Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	
Unlicensed White Space Device Operations in the Television Bands	)	ET Docket No. 20-36
	)	

To: The Commission

REPLY COMMENTS OF THE PUBLIC INTEREST SPECTRUM COALITION

NEW AMERICA'S OPEN TECHNOLOGY INSTITUTE
PUBLIC KNOWLEDGE
CONSUMER REPORTS
ACCESS HUMBOLDT
NEXT CENTURY CITIES
COMMON CAUSE
TRIBAL DIGITAL VILLAGE NETWORK
SCHOOLS, HEALTH & LIBRARIES BROADBAND (SHLB) COALITION
NATIONAL DIGITAL INCLUSION ALLIANCE
BENTON INSTITUTE FOR BROADBAND AND SOCIETY
X-LAB

June 2, 2020

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New America's Open Technology Institute, Public Knowledge, Consumer Reports, Access Humboldt, Next Century Cities, Common Cause, Tribal Digital Village Network, the Schools, Health & Libraries Broadband (SHLB) Coalition, National Digital Inclusion Alliance, Benton Institute for Broadband and Society, and X-Lab ("Public Interest Spectrum Coalition" or "PISC") hereby submit these reply comments in response to the Notice of Proposed Rulemaking ("*NPRM*") adopted in the above-captioned proceeding.[1]

I. Introduction and Summary

First, the record shows overwhelming agreement among commenters that more robust rules for TV White Space (TVWS) use would improve connectivity in rural, tribal, and other unserved and underserved areas. Commenters making these arguments in the record include consumer and rural digital equity advocates, technology companies, rural wireless internet service providers ("WISPs"), and free market groups—these groups all detail how improving the rules would expand broadband availability and help bridge the digital divide. Specifically,

[1] *Unlicensed White Space Device Operations in the Television Bands*, Notice of Proposed Rulemaking, ET Docket No. 20-36, FCC 20-17 (rel. Mar. 2, 2020) ("*NPRM*"). All citations to comments below were filed in this docket on May 4, 2020, unless otherwise noted.

commenters underscore the importance of TVWS to affordably extend broadband in unserved areas around the country, how White Space Databases ("WSDBs") can protect incumbents from harmful interference, and how the most prominent obstacle to much greater use of TVWS to address rural digital divide is the presence of unnecessarily restrictive and outdated rules.

Second, the record shows strong support for terrain-based or other real-world propagation models for WSDs, particularly the Longley-Rice Irregular Terrain Model. The Commission should heed these calls and update the TVWS rules by authorizing or requiring WSDBs to utilize one or more terrain-based propagation models to calculate allowable channels, power and HAAT at a particular location. This would provide an important change to the current rules that require WSDBs to over-protect TV viewers within standardized and static contours calculated through the use of an unrealistic and overly restrictive free space propagation model that fails to take basic geographic features (e.g., mountains, dense forests) into account.

Third, the record shows strong support for the Commission's finding that allowing fixed WSD operations to operate at a higher EIRP limit in less congested areas—which includes predominantly rural, tribal, and other underserved and unserved areas—will allow TVWS networks improve broadband coverage at a lower cost. In particular, commenters support the Commission's proposal to increase the maximum height above average terrain ("HAAT") to 500 meters for fixed WSDs operating with at least 6 megahertz separation from TV stations, as it would empower internet service providers (ISPs) to serve communities and locations where deployment would otherwise be too expensive. For rural broadband providers in particular, the flexibility to deploy at a higher power as well as at higher elevation is an important factor in the availability and affordability of rural broadband.

Fourth, most commenters agree that the Commission's proposal to authorize higher-power TV White Space devices ("WSDs") on moveable platforms that can operate within a geofence will improve broadband availability in key contexts such as for education and agriculture. Since WSDBs are fully capable of verifying the availability of vacant channels within a geofence, devices should be able to operate at the highest available fixed power level.

Fifth, the record shows strong support for the Commission to authorize higher power operations on channels immediately adjacent to television operations, including by fixed WSDs operating with a 3 megahertz separation from an occupied TV channel. The Commission's current rules were drafted a decade ago, when both geolocation databases and dynamic sharing were unproven and meant the Commission's restrictive rules were necessary. However, the engineering evidence in the record now clearly shows there is no reason to unnecessarily limit the utility of the band, particularly when making these changes could allow for more efficient use of the spectrum and help bridge the digital divide in rural, tribal, and other hard-to-serve areas.

