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

In the Matter of	)	
	)	
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	)	ET Docket No. 14-165
	)	
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	)	
	)	
Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions	)	GN Docket No. 12-268

WhiteSpace Alliance

COMMENTS OF WHITESPACE ALLIANCE

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SUMMARY

In the White Space NPRM, the Commission recognizes that following the repacking and repurposing of the television band, there will likely be fewer frequencies available in the UHF band for use by white space devices. However, based on its experience to date with the development and deployment of database-driven white space devices, the Commission recognizes that significant changes can be made in its white space technical rules which will allow for more robust white space services and promote spectral efficiency without increasing the risk of harmful interference to authorized users.

WhiteSpace Alliance is a global organization that promotes the development, deployment and use of products and services in the U.S. and globally that exploit white space technologies as a means of efficiently using underutilized spectrum to provide advanced broadband capabilities. Given its interest in a vibrant and robust white space industry, and as the membership organization of companies developing and deploying white space-based technologies, equipment, and networks, WSA applauds the Commission's efforts to further refine the white space rules, and supports many of the proposals in the White Space NPRM, which if adopted, will help to maximize the white space spectrum available in the reconfigured and legacy broadcast bands for unlicensed white space use. In these comments we also highlight a number of changes proposed by the Commission that may decrease spectral efficiency, or that may impede the development of a robust white spaces ecosystem, and have proposed additional modifications which we believe will foster the development and deployment of white space technologies.

In particular, as discussed more fully in these comments:

- WSA applauds the Commission's proposal to allow white space device operation on two vacant channels on either side of Channel 37, and its decision to no longer designate up to two unused channels for exclusive wireless microphone use.
- WSA fully supports the Commission's proposal to make channels 3 and 4 available for fixed white space device use, which will spur significant interest in providing innovative services for rural broadband, public safety and infrastructure industries in the 54 to 88 MHz band and revive interest for white space products in channels 2 to 6.
- WSA opposes the unqualified removal of the restriction on personal/portable use in channels 14 to 20, and believes that the small form factor desirable for antennas of personal/portable equipment would probably result in lower receiver sensitivity and therefore increased transmit power requirements, which is incompatible with low power, battery operated devices. Should the Commission nonetheless decide to permit portable devices below Channel 20, then it should, at a minimum, require that portable devices operating on these channels have a minimum antenna factor of 32 dB to ensure optimal use and spatial re-use of the spectrum, and prevent spectral leakage that will interfere with or preclude other uses.
- WSA fully supports the Commission's proposal to allow full power, 4 watts EIRP/6 MHz fixed white space devices to operate centered over two contiguous channels, which would eliminate the need for three vacant channels, or "triplets" for fixed white space device operations, and urges the Commission to authorize similar operations over three adjacent channels, which, would allow at least 12 MHz to be used over three channels, rather than 6 MHz under the current rules.
- WSA agrees that authorizing operations at intermediate power limits with corresponding adjustments to separation distances would allow greater flexibility and more efficient use, and closely corresponds to what is done in other jurisdictions, such as the U.K. WSA has a significant concern, however, with the Commission's assumption that the power of a device will be confined to a 5.5 megahertz band, and believes that base-lining the transmit spectrum mask to 5.5 MHz will require changes to the current IEEE 802.22 (Wi-FAR™) radio implementations, which since 2007 have specified a 5.6 MHz operation out of the available 6 MHz Channel. Instead, we urge the Commission to allow white space devices to occupy as much of the 6 MHz band as possible as long as they can meet the spectrum mask limits as specified by the FCC.
- WSA generally agrees that the location of a deployment in a rural market should alter the maximum allowable power level, but cautions that the increase in transmit power should not be allowed to compensate for inefficient receive antennas due to their limited size in portable devices, especially at lower frequencies, and recommends that the Commission adopt a table of maximum allowed output power versus distance between the receiver and the transmitter.
- WSA fully supports modification of the current emissions limits to allow users to make better use of the efficiencies associated with channel aggregation and channel bonding. That said, we also urge the Commission to provide for sufficient flexibility in its rules, so that devices themselves can make dynamic decisions on channel bonding and channel aggregation based on information on channel availability in the white space database.

- While WSA agrees that it makes sense to amend the table of separation distances in the Commission's rules to reflect the range of power levels below four watts EIRP at which fixed devices will be permitted to operate, we believe that separation distances are affected by antenna gain and directivity, and should be expressed in units of EIRP in the direction of the contour. Among other changes, WSA also prefers that the database provide the powers that are allowed on each channel at a given location, and also agrees that the current table of separation distances is overly conservative in some cases, limiting the amount of white space spectrum available for unlicensed devices, and should consider, for example, the effects of topography. WSA also agrees that the Commission should modify its rules to consider the directional antenna pattern for fixed white space devices, and recommends that the database provide maximum EIRP in various directions (*e.g.*, every 6 degrees) from the location of the device.
- In terms of white space device operation in the 600 MHz guard bands, while white space devices will meet the spectrum mask and they will abide by the requirements as conveyed to them by the database service in order to avoid causing interference, WSA recommends that similar requirements be imposed upon the downlink and the uplink transmissions of new Part 27 devices in the 600 MHz band to reduce mutual interference and optimize spectrum efficiency. WSA also believes that a requirement of a 3 MHz buffer would result in significant spectrum inefficiency, and greatly reduce the utilization of the guard bands for unlicensed use, as mandated by the Spectrum Act. WSA believes that the proposed 3 MHz guard buffer could be reduced to as little as 200 kHz.
- WSA agrees that the 3 MHz guard band on one or both sides of channel 37 should be combined with the 6 MHz of channel 37 in areas where it is not being used for RAS and WMTS to create a wider band for white space device use. WSA also supports the Commission's proposal to remove the stringent band emission limits on white space devices thus making channels 35, 36, 37, 38 and 39 useable by white space devices.
- With regard to the white space databases: additional geographic based protection for WMTS, 600 MHz Band services, and several radio astronomy sites, not currently protected by white space databases could be accommodated within a white space database system without significant additional work; the U.S. White Space Database Administrator's group can utilize a specification and procedure it developed for efficiently sharing information among databases to share information, as required, with Canadian White Space Databases to protect registered Canadian entites; the proposed method of operation for unlicensed wireless microphones is technically achievable but would require changes and provide additional load on the database, and the Commission should consider making provision for mechanisms that allow for cost recovery associated with outlays for associated increased server resources; shortening device re-check intervals and synchronization time of registrations between databases should not place an undue burden on the White Space Database, but we believe that several polling intervals without response from the database be allowed before requiring the device to cease transmission.

