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In the matter of the National Spectrum Strategy Implementation Plan RFI

Comments from SpectrumX, the NSF Spectrum Innovation Center

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Introduction

SpectrumX thanks the National Telecommunications and Information Administration (NTIA) for its significant and ongoing efforts to engage spectrum stakeholders across government and industry, Tribal Nations, academia, and the general public in the development of the National Spectrum Strategy (NSS)[1] in response to the Presidential Memorandum (PM) *Modernizing United States Spectrum Policy and Establishing a National Spectrum Strategy*[2]. Having carefully reviewed and discussed both the NSS and the PM, we appreciate the opportunity to provide inputs[3] directed at informing the NSS Implementation Plan that is being developed by NTIA in collaboration with the Federal Communications Commission (FCC) and in coordination with Federal departments and agencies.

In addition to the development of the NSS and the NSS Implementation Plan, a number of prevailing circumstances have created an unprecedented opportunity for the United States to ask more of academia to help address pressing challenges arising from the growing demand for numerous applications of the radio frequency spectrum. In particular:

- NSF created the Spectrum Innovation Initiative (SII)[4] with an increased commitment to basic research, infrastructure development, new collaborations, public outreach, education, and workforce development on a larger and more interdisciplinary scale.
- The NTIA and FCC entered into a Memorandum of Agreement with NSF[5] in February 2021 to ensure that NSF SII investments are in alignment with U.S. spectrum regulatory and policy objectives, principles, and strategies.
- SpectrumX[6], the NSF Spectrum Innovation Center, was launched in September 2021 as part of the NSF SII to connect spectrum researchers with nationwide challenges and to grow the spectrum workforce in support of industries of the future. The Center now coordinates activities among 56 researchers and staff as well as 82 students and postdoctoral scholars at 30 member institutions, including a growing number of Minority Serving Institutions (MSIs).
- SpectrumX and NSF are piloting a new Liaison Collaboration Model between academia and the NTIA's Institute for Telecommunication Sciences (ITS) and Office of Spectrum

[1] National Spectrum Strategy, https://www.ntia.gov/sites/default/files/publications/national_spectrum_strategy_final.pdf
[2] Presidential Memorandum, https://www.whitehouse.gov/briefing-room/presidential-actions/2023/11/13/memorandum-on-modernizing-united-states-spectrum-policy-and-establishing-a-national-spectrum-strategy/
[3] Notice of National Spectrum Strategy Implementation Plan Request for Input, https://www.ntia.gov/Federal-register-notice/2023/notice-national-spectrum-strategy-implementation-plan-request-input
[4] National Science Foundation Spectrum Innovation Initiative, https://www.nsf.gov/mps/osi/spectrum_innovation_initiative.jsp
[5] NTIA-FCC-NSF Memorandum of Agreement, https://www.ntia.doc.gov/files/ntia/blogimages/sii_moa_fcc_nsf_ntia.pdf
[6] SpectrumX, the NSF Spectrum Innovation Center, https://www.spectrumx.org

Management (OSM), with opportunities to translate and expand this model with other Federal departments and agencies.
- The International Telecommunications Union (ITU) released the Provisional Final Acts[7] from the World Radio Conference 2023.

These circumstances create significant potential to tap into the objective thinking and creative energy of faculty and students in academia, to foster public scholarship on wireless technologies and radio spectrum access, and to rapidly create a workforce multiplier for today's spectrum managers and policymakers. SpectrumX intends to lean into its convening role, coordination mechanisms, research, and community development activities to help its members, as well as the broader academic community, contribute to these important national and global initiatives around the radio spectrum.

