Before the
National Telecommunications and Information Administration
Washington, D.C. 20230

In the Matter of	)	
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Developing a Sustainable Spectrum Strategy for America's Future	)	Docket No. 181130999-8999-01
	)	

COMMENTS OF FEDERATED WIRELESS, INC.

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TABLE OF CONTENTS

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	)	
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Federated Wireless, Inc. ("Federated Wireless"), an innovator in the field of new spectrum management tools, such as spectrum sensing, cloud computing, spectrum access systems, dynamic frequency coordinators, 5G and small cell technology, offers these comments in response to the Request for Comments ("RFC") issued by the National Telecommunications and Information Administration ("NTIA") on the means by which the U.S. government should develop and implement a National Spectrum Strategy that ensures sustainable access to the Nation's scarce spectrum resources for all users who need it, including Federal and non-Federal stakeholders.[1] Federated Wireless urges NTIA to utilize to the maximum extent possible automated, dynamic spectrum management and sensing technologies, such those embedded in the Spectrum Access System ("SAS") and Environmental Sensing Capability ("ESC"), that will administer the multi-tier sharing regime and protect critical Federal incumbent operations in the Citizens Broadband Radio Service ("CBRS") band (3550-3700 MHz) in the development of the

[1] *Developing a Sustainable National Spectrum Strategy for America's Future*, Docket No. 181130999-8999-01, Request for Comments, 83 Fed. Reg. 65640 (Dec. 21, 2018) ("RFC").

National Spectrum Strategy. Doing so would be consistent with the President's directive to consider the power of spectrum sharing regimes,[2] and would:

1) Facilitate the implementation of a spectrum management paradigm that is both flexible and sustainable in providing spectrum access where and when users need it while enforcing necessary protections for mission-critical operations;

2) Promote U.S. interests abroad by using sharing and sensing technology to allow the U.S. mission to operate unimpeded in foreign spectrum environments while also advancing the export of U.S.-developed spectrum management products and services; and

3) Leverage and extend existing standards and research, development, testing, and evaluation ("RDT&E") work to ensure the efficiency and effectiveness of spectrum utilization and spectrum management tools.

I. DYNAMIC SHARING TECHNOLOGIES ARE THE FUTURE OF SPECTRUM MANAGEMENT, WILL FACILITATE U.S. LEADERSHIP IN 5G, AND ARE CRUCIAL TO THE SUCCESSFUL IMPLEMENTATION OF A SUSTAINABLE NATIONAL SPECTRUM STRATEGY.

Traditionally, U.S. spectrum management policy has enabled commercial access to Federal spectrum by clearing Federal users from the band, reallocating the frequencies for non-Federal use, and eventually auctioning the bands to support commercial operations. However, this legacy "clear-and-auction" approach is not a sustainable basis for spectrum policy due to the high cost, lengthy time to implement, and interruption to the Federal mission that necessarily accompany an approach that requires the relocation of entire Federal services. For example, in 2012, NTIA found that relocating existing Federal users out of a 95 MHz swath of spectrum at 1755-1850 MHz would take 10 years, cost some $18 billion, and cause significant disruption to

[2] *See* Memorandum for the Heads of Executive Departments and Agencies, *Developing a Sustainable Spectrum Strategy for America's Future*, 83 Fed. Reg. 54513, at 54514-15 (Oct. 30, 2018) ("Presidential Memorandum"), *available at* https://www.gpo.gov/fdsys/pkg/FR-2018-10-30/pdf/ 2018-23839.pdf (last accessed Jan. 20, 2019).

incumbent users.[3] Other analyses have similarly noted the extreme delays accompanying "clear-and-auction" approaches to spectrum management, with some reallocations taking as long as 18 years to make spectrum available for commercial deployment.[4] Moreover, legacy clear-and-auction spectrum management approaches pit commercial and Federal users against each other in a zero-sum game, as commercial access to valuable spectrum resources only increases when Federal access decreases. The United States can ill afford to continue such an unsustainable policy, particularly as the global race to 5G accelerates and the need to provide expeditious access to low-, mid-, and high-band spectrum becomes increasingly crucial. Indeed, the United States' continued status as the global leader in the wireless industry depends on a robust pipeline of spectrum for all users – both Federal and non-Federal. It is thus critical that the National Spectrum Strategy not rely on outdated spectrum management models that require one user group to benefit at another group's expense, all while delaying the availability of spectrum for far longer than can be tolerated. Instead, the National Spectrum Strategy must promote the reforms and programs that increase spectrum utilization, and in particular the sharing of Federal spectrum bands with the commercial wireless sector.