Finally, WSA notes that one of the major disincentives of manufacturing and deploying white space devices has been uncertainty in the technical rules governing white space

deployments. For this reason, WSA urges the Commission to complete the adoption of the revised white space rules in the instant proceeding as expeditiously as possible, take specific steps to expedite the white space device certification process, and ensure that the use of existing certified equipment and databases is grandfathered so as not to further delay the deployment of white space technologies and applications, and in order to preserve the considerable investment of the industry in existing white space technologies.

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COMMENTS OF WHITESPACE ALLIANCE

WhiteSpace Alliance ("WSA") respectfully submits its comments in response to the Notice of Proposed Rulemaking of the Federal Communications Commission ("FCC" or "Commission") in the captioned proceeding.[1]

I. INTRODUCTION AND BACKGROUND

In the White Space NPRM, the Commission recognizes that following the repacking of the television band and the repurposing of vacate television channels for wireless services

[1] 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; Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, ET Docket No. 14-165, GN Docket No. 12-268, Notice of Proposed Rulemaking, FCC No. 14-144 (Sept. 30, 2014)("White Space NPRM" or "NPRM").

required by the Spectrum Act and the Incentive Auction Report and Order,[2] there will likely be fewer frequencies available in the UHF band for use by white space devices.[3] At the same time, based on its experience to date with the development and deployment of database-driven white space devices, the Commission recognizes that significant changes can be made in its white space technical rules adopted in the TV white space proceedings,[4] which "will allow for more robust service and efficient spectral use" of white space devices "without increasing the risk of harmful interference to authorized users."[5] Among other things, the NPRM asks for comment on numerous proposed technical changes largely intended to relax various existing technical requirements that are no longer necessary to protect incumbent users, which if adopted, are intended to maximize the availability of white spaces in the TV bands for the deployment and use of white space devices.

WSA (www.whitespacealliance.org) is a global organization that promotes the development, deployment and use of products and services in the U.S. and globally that exploit white space technologies as a means of efficiently using underutilized spectrum to provide advanced broadband capabilities.[6] WSA also promotes the opportunistic use of licensed

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[2] Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, §§ 6401, *et seq.*, 125 Stat. 156 (2012) ("Spectrum Act"); *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, 29 FCC Rcd 6567 (2014) ("Incentive Auction Report and Order).

[3] NPRM, ¶ 1.

[4] *See* generally Unlicensed Operation in the TV Broadcast Bands, Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band, *First Report and Order and Further Notice of Proposed Rule Making*, 21 FCC Rcd 12266 (2006); *Second Report and Order and Memorandum Opinion and Order*, 23 FCC Rcd 16807 (2008)("*Second White Spaces Report and Order*"); *Second Memorandum Opinion and Order*, 25 FCC Rcd 18661 (2010) ("*Second White Spaces Reconsideration Order*"); *Third Memorandum Opinion and Order*, 26 FCC Rcd 3692 (2011)("*Third White Spaces Reconsideration Order*").

[5] NPRM, ¶ 3.

[6] WSA members include device manufacturers (*e.g,*. Carlson Wireless, Hitachi Kokusai, AmeriSys, Nutaq), chip manufacturers (*e.g.*, Texas Instruments, Saankhya Labs, Ramics), service and solution providers (*e.g.*, Tata Communications), research laboratories (*e g.*, NICT, ETRI) and database providers (*e.g.*, iconectiv, ISB Corporation). A complete list of WSA's members is available at *www.whitespacealliance.org/Members.html*.

spectrum by unlicensed cognitive radios. Such devices, driven by geolocation databases (or together with sensing technologies and beaconing approaches), can operate on vacant, unassigned frequencies, as well as on frequencies that may be licensed but are not yet in use.[7] In addition, WSA supports the maximum availability of unlicensed spectrum in licensed bands, which, together with vacant and unused channels in these bands, can provide additional bandwidth necessary to support robust broadband communications.

Given its interest in a vibrant and robust white space industry, and as the membership organization of companies developing and deploying white space-based technologies, equipment, and networks, WSA applauds many of the proposals in the White Space NPRM, which if adopted, will help to maximize the white space spectrum available in the reconfigured and legacy broadcast bands for unlicensed white space use. As the Commission has recognized, maximizing TV spectrum for unlicensed white space device use, will spur unique innovations to address better the meaningful communications needs of consumers, businesses and government agencies.

Unlicensed use supports a wide variety of public and private services for consumers and businesses at generally lower cost than presently available mobile broadband services.[8] Widespread deployment of new unlicensed white space technologies will foster competition and innovation, and improve the diversity of communications infrastructure, which is essential at times of emergency to aid disaster recovery. White space technologies will also assist

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[7] Indeed, in the Incentive Auction Report & Order, the Commission specifically authorized the continued operation of white space devices on repurposed TV band spectrum pending commencement of operations by the new wireless licensee. Incentive Auction Report and Order, ¶ 680.

[8] *See Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Docket No. 12-268, Notice of Proposed Rulemaking, FCC No. 12-118, ¶ 228 (Oct. 2, 2012)("Incentive Auction NPRM").

commercial wireless providers, serving as an important new source of broadband capacity for offloading network traffic and reducing network congestion.

One other important and essential use of the white spaces is for cost-effective middle mile connectivity. The absence of sufficient and robust middle mile connectivity, particularly in many rural markets, is a major cause of the so-called digital divide. This is because, while solutions and spectrum may exist for last mile access, in the absence of robust middle mile connectivity in rural markets, true, high speed Internet access cannot be provided.

