Dynamic Spectrum Alliance Limited
3855 SW 153rd Drive
Beaverton, OR 97003
United States
http://www.dynamicspectrumalliance.org

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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

COMMENTS OF THE DYNAMIC SPECTRUM ALLIANCE

Martha SUAREZ
President
Dynamic Spectrum Alliance

May 4, 2020

Dynamic Spectrum Alliance Limited
3855 SW 153rd Drive
Beaverton, OR 97003
United States
http://www.dynamicspectrumalliance.org

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http://www.dynamicspectrumalliance.org

I. INTRODUCTION AND SUMMARY

The Dynamic Spectrum Alliance (DSA)[1] submits these comments in response to the Commission's Notice of Proposed Rulemaking requesting public input regarding 'Unlicensed White Space Device Operations in the Television Bands.'[2]

Under the Commission's rules, White Space Devices (WSD) can access unassigned spectrum in the TV broadcast bands to provide Internet access to unserved and underserved communities, many of which are in rural America. Several DSA members participate in the global WSD ecosystem, including Microsoft. Over time, the company compiled information from its ecosystem partners on WSD deployments in the U.S. and other countries, and distilled the list down a handful of measured and practical improvements to the U.S. rules, which it brought to the Commission's attention through its Petition last year.[3]

The DSA supports the Commission's proposed rules that would: (1) increase the EIRP limit for fixed WSDs operating in less congested areas, (2) increase the Height Above Average Terrain (HAAT) limit, (3) allow higher power WSDs to operate in mobile platforms within geofenced areas – regardless of whether the Commission wants to classify them as fixed or

[1] The Dynamic Spectrum Alliance is a global, cross-industry alliance focused on increasing dynamic access to unused radio frequencies. The membership spans multinational companies, small- and medium-sized enterprises, academic, research, and other organizations from around the world, all working to create innovative solutions that will increase the utilization of available spectrum to the benefit of consumers and businesses alike. A full list of DSA members is available on the DSA's website at www.dynamicspectrumalliance.org/members.

[2] *Notice of Proposed Rulemaking, Unlicensed White Space Operations in the Television Bands, ET Docket No. 20-36* (Released March 2, 2020). ("NPRM").

[3] See Petition for Rulemaking of Microsoft Corporation, ET Docket No. 14-165 (filed May 3, 2019) ("Petition").

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3855 SW 153rd Drive
Beaverton, OR 97003
United States
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personal / portable devices, and (4) create a new category of narrowband WSDs intended for IoT applications – except that they should operate at higher EIRP levels in less congested areas.

The DSA believes the Commission should give White Space Database (WSDB) Administrators the option to use a terrain-based model to determine the desired DTV signal and the undesired WSD signal strengths in the proposed WSD coverage area as a means to establish the list of available channels for WSD channels and EIRP limit for each. The Commission's recent action to require Automated Frequency Coordination (AFC) systems use of a hybrid terrain-based model in its 6 GHz Report and Order[4] indicates that it may be open to consider more sophisticated models that can be calculated in the cloud before a device is turned on.

The Commission asks questions regarding whether it should eliminate the WSD height above ground level limit (HAGL) and only use the HAAT limit. The DSA agrees with this proposal as incumbent protection is based on HAAT not HAGL. The NPRM further asks questions about the definition of less congested areas. As less congested areas are used as a proxy for rural and exurban areas, it should be based on the number of vacant channels from 2 through 36, rather than the number of vacant channels within each of the low-VHF, high-VHF, and UHF bands

Finally, the Commission should consider permitting higher power fixed WSDs to operate closer in frequency to the nearest broadcast TV station than under the current rules. Several studies, including one performed by the FCC in 2014, indicate that the desired-to-undesired

[4] *See Unlicensed Use of the 6 GHz Band*, Report and Order and Further Notice of Proposed Rulemaking, (released April 23, 2020). ("6 GHz Report and Order").

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Beaverton, OR 97003
United States
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(D/U) ratio of DTV receivers have improved since 2008 when the Commission applied a D/U ratio of -33 dB in its analysis for authorizing 40 mW personal / portable WSDs to operate in the first adjacent channel to a broadcast station. Combined with the use of terrain-based propagation models and taking clutter and the relative polarizations of the DTV and TVWS antennas into account, it should be possible for the Commission to allow higher power fixed WSDs to operate closer in frequency to the DTV transmitter than permitted today.

II. THE COMMISSION SHOULD INCREASE THE RADIATED POWER LIMIT OF WHITE SPACE DEVICES OPERATING IN LESS CONGESTED AREAS

The DSA supports the Commission's proposal to permit fixed WSDs to operate up to 16 W (42 dBm) EIRP in less congested areas.[5] Increasing the EIRP limit for fixed WSDs in less congested areas by 2 dB through utilization of a higher gain antenna offers a flexible way to extend a network's coverage where and when required. Higher gain antennas have more focused transmissions than lower gain antennas and will provide network designers another tool to more finely tailor the network characteristics to reach more remote populations. And by expanding the Commission's existing WSD regulatory framework to include the higher EIRP limit, it ensures incumbents will be protected from receiving harmful interference.