Sixth, the Commission should authorize directional antennas and sectorization to make sure providers are able to best use this spectrum for fixed point-to-multipoint service. This use case can be readily calculated and verified by the WSDBs (likely as a value-added service). It will empower providers to deliver more affordable and higher-speed broadband in targeted locations without increasing the risk of harmful interference to incumbents.

Seventh, the record reflects widespread support for the Commission's proposed change of creating a new designation of narrowband WSDs with technical rules to support applications relevant to the emerging Internet of Things (IoT) such as remote monitoring, SCADA and other innovations.

II. The Record Shows Strong Agreement that More Robust TVWS Rules Can Extend Connectivity in Rural, Tribal and Other Unserved Areas

The record reflects widespread consensus that enacting more robust rules for TVWS use would improve connectivity in rural, tribal, and other unserved and underserved areas. Consumer and rural digital equity advocates, technology companies, rural wireless internet service providers ("WISPs"), and free-market-oriented groups all agree that updating and strengthening the rules governing TVWS spectrum will expand broadband availability and help bridge the digital divide.[2] Specifically, commenters highlight the power of TVWS to affordably extend broadband in unserved areas around the country, the now well-proven ability of White Space Databases ("WSDBs") to protect incumbents, and that unnecessarily restrictive and outdated technical rules are limiting much greater use of TVWS to address the rural digital divide.

The ability of TVWS to extend broadband connectivity to communities and locations that currently lack any option is a central reason why the rules governing the use of TVWS must be

[2] Comments of the Public Interest Spectrum Coalition at 5-11; Comments of the Broadband Connects America Coalition at 5-9 ("Comments of BCA"); Ex Parte Letter of Citizens Against Government Waste et al., ET Docket No. 20-36 (April 27, 2020) ("Letter of Taxpayers Coalition"); Comments of the Wireless Internet Service Providers at 1-3 ("Comments of WISPA"); Comments of the American Farm Bureau Federation, ET Docket No. 20-36 (April 29, 2020) at 1; Comments of Declaration Networks Group, Inc., ET Docket No. 20-36 ("Comments of DNG"); Comments of Microsoft at 1-3; Comments of ACT | the App Association at 5-7 ("Comments of the App Association"); Ex Parte Letter of Midwest Food Products Association, ET Docket No. 20-36 (May 4, 2020); Comments of the Consumer Technology Association at 3-4 ("Comments of CTA"); Comments of Connect Americans Now et al., ET Docket No. 20-36 ("Comments of CAN"); Comments of the Dynamic Spectrum Alliance at 7 ("Comments of DSA"); Comments of the Pennsylvania Farm Bureau at 1; Comments of Adaptrum at 1; Comments of the National Rural Education Association at 1 (Comments of NREA); Comments of RED Technologies, ET Docket No. 20-36 (May 1, 2020) at 5 ("Comments of RED Technologies"). *See also* Comments of the National Association of Broadcasters at 1 ("NAB generally supports the majority of the proposals set forth in the NPRM. NAB and Microsoft worked together over many months to negotiate a set of adjustments to the Commission's existing rules that would enable meaningful improvements for TVWS devices while protecting television reception from harmful interference.") ("Comments of NAB").

improved and reformed. PISC agrees with ACT | the App Association that "the ever-growing need for broadband access in rural areas is a preeminent concern for the Commission. . . . TVWS can provide significant 'last mile' coverage over much larger expanses than traditional Wi-Fi routers."[3] PISC urges the Commission to consider the examples provided by ACT regarding how "fully enabled TVWS technology providing 'last mile' connectivity would be particularly helpful for [their] member companies that are located outside traditional tech hubs."[4]

TVWS proven to be uniquely useful and cost-effective in rural and remote areas in particular. PISC agrees with the coalition of 35 organizations filing together with Connect Americans Now: "Updated TVWS rules will enhance the pace, scale and cost-effectiveness of hybrid network broadband deployments in rural areas in several important ways. Specifically, new rules will permit higher transmit power and higher antennas for fixed white space devices in rural areas, permit higher power mobile operations within geofenced areas, and allow for the development of new Internet of Things-based services."[5] PISC similarly agrees with 11 free market oriented organizations—including R St. Institute and the Taxpayers Protection Alliance—that the TVWS rule changes can provide necessary relief to many areas of the country that are currently lacking broadband options during the COVID-19 pandemic: "Adoption of the final rules will make TVWS part of the solution and improve the country's resiliency in times of crisis by bringing more Americans online. The proposed rule will increase and improve broadband access, particularly in rural areas, by updating how TVWS can be utilized."[6]

The Commission should also consider the fact that WSDBs have proven they are able to protect television viewers and other incumbents from harmful interference. PISC agrees with

[3] Comments of the App Association at 5.
[4] *Id.* at 5-7.
[5] Comments of CAN.
[6] Letter of Taxpayers Coalition.