Summary of comments

We present detailed comments and suggestions on the following aspects of the NSS, which we hope are useful to NTIA in framing the NSS Implementation Plan:

(1) **Spectrum Utilization and Coexistence:** We recommend that NTIA along with other Federal agencies convene the relevant stakeholders, including academia as a neutral participant, in studies that evaluate fairly how spectrum may be repurposed, reallocated, and/or shared.
(2) **Testbeds:** We recommend that NTIA explore how government, academia, and industry can collaborate in building very specific spectrum coexistence testbeds in 3.1 - 3.45 GHz and 7.125 - 8.4 GHz. This activity should include collecting detailed measurements about actual usage of these bands, as being done in SpectrumX, and leverage existing testbeds such as some of the ones being built under NSF's Platforms for Advanced Wireless Research (PAWR)[8] program. Instead of a single testbed, we recommend distributing testing with experimental licenses in different locations.
(3) **Workforce development:** We recommend that NTIA partner with NSF and leverage ongoing efforts within centers such as SpectrumX to educate the next generation of spectrum leaders. These educational efforts range from developing focused curricula to short- and long-term training, and have the goal of broadening participation of groups who have not historically engaged in these domains.
(4) **Economic valuation of spectrum:** We recommend that NTIA, in collaboration with Federal agencies, academia and industry, develop mechanisms and models that reveal or estimate the value of spectrum accounting for alternative uses by Federal and non-Federal stakeholders together with alternative access models including exclusively licensed, unlicensed, and sharing protocols.

[7] World Radio Conference 2023 Provisional Final Acts, https://www.itu.int/dms_pub/itu-r/opb/act/R-ACT-WRC.15-2023-PDF-E.pdf
[8] PAWR, https://advancedwireless.org/

Comment 1: Spectrum utilization and coexistence studies

The NSS calls for a number of "studies" to be performed in the next two (2) years to better understand current and planned uses of radio spectrum by Federal departments and agencies in the target bands. Opportunities to either repurpose spectrum for non-Federal uses or to share spectrum should both be emphasized, driven in particular by the demands for additional commercial spectrum for terrestrial mobile networks, unlicensed technologies, satellite systems, and fixed wireless links.

We encourage NTIA and Federal departments and agencies to ensure that such studies include the following key ingredients:

- Convene the relevant stakeholders from industry and government meaningfully and equitably in each study.
- Conduct diverse sets of field measurements pursuant to each study, and make data sets available for wider examination. This activity could leverage ongoing efforts within academic centers, such as SpectrumX, which is developing a sensor that can scan 0-18 GHz in 200 MHz bandwidth steps that costs approximately $200. This would therefore allow measurement of not only existing commercial bands, but also bands that have yet to be considered for extensive commercial use. With such a starting point, and the goal of driving the cost lower with time, we can enable targeted sensing deployments that can ultimately be spread nationwide.
- Summarize the full set of tradeoffs in each coexistence and spectrum sharing scenario, rather than prescribing a particular operating point on such a trade-off, and suggest opportunities for research and development on new technology and policy options to expand the trade-off region.
- Maximize openness and transparency of the studies, sharing updates at various community events held each year such as IEEE DySPAN, ISART, Spectrum Week, and SpectrumX Center Meetings.
- Engage SpectrumX researchers and students, not only to contribute to the studies themselves, but to learn more about the organizations and systems involved and thereby enhance workforce development as well.

Comment 2: Testbeds for Dynamic Spectrum Sharing

The NSS has identified five (5) frequency bands for further study over the next two (2) years, with some imperative to identify sharing mechanisms between Federal and non-Federal users. This response addresses two of these bands: 3.1 – 3.45 GHz and 7.125 – 8.4 GHz, and we recommend that dynamic sharing experiments be focused on just these two bands initially.

There have been multiple efforts in the past to establish dynamic sharing testbeds[9] [10] [11]. Although these efforts led to small-scale successes in research and development, there have not been substantive improvements to advanced spectrum sharing methods as a result. Hence, any future testbed activity should be structured in a way that the outcomes can be applied to spectrum policy making in the near term.

At the same time, as we evaluate allocating spectrum for commercial wireless applications, it is important to acknowledge that there are new, emerging non-Federal use-cases, such as private networks, that have different spectrum requirements as compared to terrestrial, licensed cellular services or unlicensed Wi-Fi. While exploring which spectrum bands could be reallocated and auctioned for exclusive use, creating spectrum spaces for such use-cases, as advocated for example by Ofcom[12], allows one to share spectrum under different rules than in the past. Further, many of the most demanding use-cases, in terms of bandwidth and latency requirements (e.g. XR) will be deployed primarily indoors, where spectrum-sharing is usually easier to implement.