In light of the significant shortcomings of legacy clear-and-auction spectrum management approaches, it is no surprise that the White House and the Federal Communications Commission ("FCC") have recognized the importance of spectrum sharing technologies to

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[3] *See* NTIA, An Assessment of the Viability of Accommodating Wireless Broadband in the 1755 – 1850 MHz Band (March 2012), *available at* https://www.ntia.doc.gov/files/ntia/publications/ntia_1755_1850_mhz_report_march2012.pdf (last accessed Jan. 22, 2019).

[4] *See, e.g.*, CTIA, Fostering 21st Century Wireless Connectivity: Key Spectrum & Infrastructure Issues for Policymakers, at 4 (Jan. 12, 2017); Thomas K. Sawanobori, CTIA, From Proposal to Deployment: The History of Spectrum Allocation Timelines, at 2 (2015) ("A review of previous allocation efforts shows that it takes, on average, 13 years to reallocate spectrum for wireless use.").

enabling robust and efficient spectrum access for all stakeholders while ensuring that Federal users' needs for certainty and flexibility of access are met on an ongoing basis. In 2010, for example, the FCC concluded that "[d]ynamic spectrum access radios, as well as the new spectrum management techniques that they can enable, hold great promise as we seek to use our nation's available spectrum resources more intensively and efficiently."[5] In 2012, the President's Council of Advisors on Science and Technology ("PCAST") released a report in which it concluded that, given the continuing spectrum needs of Federal users and the exploding demand for commercial wireless spectrum, the traditional practice of clearing portions of federally held spectrum for exclusive commercial use was not a sustainable model for future spectrum policy.[6] Instead, PCAST argued that the best way to increase the availability of spectrum for commercial broadband would be to leverage new technologies, such as dynamic frequency coordinators, spectrum databases, and improved interference mitigation tools, to allow spectrum to be shared among Federal and commercial users.[7] Indeed, the PCAST Report concluded that sharing should be the preferred model for spectrum management and that implementation of sharing regimes could increase the effective capacity of Federal spectrum by a factor of 1,000.[8]

In 2015, the FCC implemented the vision articulated in the PCAST Report and adopted a spectrum sharing regime and a tiered access system for CBRS that accommodates multiple different types of uses in the band. CBRS users provide the SAS with geolocation and technical parameters of the devices they deploy, which the SAS uses, in conjunction with sensing

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[5] *Promoting More Efficient Use of Spectrum Through Dynamic Spectrum Use Technologies*, ET Docket 10-237, Notice of Inquiry, FCC 10-198, at para. 16 (2010).

[6] PCAST, Report to the President: Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth, at vi (rel. July 20, 2012) ("PCAST Report"), *available at* https://bit.ly/2odsHi2 (last accessed Jan. 17, 2019).

[7] *Id.*

[8] *Id.*

information, to prescribe the maximum transmit power, bandwidth, and frequency assignment to each device in a way that prevents interference to incumbent and priority users and, at the same time, ensures efficient spectrum utilization by all potential users. The framework developed for CBRS is a testament to how sharing technologies can be used to support varied applications in a single band, balancing the needs of Federal users, incumbents, new licensed users, and unlicensed users.