Microsoft that the Commission's proposed rule changes would solidify the ability of WSDBs to continue to protect wireless microphone users exactly as well as they do currently.[7] PISC further agrees with Microsoft that "[b]ecause the proposed rules will effectively protect against harmful interference, and the economic benefits of connecting additional unserved households to broadband access are great, Microsoft strongly encourages the Commission to adopt the proposed increased power limit."[8]

The benefits of TVWS technology for bridging the digital divide and promoting wireless innovation are broadly agreed upon among commenters. Nearly all parties agreed with PISC that overly restrictive rules limit more productive uses of the band and have deterred internet service providers ("ISPs") from deploying broadband to many of the most challenging and unserved areas of the country. PISC agrees with Microsoft that "practical changes" to the TVWS rules would empower WISPs to expand connectivity to more communities and improve service in others. PISC urges the Commission to consider these examples, which Microsoft details:

> For example, **Evolve Cellular and Skylark Wireless** agree that updating the TVWS rules to better reflect deployment realities will 'encourage innovation in new radio technologies and vastly improve rural broadband performance while maintaining stringent requirements of non-interference.'
>
> **Declaration Networks Group** explains that the U.S. 'can make great strides in closing the digital gap if the FCC moves forward with a Rulemaking that helps spur increased private-sector deployment of broadband services using White Spaces technology.'
>
> And as **Rise Broadband** has commented, 'rule changes to increase the utility and reach of TV white space spectrum,' will boost the equipment ecosystem, 'making equipment more competitive and affordable, and making the business case a reality for service providers.'[9]

[7] Comments of Microsoft at 14.
[8] *Ibid.*
[9] *Id.* at 6 (emphasis added).

III. There is Strong Support for Authorizing or Requiring White Space Databases to Employ Terrain-Based and Other Real-World Propagation Models

PISC, in its initial comments, urged the Commission to update the TVWS rules by authorizing or requiring WSDBs to utilize one or more terrain-based propagation models to calculate allowable channels, power and HAAT at a particular location. Under current rules, WSDBs over-protect TV viewers within standardized and static contours calculated using an unrealistic and overly restrictive free space propagation model that takes no specific account of basic geographic features (e.g., mountains, dense forests), nor of trees, buildings or other "clutter" that more sophisticated GIS models use.[10]

Most parties addressing this issue agree the Commission should authorize use of the Longley-Rice Irregular Terrain Model (ITM) methodology.[11] Updating the rules in this respect follows logically from the Commission's decisions to authorize terrain- and clutter-based propagation modeling for geolocation database coordination in other bands to protect U.S. Navy radar operations in the 3.5 GHz band (the CBRS Spectrum Access Systems)[12] and to protect

[10] *See Automated Frequency Coordination: An Established Tool for Modern Spectrum Management*, Dynamic Spectrum Alliance, at 23 (March 2019), available at http://dynamicspectrumalliance.org/wp-content/uploads/2019/03/DSA_DB-Report_Final_03122019.pdf. The report notes that the TVWS rules adopted in the United Kingdom use more granular data to ensure the use of TVWS is limited only as needed to protect nearby TV viewing. "Ofcom's TVWS rules, promulgated later and with the benefit of more granular pixel-based simulations of TV signal strength, permits more accurate database calculations and hence both more bandwidth for WSDs and more protection for viewers."

[11] Comments of DSA at 21-22; Comments of WISPA at 4-7 ("now widely accepted, this [Longley-Rice] ITM model is a far more accurate model of interference potential that the Commission has adopted" for CBRS and 6 GHz geolocation database calculations); Comments of the Broadband Connects America Coalition at 9-10; Comments of Microsoft at 28-30.