Fostering solutions that bridge the broadband gap on middle mile connectivity is also an opportunity for chip and device manufacturers in the United States to provide cost-effective solutions to serve this large market. This will also potentially bring billions of dollars in revenues to the United States in terms of exports to emerging economies. On the other hand, not having a sustainable white space ecosystem, including inadequate white space spectrum in the United States, will have an adverse impact on the manufacturers of these solutions and the U.S. economy as a whole.

WSA also supports the development and deployment of standards-based white space products and services as an enabler of an emerging and robust white spaces ecosystem. IEEE 802,[9] has already published standards for white space devices and is in the process of completing additional amendments to standards which support additional operation in the TV broadcast bands under the Commission's Part 15 rules. These include the use of the IEEE 802.22 (Wi-FAR™), IEEE 802.11 (Wi-Fi™), 4G-WhiteSpace™, and IETF PAWS standards.

For example, the WhiteSpace Alliance Wi-FAR specification will allow for the deployment of wireless regional area networks (or "WRANs") that with current technology can

[9] The IEEE Local and Metropolitan Area Networks Standards Committee ("IEEE 802").

deliver a wireless broadband connection over 30 km (19 miles) from the base station, and provide speeds of up to 22 Mbps in a standard 6 MHz TV channel. In addition, the Internet Engineering Task Force (IETF) is likewise developing a standard protocol to access the white space database,[10] and there are numerous other ongoing standardization activities for a wide variety of applications using white spaces.[11] WSA estimates that more than $200 million has been invested by various companies and organizations to participate and create these inter-operability specifications.

These standards and amendments support applications which include rural and regional broadband wireless access, hotspots in rural, remote, and other types of areas, wireless local area network operations, including home, business applications and cellular data offload applications, and machine to machine ("M2M") operations, including smart grid and smart metering applications.[12] Hence, unlicensed TV white space device use in the TV bands will support applications such as rural broadband, healthcare, education, smart utility networks, disaster recovery, environment monitoring, critical infrastructure monitoring, border protection, homeland security, high speed internet, among others. This will also create a digitally inclusive economy where both, urban and the rural areas have additional ways to be able to obtain cost-effective broadband connectivity. This will in turn create diversity in the market and reasonable costs.

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[10] IETF is considering a standardized protocol for accessing white spaces data bases (known as the Protocol to Access White Spaces Data Bases or "PAWS"), in order to achieve interoperability among multiple White Spaces devices and databases. *See* *http://datatracker.ietf.org/wg/paws/*.

[11] These include, for example, IEEE 802.11af (Wireless Local Area Networks), IEEE 802.15.4m (Wireless Personal Area Networks), IEEE 802.19.1 co-existence in TV Band White Spaces, and IEEE DySPAN (Dynamic Spectrum Access Network), among others.

[12] WSA itself is developing and adopting numerous such standards for a wide variety of such applications. WSA will also engage in interoperability and conformance testing of white space devices and associated certification in order to provide low cost, reliable equipment for consumers in the U.S. and globally. WSA is also developing WSA Connect™, an IETF PAWS certification and inter-operability testing specification.

As discussed in comments filed by WSA in the incentive auction proceeding, there are already numerous white spaces success stories in the U.S. and throughout the world, reflecting the emergence of a robust white space ecosystem based on the Commission's white space regime, comprised of technology companies, equipment manufacturers, wireless providers, and governmental entities.[13] Given the TV bands' favorable propagation characteristics, improved building penetration and resulting enhanced regional and rural coverage, with the adoption of appropriate rules in this proceeding, TV white space deployments are poised to become increasingly vital across numerous industries and sectors.

WSA urges the Commission to continue to foster the demonstrated benefits of unlicensed white space through efforts such as this proceeding to streamline and update its technical rules to reflect recent experience with white space technologies and improvements in technology. At the same time, WSA notes that one of the major disincentives of manufacturing and deploying white space devices has been uncertainty in the technical rules governing white space deployments. For this reason, WSA urges the Commission to complete the adoption of the revised white space rules in the instant proceeding as expeditiously as possible, so that the whitespace ecosystem can flourish and devices can be deployed on a large scale. In addition, the certification of the white space devices under the existing rules has been a long and difficult process. WSA urges the Commission to take specific steps to expedite the white space device certification process including using Telecommunication Certification Bodies (TCB) to the maximum extent feasible for white space device testing and certification. Finally, it is imperative that the Commission grandfather the use of existing certified equipment and databases so as not to further delay the deployment of white space technologies and

[13] *See* Comments of WSA in ET Docket No. 12-268, Attachment A (Jan. 25, 2013).

applications, and so as to preserve the considerable investment in existing white space technologies that has already been made.

II. DISCUSSION

A. Fixed and Portable White Space Devices

1. Permissible frequencies of operation

Elimination of prohibition on white space device operation on first two vacant channels above and below channel 37. WSA applauds the Commission's proposal to allow white space device operation on two vacant channels on either side of Channel 37, and its decision to no longer designate up to two unused channels for exclusive wireless microphone use.[14] At the same time, the Commission still appears to be proposing to establish a preference for wireless microphone use in these channels to the exclusion of white space devices by increasing the frequency at which white space devices must query the database for microphone operations, and hence the speed with which it must cease operations. WSA believes that push technology whereby, the database actively pushes information back to the WSDs would be far more efficient and could provide sub-second response times. As we discuss below, in theory the databases can handle the increased queries that would flow from the Commission's proposal, but the Commission should also consider including mechanisms that allow for cost recovery associated with outlays for increased server resources, which could flow from adoption of its proposal.

