Federal Register Notice: 89 FR 12871, https://www.federalregister.gov/documents/2024/02/20/2024-03400/request-for-information-on-the-national-spectrum-research-and-development-plan, February 20, 2023.

Request for Information on the National Spectrum Research and Development Plan

ARA PAWR Rural Wireless Living Lab and Iowa State University Center for Wireless, Communities and Innovation (WiCI)

Before the
NITRD National Coordination Office
National Science Foundation

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National Spectrum R&D Plan	)

Spectrum Research and Development for and by Rural America[1]

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February 21, 2024

About ARA PAWR Rural Wireless Living Lab

The National Science Foundation Platforms for Advanced Wireless Research (NSF PAWR) program has been supporting the development and operation of the ARA rural wireless living lab to enable research, education, and innovation in agriculture- and rural-focused wireless technologies and applications. ARA is committed to the development and deployment of 5G-and-beyond technologies for rural America, and it is led by the Iowa State University (ISU) Center for Wireless, Communities and Innovation (WiCI). The mission of WiCI is to advance the frontiers of wireless systems and applications while addressing the broadband gap between rural and urban regions at the same time. To this end, WiCI has been collaborating with 65+ public-private partners from industry, academia, government, and communities to drive ARA-enabled wireless and applications technology development, deployment, and adoption, and it serves as a neutral entity in wireless research, education, and innovation. WiCI is a member of the O-RAN Alliance and Next G Alliance, and it has led the establishment of the ARA O-RAN Open Testing and Integration Center (ARA OTIC) to focus on Open RAN for rural America.

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ARA deploys advanced wireless, edge, and cloud equipment across the Iowa State University (ISU) campus, City of Ames (where ISU resides), and surrounding research and producer farms as well as rural communities in central Iowa, spanning hundreds of square miles of rural area [1]. Wireless platforms featured by ARA have demonstrated promising performance so far, for instance, up to 3Gbps wireless access throughput, up to 10km (about 6.21 mi) effective cell radius, and close to 10Gbps throughput across a wireless backhaul link of over 10km.

Spectrum innovation is a core focus area of ARA and WiCI, and WiCI is a member of the National Spectrum Consortium. Building upon ARA, WiCI is leading the ARA National Radio Dynamic Zone (ARA-NRDZ) project to focus on spectrum sharing and innovation for rural America.

More information about ARA and WiCI can be found at arawireless.org and wici.iastate.edu respectively, and inquires can be emailed to e2@arawireless.org.

Input on National Spectrum Research and Development Plan: Perspectives from Rural America

World-leading spectrum R&D is an integral element of the National Spectrum Strategy, and it is critical to the science, engineering, and technology foundation needed to modernize the U.S. spectrum policy and to make the most efficient use of this national spectrum resource. As we develop the national spectrum R&D plan, it is important to pay attention to the unique needs of diverse communities and sectors. In particular, ***rural America presents unique needs for spectrum policy and technology innovation, and it provides unique use cases to advance the state of the art in spectrum policy and practice.*** For instance, community- and non-profit-led rural wireless is expected to serve as a key enabler for rural broadband, if affordable spectrum access can be enabled for rural communities/ non-profits [1]. In addition, agriculture farms and rural America in general can serve as important test grounds for wireless spectrum innovation to support safe-critical wireless applications such as the use of Unmanned Aircraft Systems (UAS) in precision agriculture and telehealth [1].

Therefore, it is critical that the National Spectrum R&D Plan keeps in mind the unique needs and opportunities provided by rural America, with a special focus on spectrum needs, use cases, policy and technology innovation, as well as rural ecosystem engagement and workforce development.

1. Strategy for Spectrum R&D. Given that dynamic spectrum sharing and using advanced wireless as a key rural broadband solution are new fields of innovation and practice, rural-focused technology and policy innovation is critical, which in turn calls for *the* engagement of rural telecom ecosystem and rural-focused workforce development and innovation capacity building. There are over 800 rural telcos across U.S., and over 130 rural telcos in Iowa alone.

Deeply embedded into the rural communities and industries (e.g., agriculture) around them, these rural telcos have first-hand insight into the unique spectrum needs and use cases in rural America. Therefore, it is important to engage these rural telcos and related stakeholder communities in the nation spectrum R&D process in terms of problem formulation, application pilot, technology adoption.