[12] *See* WinnForum Requirement R2-SGN-03, et al., in WINNF-TS-0112v1.8.0.

incumbent fixed links in the 6 GHz band (the Automated Frequency Coordination systems).[13] AFCs are also authorized to use a supplemental model to take account of clutter losses.[14]

PISC agrees with the Dynamic Spectrum Alliance ("DSA") that methods using point-to-point modeling are preferable, as well as those that "account for the variability in terrain in calculating propagation and spectrum availability," with the Longley-Rice ITM propagation model being the ideal.[15] PISC further agrees with the DSA that the ITU-R P.1812 propagation model would also be acceptable and that other models could be adequate as long as they "use point-to-point calculations and account for terrain variability."[16]

Contrary to most stakeholders, the National Association of Broadcasters ("NAB") urges the Commission not to authorize "more sophisticated computer models, such as the Longley-Rice," in part because the WSDB does not know the location of every television receiver (the old "hidden node" problem).[17] This objection is irrelevant. Under current rules the WSDB does not need to know the location of individual TV sets; it protects all viewers inside the station's licensing contour. Real-world propagation modeling would take account of the terrain outside the TV station's protected contour. A random TV receiver outside a station's service area has never been protected by the WSDB under the rules regardless of propagation modeling.

Moreover, NAB's skepticism of the technological accuracy of propagation modeling runs contrary to the Commission's previous actions which supported more modern, terrain-based

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[13] Report and Order and Further Notice of Proposed Rulemaking, *Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295 and GN Docket No. 17-183 (rel. Apr. 24, 2020).
[14] *Ibid.*
[15] Comments of DSA at 21.
[16] *Id.* at 21-22 ("With the growth of the cloud computing model, the WSDB calculation of available channels in smaller cell sizes is not capacity constrained. It is now both desirable and feasible for the Commission to permit use of a terrain-based model to calculate the list of available channels for fixed WSD operations at a location and the maximum EIRP for each channel.").
[17] Comments of NAB at 7-8.

propagation models in cases where it *benefitted* broadcasters. As Microsoft highlights: "The use of a terrain-based propagation model combined with . . . a more accurate D/U ratio for TV receivers will produce more accurate interference protection calculations and will allow service providers to expand service to additional areas where doing so would otherwise be precluded by outdated models and assumptions."[18]

Contrary to NAB's claims, commenters note that the complex calculations required for ITM terrain-based modeling is no longer a limiting factor in the TVWS context. As WISPA explains: "ITM may have been computationally intensive at the time it was introduced, but today, more than 50 years later, it is a trivial calculation. The SAS used for CBRS must compute ITM losses from every CBSD within hundreds of kilometers (over 400 km in some cases) of some coastal dynamic protection areas ('DPAs') to a grid of points 1 km spaced across the DPA, which covers thousands of square kilometers. Common propagation prediction calculators perform ITM calculations on desktop computers at the rate of thousands per second."[19]

PISC likewise agrees with the Dynamic Spectrum Alliance that "[w]ith the growth of the cloud computing model, the WSDB calculation of available channels in smaller cell sizes is not capacity constrained. It is now both desirable and feasible for the Commission to permit use of a

[18] Comments of Microsoft at 30. "In evaluating the potential for interference between the Automated Maritime Telecommunications System ('AMTS') and TV stations, the FCC explained that OET used software that implements the Longley-Rice model and provides integrated mapping. Further, the FCC's rules allow low-power TV station applicants to use 'terrain shielding and Longley-Rice terrain dependent propagation prediction methods to demonstrate that the proposed facility would not be likely to cause interference to low power TV, TV translator and TV booster stations.' The Commission's rules also permit the use of the Longley-Rice model in determining whether a new DTV station will cause interference in areas served by another post-transition DTV station. In addition, the Commission has recently suggested the Longley-Rice model for determining whether a television signal reaches a certain percentage of the population in a community, in connection with updating its methodology for determining whether a broadcast station is 'significantly viewed' in a community outside of its local television market." *Ibid*.

[19] Comments of WISPA at 5-6.

terrain-based model to calculate the list of available channels for fixed WSD operations at a location and the maximum EIRP for each channel."[20] With the technology available in 2020 and given a raft of proven precedent, the Commission should not hesitate to authorize the use of real-world propagation modeling by WSDBs.