The CBRS model preserves spectrum access for critical Federal operations, brings much-needed mid-band spectrum to the commercial market to meet current consumer demand and provide crucial capacity for supporting near-term 5G deployments, and will do so in a far more expeditious manner than legacy approaches, with widespread commercial operation in CBRS expected in the first half of 2019. This is just over four years after the FCC allocated the spectrum for shared use, as compared to the decade-long timelines that accompany traditional clear-and-auction reallocations. Given the degree to which much of the spectrum suitable for 5G operations is already occupied by incumbent users and the importance of making sufficient spectrum available for 5G services, dynamic sharing technologies are significantly better suited to enabling 5G operations in the near term than lengthy clear-and-auction approaches. In light of its clear advantages over traditional management paradigms and ability to both preserve spectrum access to meet Federal mission requirements and facilitate near-term access to the spectrum needed to maintain U.S. global leadership in the race to 5G, this SAS-enabled sharing model can and should be replicated in other frequency bands as part of an effort to develop and execute a sustainable National Spectrum Strategy.

II. DYNAMIC SPECTRUM SHARING TECHNOLOGIES WILL PLAY A PIVOTAL ROLE IN IMPROVING THE PREDICTABILITY OF SPECTRUM ACCESS FOR ALL USERS, EXPEDITING COORDINATION OF SHARED USE, AND IMPLEMENTING A SPECTRUM MANAGEMENT PARADIGM THAT MEETS THE NEEDS OF BOTH FEDERAL AND COMMERCIAL USERS.

In the RFC, NTIA asks a number of questions on how best to develop a National Spectrum Strategy that ensures sustainable spectrum access for Federal users and facilitates sharing between and among Federal and non-Federal users, including: (A) the means by which the predictability of spectrum access could be improved; (B) the extent to which automation could expedite coordination of shared access; and (C) how a spectrum management paradigm could be structured to satisfy both Federal users' ongoing need for spectrum access to perform their missions and non-Federal users' need to meet ever-growing consumer demand for wireless services.[9] Dynamic spectrum access technologies, such as those embedded in the CBRS SAS, hold particular promise for developing and implementing a National Spectrum Strategy that accomplishes these ends.

A. Dynamic Spectrum Sharing Technologies Improve the Predictability of Spectrum Access for All Users.

Utilizing a SAS or similar dynamic spectrum sharing technology would vastly improve certainty of spectrum access for all users.[10] The SAS is a dynamic database tool that, using its up-to-the-second inventory and modeling of spectrum use, provides real-time coordination and manages access on a protected basis for priority users while simultaneously supporting coexistence among secondary users. The CBRS SAS utilizes location and technical operating

[9] RFC at 65641.

[10] *Id.* ("In what ways could the predictability of spectrum access for all users be improved?").

parameters from user equipment, together with collected sensor information, to manage users and make spectrum available to whomever needs it. Moreover, the SAS is smart technology. It relies on learning or cognitive algorithms for spectrum management.[11] The more it is used, the more devices it is managing, the smarter it gets. It becomes increasingly more accurate and efficient at assigning spectrum and ensuring interference protections. Access to more data, and more experience with a radio environment, translates into more accurate modeling by the SAS. As the SAS learns, it more efficiently administers scarce spectrum resources, helping to ensure that spectrum is available when and where users need it and providing users in SAS-administered frequency bands the certainty of spectrum access they need to perform their missions.

Federated Wireless notes that, pursuant to the President's directive, Federal spectrum users have already embarked on the crucial first step of improving the predictability of spectrum access by compiling an inventory of their current frequency assignments and uses.[12] The National Spectrum Strategy should take advantage of these efforts by making available such an inventory[13] and applying to it the machine learning and other capabilities developed for the CBRS SAS, which will greatly improve the transparency and certainty of spectrum access for Federal users and commercial operators seeking access on a shared basis.

[11] Using performance and spectrum measurements from managed devices, the SAS applies sophisticated machine learning techniques to continually improve propagation models and interference estimates, leading to greater spectrum utilization while enhancing safeguards for protected systems.

[12] *See* Presidential Memorandum at 54514 (directing Federal agencies to "initiate a review of their current frequency assignments and quantification of their spectrum usage").

[13] *See id.* (permitting the public release of "a summary of information provided by agencies").

B. The Automation Functionalities of SAS Technology Facilitate Instantaneous Assessments of Spectrum Use and Coordination of Shared Spectrum Access.