Suggestions for testbed implementation

1) General purpose dynamic sharing testbeds are not very effective for impacting spectrum policy. It is unlikely that a single or even a few testbed locations will satisfy all the requirements for testing dynamic spectrum sharing, in any given frequency band, for any particular technologies, and for different sharing environments. NTIA should consider developing a testing framework for authorizing testbeds as appropriate to analyze particular technical issues while ensuring incumbent services are not put at risk. These testbeds can be developed in conjunction with NTIA, the FCC and relevant parties with defined purposes and timelines. Multiple testbeds, developed in collaboration with industry and academia, would better support "the U.S. Government's effort to advance the technology for spectrum access within 12-18 months."[13]
2) The 3.1 - 3.45 GHz and 7.125 - 8.4 GHz bands are well positioned for development activity in the near term since the equipment required to build these are more easily available than the higher bands and are also aligned with WRC-23 study items. Furthermore, these are the bands that are of most interest for non-Federal applications due to their propagation characteristics. 5G base stations operating in 3.4 GHz are already available, both for high-

[9] The President's Spectrum Policy Initiative Spectrum Sharing Innovation Test-Bed, 2006. https://www.Federalregister.gov/documents/2006/06/08/E6-8874/the-presidents-spectrum-policy-initiative-spectrum-sharing-innovation-test-bed
[10] NTIA, Spectrum Sharing Innovation Test-Bed, 2008, https://www.ntia.gov/category/spectrum-sharing-innovation-test-bed?page=14
[11] WSRD, "Toward Innovative Spectrum Sharing Technologies: A Technical Workshop on Coordinating Federal Government/Private Sector R&D investment," 2011 https://www.nitrd.gov/pubs/WSRD_Workshop_I_Report.pdf
[12] Ofcom Consultation, "Supporting Increased Use Of Shared Spectrum," November 23, 2023. https://www.ofcom.org.uk/__data/assets/pdf_file/0017/272051/Consultation-Shared-Access-Licence.pdf
[13] National Spectrum Strategy, p 16. https://www.ntia.gov/sites/default/files/publications/national_spectrum_strategy_final.pdf

power, outdoor use by MNOs and lower power use by private network operators. The 7.125 – 8.4 GHz band will also have software-defined-radios (SDRs) available soon.

3) Since both bands will have equipment available shortly, instead of having one testbed, NTIA and the FCC, along with the relevant Federal agencies, should consider allocating experimental licenses to experimenters anywhere in the country. This will allow interference testing in real-world conditions rather than in a laboratory or a single, purpose-built environment. Furthermore, real-world coexistence with adjacent channel incumbents can also be better tested with this "distributed" approach. This approach is similar to the recent experimental license given to SpaceX for testing direct-to-mobile transmission to phones[14]. The University of Notre Dame, for example, has an experimental license to transmit outdoors in the 6 GHz band, which will be used with commercially available equipment for research into sharing in this band[15] in a representative, real-world environment.
4) A dynamic spectrum sharing testbed, especially one that seeks to share spectrum with Federal systems, requires full cooperation from incumbents. It is impossible to develop reasonable sharing mechanisms if one has limited understanding of the systems one is sharing with. The NSS mentions transparency and sharing of information between agencies; this needs to be prioritized, since without information on incumbent usage, as opposed to allocation, designing and building a testbed will deliver limited insights on how spectrum could be shared. This cooperation is essential in obtaining experimental licenses quickly.
5) Testbeds should consider commercial use cases beyond high-power, outdoor, mobile cellular which are the most difficult for sharing. There are many other applications, such as local-area networks and private cellular networks in verticals such as factory automation and precision agriculture that need better Quality-of-Service (QoS) than available from unlicensed bands. Such applications could easily share spectrum with incumbents using lower power, localized transmissions in spectrum that is available under a different licensing scheme. Testbeds that experiment with these kinds of applications may be easier to get off the ground with the appropriate experimental licenses.
6) Testbeds should enable dynamic sharing methods beyond databases (e.g. SAS as used by CBRS and AFC as used in 6 GHz) and explore distributed sensing, perhaps in combination with databases. Incumbent Informing Capability (IIC) should also be considered. However, true dynamic sharing can only be enabled by sensing on the ground, especially when sharing between secondary users[16].
7) Ideally, Federal incumbents should also be willing to experiment with new technology that facilitates sharing, and testbeds should be built to allow such experimentation. If future Federal systems that are being designed today continue to assume access to exclusive spectrum for perpetuity, then real progress will be limited since the onus of dynamic sharing will continue to fall fully on new entrants. Encouraging Federal departments and agencies to utilize commercial wireless technologies to the extent possible, possibly as private networks,