IV. The Record Strongly Supports Higher Power and HAAT Limits for Fixed White Space Devices, as Well as Easing the 'Less Congested Areas' Restriction

In our initial comments, PISC fully agreed with the Commission's finding that allowing fixed WSD operations to operate at a higher EIRP limit in less congested areas—and therefore rural areas—will empower TVWS networks "to reach users at greater distances, thus enabling improved broadband coverage at less cost in these hard-to-reach areas."[21] The record reflects overwhelming support for the Commission's proposal to increase the EIRP limit for fixed WSDs operating in less congested areas.[22] There is a strong consensus that the Commission can adopt this modest change without undue risk of harmful interference to incumbent services.

PISC agrees with Microsoft that the Commission's proposal to increase the permissible radiated power level from 10 to 16 watts EIRP for fixed white space devices in less-congested areas would "allow service providers to expand their service areas to expand and improve broadband coverage for hard-to-reach areas."[23] As Microsoft argues, both broadband providers and TVWS equipment manufacturers agree this change would "improve spectrum efficiency by

[20] Comments of DSA at 22.
[21] *NPRM* at ¶ 12.
[22] Comments of American Farm Bureau at 1; ARK at 5; BCA Coalition at 3, 11-12; Comments of Cal.net at 1; Letter of Taxpayers Coalition at 1; Comments of CAN at 1; Comments of DNG at 1; Comments of Microsoft at 13-15; Comments of Comments of the App Association at 8; Comments of DSA at 5; Comments of MFPA at 1; Comments of Adaptrum at 2; Comments of NREA at 1; Comments of RED Technologies at 2; Comments of RTO at 1.
[23] Comments of Microsoft at 13.

ensuring that less white space device energy is directed outside the main antenna beam than would be the case if [the rules] permitted higher transmitter power using lower gain, less directional antennas."[24]

There is likewise strong and diverse support for the Commission's proposal to increase the maximum height above average terrain ("HAAT") to 500 meters for fixed WSDs operating with at least 6 megahertz separation from TV stations.[25] For rural broadband providers in particular, the flexibility to deploy at a higher power and/or higher elevation is a critical factor in the availability and affordability of rural broadband. WISPA notes that the Commission's proposed alternative coordination process should be sufficient to protect incumbents, arguing that "a prior notice requirement in combination with other changes to the separation table are reasonable means to ensure interference-free operations and to provide licensed stations with information necessary to resolve rare cases of harmful interference."[26]

The Commission's proposal to increase the HAAT limit would better equip providers to extend broadband connectivity to those who have no current options in part due to the topography of where they live. As the Consumer Technology Association highlights, raising the HAAT limits to 500 meters and easing the restrictions in "less congested" areas are "vital to enabling white space devices to extend their transmission range and provide increased service to

[24] *Ibid.* "Service providers and TVWS equipment makers have confirmed this benefit. . . . Overall, '[i]ncreasing radiated power by allowing greater directional gain will directly improve the cost-to-coverage ratio for providers and allow them to serve more Americans by enabling more homes to be served from a single tower.'"

[25] See Comments of App Association at 9; Comments of Adaptrum at 3; Comments of ARK at 5; Comments of BCA Coalition at 12; Comments of Cal.net at 1; Comments of DSA at 9-10; Comments of CAN at 1; Comments of DNG at 1; Comments of MFPA at 1; Comments of Microsoft at 15-18; Comments of RADWIN at 3; Comments of RED Technologies at 2; Comments of RTO at 1; Comments of WISPA Comments at 7.

[26] Comments of WISPA at 7-8.

rural communities."[27] ACT | The App Association similarly states that a HAAT increase "will be particularly helpful to App Association members that are involved in the precision agriculture and livestock community, as well as many other IoT solutions."[28]

PISC further agrees with Microsoft that increasing the HAAT to 500 meters would be valuable "in challenging geographies, particularly in mountain foothills and valleys . . . Often the only available location is a natural feature such as a ridge, but, because these natural features are often well above the average elevation of the surrounding terrain, it can be impossible to deploy fixed WSDs on them below the current 250-meter HAAT limit."[29] Microsoft notes from direct experience that these issues are frequently raised by rural technology and broadband providers.[30] PISC also agrees with the Dynamic Spectrum Alliance that this change will benefit the communities most challenging to serve:

> The typical rural community that could benefit is expected to be those located in the foothills of mountains and valleys, where the transmitter would be placed on a natural feature above such as on a ridge . . . . a 500 meter HAAT limit serve[s] the public interest by facilitating broadband connectivity in unserved rural communities with very difficult to reach geographies, such as Appalachia and parts of the American West.[31]

