

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

In the Matter of)	ET Docket No. 14-165
)	
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)	GN Docket No. 14-166
)	
Promoting Spectrum Access for Wireless)	
Microphone Operations)	GN Docket No. 12-268
)	
Expanding the Economic and Innovation)	
Opportunities of Spectrum Through Incentive)	
Auctions)	

REPLY COMMENTS OF CTIA – THE WIRELESS ASSOCIATION®

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I. INTRODUCTION AND SUMMARY

CTIA – The Wireless Association® (“CTIA”) hereby submits these reply comments in response to the Commission’s two Notices of Proposed Rulemaking seeking comment on issues related to unlicensed white space device and wireless microphone operations impacted by the Commission’s broadcast television incentive auction.¹ CTIA supports rules that maximize the

¹ First, in a Notice of Proposed Rulemaking (“Unlicensed NPRM”), the Commission seeks comment on proposed rules for unlicensed operation of white space devices and wireless microphones in the reconstituted TV bands and the repurposed 600 MHz band after the incentive auction. *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 600MHz Duplex Gap*, Notice of Proposed Rulemaking, FCC 14-144, at ¶ 2 (Sept. 30, 2014) (“*Unlicensed NPRM*”). Second, in a concurrently-released Notice of Proposed Rulemaking (“*Wireless Microphones NPRM*”), the

repurposing of spectrum for licensed exclusive use in the 600 MHz band and provide for unlicensed use of the 600 MHz guard band and duplex gap, consistent with the Spectrum Act's requirements. Specifically, the Spectrum Act emphasizes that the "Commission may not permit any use of a guard band that the Commission determines would cause harmful interference to licensed services."² Therefore, in accordance with the Spectrum Act unlicensed operations in the 600 MHz guard band and duplex gap can only be introduced through a regulatory framework that ensures that such operations do not raise interference concerns. In its initial comments, CTIA provided the results of real-world testing conducted by V-COMM, Inc. ("V-COMM") and outlined a proposed framework for the 600 MHz band that would comply with the Spectrum Act's requirement that unlicensed operations in the guard bands and duplex gap not cause harmful interference to licensed services. The V-COMM testing, together with other test data provided in this proceeding, demonstrates that there are specific steps the Commission must take to comply with the Spectrum Act's non-interference requirements. Proponents of expanded white space device and wireless microphone operation have failed to supply technical data supporting their proposals. As such, the Commission should heed the real-world testing data provided in the record, and take the following actions:

Commission examines wireless microphone users' needs and technologies that can address them, and seeks comment on a variety of existing and new spectrum bands that might accommodate those uses. *Promoting Spectrum Access for Wireless Microphone Operations*, Notice of Proposed Rulemaking, FCC 14-145, ¶ 4 (Sept. 30, 2014) ("*Wireless Microphones NPRM*"). Because the *Unlicensed NPRM* and *Wireless Microphones NPRM* implicate many of the same issues, and because there is significant overlap in CTIA's responses, CTIA is filing a single set of reply comments in response to both Notices.

² Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, § 6407(e) (codified at 47 USC §1452), 126 Stat. 156 (2012) ("Spectrum Act").

- Adopt more stringent out of band emissions (“OOBE”) limits to ensure that co- and adjacent-channel interference is not caused by white space devices or wireless microphones to 600 MHz licensed operations.
- Provide appropriate frequency buffers between licensed downlink spectrum and both wireless microphones and white space devices.
- Reject unsupported arguments to maintain the OOBE limits proposed by the Commission, reduce buffers between white space devices and licensed 600 MHz downlinks, and increase the power limits for white space devices.
- Decline to adopt the proposed “4-6-1” duplex gap proposal advocated by white space device proponents, as this framework would cause interference to licensed services.
- Prohibit the operation of “Mode I” unlicensed white space devices in the duplex gap and guard bands.
- Reject proposals to adopt requirements that licensed downlink and uplink transmissions protect lower-priority unlicensed operations.
- Decline to adopt changes to the technical rules for wireless microphone operation in the absence of evidence that these changes would comply with the Spectrum Act.

The actions supported by CTIA in these reply comments, if taken, will create a 600 MHz environment where licensed wireless services are protected from harmful interference, while new spectrum is made available for unlicensed uses.