WSA also questions the Commission's proposal where only one channel is available after repacking to make that channel available on a shared-use basis between white space devices and

[14] *See* NPRM, ¶ 25.

wireless microphones.[15] WSA believes that if only one channel may be available, and it were to be shared with microphones, as microphones would have precedence over white space devices, there would be no incentive for any operator to use the available channel, as vacating that channel would result in a denial of service to its customers. In addition, we believe that allocating a specialized channel for wireless microphones, or allowing shared use in single channel markets is not necessary, since broadcasters typically place wireless microphones on channels adjacent to their licensed broadcast services.

Operations of fixed devices on channels 3 and 4. WSA fully supports the Commission's proposal to make channels 3 and 4 available for fixed white space device use.[16] Doing so will spur significant interest in providing innovative services for rural broadband, public safety, and infrastructure uses, among others, in the 54 to 88 MHz band and revive interest for white space products in channels 2 to 6. Without this possibility, and a gaping "hole" in the middle of the band, it is possible that manufacturers would stay away from the VHF low band altogether. One reason this is the case is that manufacturers need to consider that devices operating in this band require the inclusion of a third harmonic low pass filter to protect channels 7-13 (174 to 216 MHz) when Channels 2 to 6 are being used. However, if channels 3 and 4 remained unavailable, this would only allow for operations in channels 2, 5, and 6, and particularly with the large antenna size required in these frequencies, it is anticipated that manufacturers would in all likelihood choose not to offer a product covering those three channels. However, with two more channels available, for a total of five channels, WSA believes that white space device manufacturers would find product development in this band far more appealing. Given the

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[15] *Id.*, ¶ 26.

[16] *Id.*, ¶ 28.

propagation characteristics in the 54 to 88 MHz band, WSA would anticipate that this would be a boon not only for rural deployments, but for public safety and infrastructure-related deployments as well.

Removal of restriction on personal/portable use in channels 14 to 20 (470 MHz to 512 MHz). WSA opposes the removal of the restriction on personal/portable use in channels 14 to 20.[17] We believe the removal of the restriction on personal/portable use in channels 14-20 would give a false illusion of spectrum availability. For one thing, antennas in these bands have to be physically large to be efficient receivers. The small form factor desirable for antennas of personal/portable equipment would probably result in lower receiver sensitivity and therefore increased transmit power requirements. This is incompatible with low power battery operated devices. It provides a false illusion that such spectrum would have been made available. Therefore, it would be better to maintain the current restrictions on personal portable devices and instead, make higher frequency spectrum available to those devices.

Millions of Americans today do not have economical access to low-latency broadband connectivity, a majority of whom live in rural areas where there is a dire need for cost-effective middle mile and backhaul solutions. In order for the U.S. to provide pervasive and cost-effective broadband connectivity, this middle mile problem needs to be solved, and maintaining available white spaces in channels 2-20 for fixed white space device operation is of paramount importance. Allowing personal portable operation in these channels will reduce the availability of these channels for longer distance applications, in favor of short range connectivity, which can be better achieved in higher frequency bands. If, however, the Commission nonetheless decides to permit portable devices below Channel 20, which it should decline to do, then the

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[17] *Id.*, ¶ 31-32.

Commission should, at a minimum, require that portable devices operating on these channels have a minimum antenna factor of 32 dB to ensure optimal use and spatial re-use of the spectrum, and prevent spectral leakage that will interfere with or preclude other uses.

2. Fixed device operation on adjacent channels

Operation of fixed devices where two contiguous channels are available. WSA fully supports the Commission's proposal to allow full power, 4 watts EIRP/6 MHz fixed white space devices to operate centered over two contiguous channels, which would eliminate the need for three vacant channels, or "triplets" for fixed white space device operations.[18] As the Commission recognizes in the NPRM, white space operations as proposed within two contiguous adjacent channels "will not increase the potential of interference to television reception."[19] WSA also believes that further optimization and operation can be carried out with current white space device transmit and receive filter specifications, however this could be considered in later proceedings.[20] In addition, as WSA urged in its incentive auction comments, the Commission should authorize similar operations over three adjacent channels, which, would allow at least 12 MHz to be used over three channels, rather than 6 MHz under the current rules.

As WSA urged in its comments on the incentive auction NPRM, this would significantly increase spectrum available for white space deployments in several respects.[21] First, in contrast to the current situation where triplets are required for fixed white space deployments, only two channels would be required on either side of a TV station. The result would allow white space

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[18] *Id.*, ¶ 37.

[19] *Id.*

[20] WSA believes that the 3 MHz buffer proposed in the NPRM is far too conservative and can be significantly reduced, particularly over time as the embedded base of legacy television broadcast receivers are reduced.

[21] *See* WSA Incentive Auction Comments at 32-33.

deployments over a far greater range of scenarios where there are two vacant channels, as opposed to the need to find triplets. In addition, where there are triplets, at least 12 MHz of spectrum would be available for operations over the 18 MHz block. This is in contrast to the current scenario where even with a triplet, only 6 MHz would be available in the center channel, with the two end channels remaining vacant for protection. Hence, all the doubles become usable and the capacity in all the triplets can be at least doubled.

3. Operation at lower power levels

Use of Intermediate Power Limits. The NPRM proposes authorization of operations at intermediate power limits with corresponding adjustments to separation distances.[22] Basically, the Commission would propose a series of tables defining separation for fixed operations at intermediate power levels of 40, 100, 250, 625, and 1600 milliwatts. Such an approach would allow greater flexibility and more efficient use, and closely corresponds to what is done in other jurisdictions, such as the U.K., and should provide more optimal operation outlooks.

We do however, have significant concerns with the Commission's assumption that the power of a device will be confined to a 5.5 megahertz band to allow a 250 kilohertz roll-off at the upper and lower edges of a channel to meet the adjacent channel emission limits.[23] We urge the Commission to allow white space devices to occupy as much of the 6 MHz band as possible as long as they can meet the spectrum mask limits as specified by the FCC.

WSA believes that base-lining the transmit spectrum mask to 5.5 MHz will require changes to the current IEEE 802.22 (Wi-FAR™) radio implementations. Since 2007, the Wi-FAR inter-operability standard has specified a 5.6 MHz operation out of the available 6 MHz

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[22] NPRM, ¶ 40.