[14] SpaceX, Request for STA to conduct experimental operations, https://apps.fcc.gov/els/GetAtt.html?id=337665&x=
[15] Experimental license at 6 GHz, University of Notre Dame, https://apps.fcc.gov/els/GetAtt.html?id=333298&x=.
[16] A. Tusha, S. Tusha, H. Nasiri, M. I. Rochman and M. Ghosh, "A Comprehensive Analysis of Secondary Coexistence in a Real-World CBRS Deployment," submitted to DySPAN 2024.

and sharing their own spectrum with other radio systems that support their missions, could be a compelling way to spur spectrum sharing innovations as well as effective utilization of spectrum.

8) Spectrum measurements will continue to play a critical role in informing spectrum strategy and should be a complement to testbed activities. SpectrumX activities in sensing[17] can be leveraged to understand actual spectrum usage, in both Federal and non-Federal bands, as detailed in the response to FCC's recent Notice of Inquiry on Advancing Understanding of Non-Federal Spectrum Usage[18]. Other ongoing research, for example in real-world measurements of 6 GHz[19] and CBRS[20], can be further extended to the new bands being considered for sharing.

Comment 3: Workforce development

A spectrum workforce requires deep understanding of system design, communications, propagation models, interference analysis, and other engineering aspects as well as use-cases, economic valuations, and spectrum policy. In addition, the increasing role of AI in spectrum management and engineering necessitate broadening of the skill set to include machine learning. These can be developed through (i) undergraduate courses tailored to educate the next generation spectrum workforce in departments such as Electrical and Computer Engineering, Computer Science, Economics and Public Affairs; (ii) graduate programs that span multiple academic departments (such as the MS in Telecommunications, Electrical Engineering, Computer/Information Science, Public and International Affairs at the University of Pittsburgh); (iii) short-term training, such as summer schools at both levels and continued professional training (such as in AI).

SpectrumX is well positioned on all these fronts and has initiated efforts in developing graduate courses, research experiences, and summer schools with the goal of educating the future spectrum workforce and broadening participation from historically underrepresented groups. SpectrumX welcomes input from and collaboration with NTIA in continued efforts as well as efforts to soon commence on undergraduate training.

Summer school efforts in several focused areas such as communications, machine learning, quantum science and information theory have been led by professional organizations (such as

[17] ND Wireless RadioHound Platform, https://wireless.nd.edu/research/radiohound-distributed-spectrum-sensing/

[18] SpectrumX comments on FCC NOI on Advancing Understanding of Non-Federal Spectrum USage, https://www.fcc.gov/ecfs/document/10042724106232/1

[19] S. Dogan-Tusha, M. I. Rochman, A. Tusha, H. Nasiri, J. Helzerman and M. Ghosh, "Evaluating the interference potential in 6 GHz: an extensive measurement campaign of a dense indoor Wi-Fi 6E network," WiNTECH '23, Proceedings of the 17th ACM Workshop on Wireless Network Testbeds, Experimental evaluation & Characterization, October 6, 2023, https://dl.acm.org/doi/abs/10.1145/3615453.3616518

[20] M. I. Rochman, V. Sathya, B. Payne, M. Yavuz and M. Ghosh, "A Measurement Study of the Impact of Adjacent Channel Interference between C-band and CBRS," *2023 IEEE 34th Annual International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC)*, Toronto, ON, Canada, 2023, pp. 1-7, doi: 10.1109/PIMRC56721.2023.10294066, https://arxiv.org/pdf/2304.07690.pdf

IEEE) in partnership with academia, supported by NSF, DoD and industry. Translating these efforts towards building the next-generation spectrum workforce necessitates the summer schools to be broad and multidisciplinary. Further, such know-how can translate into partnerships for continuing education of spectrum professionals in emerging advances (such as the role of AI in spectrum management). SpectrumX is developing plans for its first summer school to be held in 2024, and welcomes partnerships with professional societies, government, and industry.