II. THE REAL-WORLD TESTING DATA PROVIDED IN THE RECORD DEMONSTRATES THAT THE COMMISSION’S TECHNICAL PROTECTIONS FOR LICENSED SERVICES IN THE 600 MHZ BAND MUST BE STRENGTHENED.

The testing data submitted by parties in this proceeding demonstrates that the Commission’s proposed technical protections for licensed services in the 600 MHz band are not sufficient to protect such services from interference, and that more stringent requirements must be adopted to comply with the Spectrum Act’s requirements. Since the initiation of this proceeding, several parties have conducted real-world testing to evaluate the interference impact of the Commission’s proposals with respect to unlicensed white space devices and wireless

microphones. The testing conducted by V-COMM for CTIA, by Qualcomm, and by the Consumer Electronics Association (“CEA”) confirms that the Commission’s band plan proposals must be modified to fully protect licensed services. In particular, more stringent OOB limits and frequency buffers are required to ensure compliance with the Spectrum Act’s dictate that unlicensed operations in the 600 MHz band not cause interference to licensed wireless services.

A. The Commission Should Heed the Findings of Real-World Testing.

Over the course of this proceeding, V-COMM, Qualcomm, and CEA have each conducted real-world testing of potential interference caused by unlicensed white space devices and wireless microphones to wireless operations in the 600 MHz band. All three sets of test results reveal that for these operations to coexist in the 600 MHz band, the Commission must adopt significant protections for licensed services. What the Commission has proposed in the *Unlicensed NPRM* is insufficient to protect licensed wireless services, and thus is at odds with the Spectrum Act.

In preparation for filing comments in this proceeding, CTIA and its members commissioned V-COMM to test mobile broadband devices to gauge the impact of unlicensed white space devices and wireless microphones in the 600 MHz duplex gap and guard bands.³ The objective of this testing was to build a framework for unlicensed operation in these bands that would ensure the protection of licensed services from interference. V-COMM tested LTE devices operating in the 3GPP LTE Band 12, which were the closest possible substitute for 600 MHz wireless handsets (which have yet to be developed).⁴ V-COMM simulated interference

³ Comments of CTIA – The Wireless Association®, ET Docket No. 14-165, GN Docket Nos. 14-166 and 12-268, at 7-11 (Feb. 4, 2015) (“CTIA Comments”).

⁴ *Id.* at 8.

from unlicensed white space devices and wireless microphones and conducted a variety of tests.⁵

V-COMM used reasonable and conservative technical assumptions and parameters that are consistent with those used by wireless industry standard practices. V-COMM reached the following conclusions in its testing:

- To prevent harmful interference to licensed wireless services, OOB from both white space devices and wireless microphones would need to be attenuated much more than proposed by the Commission. In particular, an OOB limit of -89 dBm/100 kHz would be required at the band edge of the licensed downlink spectrum.⁶
- Assuming that this OOB limit is adopted, white space devices and wireless microphones may operate at the Commission's proposed power levels in the duplex gap so long as a 5 MHz frequency buffer is provided.⁷
- As for the guard band, in addition to stricter OOB limits, a nine megahertz buffer is necessary to protect licensed wireless operations from wireless microphones operating at the Commission's proposed power limits.⁸
- The V-COMM testing further demonstrated that white space devices in the guard band, even when subject to more stringent OOB requirements and a lower power limit (5 milliwatts or 6.6 dBm), will need a five megahertz buffer to prevent harmful interference to 600 MHz downlink operations.⁹

V-COMM's test results were supported by additional real-world testing conducted by Qualcomm¹⁰ and the Consumer Electronics Association.¹¹ Qualcomm's test results echoed V-

⁵ *Id.* at 8-9.

⁶ CTIA Comments, Appendix B at 82.

⁷ CTIA Comments at 18-19.

⁸ CTIA Comments, Appendix B at 25.

⁹ CTIA Comments, Appendix B at 78.

¹⁰ In response to the *Unlicensed NPRM*, Qualcomm conducted testing using commercially-available LTE transceivers (supporting 3GPP Band 20) and FCC-compliant white space device waveforms. Like V-COMM, Qualcomm tested for 1 dB desense to the LTE device. Comments of Qualcomm Incorporated, ET Docket No. 14-165, GN Docket No. 12-168, at 8 (Feb. 4, 2015) ("Qualcomm Comments").