V. Most Commenters Support Authorizing White Space Devices on Portable Platforms within Geofenced Areas Verified by the TV Bands Database

The vast majority of parties filing comments joined PISC in supporting the Commission's proposal to authorize higher-power TV White Space devices ("WSDs") on moveable platforms

[27] Comments of CTA at 4.
[28] Comments of ACT at 9.
[29] Comments of Microsoft at 15-16. Accord, Comments of WISPA at 7.
[30] *Ibid.*
[31] Comments of DSA at 9.

that can operate within a geofence.[32] Adopting this policy will empower users to extend connectivity for novel use cases such as agriculture and education in rural areas without any increased or undue risk of harmful interference to incumbents.

Allowing higher-power TVWS use on movable platforms within a pre-calculated geofence promotes smart farming and ranching technology, school buses with Wi-Fi connectivity, and new innovations that can benefit from internet access on a roaming basis. For example, connectivity to tractors and irrigation systems, as well as monitors on ranch or farm animals, should not need to remain "fixed" if a WSDB verifies that a vacant TVWS channel is safe to use in every location on the farm or ranch.

Microsoft correctly observes that "[r]ural industries such as agriculture will benefit from more information-intensive farming practices and remote livestock monitoring. Additionally, WSDs can be placed on the roof of a school bus operating on a rural route, allowing children to do homework during often long travel times."[33] The Consumer Technology Association elaborates on this argument, highlighting the fact that "the experimental licenses granted to Microsoft and the waiver granted to Deere & Company demonstrate how industries, such as agriculture and transportation, will benefit from rules that permit white space devices to operate at higher powers on a mobile platform within geo-fenced areas."[34] PISC agrees with ACT—the App Association: "Such geo-fenced areas, especially in light of the COVID-19 public health emergency, would support much-needed connectivity for a wide range of use cases, such as providing broadband access to students in rural areas via school bus hotspots or could provide

[32] Comments of Microsoft at 19-25; Comments of the App Association at 9-10; Comments of CTA at 4; Comments of DSA at 15-18; Comments of Sennheiser at 9; Comments of the BCA Coalition at 14-16; Comments of DNG; Comments of RED Technologies at 5.
[33] Comments of Microsoft at 19.
[34] Comments of the CTA at 4.

farmers assistance with the management of their crops through IoT equipment, and many other consumer and enterprise use cases…"[35]

Most commenters support the Commission's proposal. However, while Shure does not explicitly oppose the concept, the microphone maker "urges the Commission to refrain from allowing higher power operations on movable platforms," claiming that "higher power operations would create an unacceptable risk of harmful interference."[36] To the contrary, as several commenters explain, there is no reason to assume that a higher-power WSD on a movable platform within a geofenced area calculated by the WSDB would increase the risk of harmful interference to microphone use or any other incumbent. For example, Shure's counterpart, Sennheiser, "agrees with the Commission's basic approach to preventing harmful interference of protected services from WSDs in geo-fenced areas."[37]

PISC agrees with RED Technologies "[g]iven appropriate rules and computation of available channels and power limits, there is no additional risk of interference above that of a fixed device."[38] DSA states this change would not increase the risk of harmful interference and urges the Commission to review DSA's detailed analysis for how best to manage these rules.[39] As DSA argues: "The Commission should not place a limitation on the size of a geofenced area. So long as all incumbents' operations across the geofenced area are protected, the optimum size of the geofence will be determined by the market. In the event there are multiple, independent entities applying for geofenced areas that are partially overlapping, it should be solely up to these

[35] Comments of the App Association at 9-10.
[36] Comments of Shure Incorporated at 6 ("Comments of Shure").
[37] Comments of Sennheiser Electronic Corporation at 9 ("Sennheiser agrees with the Commission's basic approach to preventing harmful interference of protected services from WSDs in geo-fenced areas.").
[38] Comments of RED Technologies at 5.
[39] Comments of DSA at 15-17.

entities to manage co-existence as WSD devices operate on a no protection / no interference basis."[40]

Moreover, because it is perfectly feasible for a WSDB to calculate the geofence, PISC recommends that particularly if this category of WSDs is limited to less congested areas, the Commission should authorize devices to operate at up the corresponding fixed EIRP limit for less congested areas. While Shure argues, as a fallback, that the Commission "should not in any event allow for movable platform WSD operations in excess of 4 watts EIRP,"[41] that power level would be arbitrary and undermine important economic and social benefits of the technology. If the Commission agrees the WSDB is capable of calculating the geofence, then the only appropriate limitation is at the boundary of the geofence to account for the unlikely possibility that a tractor or school bus is moving at a very high speed. In that regard, and contrary to Shure's proposal to *increase* the boundary restriction,[42] the proposed limitation of 1.6 kilometers is overkill given how unlikely it is that a farm implement, school bus or other connected platform will be moving at 60 miles per hour during the 60 seconds between authorizations by the WSDB—and in time to arrive immediately next to an active licensed microphone.