Under the proposal, the fixed WSD's conducted power limit would remain at 1 W (30 dBm), with the increase in the EIRP limit achieved only by permitting a higher gain

[5] *See* NPRM at ¶12.

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Beaverton, OR 97003
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antenna.[6] In parallel with the current rules, if the WSD operator installs a transmit antenna with a gain greater than 12 dBi, the WSD conducted power would have to be reduced by a commensurate amount to maintain the 42 dBm EIRP limit.

A new row for 42 dBm would be added to Table 1 of Section 15.709(b)(1)(iii)[7]. The conducted power limit, power spectral density limit and the conducted adjacent channel power limit for the 42 dBm fixed WSD transmitter would reflect that the conducted power limit is the same as for fixed WSDs with a radiated power limit of 36 dBm (4W) and 40 dBm (10 W).

A new column for 42 dBm would be added to Table 3 of Section 15.712(a)(2)(v).[8] A fixed WSD device operating at these highest radiated power limits must increase its separation distance beyond a broadcaster's protected contour on the co-channel and first adjacent channel. These distances would be calculated by extending the existing equations. Additionally, the Commission proposes proportional increases in separation distance between fixed WSD operating at these higher EIRP and other incumbent operations in the affected segments of the VHF and UHF bands.[9] A number of these proportional increases in the separation distance are based on use of the overly conservative free space path loss model. If the Commission permits use of a terrain-based model to calculate the minimum separation distances between WSD and

[6] *See* NPRM at ¶13.

[7] *See* NPRM at Appendix A, paragraph 3, revision to Table 1 to Section 15.709(b)(1)(iii).

[8] *See* NPRM at ¶¶28,29A.

[9] *See* NPRM at ¶¶31-34.

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United States
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broadcast TV stations, it should likewise allow use of a terrain-based model to calculate the minimum separation distance between WSDs and other incumbents operations in the television band based on their respective protection requirements.

The DSA agrees with the Commission's assessment that permitting fixed WSD operations at a higher EIRP limit in less congested areas, including rural areas, will enable a WSD network "to reach users at greater distances, thus enabling improved broadband coverage at less cost in these hard-to-reach areas."[10] Additionally, the DSA agrees higher EIRP limits will also provide improved coverage at locations, by enabling signals to better penetrate obstacles where there is not a direct line-of-sight to the transmitter. Even though radio waves in the UHF experience less attenuation through trees and other foliage than do radio waves at higher frequencies, they still experience attenuation. The experience of some DSA members has shown that having an extra 2 dB available in rural communities, where there is typically more tree cover, will make a difference.

WSD links can be used to provide point-to-point ("P2P") backhaul to an Internet point or presence and provide point-to-multipoint ("P2MP") broadband access from the base station for the customer premise equipment (CPE). Higher gain antennas may have the greatest impact in reducing the cost of network topologies incorporating P2P backhaul over fixed WSD channels as there would be a limited number of large antennas required. In this network concept, the last-

[10] *See* NPRM at 12.

mile broadband access could also be provided to rural consumers by fixed P2MP WSDs operating over a different set of white spaces channels or in a different frequency band.

As wireless network designers become more familiar with the capabilities of white space devices, they are exploring different network topologies. One interesting proposed network topology to reach more remote enclaves is a hybrid WSD network that connects a fixed point-to-point (P2P) WSD network that terminates at an Internet point of presence, to a point-to-multipoint (P2MP) WSD network, with end points at residences. Here, more powerful WSD transmitters are envisioned for the longer P2P segment than the relatively shorter P2MP links. Even in rural America, there is some agglomeration of residences in small communities, albeit more spread apart.

The DSA's understanding is that the range of antenna gains for fixed WSDs fall in the 6 - 13 dBi range. The idea behind 'affordable' WSD networks has always been that the WSD base station (BS) and the WSD customer premise equipment (CPE) are (more or less) symmetric. These hypothetical hybrid P2P / P2MP networks, depending on the specific location, will require an even higher EIRP limit for the P2P segment. Assuming the 30 dBm conducted power limit for fixed WSDs remain, EIRP levels above 42 dBm would be achieved exclusively through higher antenna gain. The DSA suggests that the Commission handle such requests on a case-by-case basis.

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III. THE COMMISSION SHOULD INCREASE THE HEIGHT ABOVE AVERAGE TERRAIN LIMIT OF WHITE SPACE DEVICES

Increasing the HAAT limit, when combined with the height above ground level (AGL) limit of 100 meters in less congested areas and 30 meters AGL elsewhere, will benefit ISPs in geographies where there is great variation in elevation across the 360 radials emanating from the WSD site. 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 to provide P2MP coverage to residents in the valley below. The DSA believes that, while there may only be a limited number of WSD deployments that will be able to take full advantage of a 500 meter HAAT limit, it does serve 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.