COMM's findings that to protect licensed operations, more stringent OOB limits,¹² reduced power levels, and additional frequency buffers are needed for both white space devices and wireless microphones operating in the duplex gap¹³ and guard bands.¹⁴ Meanwhile, CEA's study emphasized the need for protection bands, physical separation distances, and careful frequency assignments to minimize the risk of harmful interference.¹⁵

¹¹ In December 2013, the Consumer Electronics Association submitted a paper titled "Protection Bands and Potential Interference at 600 MHz." This technical report, which was drafted by a former Chief of the Commission's Office of Engineering and Technology, described testing of thirteen coexistence scenarios that might occur with some or all of the 600 MHz band plans then under consideration by the Commission. CEA Technical Paper, *Protection Bands and Potential Interference at 600 MHz* (Dec. 2013), available at <http://apps.fcc.gov/ecfs/document/view?id=7520962751> ("CEA Technical Paper").

¹² Qualcomm Comments at 11-12 ("This testing also demonstrates that the FCC's proposed -55 dBc OOB level is woefully insufficient to achieve good electromagnetic compatibility and prevent harmful interference.").

¹³ *See id.* at 10-11 (finding that a wireless microphone operating in the duplex gap with a one megahertz frequency buffer would need to operate at a maximum transmit power of -32 dBm EIRP (45 dB lower than what the Commission has proposed to authorize) to prevent receiver blocking interference to a mobile device receiver); *id.* at 10 (finding that a white space device operating in the duplex gap at the Commission's proposed power levels (with a five megahertz buffer) would cause receiver blocking interference to mobile device receivers 18 meters away); *id.* at 11 (concluding that in a scenario where both a wireless microphone and a white space device occupy the duplex gap (with a 1.5 megahertz buffer for the wireless microphone and a five megahertz buffer for the white space device), the devices would cause receiver blocking interference to licensed wireless operations at power levels of -33 dBm EIRP and -15 dBm EIRP, respectively).

¹⁴ *Id.* at 11 (finding that a white space device operating in the guard band at the Commission's proposed power level (with a three megahertz buffer) would cause receiver blocking interference to mobile device receivers 29 meters away).

¹⁵ CEA Technical Paper at 6 (stating that to prevent overload and OOB interference, the Commission will need to employ protection bands, physical separation distances, and careful frequency assignments to minimize the risk of harmful interference). Under the assumptions used by CEA, unlicensed devices generally cannot operate in the guard bands above "unacceptably low transmission power thresholds" without the potential for harmful overload or OOB interference to adjacent-channel end-user mobile broadband equipment. CEA suggested a frequency separation of three or four megahertz. *Id.* CEA also concluded that if both unlicensed transmitters and licensed 600 MHz receivers are operating in the same room or in

All of these test results indicate a significant potential for interference to licensed LTE services caused by unlicensed white space devices and wireless microphones operating in the guard band and/or duplex gap. In light of these findings, which are based on real-world testing, the Commission should reconsider the proposals outlined in the *Unlicensed NPRM*, modify its band plan proposals, and adopt the interference mitigation mechanisms suggested by CTIA in its opening comments.

B. To Protect Licensed Services, the Commission Should Alter its Technical Rules for Unlicensed Operation.

The real-world tests conducted by V-COMM, Qualcomm, and CEA demonstrate that the Commission must take additional steps to protect licensed 600 MHz services from interference caused by unlicensed operations in the guard band and duplex gap. Specifically, the Commission should, at a minimum, adopt more stringent OOB limits and provide frequency buffers between licensed and unlicensed services. CTIA provided a detailed explanation of the necessity of these actions in its initial comments, and the record makes clear that these proposals are the only path forward that will maximize the availability of licensed wireless services, protect those licensed services from harmful interference (consistent with the Spectrum Act), and make available spectrum for unlicensed services.