Similarly, Shure's proposal to increase the required check-in interval to 10 seconds resembles more of an effort to shut down the use case. However, assuming that 10-second check-in times are feasible, the Commission could consider waiving the boundary distance limitation entirely for any moveable platform re-checking every 10 seconds. This could be an optional value-added service that a WSDB could offer to users of moveable platforms in addition to the standard 60-second check-in.

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[40] *Id.* at 18.
[41] Comments of Shure at 6.
[42] *Id.* at 10-11 (proposing to increase the limitation to 2.7 kilometers).

VI. There is Strong Support for Using TVWS Spectrum More Efficiently by Permitting Higher Power Limits for Fixed Devices in First Adjacent Channels

The Commission should allow higher power operations on channels immediately adjacent to television operations. The record reflects considerable support for updating the rules in this respect.[43] While the Commission was understandably conservative in adopting the initial TVWS rules a decade ago—when both geolocation databases and dynamic sharing were unproven—the engineering evidence in the record clearly shows there is no reason now to unnecessarily limit the utility of the band. And although the NAB claims that "nothing has changed regarding white space technology, broadcast technology, or the laws of physics that would warrant reexamination of the Commission existing rules with respect to first-adjacent channel operations,"[44] the record suggests that the agency should reject his techno-know-nothingness and update the rules to facilitate more productive use of vacant TV spectrum.

Microsoft filed data from field testing that demonstrates a 34 dB EIRP fixed WSD downlink and a 33 dB EIRP fixed WSD uplink can operate without causing harmful interference to ATSC 1.0 (DTV) receivers, concluding:

> The test results demonstrate that in the real world, . . . a WSD base station transmitting to a WSD CPE in consumers' homes at 34 dBm EIRP will not cause harmful interference to broadcasting operations. Even without any form of database control or other protections, . . . our field testing found only a small number of impairments to broadcast standard video (dropped pixels) out of several hundred combinations of transmitter and receiver locations, and TVWS transmitter heights.[45]

[43] Comments of the App Association at 11; Comments of Adaptrum at 2-3; Comments of WISPA; Comments of ARK 4-5; Comments of Cal.net at 1; Comments of DNG at 1; Comments of Microsoft at 28; Comments of BCA at 13; Comments of RTO at 1.
[44] Comments of NAB at 8.
[45] Comments of Microsoft, Appendix A, at 36-37.

WISPA similarly finds that a three-megahertz guard band between a TV white space signal and a broadcast channel is generally sufficient at a higher power. WISPA predicts that "an EIRP level of +32 dBm, if not higher, would be possible without causing harmful interference. Coupling this with the use of ITM instead of distance tables would further reduce the risk of harmful interference to facilities entitled to protection."[46] As the Dynamic Spectrum Alliance details, "Empirical trials conducted in South Africa and Ghana several years ago indicate that a higher power fixed WSD can operate on a first adjacent channel to a broadcaster without causing harmful interference."[47]

VII. The Record Shows Strong Support for Authorizing Directional Antennas and Sectorization to Facilitate Fixed Point-to-Multipoint Deployments

The Commission should authorize directional antennas and sectorization to ensure fixed point-to-multipoint deployments are able to deliver high-speed broadband in targeted locations without increasing the risk of harmful interference to incumbents. PISC agrees with WISPA: "If the database has information describing the location, height, directional pattern, azimuth and gain of the TV white space antenna, it can determine the appropriate power level and separation distance needed to protect TV stations. With advances in spectrum sharing… such capabilities can be incorporated into the TV white space database with relative ease, with proper deployment confirmed through professional installation, thereby enhancing the ability of the spectrum to be used more efficiently to serve more locations without increasing the potential for harmful interference to facilities entitled to protection."[48]

[46] Comments of WISPA at 10.
[47] Comments of DSA at 22-25.
[48] Comments of WISPA at 13. *Accord* BCA Coalition at 13.