The DSA supports the Commission's proposal to extend its existing WSD regulatory framework to include the higher HAAT limit for ensuring incumbent broadcasters will be protected from receiving harmful interference.[11] The separation distance for a fixed WSD operating at 40 dBm EIRP (and above) and a HAAT approaching 500 meters is more than 50 km beyond the broadcaster's protected contour. The DSA doesn't see a need for the Commission to make a rule limiting HAAT's above 250 meters to less congested areas only.

[11] *See* NPRM at ¶17.

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Beaverton, OR 97003
United States
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Both the underlying Petition and Commission's proposal call for a coordination mechanism that goes beyond the basic concept of a WISP interested in establishing a WSD network in an area to look up the list of available channels themselves by accessing a certified White Space Data Base (WSDB) tool. Philosophically, there should not be any need for a coordination mechanism for the same reason the Commission believes that a 30-day trial period is not required – an unlicensed WSD 'must not cause harmful interference to authorized services and must cease interference if harmful interference occurs'.[12]

With that said, all things being equal, if the Commission chooses to go forward with a coordination mechanism, the DSA supports the Commission's simpler alternative to Microsoft's suggested procedure, as the Commission believes both approaches could achieve the same results.[13] Again, the DSA believes that deployment of a TV White Spaces network between 250 meters and 500 meters HAAT will be limited to certain geographies and not widespread. And while some WSD network operators may consider the need to identify protected entities and contact licensees as being somewhat burdensome, the expectation is that projects in these more challenging geographies will take time to plan and deploy. If the Commission requires a WSD network operator to contact and notify the licensees by e-mail (or other electronic messaging) and by certified mail so that there is record of notification, the DSA believes it would not unduly

[12] See 47 CFR §15.5.

[13] See NPRM at ¶20.

limit the WSD network operator's ability to deploy WSDs in a timely manner at a location where the HAAT is between 250 - 500 meters.

The coordination process will also impact the WSDB operations. The change in separation distances with respect to the stepped increase in HAAT between 250 meters and 500 meters can be programmed into the calculation engine. The coordination mechanism requires information beyond a list of available channels. WSD network operators would presumably have to acquire this information from a trusted source, the WSDB Administrator. As it considers the coordination process, the Commission should try to minimize the need for a WSDB Administrator to modify its software to provide a list of protected entities at a given location (and channel).

IV. THE COMMISSION SHOULD CONSIDER BASING INCUMBENT PROTECTION ON HEIGHT ABOVE AVERAGE TERRAIN WITH ONE CAVEAT

The Commission's 2008 WSD rules broke new regulatory ground. When it came to protecting incumbents, the Commission approach was for simplicity of calculation. Initially, there was only a height AGL limit.[14] In the second MO&O, the Commission applied the concept

[14] See *Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket Nos. 04-186 and 02-380, Second Report and Order and Memorandum Opinion and Order, 23 FCC Rcd 16807 (2008) at ¶227.

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United States
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of HAAT to WSDs and created a 76 meter limit[15], which was increased two years later to 250 meters, once it became clear that many places in the continental U.S. would be precluded from operating fixed WSDs.[16] Up until its 2015 R&O,[17] the Commission's rules assumed fixed WSD were always operating at their maximum height and EIRP. To expand the availability of WSDs, the Commission created a table for separation distances beyond the co-channel and first adjacent channel, for incremental steps of WSD HAAT and EIRP levels.[18]

In March 2019, the Commission increased the maximum permissible antenna height above ground level from 30 meters to 100 meters in less congested areas.[19] It was well received and appreciated by the white spaces ecosystem. Anecdotally, the DSA understands from some of its members that this change has improved WSD network coverage in rural areas, especially where the terrain is more varied.

The DSA agrees with the Commission that in areas with flat terrain, increasing the WSD height AGL limit from 30 to 100 meters in less congested areas will increase the WSD network's

[15] See *Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket Nos. 04-186 and 02-380, Second Memorandum Opinion and Order, 25 FCC Rcd 18661 (2010) at ¶66.

[16] See *Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket Nos. 04-186 and 02-380, Third Memorandum Opinion and Order, 27 FCC Rcd 3692 (2012) at ¶13.

[17] See *Amendment of Part of the Commission's Rules for Unlicensed Operations in the Television Bands, Repurposed 600 MHz Band, 600 MHz Guard Bands and Duplex Gap, and Channel 37; Amendment of Part 74 of the Commission's Rules for Low Power Auxiliary Stations in the Repurposed 600 MHz Band and the 600 MHz Duplex Gap, Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, ET Docket No. 14-165 and GN Docket No. 12-268, 30 FCC Rcd 9551 (2015) ("White Spaces Order").

[18] See 47 CFR § 15.712(a)(2)(iv), Table of Separations for Fixed White Space Devices.