1. More Stringent Out of Band Emissions Limits are Needed.

V-COMM's testing demonstrated – and Qualcomm's testing affirmed – the need for more stringent OOB requirements for white space devices and wireless microphones operating in the 600 MHz band. V-COMM evaluated ten sample devices and determined that based on the

close proximity, an unlicensed device operating in the guard band or duplex gap could cause an LTE end-user receiver to fail. This failure is unlikely to be resolved through typical self-help measurements; instead, the interference mechanism will prevent the LTE receiver from receiving incoming signals. *Id.* at 35.

additive white Gaussian noise interference level, combined with coupling losses from white space devices and/or wireless microphones to LTE user equipment, an OOB limit of -89 dBm/100 kHz into 600 MHz downlink spectrum was required.¹⁶ Should the Commission uphold its proposed OOB limit of -56.8 dBm/100 kHz, white space devices and wireless microphones would cause a significant level of interference (26 dB of desensitization at a 1 meter separation) to LTE devices.¹⁷ Qualcomm similarly concluded that the OOB limits proposed by the Commission were unacceptable.¹⁸ As such, the Commission should adopt the -89 dBm/100 kHz standard advanced by V-COMM in its test report.

2. Unlicensed White Space Devices and Wireless Microphones Cannot Operate Adjacent to Licensed Wireless Operations Without Causing Interference.

V-COMM, Qualcomm, and CEA have all concluded that the close spectral proximity proposed between 600 MHz licensed downlinks and unlicensed operations would result in harmful interference to licensed services. In addition to more stringent OOB limits, frequency buffers between licensed downlink spectrum and unlicensed operations will be necessary to prevent harmful interference to licensed operations.

In the duplex gap, V-COMM's testing revealed that a five megahertz buffer between licensed downlinks and wireless microphones and white space devices would be necessary.¹⁹ V-COMM's testing also demonstrated that the Commission's proposal for the duplex gap would allow harmful interference from licensed wireless microphones that are more than 21 meters

¹⁶ CTIA Comments at 13-14.

¹⁷ *Id.* at 14.

¹⁸ Qualcomm Comments at 11-12.

¹⁹ CTIA Comments at 18-19.

away from licensed LTE devices.²⁰ As for the guard band, V-COMM's testing determined that white space devices require a five megahertz buffer *and* a reduced power limit of 6.6 dBm (5 milliwatts) to prevent interference to LTE devices one meter away.²¹ V-COMM found that any white space device operating at the Commission's proposed power levels with a five megahertz frequency buffer would cause interference to LTE devices within three meters.²² Meanwhile, V-COMM determined that a nine megahertz buffer is required for wireless microphones to operate at the FCC's proposed power levels without causing harmful interference to LTE downlinks.²³ Qualcomm's testing similarly concluded that operations at the spectral distances proposed in the NPRM would result in unacceptable harmful interference to LTE downlinks.²⁴

III. WHITE SPACE DEVICE PROPONENTS HAVE FAILED TO DEMONSTRATE THAT LICENSED SERVICES WILL BE PROTECTED FROM HARMFUL INTERFERENCE.

The Commission should reject the submissions of white space device proponents that are not based on real-world testing and which simply repeat disproven technical arguments regarding the 600 MHz interference environment. Unlike V-COMM and others, who have conducted real-world testing of the interference impact of unlicensed operations in the 600 MHz guard band and duplex gap, white space device proponents have based their findings on unsupported technical

²⁰ *Id.* at 19.

²¹ *Id.* at 24-25.

²² *Id.* at 25.

²³ *Id.* at 26.

²⁴ Qualcomm Comments at 9-11 (finding interference caused by white space operations five megahertz away from downlinks in the duplex gap, wireless microphones one megahertz away from downlinks in the duplex gap, white space operations three megahertz away from downlinks in the guard band, and wireless microphones located 1.5 megahertz away from downlinks in the duplex gap).

assumptions. The Commission should similarly reject calls to reconfigure the 600 MHz duplex gap in a manner that would create even more interference than the Commission’s proposal, and to permit the operation of Mode 1 unlicensed devices in the duplex gap and guard bands. Further, proponents of unlicensed operations have sought to impermissibly elevate the interference protection rights of secondary unlicensed services.

A. The Commission’s Proposed Technical Rules Would Not Protect Licensed Services From Harmful Interference.

Contrary to the assertions of white space device proponents, the Commission’s proposed technical rules for the 600 MHz band are not sufficient to comply with the Spectrum Act’s mandate that licensed services be protected from harmful interference caused by unlicensed operations.²⁵ In particular, the OOB limits proposed by the Commission will not protect licensed services from harmful interference, the buffers between unlicensed white space devices and licensed downlinks should be increased, not reduced, and the Commission’s proposed power limits are only acceptable if appropriate buffers are provided.