[23] *Id.*, ¶ 41.

Channel. In fact, several device and chip manufacturers have already implemented the Wi-FAR specification in hardware. Figures 1 and 2 below show the output conducted transmission mask from two manufacturers that are WSA members:

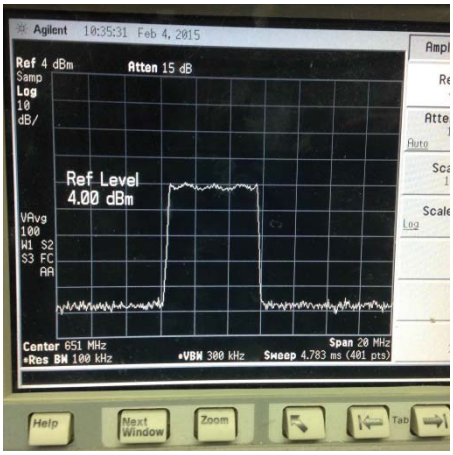

Figure 1: Conducted output transmission spectrum of Carlson Wireless white space device

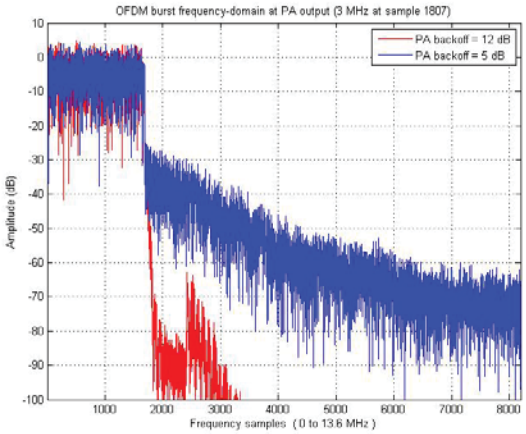

Figure 1: Output conducted transmission spectrum of AmeriSys white space device with 12 dB backoff

These devices meet the requirements of the Wi-FAR specification as well the Commission's Third White Spaces Reconsideration Order. However, any changes requiring base-lining the transmit mask to 5.5 MHz bandwidth may require substantial changes to the current hardware implementations.

4. Technical rule changes to facilitate white space devices in rural areas

Definition of operation in rural area. The Commission proposes to define rural areas as the areas where at least half of the TV channels are unused and available for white space use, and to relax various white space technical rules in these areas.[24] We generally agree that the location of a deployment in a rural market should alter the maximum allowable power level – i.e. if there is nothing to protect, then higher power should be allowed, provided TV incumbent operation contours remain protected.

[24] *Id.*, ¶ 45.

Allowing 10 Watts operation in rural areas for Fixed Devices. We welcome the use of 10 dBi antenna gain for up to 10 Watts EIRP.[25] In fact, this will promote efficient frequency re-use as a result of high gain directional connectivity. Although WSA welcomes increase of conducted power to 10 watts, it also cautions in order for this band to be used efficiently, that the increase in transmit power should not be allowed to compensate for inefficient receive antennas due to their limited size in portable devices, especially at lower frequencies.[26] Consequently, we recommend that the Commission adopt a table of maximum allowed output powers versus distance between the receiver and the transmitter. We are concerned with the efficient use of the band, and such power should only be authorized when long-range connectivity is needed (e. g. > 15 km).

Higher power limits for portable devices in rural areas. We caution the Commission that higher conducted power for personal portable devices could result in lower spatial re-use of the band and therefore recommend that the Commission mandate higher gain antennas on personal portable devices, rather than higher power limits. The Commission asks if it should adopt special requirements if it allows personal/portable devices to operate at higher power levels.[27] As one example, the Commission asks whether personal/portable devices should be required to comply with larger separation distances from authorized services than fixed devices operating at comparable power levels.

In WSA's view, fixed devices have inherently more stable directional properties as their antennas are fixed and, by definition, do not move. Personal portable devices by their nature have antennas which may significantly move beyond the control of the network operator. In

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[25] *Id.,* ¶ 49.

[26] *See id.,* ¶ 50.

[27] *See id.,* ¶¶ 51-53.

addition, it is a well known fact that radio energy may bounce off large objects (such as mountains, large buildings, and other structures), and be misdirected, potentially causing harmful interference to licensed incumbent services. If such were to happen from a fixed device, it is reasonable to assume that it can be tracked down and corrected. However, due to the intermittent (due to orientation) nature of the transmissions from a personal portable device, it may be difficult to track down such interference. Once again, we recommend that rather than allowing higher conducted power from the personal portable devices, this be accommodated by using higher gain antennas.

In addition, we believe that the database should be sufficient to limit power versus location and thereby provide incumbent protection. Therefore, power limitation policy should be expressed by the FCC via the database and may be changed by the FCC at a further time, even after a device has been, manufactured, installed and deployed.

5. Channel bonding and out-of-band emission limits

In its discussion of channel bonding and out-of-band emission limits, the Commission recognizes that its three-part rule on out-of-band emission limits,[28] do not account for the fact that white space devices can transmit on multiple bonded channels simultaneously.[29] In particular, the Commission notes that modification of the current emissions limits will allow users to make better use of the efficiencies associated with channel aggregation and channel bonding. WSA fully supports this proposal and agrees with the Commission that it will allow the development of devices that transmit at higher data rates, thus making higher speed equipment available to service providers and consumers and promoting the efficient use of

[28] *See* 47 C.F.R. § 15.709(c)(1), (3) and (4).

[29] *See* NPRM, ¶¶ 56-62.

available white spaces. While WSA generally supports the specific rule changes proposed by the Commission for out-of-band emissions limits in adjacent channel scenarios,[30] we also urge the Commission to provide for sufficient flexibility in its rules, so that devices themselves can make dynamic decisions on channel bonding and channel aggregation based on information on channel availability in the white space database.