[19] See *White Spaces Order on Reconsideration*, 34 FCC Rcd at 1851 at ¶64.

coverage area, but not as much as if there was only a HAAT limit. In flat terrain, the WSD HAAT is typically very close in value to the height AGL.[20] Additionally, when WSDs are located in a valley, the HAAT can be negative and the WSD height AGL limit positive. Here too, the height AGL becomes the limiting factor. There could also be very hilly terrain in less congested areas where the HAAT is the limiting factor rather than the height AGL.

The DSA would welcome the Commission eliminating height AGL and relying only on HAAT. Using a HAAT only approach through application of a terrain-based propagation model would make more efficient use of the spectrum. Additionally, using a HAAT only approach will still protect broadcasters. In this spirit, the Commission should revisit previous decisions that limited 40 mW fixed WSD operating on the first adjacent channel to 10 meters AGL independent of any other factor,[21] and applied the same limit for a 100 mW fixed WSD operating on the center 6 MHz of the first two adjacent channels.[22]

V. THE COMMISSION SHOULD MAINTAIN THE CONCEPT OF LESS CONGESTED AREA BUT DEFINE IT FOR CHANNELS 2 THRU 36

The Commission developed the construct of the less congested areas as a proxy for rural areas. Less congested areas are defined in the Commission's rules with respect to each frequency band where it allows high power fixed WSD operations. In each of these TV bands ‑ low VHF,

[20] Ibid.

[21] *See* 47 CFR § 15.709(2)(g)

[22] Id.

high VHF, and UHF (channel 14 and above; beginning at 470 MHz) ‑ less congested areas are locations where at least half of the TV channels for the bands that will continue to be allocated and assigned only for broadcast service are unused for broadcast and other protected services.[23] Under this rule, an area can be considered rural for some channel ranges but non rural for other channel ranges. The DSA suggests that rather than considering each TV band separately, the Commission consider the number of unused channels across all three TV bands together for its definition of less congested.

The DSA recognizes that the number of vacant channels at a given location can vary based on the WSD base station antenna height and EIRP level and that looking at channels 2 through 36 will add to the number of computations required. At higher EIRP levels and antenna heights, there is greater coverage, and depending on its specifics of its location, a WSD base station could be in a less congested area, but its far flung WSD client could be in a location that is other than less congested. The EIRP level and/or antenna height would have to be adjusted to provide broadband service to this location. Truth be told, whether more locations will be designated as "less congested" under the current rules or under DSA's proposal is likely location dependent. Nevertheless, the DSA feels that looking at channels 2 through 36 is more consistent with the intent of the less congested area rule.

Globally, the DSA has observed that regulators have struggled with how to define rural areas that would benefit from the greater coverage afforded by higher power WSDs and not

[23] See White Spaces Order ¶ 54, 47 CFR §

cause harmful interference to incumbents, which are usually exclusively broadcasters. For countries that collect a tax to support over the air TV, in theory, the regulators have very good vision into the density of over the air TV users, assuming a high degree of compliance.

In theory, using population density as a proxy for rural area would seem the most precise approach. In the U.S., different Federal agencies have different definitions of rural. The Commission would have to define a rural population density for purposes of permitting WSD operations at higher EIRP limits. While a population density approach can work in countries where there is a single definition of rural, in the U.S., the Commission's construct is a practical solution, that can be improved by adopting our proposal.

VI. THE COMMISSION SHOULD ALLOW WHITE SPACE DEVICES TO OPERATE AT HIGHER POWERS WITHIN A GEOFENCE IN LESS CONGESTED AREAS

The Commission's rules allow for personal / portable WSDs to operate on available channels within a geofenced area that the WSDB has determined will not cause harmful interference to incumbents.[24] The DSA believes the Commission should authorize higher power WSD devices on moveable platforms that can operate within a geofence.

The DSA asks the Commission to consider introducing a method that would allow a geofence to be created for available white space channels over a pre-defined area. The area covered could be as large or as small, as required. Unlike the current rule, the list of available

[24] *See* 47 C.F.R. § 15.711(d)(5)

channels could vary across the geofence. The method to obtain the channel availability list for a larger area should require checking the channel availability along the entire pre-defined planned route and input the coordinates into the WSDB.

We believe there are three likely scenarios. The first scenario is where the WSD base station is fixed and the WSD CPE moves within the geofence. An example is a school bus with a CPE antenna on its roof, traveling under the coverage canopy of the fixed WSD base station. The second scenario is where the WSD base station is moving and the WSD CPEs are fixed. An example is a tractor moving through a farmer's fields, in communication with short-range fixed WSD monitors (soil, water, etc.). If small WSD CPEs were placed on livestock and information communicated back to the tractor then there is the third scenario, where both the WSD BS and WSD CPE are in motion. Overall, the DSA believes that this proposal, limited to less congested areas, will principally benefit rural communities and industries.