OOB Limits. The out of band emission limits proposed by the FCC will not protect licensed services from harmful interference. Parties generally rely upon analysis conducted by Broadcom Corporation to support the Commission’s proposed OOB limits.²⁶ However, the thresholds used by Broadcom to determine OOB impact to licensed services are incorrect. Broadcom’s analysis is based on 3GPP standard defined values for receiver desensitization, rather than measured values. Meanwhile, V-COMM evaluated the interference susceptibility of

²⁵ Spectrum Act § 6407(e).

²⁶ Comments of Broadcom Corporation, ET Docket No. 14-165, GN Docket No. 12-268, at 8-9 (Feb. 4, 2015) (“Broadcom Comments”); Comments of Google Inc., ET Docket No. 14-165, GN Docket No. 12-268, at 10-12 (Feb. 4, 2015) (“Google Comments”); Comments of Microsoft Corporation, ET Docket No. 14-165, GN Docket No. 12-268, at 9 (Feb. 4, 2015) (“Microsoft Comments”).

LTE devices reference to the devices' desensitization levels to better model real world effects of interference from adjacent white space devices and wireless microphones to actual LTE devices.²⁷ The difference is significant – the 3GPP sensitivity specification is -97 dBm/5 MHz, while V-COMM's average measured sensitivity value was -105.1 dBm/5 MHz.²⁸ V-COMM then applied a 1 dB degradation threshold, requiring the interferer to be 6 dB below the receiver sensitivity (-111 dBm/5 MHz).²⁹ This calculates to approximately -127 dBm/100 kHz³⁰ and, when measured path link losses of 38 dB are applied, results in an OOB limit of -89 dBm/100 kHz.³¹

While Broadcom relied on FCC assumptions – not measured values – to calculate OOB thresholds, it conducted laboratory tests of a TV white space transmitter to conclude that the average out of band emissions into the LTE receive band would fall below the -98.5 dBm/5 MHz LTE interference threshold.³² However, Broadcom's theoretical analysis of the OOB requirements is not supported by the testing data with actual LTE devices provided by V-COMM and Qualcomm. The -98.5 dBm/5 MHz metric relied upon by Broadcom, translated for bandwidth, is equivalent to -115.5 dBm/100 kHz – a co-channel noise level of 11.5 dB above the -127 dBm/100 kHz level shown to cause OOB interference in tests with actual LTE devices. Notably, Broadcom's analysis is based on a mix of measured data and standards-derived

²⁷ CTIA Comments at n. 26.

²⁸ CTIA Comments, Appendix B at 14.

²⁹ See CTIA Comments, Appendix B at 82.

³⁰ CTIA Comments at 13-14.

³¹ *Id.*

³² Broadcom Comments at 8-9.

assumptions, whereas V-COMM's analysis is based entirely on real-world testing. Significantly, Broadcom has elected to rely upon 3GPP standards where actual device performance greatly exceeds such standards (in the case of receiver desensitization levels), but has used measured data where devices outperform assumed parameters (in the case of receiver blocking capabilities). In effect, Broadcom has tilted the scales to select device performance capabilities that best suit its arguments rather than basing its assumptions on actual, real-world performance of LTE devices. This mix of data renders Broadcom's analysis technically unsound, and underscores that the OOBE figure derived by V-COMM is a more accurate representation of the actual 600 MHz frequency environment. As such, arguments supporting the Commission's or others' less stringent OOBE requirements should be rejected.

Frequency Buffers. The Commission should reject calls to reduce or eliminate frequency buffers between licensed and unlicensed operations in the 600 MHz band. Contrary to the arguments of white space device proponents,³³ the frequency buffers established by V-COMM's testing are necessary to protect LTE devices from harmful interference. These commenters base their assertions on claims that white space devices can safely operate at higher power levels than the Commission has proposed, and therefore operation at the Commission's

³³ Broadcom Comments at 18-20; Comments of the Dynamic Spectrum Alliance, ET Docket No. 14-165, GN Docket No. 12-268, at 8 (Feb. 4, 2015) ("Dynamic Spectrum Alliance Comments") ("DSA members agree with the Commission's tentative conclusion that a 3 MHz frequency separation will be sufficient to protect LTE downlink operations from harmful interference by unlicensed devices."); Google Comments at 12-14; Microsoft Comments at 5-9; Comments of WhiteSpace Alliance, ET Docket No. 14-165, Gn Docket No. 12-268, at 21-22 (Feb. 4, 2015) ("WhiteSpace Alliance Comments") ("WSA believes that a requirement of a 3 MHz buffer would result in significant spectrum inefficiency. . . Hence, WSA believes that the proposed 3 MHz guard buffer likewise could be reduced to as little as 200 kHz.").