Compiling an inventory of current Federal spectrum usage is an extremely valuable step and is long overdue in the United States' efforts to ensure its spectrum resources are used as effectively and efficiently as possible. It is imperative, however, that this inventory not simply be a static accounting of Federal use at a particular moment in time, which would severely limit its utility beyond the immediate term as uses and spectrum needs change over time. Instead, the inventory should evolve along with the use cases and user needs, thus ensuring that at any given time, the spectrum management paradigm accounts for current and future spectrum access requirements. To that end, exploiting the automation capabilities of dynamic coordination databases, such as the SAS, would significantly expedite the process of both assessing spectrum use and coordinating shared access, whether among Federal users or between Federal and commercial users.[14]

1. Automation Facilitates Rapid Assessments of Spectrum Usage.

With respect to conducting assessments of spectrum use, by combining the SAS's automation function with a requirement that: (1) all devices regularly request or maintain spectrum assignments, *e.g.*, through a periodic heartbeat message conveyed to the SAS; and (2) the SAS records all such requests, assessments of past, current, and predicted future use could be accomplished through a simple query to the SAS and completed in mere seconds. Moreover, such queries could be aggregated readily across multiple SAS instances through the use of

[14] *See* RFC at 65641 ("To what extent would the introduction of automation facilitate assessments of spectrum use and expedite the coordination of shared access, especially among Federal and non-Federal spectrum stakeholders?").

standardized interfaces or coordination of assessments between the multiple SASs.[15] This approach would enable the SAS or similar technology to conduct spectrum usage assessments in seconds, rather than over the course of many months as is required to complete the current manual process for evaluating Federal spectrum usage. This instantaneous assessment of spectrum usage would also serve to expedite evaluations of the viability of shared access to a particular frequency band at a given moment in time, as an efficient sharing regime requires up-to-date information on past, current, and future spectrum needs. Utilizing the SAS's ability to assess the amount of unused spectrum and model the impact of adding operations to that spectrum would enable assessments of sharing viability to be conducted in mere seconds.[16]

2. Automation Expedites Coordination Between and Among Disparate Users, Including Federal and Commercial Users.

In addition to facilitating rapid assessments of spectrum use, which themselves aid in expediting the coordination of shared access, the use of automation would also facilitate sharing between disparate users, such as Federal and commercial users. This is because the use of automation tools would necessarily lead to schema standardization between these user groups, which have typically implemented varied spectrum management regimes tailored to the needs of their particular use cases. This standardization enables automation of coordination between and among different uses and generates significant benefits to all users in the shared frequency bands. These benefits are powerfully demonstrated in the CBRS band, where the SAS's overarching purpose is to automate the sharing of spectrum between Federal and commercial users,

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[15] *See, e.g.*, Wireless Innovation Forum, "SAS-SAS Protocol Technical Specification," Document WINNF-TS-0096 (Apr. 24, 2018) (setting forth protocols for information exchanges between multiple SASs administering CBRS operations).

[16] *See, e.g.*, Wireless Innovation Forum, "SAS to CBSD Technical Specification," Document WINNF-TS-0016 (Oct. 31, 2018) (setting forth protocols for SAS-administered devices to request and receive grants of spectrum access from the SAS).

protecting offshore naval radars and inland radar operations while facilitating commercial access to much-needed mid-band spectrum. The use of the SAS enables automated coordination of commercial radio deployments in the vicinity of military and other critical Federal installations, replacing the legacy, time-consuming approaches, such as using a manual or semi-manual notification portal. The automation embedded in the SAS facilitates commercial access at the earliest opportunity while ensuring that Federal operations are unimpeded. It also eliminates the problem of static database entries that reserve spectrum access for a particular user and preclude others from using the reserved frequencies regardless of whether the spectrum is actually in use. Use of the SAS automation instead enables opportunistic access and maximizes the utilization of scarce spectrum resources when they are not being used in a given location at a given time. Automated coordination of shared use is further enhanced by transmitting real-time sensing data from the devices operating in the shared spectrum to a centralized coordination database, which enables the database to maximize the utilization of spectrum in the frequencies it is coordinating.