These communities will be able to reap greater benefits if these WSDs are either under the Commission's rules for fixed WSDs or a new category is created. Under the Commission's rules, personal / portable devices operate with an omnidirectional antenna. Effectively, the WSD's conducted power, which is limited to 30 dBm, also serves as the WSD's EIRP limit. For many of the applications envisioned, a higher gain antenna is required to close the link over the greater distances expected in rural areas. The rural school bus route is a case in point. The CPE WSDs would be mounted on the bus's roof and mechanically pointed in the direction of the nearest WSD base station along the route to ensure the link was always maintained.

In general, when examining larger rural routes, the lower the antenna gain is for the WSD on the bus's roof, the more WSD base stations are required to provide the wireless canopy for connectivity, and the greater the capital expense. Additionally, a higher gain antenna on the WSD CPE (bus) will lead to greater spectrum efficiency, and the more focused beam will also minimize the potential for interference with other fixed WSDs that may be operating in the area.

From the standpoint of equipment approval process, the WSD should be fixed WSD transmitters that meet the limits for conducted power, power spectral density, and conducted adjacent channel emissions. The antenna gain can be varied depending on what is required for the route. Certifying WSDs under this proposed section as a fixed WSD lowers the cost for both for industry and the Commission as no new Knowledge Data Base (KDB) needs to be developed and commercially available fixed WSDs can be used.

The DSA believes that the Commission should allow the WSDs used within a geofence to use detachable, higher gain antennas as it permits for fixed devices. The EIRP limit in less congested areas should also apply. There are certain characteristics of the proposal, beyond the obvious, such as the frequency of the WSD CPE contacting the WSD base station, that is more akin to a personal / portable WSD. A potential regulatory path includes exceptions to the fixed WSD rules, exceptions made to the personal / portable WSD rules, or a new category of WSD can be created. The Commission is best positioned to determine the regulatory means by which to achieve the objectives.

The Commission will need to define how the geofenced area will be presented to the WSDB. Most likely the area or route will have to be defined by a polygon, with a certain density

of points. 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 entities to manage co-existence as WSD devices operate on a no protection / no interference basis.

VII. THE COMMISSION SHOULD AUTHORIZE NARROWBAND WHITE SPACE DEVICES AS A NEW CATEGORY OF WHITE SPACE DEVICES

The DSA generally supports the Commission's proposal to authorize a new category of WSD devices -- narrowband WSDs for IoT applications. The NPRM describes the Commission's rationale for its WSD conducted PSD limits[25] and why Microsoft, in its Petition, argued that the unintentional consequence of requiring the WSD signal to be spread across the full channel bandwidth regardless of conducted power level was to limit narrowband WSDs to power levels that are not commercially useful. The other technical rule impacting potential narrowband WSD operations is the Commission current framework for limiting the conducted adjacent channel emissions.

The Commission's proposal defines narrowband WSDs, firmly places narrowband WSDs in its existing regulatory framework, and creates fairly conservative technical rules to protect licensees, but which are more suitably tailored for IoT uses. The Commission defines the channel size for the narrowband WSD as 100 kHz, which is the same as the measurement bandwidth

[25] See NPRM at ¶43.

used for the PSD calculation. Equating the maximum conducted power in an IoT WSD (within its 100 kHz channel) to the maximum PSD per 100 kHz for a WSD operating at 1 W conducted power forms the basis of the protection schemes and corresponding narrowband WSD technical rules.[26]

The DSA asks that the Commission consider allowing narrowband WSD to operate with a higher EIRP limit in less congested areas, while maintaining the same regulatory framework. The Commission's proposal limits the antenna gain to 6 dBi, without having to reduce the conducted power by 1 dB for each additional 1 dB increase in antenna gain. The DSA believes the EIRP limit for a narrowband WSD can be increased safely in less congested areas by scaling down the EIRP limit for a 6 MHz WSD channel to 100 kHz (after subtracting the top and bottom 250 kHz of the channel).

The Commission's channelization plan makes it easier to construct the mechanism to protect incumbents from receiving harmful interference. What the Commission did not do, and should not do, is to describe the mechanism by which individual 100 kHz channels within the 6 MHz channel is accessed opportunistically. That should be left to industry to determine.

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, dug into the ground next to crops sending periodic readings back to the farmhouse (or farm vehicle), is operating at a fixed location. Nevertheless, if the farmer takes the same sensor and attaches it

[26] *See* NPRM at ¶¶45-47.

to her/his tractor to measure (and transmit back) air temperature / relative humidity across her/his field, then the narrowband WSD is portable. As discussed in Section VI, fixed devices must operate with an external antenna gain of at least 6 dBi, while personal / portable devices operate with a 0 dBi gain antenna. By creating a new category of narrowband WSD, the Commission avoids this issue in its entirety.

The Commission asks whether it is necessary for the Commission to require a listen-before-talk spectrum access mechanism to prevent harmful interference to protected services in the TV bands. It then lists a series of technical parameters it would need to specify such a mechanism. The DSA believes that the Commission could merely say that it requires a contention-based-mechanism and then leave it to industry to figure out what it entails and be able to describe it during the equipment approval process.