proposed power levels could occur with less frequency separation.³⁴ As an initial matter, each of these commenters incorrectly concludes that the allowed power for unlicensed white space devices could be increased from 40 milliwatts (see below). However, V-COMM's testing demonstrates that even if power limits were *not* increased as white space device proponents suggest, white space device operations in the duplex gap would only just satisfy the 3GPP's standardized 1 meter protection criteria when operating at the Commission's proposed power limits.³⁵ And in the guard band, white space devices operating at the Commission's proposed power levels with a one or three megahertz frequency separation would cause interference at separation distances of 13 and 6.6 meters, respectively.³⁶ Even with a five megahertz frequency buffer, a reduction in power for white space devices would be required.³⁷ Finally, the white space proponents make various broad assumptions on LTE device rejection based on theoretical analysis and assumptions of LTE device filters. This analysis is irrelevant and should be rejected now that V-COMM and Qualcomm have put actual LTE device performance and rejection data into the Commission record. Real world device performance should be relied upon by the

³⁴ See, e.g., Broadcom Comments at 18 ("At 4 MHz separation, an unlicensed device can conservatively operate at a power level as high as 112.5 mW before the odds of interference with LTE uplink becomes significant. In fact, at the 5 MHz separation the Commission has proposed, an unlicensed device in the duplex gap could operate at a power as high as 183.5 mW. Or, holding the power variable constant at 40 mW, an unlicensed device could operate at only 2.8 MHz spectral separation from LTE downlink before harmful interference became likely."); Google Comments at 14 (arguing that at 3 MHz separation, a white space device could operate at power levels 9 mW greater than the Commission's proposed limit and not cause interference).

³⁵ CTIA Comments at 18.

³⁶ *Id.* at 24.

³⁷ *Id.* at 24-25.

Commission when promulgating the technical protections for licensed operations in the 600 MHz band, as Broadcom and others have argued in the past.³⁸

Power Limits. The Commission should not increase its proposed power limit (40 milliwatts or 16 dBm) for white space devices, and indeed this power limit is only acceptable for the duplex gap if appropriate frequency buffers are provided and a reduction in power is required for white spaces device operation in the guard band, as described above. Several parties have argued that the allowed power for unlicensed white space devices could be increased from the Commission’s proposed limits without interference to licensed users.³⁹ These parties generally have cited Broadcom’s findings regarding device power in support of their conclusions. However, Broadcom’s derivation of power limits suffers from some of the same flaws as its OOB analysis. In particular, Broadcom assumes significantly more path loss than is appropriate, based on the real-world conditions studied by V-COMM.

³⁸ See *Ex Parte* Presentation of Broadcom, GN Docket No. 12-268 (filed April 23, 2014) at 2 (“...Broadcom explained that the Commission’s assessment of accommodating unlicensed broadband operations should reflect real world device performance...”).

³⁹ See, e.g., Broadcom Comments at 15 (“In fact, the substantial margin between the received power and the likely blocking threshold means that an unlicensed device could operate at significantly higher power than 40 mW without causing blocking interference.”); Google Comments at 14-16 (“In fact, the Commission could permit unlicensed devices to transmit at higher power, without an excessive risk of interference to LTE.”); Microsoft Comments at 8-9 (“For instance, with a 40 mW unlicensed transmit power(16.0 dBm), adjusted down for 53 dB propagation loss and for LTE receive filter attenuation of -18.1 dBr based on the FCC’s assumptions, Broadcom’s numbers yield a total unlicensed receive power to an LTE handset of -55.1 dBm, well below the blocking threshold of -47 dBm. In fact, Microsoft believes that the margin is great enough that unlicensed devices operating at 4 MHz spectral separation from LTE could operate with at least 100 mW transmit power without causing harmful interference to LTE.”); Comments of Motorola Solutions, Inc., ET Docket No. 14-165, GN Docket Nos. 14-166 and 12-268, at 8-9 (Feb. 4, 2015) (“Motorola Solutions Comments”) (“We support the use of WDS power levels up to 100 mW in the lower guard band . . .”).