Successful workforce development efforts in other areas of critical national importance have involved joint efforts between academia, NSF, and other government agencies. For example, over the last 20 years[21] NSF has worked with the US Office of Personnel Management (OPM) and the Department of Homeland Security (DHS) to provide scholarships through universities in the CyberCorps program for training and recruiting a "superior cybersecurity workforce". Starting with 9 graduates in 2002, the program has graduated nearly 4000 students (including both undergraduate and graduate degrees) all over the country. Recipients of such scholarships have a service obligation (for at least as long as the scholarship was provided) with Federal, state, local, or tribal governments as well as in some Federally Funded Research and Development Centers (FFRDCs). The program initially had both scholarships and a capacity-building component for universities to develop curriculum and labs. The capacity-building component has since been rolled into other programs at NSF.

Suggestions for developing a "Spectrum Corps"

SpectrumX encourages a whole-of-government approach to create a "Spectrum Corps" initiative similar to the CyberCorps initiative. A Scholarship of Service program in this field would allow Federal agencies, first responders, state, local, and tribal governments to recruit from a "spectrum-ready" pool of graduates. Such a program can also catalyze interest and visibility in radio spectrum and related technologies that would benefit innovation in the private sector. Leveraging its large and diverse team as well as growing government and industry collaborations, SpectrumX has already been developing two key components of such a broad initiative through its Education and Workforce Development (EWD) Working Group (WG).

First, SpectrumX EWD WG has a comprehensive plan to develop educational materials that enable introductory modules and courses for middle schools and high schools (Grades 6-12) and for institutions of higher education (undergraduate and master's levels). The focus is on providing broad, introductory, and compelling surveys of the field in order to raise awareness and attract larger and more diverse groups of learners to the field. We are developing the materials as a community, with guidance and support from experts in learning design, and will make them widely available through the Center website as well as partner websites. To promote access and reuse of the courseware, we are targeting a content licensing framework based upon Creative Commons that will allow us to offer low-cost specializations through Coursera as well as for-credit offerings at any SpectrumX member institution.

[21] The 2021 NSF Biennial Report for CyberCorps: Scholarship for Service: Available at 2021SFSBiennialReport.pdf (nsf.gov)

As part of the NSS EWD Plan, SpectrumX invites the Federal government and industry stakeholders to help maximize the adoption of these introductory course materials. SpectrumX has already interviewed staff and / or visited locations at NTIA, NOAA, NRAO, FAA, and NASA as well as Qualcomm, Intel, Nokia, and Google with additional interactions being scheduled. We have also shared updates and asked for feedback on the course materials individually and in working sessions at our Center meetings as well as during NSF Spectrum Week. These collaborations enable government and industry partners to directly share perspectives on spectrum-related aspects of their mission, challenges, and career opportunities. In addition to making the introductory materials more compelling, we anticipate that such collaborations will foster identification and prioritization of additional specialized and training courses that could be developed with additional funding, while avoiding duplication of effort.

Second, SpectrumX EWD WG has collaborated with staff at NTIA ITS on a Spectrum Corps concept for building education and training capacity at a network of universities and community colleges, with coordination through a central program office.[22] The coordination office can collect government and industry needs with regard to areas of expertise, project tasking, and internship and career opportunities, and then fan them out to the network of academic partners. Key elements of the capacity-building component include providing sustained funding to support the latest equipment and software tools, as well as technical and project management staff time, to enable students to develop expertise and contribute to collaborative projects across the network.