It is envisioned that narrowband WSDs will include master devices that incorporate geolocation and communicate directly with the WSDB, client devices that incorporate geolocation (as a critical piece of IoT in outdoor use cases such as agriculture, environmental sensing, etc. in correlation with location), and client devices that do not incorporate geolocation. It would not be unreasonable if the Commission approaches the separation distance for narrowband WSDs without geolocation along the lines of rules it developed for Mode I personal / portable devices.

The DSA believes the Commission should not limit the duty cycle of individual IoT WSDs, but recognizes that this may have been something that was worked out amongst interested parties as a ‘safe place’ in which to initiate operations for this new category of WSD.

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United States
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VIII. THE COMMISSION SHOULD ALLOW WHITE SPACE DATABASES TO USE TERRAIN BASED MODELS

The DSA supports propagation models that protect incumbents but maximize spectrum utility. To that end, we support models that use point-to-point modeling. In addition, we support models that account for the variability in terrain in calculating propagation and spectrum availability. Annex B to our proposed model rules describes the preferred model, being the Longley-Rice propagation model. However, the DSA believes that ITU-R. P-1812 is also an acceptable propagation model for this purpose as described in Annex C of our model rules.[27] Other models may also be appropriate, provided they use point-to-point calculations and account for terrain variability.[28] The DSA is also supportive of models that incorporate clutter.

The DSA applauds the Commission for authorizing a complex propagation model to be incorporated into the AFC calculations to protect incumbents operating in the U-NII-5 and U-NII-7 bands.[29] The DSA believes that the Commission can use its recent actions in the 6 GHz band proceeding to reconsider its approach to propagation models used for WSD devices.

When the WSD rules were first considered, the Commission placed a premium on the simplicity of calculations required to determine the available channels and whether the infrastructure could handle the projected volume of calculations. The Irregular Terrain Model

[27] See *Model Rules and Regulations for the Use of Television White Spaces v2.0*, Dynamic Spectrum Alliance, December 2017

[28] Id. at Footnote 1.

[29] See 6 GHz Report and Order at ¶¶63,64.

(also known as Longley-Rice) is computationally intensive, the cell size used in the OET 69 (and OET 74) methodology is 2 km x 2 km,[30] and there were going to be many calculations being performed at any given time. 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.

While there is a belief that using a terrain-based model will allow for a greater number of available channels at a location, or allow them to operate at higher powers, the answer is – it depends. The only guarantee is that there will be a greater degree of accuracy for both the incident DTV power and fixed WSD power received at a location. The Commission should permit use of such models.

IX. THE COMMISSION SHOULD CONSIDER ALLOWING WHITE SPACE DEVICES TO OPERATE WITH HIGHER POWERS CLOSER IN FREQUENCY TO THE BROADCAST TELEVISION CHANNEL

The Commission should allow higher power WSD to operate closer in frequency to broadcast stations than it currently permits in less congested areas. Empirical trials conducted in South Africa and Ghana several years ago indicate that a higher power fixed WSD can operate

[30] See Office of Engineering Technology, FCC, Longley-Rice Methodology for Evaluating TV Coverage and Interference, OET Bulletin 69, February 06, 2004, at 5; and Office of Engineering Technology, FCC, *Longley-Rice Methodology for Predicting Inter-Service Interference to Broadcast Television from Mobile Wireless Broadband Services in the UHF Band*, OET Bulletin 74, October 26, 2015, at 5.

on a first adjacent channel to a broadcaster without causing harmful interference. The trial in South Africa examined possible interference to both analog and digital TV broadcasts.[31] In 2014, the Commission proposed 4 W EIRP fixed WSD operations with a 3 MHz offset to the edge of the DTV broadcast channel.[32] The Commission only permitted fixed WSD operations at up to 100 mW EIRP with a 3 MHz offset to the edge of the DTV broadcast channel, but limited its height AGL to 10 meters.

The DSA understands that harmful interference to a DTV receiver can be created when the undesired signal on the first adjacent channel is above the DTV receiver's threshold of detection on the desired channel. There appears to be two components – the first is the signal on the first adjacent channel that leaks into the desired DTV channel and the second is the signal the DTV receiver sees in the adjacent channel based on its adjacent channel selectivity.

The FCC established very stringent limits for WSD conducted adjacent channel leakage. The maximum value allowed, a fixed WSD operating at 1 W conducted power, cannot be greater than -42.6 dBm at a frequency separation of 100 kHz from the WSD channel edge.[33] At these power levels, other than using free space path loss, this value drops off fairly quickly below the DTV threshold with increasing distance from the fixed WSD transmitter. In the real world, for

[31] See M.T. Masonta, L.M. Kola, A.A. Lysko, L. Pieterse and M. Velempini, Network Performance Analysis of the Limpopo TV White Space (TVWS) Trial Network at 2, IEEE Africon 2015.