The SAS's automated coordination capabilities also generate significant regulatory efficiencies, particularly in a Federal-non-Federal sharing regime. By automating coordination between Federal and commercial users, a SAS-enabled sharing framework would reduce the administrative burdens on the FCC and NTIA by streamlining and centralizing the process of conducting interference analyses, assessing Federal user protection requirements, and determining the operational parameters needed to enable shared use. This is of particular benefit when compared to the current Federal-non-Federal coordination process, which is highly manual for both the FCC and NTIA and is exceedingly time-consuming in many instances.

The use of real-time sensing data also allows the database to facilitate real-time adaptation to interference events by reassigning affected devices to unaffected frequencies and

makes it possible for the database to provide automatic interference notification into wireless network operations centers to address interference events. This, in turn, shifts much of the cost of regulatory compliance, or adapting to changes in regulation, from the hardware used in a band to the software in the SAS that manages the band—resulting in significant cost savings and flexibility in operations. With a certified SAS in place, equipment manufacturers develop devices that comply with the relevant regulatory requirements and obtain the necessary authorizations demonstrating the equipment's compliance therewith, and thereafter users simply rely on the SAS to allocate spectrum in a manner that ensures that operations comply with the rules of the band and prevent interference. Moreover, because the SAS dictates the operations of devices in the band, the SAS can simplify efforts to monitor and ensure compliance with the rules and enforce any corrective action. In doing so, the SAS reduces the administrative burdens on both users and regulators, who are able to rely on its automated management, monitoring, and enforcement capabilities rather than time-consuming manual efforts to assign spectrum rights and investigate and address interference events or other potential instances of noncompliance with operating requirements. This also makes regulatory enforcement a more affirmative system by providing a single point of contact for numerous different network operators, providing independent logs of spectrum activity available for auditing and analysis, and providing knowledge of registered device locations.[17]

[17] *See, e.g.*, PCAST Report at 102.

C. SAS Technology Facilitates the Implementation of a Spectrum Management Paradigm that Satisfies the Needs of Commercial Interests and Preserves the Spectrum Access Necessary to Satisfy the Mission Requirements and Operations of Federal Entities.

The use of a centralized, automated, dynamic coordination tool, such as the CBRS SAS, is the best means of structuring a spectrum management regime that both satisfies the needs of commercial interests and provides Federal users the access, protection, and flexibility needed to accomplish their missions now and in the future.[18] Federal entity mission requirements and operations, as well as the needs of commercial operators, evolve over time, and it is imperative that the National Spectrum Strategy adopts a spectrum management paradigm that is sufficiently flexible to evolve along with those needs. A management system predicated on software-defined spectrum policies that are enforced by a cloud-based, automated coordination tool, such as the SAS, would best provide this flexibility and allow the spectrum management regime to adapt to users' needs as their missions and operational environments change.

The use of dynamic sharing technologies would relieve NTIA and Federal users of the need to predict future uses for the bands or adopt rules today with particular technologies or future uses in mind. A flexible sharing framework, based upon a set of common technical standards and utilizing SAS technology to manage a wide variety of uses and technologies, provides a flexible framework that allows use cases to develop over time. When SAS technology is deployed in a band, the SAS evolves as the technology and use cases evolve – optimizing both. In particular, the rules implemented by the SAS can change to match evolving technologies and use cases, adjusting the administration of the band in response to business, technological,

[18] RFC at 65641 ("How could a spectrum management paradigm be structured such that it satisfies the needs of commercial interests while preserving the spectrum access necessary to satisfy the mission requirements and operations of Federal entities?").

and regulatory developments and optimizing the efficiency of spectrum utilization and the oversight of operations in the band. Furthermore, as the tools employed by a SAS improve, such as with more accurate propagation models or radio environment sensors, all of the SAS-managed devices benefit from the resulting gains in spectrum efficiency and access. The adaptability of the SAS is such that, with a relatively simple set of baseline requirements and standards for operations in a SAS-administered band, the SAS can quickly—and with minimal cost and impact to users—modify those operations to account for changes in the technological, business, or regulatory landscape. Such an approach would be particularly valuable for those bands in which Federal use is limited today but may become critical to the U.S. mission in the future.