As was true for the OOB case, Broadcom has utilized performance capabilities that are tilted in the favor of its arguments – selecting measured data when it best makes its case and 3GPP standards values when that is in its best interest. Broadcom also continues to add link budget losses that are inconsistent with the interference environment – rendering its findings technically incorrect. As V-COMM’s test results made clear, the 38 dB of aggregate link losses are the only losses that should be applied to the interference case between white space devices and licensed 600 MHz operations.⁴⁰ Broadcom’s steadfast reliance on 15 dB of additional link losses is flawed and has been soundly rebutted by the numerous commenters in the record.⁴¹ This is especially concerning given that Broadcom and the other white space device proponents have asserted that the Commission should allow Mode I white space devices⁴² in the duplex gap and guard bands.⁴³ Broadcom’s analysis of the path losses has consistently argued that white space devices would necessarily be two to three meters from any licensed LTE devices due to the type of devices that would be deployed.⁴⁴ However, Mode I white space devices, as discussed in more detail in Section III.C. below, would be laptops, tablets and mobile devices that would absolutely be operated in close proximity to licensed LTE devices. This eliminates more of the

⁴⁰ CTIA Comments, Appendix B at 9-10.

⁴¹ *See id.*; Qualcomm Comments at 10-11.

⁴² Mode I devices are not required to incorporate geo-location or database access capabilities, and instead obtain a list of available channels on which they can operate from either a fixed or Mode II device that has database access.

⁴³ *See infra* Section III.C.

⁴⁴ Broadcom Comments at 5 (“In particular, while users typically keep client devices on or near their bodies, access points typically are located in fixed locations, considerably farther from users than client devices. For this reason, the FCC should assume that a signal emitted by an access point will not be subject to body loss. Correspondingly, the FCC should assume that an access point will typically be at least one meter further away from the user than a client device, and, accordingly, from the user’s LTE handset.”).

propagation losses assumed by Broadcom – as the industry has carefully modeled interference from white space devices that would be separated from LTE devices by one meter – where Broadcom has assumed additional propagation losses based on two and three meter separations.

Broadcom’s use of flawed assumptions for calculating propagation and link losses leads to its results-oriented findings that white space devices may increase power from 40 dBm – a result that has been refuted by the V-COMM and Qualcomm real world testing of actual LTE device performance. The Commission should instead look to the V-COMM and Qualcomm assumptions and parameters to determine the acceptable power limits for white space devices.

B. The Commission Should Reject the “4-6-1” Duplex Gap Proposal.

The Commission should decline to adopt the proposed “4-6-1” duplex gap proposal advocated by white space device proponents, as this configuration would cause harmful interference to licensed operations and would improperly elevate the rights of secondary services. Several parties have suggested that the Commission place a one megahertz frequency buffer at the *top* of the duplex gap, rather than at the bottom, and place the proposed four megahertz wireless microphone channel immediately adjacent to licensed downlinks.⁴⁵ The Commission should reject this proposal for two reasons.

First, real-world testing conducted by V-COMM demonstrated that wireless microphones cannot operate immediately adjacent to licensed downlink operations. The “4-6-1” duplex gap proposal would provide for *no* buffer between wireless microphones and licensed downlinks, and would provide for only a four megahertz buffer between white space devices and licensed

⁴⁵ See, e.g., Broadcom Comments at 18-19; Dynamic Spectrum Alliance Comments at 8; Google Comments at 16-18; Microsoft Comments at 12-13; Comments of Wi-Fi Alliance, ET Docket No. 14-165, GN Docket No. 12-268, at 26-27 (Feb. 4, 2015) (“Wi-Fi Alliance Comments”).

downlinks. As V-COMM's testing makes clear, to prevent interference to licensed downlinks there must be at least five megahertz of separation between licensed downlinks and any unlicensed device operation in the duplex gap. Thus, the "4-6-1" proposal would violate the Spectrum Act by allowing use of the duplex gap (a guard band) to cause harmful interference to licensed services.⁴⁶ More importantly, white space device proponents that have suggested this "4-6-1" configuration have provided absolutely no technical evidence that wireless microphones operated in close proximity to licensed downlink operations would not cause harmful interference. Given that the V-COMM and Qualcomm testing data clearly demonstrated the harms from operations of wireless microphones even within *one* megahertz of licensed downlink spectrum, white space device proponents have failed to demonstrate how their duplex gap proposal would fully protect licensed services in accordance with the Spectrum Act.