The Commission also proposes new adjacent channel emission limits, corresponding to various conducted power limits that it is proposing to authorize for fixed devices.[31] WSA agrees that varying the adjacent channel emission limit based on the conducted power limit of the device, as proposed in the table in paragraph 59 of the NPRM, is reasonable. We also agree with the Commission that this will provide greater flexibility for users, allowing closer operation to TV contours, while protecting incumbents, and would be preferable to setting the fixed level of -42.8 dBm for all power levels.[32]

That said, WSA believes that the conducted transmit mask should remain the same no matter what the antenna gain is.[33] Any change in the resulting separation distance could be accommodated by the database. It has taken the industry considerable time to reach the current spectrum mask levels. Any additional levels change is likely to create further delays in implementation of white space devices. WSA believes that higher gain antennas (*e.g.*, greater than 6 dBi) are likely to be spatially constrained, and oriented in such a way so as to not cause interference. Hence the spectrum mask limits should not be altered for directional antennas with higher antenna gains.

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[30] *Id.*, ¶¶ 56-58.

[31] *Id.*, ¶ 59.

[32] *Id.*, ¶ 60.

[33] *Id.*, ¶ 61.

WSA agrees that technology is available today to meet the current mask in a reasonably economical fashion.[34] Relaxation of the mask will probably result in a slight cost reduction but we believe that the adverse effects (e.g., delay in rulemaking and spectrum efficiency, protection of incumbents, restrictions on available channels) far outweigh this slight reduction in cost. In order for this industry to swiftly move forward and deployments to begin, we recommend stability in the specification of the spectrum mask. In addition, fixed devices that can control their power down to 40 mW should be allowed to operate on channels that are adjacent to the TV incumbents.

The database does not need to be aware of the white space device characteristics, it just needs to supply the device with maximum allowed power in each channel at its location. The device can then determine if and how (in what mode, aggregation, bonding, etc.) in full respect to the requirements at its location.

6. Calculating separation distances from a TV station contour

WSA agrees that it makes sense to amend the table of separation distances in the Commission's rules to reflect the range of power levels below four watts EIRP at which fixed devices will be permitted to operate.[35] That said, we believe the proposed table of separation distances in paragraph 66, as it is affected by antenna gain and directivity, should be expressed in units of EIRP *in the direction of the contour*. For example, depending on the white space device antenna gain, directivity and orientation, separation distances will be affected. Thus, expressing units of EIRP in the direction of the contour more closely represents a fair assessment of required signal levels to protect incumbents.

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[34] *Id.*, ¶ 62.

[35] *Id.*, ¶ 65.

Moreover, for rural broadband connectivity, customer premises equipment (CPE) radiating above 1 Watt EIRP (*e.g.*, 4 Watts EIRP) need to have antennas with gain and directivity. For example, the IEEE 802.22 (Wi-FAR™) Standard recommends that CPEs have a front-to-back lobe ratio of 14 dB similar to TV receiver antennas. In such cases, where the antenna directivity is pointing away from the protected contour, additional reduction in the separation distance should be allowable. In this case, the database could provide additional information on the maximum power that is allowed in various directions in order to most efficiently use these frequencies while protecting incumbents. In particular, WSA prefers that the database provide the powers that are allowed on each channel at a given location.

The Commission also proposes to include HAAT considerations in required co-channel and adjacent channel separation distances.[36] WSA agrees that HAAT considerations should be applied for fixed and portable devices in order to improve the spectrum efficiency and protect incumbents, and fully supports the Commission's proposal to meticulously provide the HAAT with variable EIRPs.

WSA also agrees that the current table of separation distances is overly conservative in some cases, limiting the amount of white space spectrum available for unlicensed devices.[37] For example, contours should consider the effects of topography to ensure white space device cannot operate because a "perfect circle" predicts incumbent service when topography precludes service in a given location.[38]

In particular, WSA believes that using a model such as Shuttle Radar Topography Mission (SRTM-2002) and assuming Line of Sight (LoS), very precise worst case interference

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[36] *See id.*, ¶¶ 66-68.

[37] *Id.*, ¶ 69.

[38] *Id.*, ¶¶ 70-72.

may be calculated very quickly. This model considers topography, and this would provide precise and deterministic answers on interference. The contours may still be computed based on the F curves to provide the available power per direction and hence it does not change the established method for computing the protected contours of the TV incumbents.

WSA also agrees that the Commission should modify its rules to consider the directional antenna pattern for fixed white space devices.[39] WSA's position is that the antennas for fixed apparatus should be professionally installed. In addition the IEEE 802.22 (Wi-FAR™) standard mandates that fixed devices must communicate antenna characteristics (pattern, directivity, gain) to the individual white space device transceiver so the device is cognitive and can take appropriate action. If the separation tables are created with EIRP rather than conducted radiation in any direction that may impinge on a contour, then the individual white space device transceiver can determine if the white space device can operate in compliance with the requirements based on antenna information registered with the database.

WSA also recommends that the database provide maximum EIRP in various directions (*e.g.*, every 6 degrees) from the location of the device. The IEEE 802.22 (Wi-FAR) standard working group as well as the WSA have created an interface between the antenna and the device. The antenna pattern is stored in a memory device lodged in the antenna. This antenna pattern is conveyed back to the white space device. The transceiver will then correlate the information from the database with the antenna pattern and adjust its output power so as to avoid interference to incumbents.

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[39] *Id.*, ¶¶ 73-75.

This was recommended precisely to control the radiation in different directions. Even subsequent to the antenna replacement, the transceiver upon powering up will realize the antenna substitution and readjust the maximum output power to comply to the database requirements.

7. Location accuracy

The Commission asks whether other location methods besides GPS can determine a white space device's location to within ± 50 meters necessary to provide location information to the white spaces database.[40] Other methods (such as terrestrial geolocation methods) have been proposed and adopted within the IEEE 802.22 standard for determining device location. In addition, the service map of a white space device could be "downloaded" to base stations/access points to which CPE/stations are enslaved. Such information is static for each base station/access point until an update is made at the database. Details of every slave could be managed by the master base station/access point and the burden on the database is greatly reduced, especially in cases where the CPE/stations are personal/portable devices. We do not see the logic nor the need to provide this information directly from the database to the slaves, the master being able to act as a local proxy.