Use of a SAS can also facilitate transitional sharing, as the uses of particular spectrum bands evolve, sharing in multi-user environments, as well as implementation of license overlay strategies. Just as is the case in the CBRS band, the SAS can administer multi-tier sharing regimes that grant certain users and uses priority over others, whether between Federal and commercial users or among Federal users themselves. This capability would enable, for example, the establishment of a tiered architecture between and among Federal users with a need to access the same spectrum where certain users' missions are critical in nature. Moreover, the scalability and resiliency of the cloud allows the SAS to easily handle the volume and complexity of computations required to implement a dynamic spectrum sharing regime. By leveraging the computational capacity of the cloud, a SAS allows end user equipment in any band to negotiate directly with the SAS in a frictionless and transparent manner for frequency allocation, power limits, and other operational parameters, which makes the equipment effectively auto-configurable and operation of the equipment transparent to the end user. Implementing an adaptable National Spectrum Strategy that incorporates the use of sensing and sharing

technologies would future-proof the management of the bands, obviating the need for NTIA and Federal users to guess at future use cases. It will also minimize the time, cost, and impact of implementing modified regulations as technology and user needs change.

In addition, the SAS can facilitate sharing between Federal and commercial users on a co-primary basis, where appropriate. Such co-primary status would allow both Federal and commercial operators to become users of a single commercial SAS, coordinating operations in real time and on a co-equal basis, and enabling Federal users to quickly leverage next-generation commercial technology without the delays associated with the lengthy Federal procurement process. Furthermore, if necessary, the SAS could implement temporary priority access for Federal users without requiring a set-aside that would artificially constrain the spectrum available to non-Federal users even when there are no priority Federal operations ongoing in a particular area. Similar to a Federal user detection event in the CBRS band, a SAS administering a co-primary sharing regime could dynamically make spectrum available on a priority basis when needed to support critical Federal operations, even when the entire band is in use, by reconfiguring the channels in use by other operators or by clearing the necessary channel size. The SAS is also able to preserve the operational security of Federal operations when dynamically allocating spectrum, such as by sharing a defined contour of use provided by a Federal user or Federal intermediary without exposing Federal system specifics. In the event that critical Federal operations require certainty that no harmful interference will occur from other users in the shared band, the SAS is capable of implementing a protection zone around the area of the critical transmissions. The SAS would then ensure that co-channel and adjacent-channel transmissions are prohibited or limited in these areas to ensure interference-free operation for critical Federal purposes.

III. THE NATIONAL SPECTRUM STRATEGY SHOULD LEVERAGE DYNAMIC SHARING TECHNOLOGIES TO PROMOTE THE U.S. MISSION AND INDUSTRY ABROAD.

In the RFC, NTIA seeks comment on how the National Spectrum Strategy can promote the global competitiveness of U.S. industries.[19] As a high-level conceptual matter, aligning U.S. spectrum management policies and standards to global policies and standards would appear to aid in promoting U.S. industry abroad, as such alignment would ensure that U.S. products and services are relevant to overseas markets. In reality, however, the demands of disparate users, in different regions and at different times, are not static and vary widely. As a result, the adoption of a spectrum management paradigm that relies on fixed national policies and standards would necessarily create barriers to U.S. global competitiveness in those regions where demand is not aligned with the fixed U.S. policy. The National Spectrum Strategy therefore should not only adopt a flexible spectrum management policy for U.S. operations, but also emphasize the importance of promoting the use of such flexible policies in other regions of the world, including through international regulatory and standard-setting bodies.