These components of Spectrum Corps would create a national network of university teams that engage directly with agencies and businesses to coordinate hands-on experiential spectrum workforce development and to offer rapid response to priority spectrum issues in targeted areas of specialization. Comparable to the Farm System in Major League Baseball (MLB), the approach is to establish a managed network of universities (Single-, Double-, and Triple-A Teams) with the long-term funding, infrastructure, and technical staff to perform EWD that aligns with the requirements of partnering government agencies and businesses (MLB Teams). As students and trainees advance through the Spectrum Corps from Single-A to Triple-A (progressing to more advanced, applied, multi-disciplinary problems), they become more well-rounded and prepared for work in the Major League.

As part of the NSS EWD Plan, SpectrumX encourages NTIA and the Federal government to adopt these elements of the Spectrum Corps concept and help shape and fund the program through a whole-of-government approach. SpectrumX is leading the organizing of NSF Spectrum Week in Washington, DC from May 13-17, 2024, and we would be happy to coordinate a workshop on the NSS EWD Plan during that week as well as collect and summarize academic input ahead of such an event.

[22] NTIA ITS-SpectrumX Spectrum Corps White Paper, available from J. Nicholas Laneman <jnl@nd.edu>

Comment 4: Economic valuation of spectrum

Strategic Objective 1.3 of the NSS seeks to maintain the spectrum pipeline by applying guiding principles and leading program management practices to identify additional bands for study. One of the guiding principles for maintaining such a spectrum pipeline should be a continuous evaluation of spectrum needs for both Federal and non-Federal systems, which would take into account the economic valuation of spectrum early in the process of identifying new spectrum bands outlined in the NSS.

The NSS further states: "*Leveraging our Nation's intellectual capacity, the U.S. Government will develop models that use a value-based framework to assess the potential impacts of spectrum reallocation options. The societal value of the spectrum will be calculated based on a quantifiable estimation of the direct and indirect benefits of the different uses of the spectrum to the Nation.*"

Suggestions for developing a value-based framework

Prior to beginning the process of identifying new spectrum bands, we recommend that NTIA revisit the effectiveness of existing incentives to repurpose spectrum, including provisions of the Commercial Spectrum Enhancement Act (CSEA), the Spectrum Relocation Fund (SRF), and OMB Circular A-11.[23]

We agree that in considering spectrum bands for possible repurposing it is important to consider the potential value generated by competing uses. When performing economic analysis, "value" typically refers to a social welfare or sum utility metric. If access rights are defined in such a way that they can be traded, market prices usually serve as a guide for maximizing this metric. That is, a market price represents marginal value, inherently taking into account alternative uses for the spectrum as expressed by bidders. Hence prices generally provide information needed to allocate resources efficiently.

When spectrum is centrally assigned and managed without tradeable access rights, assessing value becomes more difficult. Prior work on valuing spectrum[24] [25] [26] addresses this problem and identifies basic challenges in valuing spectrum in the absence of a market and prices together with analyses of past methods used by regulators to estimate the value of spectrum.

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[23] See, for example, CSMAC Spectrum Efficiency Report, July 2018 https://www.ntia.gov/sites/default/files/publications/csmac_spectrum_efficiency_subcommittee_report_0.pdf or K. Gordon et al, A Review of Approaches to Sharing or Relinquishing Agency-Assigned Spectrum January 2014 https://www.ida.org/research-and-publications/publications/all/a/ar/A-Review-of-Approaches-to-Sharing-or-Relinquishing-Agency-Assigned-Spectrum.

[24] Thomas W. Hazlett & Michael Honig, *Valuing Spectrum Allocations*, 23 Mich. Telecomm. & Tech. L. Rev. 45 (2016-2017)

[25] Thomas W. Hazlett, *Rent-Seeking for Spectrum Sharing: The 5.9 GHz Band Allocation*, Ohio St. Tech. L.J. (2022)

[26] Thomas W. Hazlett, *Cost-Benefit Analysis in the 5.9 GHz Band*, J. Cost-Benefit Analysis (forthcoming)

Are market solutions appropriate for allocating spectrum among Federal users and between Federal and non-Federal uses? That is, can access rights be defined which are tradeable and enable demand revelation by both Federal and non-Federal service providers? In general, there may be several ways in which markets can be introduced. For example, prior work on auctions and overlay rights[27] indicates how flexible overlay rights might be used to repurpose spectrum currently assigned to both Federal and non-Federal use.