In response to the Commission's question whether white space devices should be allowed to use less accurate geolocation methods so long as they provide the same level of protection to authorized services,[41] WSA believes that it is imperative that the white space devices maintain information on the accuracy of its geolocation technique. We also recommend that the coverage area be determined with respect to a fixed device such as a base station, which may have more accurate geolocation information than portable devices. WSA also recommends that if the

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[40] *Id.*, ¶ 76.

[41] *Id.*, ¶ 77.

manufacturer builds a white space device with a lower resolution for geolocation, then the consequential burden to compute the available channel list should be placed on that device in the sense that the device will be required to make many more queries to cover for the poor accuracy.

8. 600 MHz Guard Bands and Duplex Gap

In terms of white space device operation in the 600 MHz guard bands, the Commission proposes to protect Part 27 devices operating in adjacent frequencies by limiting the power of white space devices in the guard bands and by requiring a 3 MHz buffer between the edge of the channel used by the white space device and wireless downlink services.[42] As required by the Spectrum Act, WSA fully supports use of unlicensed devices in the guard bands and the duplex gaps, and commends the Commission's efforts to tailor the white space rules for operations in the guard bands and the duplex gaps in a manner that maximizes the availability of this spectrum for white space device use, while protecting new commercial wireless uses in adjacent bands.

In particular, WSA believes that Fixed and Mode II, Mode I portable devices today will be able to meet the proposed spectrum mask requirements for white space devices operating in the guard bands.[43] It has been demonstrated today that database driven white space devices do not cause interference to incumbent services. While white space devices will meet the spectrum mask and they will abide by the requirements as conveyed to them by the database service in order to avoid causing interference, WSA recommends that the Commission consider whether similar requirements should be applied to the downlink and the uplink transmissions of new Part 27 devices in the 600 MHz band to reduce mutual interference and optimize spectrum efficiency

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[42] *Id.*, ¶ 81.

[43] For an illustration of this, *see* Figures 1 and 2, above.

by allowing white space devices to use the guard bands and duplex gaps free of spurious emissions from the licensed devices, and vice versa.

The Commission, however, proposes, a 3 MHz "buffer" or separation between white space devices and the Part 27 device receive band in order to offset a worst-case interference distance of less than seven meters.[44] WSA believes that a requirement of a 3 MHz buffer would result in significant spectrum inefficiency, and greatly reduce the utilization of the guard bands for unlicensed use, as mandated by the Spectrum Act.

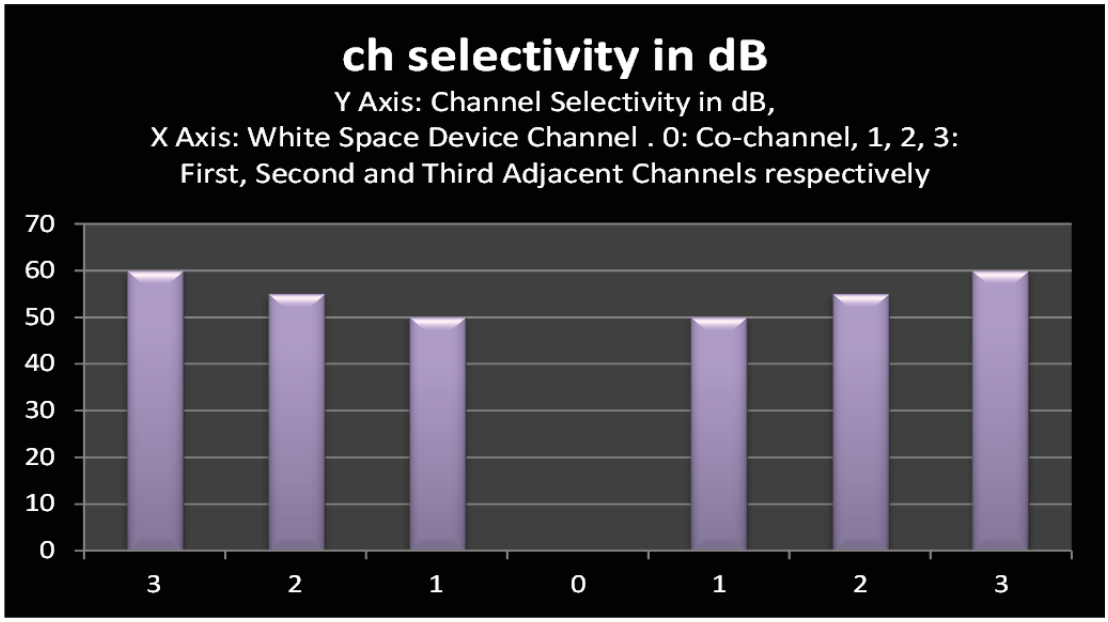

Figure 3: Receiver selectivity of a white space device from WSA member company

Today, white space devices not only have to meet the spectrum mask requirements on the transmit side, but they also have to have sufficient selectivity on the receive side in order to operate in the adjacent channel to a higher power television transmitter. White space device manufacturers have shown that devices can be implemented with such selectivity where they are able to operate adjacent to a high power TV transmitters. White space device manufacturers

[44] *See* NPRM, ¶¶ 81-82.

have already deployed devices with greater than 50 dB of selectivity in the adjacent channel, which is a 17 dB improvement over the Commission's assumption of 33 dB rejection in its calculations. Current white space device implementations only require a buffer of 200 kHz in order to achieve this level of performance. Hence, WSA believes that the proposed 3 MHz guard buffer likewise could be reduced to as little as 200 kHz. For the reasons noted above, we see no reason why Part 27 devices occupying bands adjacent to the guard band should not be manufactured in such a way that the white space devices could operate immediately adjacent to the Part 27 devices with as little as 200 kHz separation and at 4 Watts allowed for fixed devices.