Promoting the use of flexible spectrum management policies, enabled and enforced through the use of dynamic sharing technologies, such as a SAS, would advance the export of business models, products, and services developed by U.S. industry, which is leading the world in building dynamic spectrum sharing tools. This is particularly crucial as the United States seeks

[19] *Id.* ("What are the risks, if any, to the global competitiveness of U.S. industries associated with spectrum management and policy actions?").

to maintain its leadership in the global race to 5G, for which shared access is a foundational principle.[20]

Moreover, promoting the export of U.S. spectrum sharing business models would aid in ensuring that Federal users are able to continue to access spectrum bands critical to their missions, even as foreign administrations reallocate bands for particular uses. For example, the United Kingdom, Ireland, Spain, Italy, Australia, and South Korea have all auctioned spectrum in the 3.4-3.8 GHz range for 5G use in recent months, and commercial 5G deployments in the 3.5 GHz band have been announced in the United Arab Emirates, Saudi Arabia, and Qatar.[21] These same bands are used by the U.S. military for critical radar operations. Without a mechanism to provide protected, coordinated spectrum access, such operations may experience and/or cause harmful interference when conducted abroad. The export of U.S. spectrum management tools and global harmonization of flexible, dynamic management policies is thus crucial to ensuring that Federal users are able to access the spectrum needed to conduct their missions unimpeded in the face of competing local uses.

In addition, by allowing for the establishment of secure, private networks and monitoring and managing spectrum access in shared frequency bands, the SAS enables secure, flexible management of shared operations. This function allows the SAS to facilitate secure spectrum

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[20] *See, e.g.*, Qualcomm, 5G Spectrum Sharing, available at https://www.qualcomm.com/invention/technologies/5g-nr/spectrum-sharing ("Access to shared and unlicensed spectrum will extend 5G in multiple dimensions - such as more capacity, higher spectrum utilization, new deployment scenarios. It will benefit mobile operators with licensed spectrum but also opens the doors to those without licensed spectrum – such as cable operators, enterprise or IoT verticals – to take advantage of the 5G New Radio (5G NR) family of technologies. 5G NR is designed to natively support all spectrum types and, through forward compatibility, has the flexibility to take advantage of new spectrum sharing paradigms. This creates opportunities for new innovation to take spectrum sharing to the next level in 5G.").

[21] *See, e.g.*, Sacha Kavanagh, "5G UK auction" (June 11, 2018), *available at* https://5g.co.uk/guides/5g-uk-auction/; Majithia, Kavit, Mobile World Live, "Middle East Giants Jostle for 5G-First Status" (May 15, 2018), *available at* https://www.mobileworldlive.com/featured-content/home-banner/middle-east-giants-jostle-for-5g-first-status/.

sharing not only between Federal and commercial users, but also between U.S. entities and international partners, further preserving Federal user access to spectrum to support mission requirements overseas and promoting the export of U.S. products and services.

IV. THE NATIONAL SPECTRUM STRATEGY SHOULD LEVERAGE AND EXTEND EXISTING RESEARCH AND DEVELOPMENT AND STANDARDS WORK TO MAXIMIZE THE EFFECTIVENESS OF THE SPECTRUM MANAGEMENT PARADIGM.

In the RFC, NTIA seeks comment on the degree to which standards, incentives, enforcement mechanisms, and investment in RDT&E could enhance more efficient and effective spectrum use.[22]

A. The National Spectrum Strategy Should Promote the Use of Open, Extensible Standards and Robust, Automated Enforcement Mechanisms to Ensure Efficient Spectrum Use.

As an initial matter, Federated Wireless notes that the effectiveness of both standards and incentives is dependent in large measure on a cost-benefit analysis. To the extent the cost of implementing a standard outweighs its benefits, or the cost of engaging in an incented behavior outweighs its expected benefits, neither the standard nor the incentive is likely to be effective. In addition, the effectiveness of applying a standard is limited by the degree to which the information content of the standard can be made public. The more restricted the information is, the narrower the applicability of the standard, and as a result its potential benefit is necessarily limited.

[22] RFC at 65641 ("What is the practical extent of applying standards, incentives, and enforcement mechanisms to promote efficient and effective spectrum use? How might investment in RDT&E improve spectrum-utilization methods, and spectrum-sharing tools and techniques?").