The WSDBs can readily coordinate these entirely fixed use cases. Accounting for the directionality of an ISP's transmission should enhance, not diminish, protections for incumbent services. PISC concurs with the BCA Coalition that a WISP and WSDB can readily "calculate and coordinate a sectorized P2MP deployment scenario to avoid harmful interference to incumbents while simultaneously serving a targeted area needing service. This could be defined as a value-added service provided by the WSDB's for an additional fee."[49]

This coordination would also seem to be similar to – and no more complex than – coordinating use within a geofenced area. Microsoft correctly notes that "technologies including electronically steerable beams could enable mobile devices to operate with higher gain and therefore more highly directional antennas."[50]

VIII. There is Strong Support for Authorizing a New Class of Narrowband White Space Devices

Most comments addressing this issue supported the Commission's proposal to create a new class of narrowband WSDs with technical rules that facilitate applications relevant to the emerging Internet of Things (IoT) such as remote monitoring, SCADA and other innovations.[51]

[49] Comments of BCA Coalition at 13.

[50] Comments of Microsoft at 24 ("To ensure that the rules are as useful as possible . . . we recommend two other improvements. First, the Commission should state that the same antenna requirements that apply to fixed WSDs will apply to higher power mobile devices, including the provisions regarding detachable antennas with higher gain. Second, . . . technologies including electronically steerable beams could enable mobile devices to operate with higher gain and therefore more highly directional antennas. The rules should therefore allow mobile geofenced devices to incorporate such technologies but should not mandate their use, as such a requirement could unnecessarily increase the cost of producing and procuring devices for smaller manufacturers and rural operators.").

[51] Comments of Microsoft at 25-28; Comments of the CTA at 4; Letter of Taxpayers Coalition at 1; Comments of DSA at 18-21; Comments of RED Technologies at 8; Comments of the App Association at 10-11; Comments of BCA Coalition at 16; Comments of CAN at 1; Comments of DNG at 1; Comments of MFPA at 1; Comments of NPSTC at 10-11; Comments of RTO at 1.

It appears no stakeholders oppose the concept. CTA notes the importance of the Commission considering rules "to facilitate the deployment of narrowband IoT devices, while providing existing licensees the same level of protection from harmful interference."[52] RED Technologies notes that the proposed change "will enable large-scale environmental and agricultural monitoring in a wide range of rural environments due to the suitability of the TV bands to non-line-of-sight propagation in foliated areas."[53] PISC also agrees with Microsoft that narrowband WSDs "will be especially useful for rural industries such as agriculture and mining, where IoT applications geared for denser urban settings with far different telecommunications and electric power environments are less effective."[54]

PISC further concurs with ACT | The App Association that the Commission's proposed technical changes "will clarify that a white space device can operate with a single or several narrowband carriers rather than having to spread all of its energy across a six megahertz channel."[55] PISC also agrees with the DSA that the Commission should ensure that rules authorizing narrowband IoT devices and mobility within a geofenced area are consistent and optimize the potential productivity of sensors and other devices for farming, utilities and a wide range of future innovation:

> A relatively low-power narrowband IoT device can operate as a fixed and personal/portable device at different times. An air temperature/humidity sensor mounted on a post [or] dug into the ground next to crops . . . is operating at a fixed location. Nevertheless, if the farmer takes the same sensor and attaches it to her/his tractor to measure (and transmit back) air temperature / relative humidity across her/his field, then the narrowband WSD is portable. . . . By creating a new category of narrowband WSD, the Commission avoids this issue in its entirety.[56]

[52] Comments of the Consumer Technology Association at 4.
[53] Comments of Red Technologies at 8.
[54] Comments of Microsoft at 25-26.
[55] Comments of the App Association at 10-11.
[56] Comments of DSA at 19-20.

IX. Conclusion

The Public Interest Spectrum Coalition urges the Commission to make these important changes to the rules governing TV White Spaces so that WISPs, school districts and other entities can extend broadband internet access to more locations in rural, tribal, low-income, and other hard-to-serve areas at a reasonable cost. TV White Space technology has now proven it has the capability to bridge the digital divide in meaningful ways while fully protecting incumbent services. The Commission should adopt these rule changes to capitalize on this potential to the fullest extent possible.

Respectfully submitted,

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