[32] *See* Amendment of Part 15 of the Commission's Rules for Unlicensed Operations in the Television Bands, Repurposed 600 MHz Band, 600 MHz Guard Bands and Duplex Gap, and Channel 37, and Amendment of Part 74 of the Commission's Rules for Low Power Auxiliary Stations in the Repurposed 600 MHz Band and 600 MHz Duplex Gap, ET Docket No. 14-165, Notice of Proposed Rulemaking, 29 FCC Rcd 12248 (2014) at ¶37.

[33] See Table 1 to 47 CFR §15.709(b)(1)(iii).

fixed WSDs that typically operate on a rooftop or side of a building, there are several loss mechanisms that effectively reduce the signal received from the adjacent channel leakage.

The Commission asks whether tightening the adjacent channels emission limit for fixed WSD white space devices could result in any reduction in the potential for interference to adjacent channel TV reception. The DSA concludes that it is only at the highest EIRP levels, where a tighter emissions mask could make a difference for reducing the potential for interference on the first adjacent channel. Based on our understanding of past challenges the industry has endured in meeting the Commission's current emissions mask, we oppose establishment of a tighter emissions mask.

The second signal component, adjacent channel selectivity, is a function of the DTV receiver. The FCC considers WSD interference into DTV as being noise-like.[34] For this reason, it treats an undesired signal from a WSD operating on the first adjacent channel to a DTV broadcaster as if it is another DTV broadcaster transmitting an undesired signal to a DTV broadcaster operating on the first adjacent channel.[35]

The ratio of the power of the undesired (WSD) signal in the first adjacent channel to the power of the desired DTV signal is given by its D/U ratio. The FCC settled on the D/U ratio for DTV-into-DTV interference on the first adjacent channel over two decades ago and adopted it

[34] See *Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket Nos. 04-186 and 02-380, Second Report and Order and Memorandum Opinion and Order, 23 FCC Rcd 16807 (2008) at ¶167.

[35] Id.

into its rules.[36] The D/U ratio for the first adjacent channel above and below the desired DTV signal are different. Additionally, given the high ERP limit of DTV transmitters and its sideband emission 'splatter' into its first adjacent channel through its emissions mask, apparently this has proved difficult to measure in the field.

The Advanced Television Systems Committee (ATSC) group averaged the Commission's D/U ratio for the first adjacent channel above and below the desired DTV channel, added a 6 dB margin, and recommended a D/U ratio of -33 dB for laboratory measurements that would be equivalent to the Commission's D/U ratio used for planning in the field.[37] Measurements made for the Commission in 2007 validated that the D/U ratios on the first adjacent channel for the DTV receivers test performed were in several instances better than the ATSC recommended value.[38]

In 2008, in its analysis for authorizing personal / portable WSD operations on the first adjacent channel at up to 40 mW, the Commission used the ATSC recommended D/U ratio and the 2007 OET report.[39] In fact, the Commission states, "With regard to TV receiver rejection of

[36] See 47 CFR §73.623(c) and *See Advanced Television Systems and Their Impact upon the Existing Television Broadcast Service*, MM Docket No. 87-268, Memorandum Opinion and Order on Reconsideration of the Sixth Report and Order, February 23, 1998.

[37] Advanced Television Systems Committee, ATSC Recommended Practice: Receiver Performance Guidelines, 4 Document A/74:2010, 7 April 2010 at 15.

[38] See Office of Engineering Technology, FCC, *Interference Rejection Thresholds of Consumer Digital Television Receivers Available in 2005 and 2006*, Report FCC/OET 07-TR-1003 (March 30, 2007).

[39] See *Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, ET Docket Nos. 04-186 and 02-380, Second Report and Order and Memorandum Opinion and Order, 23 FCC Rcd 16807 (2008) at ¶172, footnote 237.

undesired signals on first-adjacent channels, we note that ATSC Standard A/74 specifies a ratio of -33 dB, fully 5 and 7 dB more stringent than our planning factor values, and that our tests of DTV receiver performance demonstrate that those improved selectivity values are included in consumer receivers and set-top boxes. We therefore use the A/74 value in our analysis of the interference potential of TVBDs."[40]

The TV receiver's threshold of detection for the desired signal minus the D/U ratio yield the maximum WSD signal power on the first adjacent channel on the DTV receiver that will not cause interference (*e.g.*, below the detection threshold). The Commission, based on its set of assumptions, can determine the minimum separation distance between the WSD (for a given EIRP level) and the DTV receiver, required for the undesired WSD signal incident on the DTV receiver to be below the WSD power limit.

The most conservative separation distance is represented by the free space path loss model, where there are no other losses. In real world deployments, there are several mechanisms that may cause a reduction in the undesired WSD power incident on the DTV receiver. These mechanisms may include terrain, clutter, angular misalignment, and with respect to WSDs – cross polarization loss. The DTV antenna is horizontally polarized and the WSD antenna is vertically polarized.