In light of the above, it is important that any standards be as open and transparent as possible. In the CBRS band, for example, the Wireless Innovation Forum, a cross-industry stakeholder group comprised of representatives of all interested parties, including commercial and Federal users, created a set of open standards for SAS protection of incumbent Federal and commercial operations and coordination of newly authorized uses.[23] These open standards ensure that the needs of all interested parties are addressed, maximizing their effectiveness. Moreover, the open CBRS standards and ecosystem are extensible, such that they would enable the implementation of tiered shared architectures between and among disparate users in other frequency bands. In addition, as described above, the SAS's automation functions allow it to provide real-time enforcement of the standards and regulations governing CBRS operations. The automated, centralized enforcement function of the SAS is far more efficient and robust than the standard, time-consuming, manual process of seeking to identify and address sources of interference in other frequency bands. In fact, the only currently contemplated enforcement mechanism that may provide similarly robust interference monitoring and mitigation is the National Oceanographic and Atmospheric Administration's planned Radio Frequency and Interference Monitoring System, which will "monitor, identify and mitigate harmful radio frequency interference from wireless carriers' LTE services" to Federal fixed-satellite service earth stations.[24] Federated Wireless urges NTIA to ensure that the National Spectrum Strategy promotes the use of open standards and automated enforcement mechanisms to facilitate the efficient use of spectrum.

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[23] *See* Wireless Innovation Forum, "CBRS WinnForum Standards, Release 1 of the Baseline Standard Specifications," (2018) *available at* https://cbrs.wirelessinnovation.org/release-1-standards-specifications (last accessed Jan. 21, 2019).

[24] NOAA, Radio Frequency and Interference Monitoring System, *available at* https://www.nesdis.noaa.gov/OSGS/assets/rfimsinfosheet.pdf (last accessed Jan. 21, 2019).

B. Investments in Next-Generation Spectrum Management Tools Will Vastly Improve Spectrum-Utilization Methods.

As noted above, the SAS standards and CBRS ecosystem are readily extensible to meet the needs and operational profiles of users in other bands, thus facilitating shared access throughout the radiofrequency spectrum. This ecosystem is the product of cross-stakeholder RDT&E to ensure the CBRS spectrum is used as densely and efficiently as possible. The National Spectrum Strategy should therefore build on the work of the FCC, Federal users, industry, and the Wireless Innovation Forum and require expeditious investment in the RDT&E necessary to extend the SAS for use in other bands, including by researching the potential sources of interference in those bands and protection criteria needed to facilitate shared access. More broadly, the National Spectrum Strategy should provide for the RDT&E necessary to evaluate how best to evolve the management of Federal spectrum use to cloud-based management tools to leverage the computing power of the cloud and enable real-time management of spectrum to maximize the efficiency and flexibility of Federal use. In addition, RDT&E could further enhance spectrum-sharing tools by improving the obfuscation and other cyber and operational security tools needed to allow non-Federal SAS's to receive or sense data from military and other Federal systems and manage the local RF environment to provide those systems the protections they need. Finally, RDT&E aimed at creating a sharing mechanism to coordinate uses on and in the vicinity of the major military test and training ranges and replace the current, semi-manual static approach would further enhance spectrum efficiencies and enable commercial access while protecting vital Federal operations.

V. CONCLUSION.

Federated Wireless appreciates the opportunity to submit these comments on the development and implementation of a National Spectrum Strategy and stands ready to assist

NTIA and Federal users in ensuring that it provides sustainable, flexible spectrum access for all those who need it, including Federal and non-Federal users. To do so, for the foregoing reasons, Federated Wireless submits that the National Spectrum Strategy should exploit the availability of dynamic, automated coordination tools such as the SAS, which will: (1) facilitate the implementation of a spectrum management paradigm that is both sustainable and flexible in providing spectrum access where and when users need it and enforcing necessary protections for mission-critical operations; (2) promote U.S. interests abroad by using sharing and sensing technology to allow the U.S. mission to operate unimpeded in foreign spectrum environments and advancing the export of U.S.-developed spectrum management products and services; and (3) leverage and extend existing standards and RDT&E work to ensure the efficiency and effectiveness of spectrum utilization and spectrum management tools.

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