Alternatively licensed carriers might consider using white space devices where they can, due to white space devices' superior transmit mask characteristics and receiver selectivity. This will also enhance spectrum efficiencies in these bands.

The only exception to this that should reasonably be considered by the Commission would be to grandfather existing TV, radio astronomy, and medical telemetry receivers and provide protection to these legacy apparatus. New Part 27 equipment entering the band could be manufactured to the same requirements that white space device manufacturers have shown to be technically and economically feasible, and that are more spectrally efficient.

9. <u>Channel 37</u>

Power limits and separation distances. WSA strongly supports the use of white space Mode II, Mode I and Fixed devices up to an EIRP of 4 watts on Channel 37 and guard bands.[45] The signal level protection contours, managed by the database for WMTS and the RAS sites, proposed by the commission for the 3 scenarios, seem reasonable.

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[45] *See Id.*, ¶¶ 101 - 121.

Green Bank and Arecibo Observatory. WSA agrees with the Commission's proposal that white space devices not operate on channel 37 within the National Radio Quiet Zone around Green Bank or on the islands of Puerto Rico, Desecheo, Mona, Vieques or Culebra and be relieved of Section 1.924 of the Rules.[46]

Guard bands adjacent to Channel 37. The Commission notes that under certain spectrum recovery scenarios, there will be a 3 MHz guard band on one or both sides of channel 37, potentially resulting in a contiguous block of 9 or 12 MHz of spectrum. The Commission asks whether these guard bands could be combined with channel 37 in areas where it is not being used for RAS and WMTS to create a wider band for white space device use.[47] As discussed above in its comments to the Commission's channel bonding proposal, WSA fully supports the ability to bond adjacent channels and spectrum wherever available, to channels available for white space device use. The Commission's proposal to allow adjacent guard band spectrum to be bonded with Channel 37 is no different, and would potentially permit the aggregation of up to 12 MHz of spectrum. WSA believes that the Commission need not adopt a specific use case for separation distances for operations in available 3 MHz guard bands, and may use the separation distances adopted in other scenarios for downlink protection.

Out of band emissions on channels 36 to 38. WSA also supports the Commission's proposal to remove the stringent band emission limits on white space devices thus making channels 35, 36, 37, 38 and 39 useable by white space devices.[48] WSA estimates this proposal will result in more reasonable filtering requirements on white space devices and reduce the cost of white space devices by as much as 25% in some cases.

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[46] 47 C.F.R. § 1.924. *See* NPRM, ¶¶ 121-124.

[47] *See* NPRM, ¶ 125.

[48] *Id.*, ¶¶ 126-128.

B. Wireless Microphones

WSA believes that the new microphones entering this band should be required to have spectral efficiency of at least 4 bits/Hz which will reduce their spectral requirements to less than 25 kHz and will significantly improve their tolerance to transmission errors. Microphones could also consider using the fallow mobile radio spectrum, as well as spectrum in the 2.4 GHz, 3.5 GHz, 4.9 GHz and 5.8 GHz bands.

C. White Space Databases

The NPRM proposes several changes to White Space Databases. Additional geographic based protection is proposed for WMTS, 600 MHz Band services, and several radio astronomy sites not currently protected by white space databases. WSA believes that these changes could be accommodated within a white space database system without significant additional work. Likewise, the proposed changes to the information that White Space Databases provide regarding PLMRS services should be reasonably accommodated.

Regarding the sharing of information about registered Canadian entities seeking protection in the border areas, *e.g.*, receive sites registered on a particular White Space Database, we believe the simplest method to share this information with approved Canadian white space databases is to share directly with those databases, and not through the Commission. The U.S. White Space Database Administrator's group has developed a specification and procedure for efficiently sharing information regarding registered protected entities in the U.S. between approved databases and this same mechanism can equally be employed to share information with Canadian White Space Databases.

The NPRM further proposes that unlicensed wireless microphones no longer be able to request protection from white space devices, but operate in a manner similar to Fixed and Mode

II Personal/Portable white space devices. That is, the NPRM suggests that unlicensed wireless microphone equipment be required to request a list of available channels prior to transmitting. This proposed method of operation for unlicensed wireless microphones would require changes to the currently operating white space databases but is technically achievable within the current white space database architecture. The additional load on the database generated by a large number of unlicensed wireless microphones requesting available channels will result in additional capital outlay for server resources. The Commission should consider making provision for mechanisms that allow for cost recovery associated with outlays for increased server resources that could flow from adoption of these proposals.

It is also proposed in the NPRM that device re-check intervals and synchronization time of registrations between databases be shortened. Neither of the proposed intervals are seen to place an undue burden on the white space database. We do believe though that it should be allowed that several polling intervals without response from the database be allowed before requiring the device to cease transmission. The previous rules required the device to cease operation at 11:59 PM on the day following the last contact with the database, thus a period of almost 48 hours could expire before a device would cease operation. Shortening this time from 48 hours to a single polling interval of 20 minutes without a retry attempt is far too restrictive. A timescale including a configurable number of retry attempts which would allow for potential intermittent lack of connectivity should be proposed. Moreover, shortening of this timeframe is not required if push technology is implemented, which has the ability to provide sub-second response times.

III. CONCLUSION

WHEREFORE, as set forth more fully in these comments, WSA fully supports efforts by the Commission to revise existing white space technical requirements that are no longer necessary to protect incumbent users in order to maximize the availability of white spaces in the TV bands for the deployment and use of white space devices. While WSA supports many of the Commission's proposed modifications, we have highlighted in these comments a number of proposed changes that may decrease spectral efficiency, or that may impede the development of a robust white spaces ecosystem, and have proposed additional modifications which we believe will foster the development and deployment of white space technologies.

Overall, WSA applauds the Commission's efforts to foster the demonstrated benefits of unlicensed white space spectrum operations, including as engines of technological innovation, efficient spectrum utilization, and competition in broadband markets. We urge the Commission expeditiously to complete adoption of the revised white space rules in the instant proceeding in order to promote certainty and foster the large scale manufacture and deployment of white space technologies.

Respectfully submitted,
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