A challenge is to design the rights to shift the burden of assigning specific power limits in particular regions (e.g., indoor/outdoor) away from regulators, and instead let those be determined directly (via negotiations and price signals) by the interested stakeholders. In that way the allocation procedures can be better aligned with economic fundamentals.

Conclusions

There are substantial synergies between the NSS Implementation Plan and both ongoing and planned SpectrumX activities, some of which have been described in this response. The relationships between academia, government, and industry that have been fostered through the NSF SII and SpectrumX can be leveraged and dramatically expanded by NTIA in accomplishing the goals of the NSS as described in the pillars and strategic objectives.

About SpectrumX Input to Regulatory and Policy Proceedings

SpectrumX actively encourages and supports its members to contribute to regulatory and policy proceedings on radio spectrum issues. Templates, training, and mentoring are made available to all Center members. The process summarized briefly here is facilitated through the SpectrumX Policy Outreach Working Group.

Any member of SpectrumX can initiate a draft comment or response as an internal working document of the Center. They are required to invite other members of the Center to consider endorsing, if not contributing, to the working document. Dissenting views may well arise, which SpectrumX views as quite natural and even healthy; these alternative views and associated endorsements can be captured in the same working document or collected into a new working document.

Before submission to an external proceeding, the working document(s) are shared within the team as a whole, and scrutinized in particular by the Center leadership, to ensure appropriateness for SpectrumX to formally submit. If significant concerns are raised about SpectrumX being referenced in the filing, then the contributing authors are welcome to submit the document as individuals and / or through their other affiliations, without reference to SpectrumX.

[27] R. Berry, T. Hazlett, M. Honig, I. Murtazashvili and A. Palida, "Overlay Rights for Transitioning Spectrum Use," https://www.ntia.gov/sites/default/files/publications/berry_hazlett_honig_murtazashvili_and_palida.pdf

As a result, a comment or response developed and submitted through SpectrumX to a regulatory or policy proceeding should not be construed as policy advocacy on the part of the Center or as an endorsement of the document by the Center as a whole. Only the contributing authors and endorsers identified in the various sections of the document should be viewed as the submitting parties, with the understanding that the process was facilitated and working document(s) vetted by SpectrumX.

About SpectrumX

SpectrumX is the world's largest academic hub within the radio spectrum ecosystem for advancing interdisciplinary research, education and workforce development, collaboration with industry and government agencies, and policy outreach and engagement. SpectrumX's vision is to conduct projects to help modernize radio spectrum management and accelerate spectrum-dependent technologies and applications that benefit society. These efforts were initiated in September 2021 with a 5-year, $25M grant from the National Science Foundation (NSF) through its Spectrum Innovation Initiative (SII) Center program.

SpectrumX brings together broad and synergistic research capabilities from a team of 41 founding researchers and staff from 27 top universities, including a number of minority serving institutions (MSIs). This team comprises a diverse and interdisciplinary group of scientists, engineers, and educators with backgrounds in Electrical Engineering, Computer Science, Aerospace, Astronomy, Geoscience, Economics, Policy, and Workforce Development. In addition, SpectrumX benefits from an External Advisory Board (EAB) of highly experienced and influential people who are interested in serving in both advisory and ambassador roles to advance the Center's mission.

SpectrumX is positioned to serve as a trusted national resource on spectrum issues with the ability to quickly tap into a wide array of expertise across disparate use cases and user communities of radio spectrum. Through its coordination and engagement activities, SpectrumX is able to anticipate and track spectrum issues, pursue research on technology and policy breakthroughs, and share results and insights with policymakers. Although SpectrumX can summarize tradeoffs and provide recommendations for effective policy options, it does not, and in fact cannot, advocate for specific policy decisions.

More information about SpectrumX is available at the Center website https://spectrumx.org/.