade EMP attacks. Research areas here should include resilience, recovery, and restoration. This area is also particularly ripe for close coordination between the federal government and private industry in the conduct of research, development, testing, and deployment.

Automatic and rapid mitigation of interference problems. While much discussion of dynamic spectrum sharing has centered on controlling spectrum access to prevent any interference altogether,[12] another potentially more efficient solution set for some coexistence scenarios lies in rapid and automated mitigation of instances of interference. Margins of decibels, Hertz, geography, or time built-in to regimes for spectrum access management with the intent of preempting *any* interference necessarily leave more spectrum fallow and/or underutilized than necessary if and when two incompatible uses of spectrum can (1) tolerate some small degree of transitory interference and (2) have a method for mitigating or resolving it quickly. The R&D Plan should incorporate research into this area, such as identifying spectrum uses, federal and non-federal alike, that could tolerate transitory interference and supporting research into automated interference mitigations. For example, for mobile network coexistence with federal systems, this could include research into RAN-based sensing and response mechanisms and analysis of federal systems missions and interference resilience.

Modeling for coexistence analysis. AT&T's recent experiences with coexistence modeling efforts in the 3 GHz band, both as a 3.45-3.55 GHz licensee and as a participant in the PATHSS Task Group informing DoD's conduct of its EMBRSS study of the 3.1-3.45 GHz band, suggest that research into continued improvements in coexistence modeling is greatly needed. In developing spectrum sharing regimes, modeling often undergirds the baseline scoping of the coexistence challenge, e.g, determining the geographies where coexistence techniques are needed. Modeling also then informs decisions on the sharing mechanisms or coexistence techniques to apply. However, AT&T has found significant differences between its own internal network modeling, its measured, real-world network coverage and performance, and what

[12] See response to Topic 7 below for further discussion.

several different government models of 3 GHz band 5G networks predict with regard to 5G interference into federal systems at given locations. While AT&T and other industry members are working directly with various U.S. government entities to reduce the significant over-prediction of interference in the government models, this is a valid and valuable area of research to establish a common understanding and set of norms for modeling that can better support the aims of the National Spectrum Strategy. Importantly, this R&D work needs to be informed by real-world and large-scale measurements; reliance solely on laboratory testing or small-scale field tests cannot provide sufficient insights on which to base spectrum policy decisions. Failure to accurately understand and scope the coexistence challenges leads government and industry to try to solve coexistence problems that may not be extant or as significant in the real-world as current models predict.

III. Topic 7: Terminology and Definitions Relevant for Spectrum R&D

Dynamic Spectrum Sharing (DSS). As this RFI notes, the term "Dynamic Spectrum Sharing" is indeed a focus of the National Spectrum Strategy but was not formally or explicitly defined. AT&T offered the following proposed definition in our response to the RFC on the National Spectrum Strategy Implementation Plan: "a sharing mechanism that allows for spectrum access to the same frequency band by two dissimilar spectrum users that varies in near-real time across one or more other dimensions of spectrum use: geography, frequency, time, or power[,]" with the additional explanation that "power" should be understood as "received power at a given location and time"[13] vice transmitted power. The Implementation Plan subsequently offered a description of DSS that begins to approximate a definition, stating: "dynamic spectrum sharing (DSS) involves the operation of independent systems close enough together (in frequency, space, or time) that dynamic access methods are required to prevent harmful interference."[14] While AT&T still recommends establishing an explicit definition of DSS for the National Spectrum Strategy and its implementation work streams (including the R&D Plan)—preferably one that closely tracks what AT&T has suggested—conduct of R&D into DSS should be characterized by:

[13] AT&T, Inc., "Comments of AT&T, Inc. on the Implementation of the National Spectrum Strategy," NTIA Docket No. 230308-0068, January 2, 2024, p. 12.

[14] Implementation Plan, p. 19

- Examination of full-power licensed use;
- Development of a basis for predictable times and/or geographies in which dynamically shared spectrum can be used;
- Examination of a full range of interference mitigation techniques—not restricting R&D in mere 'on/off' spectrum *access* controls;
- Establishment of an objective timescale of dynamism that is non-arbitrary and relevant to the services/uses/missions sharing spectrum;
- Examination of varied architectures and/or loci of control for the sharing mechanisms: e.g., centralized, distributed, peer-to-peer, etc.;
- Seeking to define co-channel and adjacent channel interference environments to incorporate into network design and operation.

Already, research funded by NSF through the Spectrum Innovation Initiative-National Radio Dynamic Zones (SII-NRDZ) program touches on some of these areas.[15] The R&D Plan should ensure that R&D into DSS conducted under the auspices of the NSS and supported by the range of involved federal entities (e.g., DoD and NTIA) take a similarly broad conception of DSS rather than prematurely and narrowly focusing on simply evolving the current Spectrum Access System or Automated Frequency Coordination constructs.

CONCLUSIONS

Facilitating and coordinating spectrum research across government, academia, and multiple relevant private sector industries is a great challenge—one that is vitally important to meet the nation's current and future spectrum needs. The R&D Plan can aid this effort by:

- identifying and streamlining the effective use of mechanisms to enable cooperative research between industry and government in support of the NSS, such as CRADAs and OTAs;
- increasing the eligibility of for-profit corporations to relevant research funding opportunities in support of the NSS;
- improving the sharing of government research, particularly that conducted by DoD, with relevant private sector and academic researchers.

The R&D Plan can also help achieve the technical objectives of the NSS by orienting the research community on developing novel solutions to our spectrum challenges, including improved and commonly accepted coexistence modeling approaches, interference mitigation techniques beyond simple spectrum access or transmit power controls, and developing resilient

[15] See, e.g., https://www.nsf.gov/awardsearch/advancedSearchResult?ProgEleCode=151Y&BooleanElement=Any&BooleanRef=Any&ActiveAwards=true#results.

spectrum systems. Lastly, given the emphasis the NSS places on DSS, the R&D Plan should ensure that R&D efforts do not hone in too quickly on pre-determined approaches to DSS—leaving unexamined techniques and approaches that may prove more effective over the long-run, even if less readily available now. We look forward to continuing to work with NSF, the WSRD IWG, and the broader research community to drive advancement of the most effective use of the nation's spectrum through research and development.

Respectfully submitted,

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