Cross polarization loss can be a significant loss mechanism for broadcast television. Annex 1 of Recommendation ITU-R BT.419 is entitled "Advantages to be gained by using

[40] Id. at ¶169.

orthogonal wave polarizations in the planning of television broadcasting services in the VHF and UHF bands."[41] It states:

> *"Investigations have been carried out in the United Kingdom to determine the polarization discrimination in band 9 (UHF) of antennas at typical urban and rural domestic receiving sites. The results showed that for orthogonally polarized signals the median value of discrimination was 18 dB, and under the same conditions, the values exceeded at 90% and 10% of the receiving sites were about 9 dB and 25 dB respectively."*
>
> and
>
> *"Note 3: … However, it has been found in practice that a combined discrimination value of **16 dB** may be applied for all angles of azimuth in the terrestrial television Bands I to V. This value could be expected to be exceeded at more than 50% of locations"*

As the Commission considers an undesired WSD signal on the first adjacent channel as noise-like and treats it in its analysis as it would an undesired DTV signal operating in the first adjacent channel, it should include cross-polarization loss as a minimum into its analysis. The DSA recommends, though, the Commission includes all the likely loss mechanisms in its analysis.

The Commission asks questions about the adjacent channel selectivity in the next generation of TV receivers. While DSA can't directly answer this question, we can point to studies since the 2007 study that indicates the D/U ratio of DTV receivers have improved overall

[41] See *Directivity and polarization discrimination of antennas in the reception of television broadcasting*, ITU-Recommendation ITU-R BT.419, Number BT.419-3 (06/90). June 1990. https://www.itu.int/dms_pubrec/itu-r/rec/bt/R-REC-BT.419-3-199006-I!!PDF-E.pdf.

since the ATSC A/74 recommended value.[42] The 2014 OET study, examining the potential interference of LTE into broadcast TV receivers, observed improved D/U ratios on the first adjacent channel when there was no overlap between the LTE and DTV signals.[43] In 2015, TEM Consulting concluded, "…advances in both DTV and wireless technology have resulted in significant improvement in tolerance of adjacent band signals by DTV." [44] If in fact, there is an improvement in the D/U ratio in the current generation of TV receivers, the Commission should reflect this in its calculation of the WSD power limit in the first adjacent channel on the DTV receiver in the desired channel.

Finally, the DSA expects that there will be a lower level of WSD adjacent channel emissions if it is operating on a channel that is offset by 3 MHz from the edge of the broadcast channel than on the first adjacent channel. Similarly, the expectation is that a given DTV receiver has better adjacent channel selectivity with respect to an undesired WSD signal operating on a channel that is offset by 3 MHz from the edge of the broadcast channel than on the first adjacent channel. The Commission should reexamine allowing fixed WSDs to operate

[42] See Letter from J. Kearney, CEA, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 12-268, ET Docket No. 14-14, at 38 (filed May 22, 2014).

[43] See Office of Engineering and Technology, FCC, *Measurements of LTE into DTV Interference: Tests on four ATSC DTV Receivers of OFDM 64 QAM Co- and Adjacent-Channel Interference*, Report TA-2014-01, at 7421, 7428-7430 (June 17, 2014).

[44] See H. Stephen Berger, TEM Consulting, *LP, Field Study and Technical Analysis of the Potential for Interference from LTE-UE Operating in the 700 MHz A Block to Reception of DTV Channel 51, WPWR-TV*, at 9 (June 2015).

on the middle 6 MHz of the first two adjacent channels to a broadcaster at EIRP levels much higher than 100 mW.

X. CONCLUSION

The DSA commends the Commission for its proposals to make measured improvements to its WSD rules. The DSA agrees with the Commission that a fixed WSD EIRP limit should be increased to 42 dBm in less congested areas. The DSA supports increasing the HAAT limit to 500 meters everywhere, but our preference is for no HAAT limit and allow the separation distances scale accordingly.

The DSA supports authorization of higher power WSD operations on mobile platforms within a geofenced area. Regardless of how the Commission chooses to classify the WSD, it must include a detachable higher gain antenna and the ability to be certified under Commission's fixed WSD rules. The DSA supports the Commission's proposal to create a new category of WSDs – narrow channel – and requests that higher EIRP level per 100 kHz are permitted in less congested areas commensurate with a fixed WSD operating at 42 dBm EIRP.

Finally, the DSA sees the time as right for the Commission to allow WSDB Administrators to use terrain-based models in its calculation of available channels for WSDs and the maximum EIRP limit for each. Use of a terrain-based propagation model, when combined with use of an updated D/U ratio, and taking into account typical loss mechanisms encountered

Dynamic Spectrum Alliance Limited
3855 SW 153rd Drive
Beaverton, OR 97003
United States
http://www.dynamicspectrumalliance.org

in a WSD link budget analysis, should allow higher power fixed WSDs to operate on a first adjacent channel or on a channel with a 3 MHz offset to the broadcast TV station.

Respectfully submitted,

Martha SUAREZ
President
Dynamic Spectrum Alliance