Given that existing rural telcos are not as familiar with emerging spectrum access paradigms and have limited resources for deep engagement with progresses in spectrum R&D, it is important for the National Spectrum R&D Plan to pay attention to the need for workforce development, align spectrum R&D with community and capacity building, and engage rural stakeholders including research and education organizations (e.g., WiCI) and their partners. Specific action areas include 1) developing innovation capacity within the rural regions so that rural-focused spectrum and wireless innovations progress in parallel with urban-focused innovations, and 2) engaging and empowering rural-regions in spectrum and wireless innovations such as those related to dynamic spectrum sharing, Open RAN, and rural-focused massive MIMO.

2. Priority Areas of Spectrum R&D. Given the relatively sparse population/user-equipment density and the relatively large geographic space in rural America, spectrum R&D in lower frequency bands and the frequency bands suitable for non-terrestrial wireless networks (e.g., LEO satellite communications) will be critical to wireless connectivity in rural America. In particular, the lower 3 GHz band (3.1 - 3.45 GHz) as well as the bands of 7.125 - 8.4 GHz, 12.2 - 13.25 GHz, and 18.1 - 18.6 GHz as mentioned in the National Spectrum Strategy will be invaluable for rural America, and how to effectively use them for rural-focused massive MIMO as well as integrated terrestrial and non-terrestrial wireless systems will be important R&D directions.

In addition, Unmanned Aircraft Systems (UAS) are expected to be applied in diverse rural applications such as precision agriculture, infrastructure monitoring, and telemedicine, and the open space in rural America (e.g., agriculture farms) facilitates the development, testing, and early adoption of UAS in real-world settings [1]. Therefore, the spectrum and applications R&D in UAS CNPC band of 5.03 – 5.091 GHz is of particular interest to rural America too, both as users and as participants in research and innovation.

Given the expected adoption of Open RAN in rural America, the National Spectrum R&D shall also align with our country's R&D plan in Open RAN. Open RAN represents one major development in 5G-and-beyond systems, and it is poised to promote wireless network security while driving innovation, lowering costs, increasing vendor diversity and supply chain robustness, and enabling more flexible network architectures. Open RAN is of particular interest to rural America, not only because it can potentially reduce cost, but also because it reduces barrier to innovation and can enable rural-focused wireless technology development and deployment, including those on spectrum innovation. Leading Open RAN architectures such as O-RAN also have built-in mechanisms for supporting spectrum innovation, and spectrum R&D shall leverage such synergies.

3. Grand Challenges for Spectrum R&D. Unlike large commercial carriers in urban regions, many rural communities and non-profits (e.g., farmer cooperatives) are expected to operate rural wireless systems. One reason why most rural community carriers have not adopted fixed

wireless (and wireless in general) for rural broadband is due to the lack of access to spectrum. To facilitate the adoption of rural wireless broadband solutions, we need to remove the barrier of spectrum access by rural communities and non-profits. To this end, we need to develop new spectrum policies and technologies that are conducive to community- and non-profit wireless network operations [1], as well as spectrum sharing between wireless carriers (e.g., between national and local community carriers) and between wireless communications and non-communications (e.g., radar) users.

Besides typical wireless use cases that need connectivity most of the time, rural America features unique use cases that only need spectrum access and connectivity on-demand and likely in confined geographic areas. For instance, spectrum use in crop farms tends to be seasonal, and it mainly needs spectrum access from spring to fall. In addition, even in the seasons when crop farms need spectrum access, it may only need access when certain ground and aerial vehicles need to operate in the field, thus posing on-demand, mobile spectrum access at confined geographic space where the agriculture vehicles operate. Therefore, these spectrum use cases in crop farms pose unique requirements for real-time, on-demand, and mobile spectrum slicing not feasible today, and they call for both technology and policy innovations in spectrum access. In addition, many rural wireless use cases such as UAS for precision agriculture are safety-critical, thus calling for innovations in dynamic spectrum sharing for safety-critical wireless systems.

4. Spectrum R&D Accelerators. Given that we are still at the early stage of research and practice in dynamic spectrum sharing and that a wide range of policy and technology innovations need to be nurtured and field-tested before their adoption in practice, the National Spectrum R&D shall leverage rural-focused, real-world testbeds such as the ARA PAWR wireless living lab. ARA PAWR provides an at-scale, real-world environment for testing both novel spectrum policies and technologies [2-4] with diverse stakeholder communities ranging from researchers to application developers, agriculture and rural users, as well as local and state government agencies, and it can serve as a platform for bringing together diverse stakeholder communities in collaborative R&D efforts towards shared spectrum data, models, and open-source software systems.

To support collaborative efforts across rural-focused spectrum and Open RAN R&D, the the ARA O-RAN Open Testing and Integration Center (ARA OTIC) can be leveraged to support integrative research, testing, and integration activities for innovative spectrum management strategies in the Open RAN framework.

References

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