Second, the only policy argument made in support of the "4-6-1" proposal impermissibly elevates the status of unlicensed operations. Specifically, the sole argument made for this plan by white space device proponents was that this configuration would eliminate interference effects into unlicensed uses from licensed uplink spectrum.⁴⁷ These arguments ignore the fact that unlicensed white space operations are secondary in nature, and have no right to protection

⁴⁶ See Spectrum Act § 6407(e).

⁴⁷ See, e.g., Broadcom Comments at 19 (stating that "the Commission can significantly enhance the value of the unlicensed channel while maintaining extremely robust protective margins for LTE"); Dynamic Spectrum Alliance Comments at 8 (stating that this configuration would "create a small buffer between high-power LTE uplink and unlicensed devices, thereby enabling improved white space device operation."); Google Comments at 17 ("Separating consumer white space devices by even 1 MHz from LTE uplink will substantially improve white space device performance for consumers, since LTE uplink signals originate from handsets themselves and, therefore, pose the greatest interference risk indoors, where white space devices are likely to also operate."); Microsoft Comments at 13 ("In contrast, the lack of a 1 MHz buffer between LTE uplink and unlicensed white space operations would unnecessary limit the utility of the 6 MHz unlicensed channel due to interference from LTE User Equipment . . .").

from interference caused by primary operations. Thus, adoption of the “4-6-1” proposal would simultaneously subject primary licensed downlink operations to harmful interference from white space devices and wireless microphones while protecting secondary operations from interference caused by *primary* licensed uplinks. Such action is plainly inconsistent not only with the Spectrum Act, but also with general principles of frequency allocation.

C. The Commission Should Not Permit the Operation of Mode I Devices in the Duplex Gap and Guard Band.

The Commission should reject calls to permit the operation of Mode I white space devices in the duplex gap and guard band. Several parties have requested that the Commission allow Mode I white space devices to operate in this spectrum.⁴⁸ Mode I devices are not required to incorporate geo-location or database access capabilities, and instead obtain a list of available channels on which they can operate from either a fixed or Mode II device that has database access.⁴⁹ As an initial matter, the Spectrum Act requires that unlicensed use of the guard bands only be permitted by devices that have database capabilities.⁵⁰ For this reason, Mode I devices should not be permitted to use the duplex gap or guard bands. Moreover, to protect licensed services, CTIA believes that the Commission should be cautious in its approach and limit the use of the duplex gap and guard bands solely to Mode II white space devices. This is especially important because Mode I devices – which include laptops, tablets, and mobile devices⁵¹ – are more likely than other white space devices to be located within one meter or less of a licensed

⁴⁸ Dynamic Spectrum Alliance Comments at 11-12; Microsoft Comments at 17-18; Motorola Solutions Comments at 8; White Space Alliance Comments at 20; Wi-Fi Alliance Comments at 25.

⁴⁹ *Unlicensed NPRM* ¶ 20.

⁵⁰ Spectrum Act at § 6407(d).

⁵¹ *See, e.g.*, Microsoft Comments at 17.

device. As such, these devices are extremely likely to cause harmful interference to licensed operations, even when operating at reduced power levels with frequency separation between licensed and unlicensed operations.

D. The Commission Should Not Take Actions That Would Impermissibly Elevate the Interference Protection Rights of Secondary Services.

Because unlicensed operations are secondary in nature, have no interference protection rights, and must accept interference from higher priority services, the Commission should reject calls to limit licensed transmissions to “protect” unlicensed operations. The Commission should therefore reject the White Space Alliance’s request to adopt additional technical limitations on licensed 600 MHz user equipment.⁵² The law on this point is clear – unlicensed, secondary Part 15 services may not cause harmful interference to authorized radio services and must accept any interference that they receive.⁵³ Any limitations on use of licensed 600 MHz spectrum to protect unlicensed devices in the duplex gap and guard bands would impermissibly increase the protection rights of the secondary users of the 600 MHz band. Further, the White Space Alliance essentially is asking for a *de facto* extension of the guard bands into licensed spectrum to accommodate unlicensed services. Such action runs afoul of the Spectrum Act’s requirement that guard bands shall be no larger than is technically reasonable to prevent harmful interference to *licensed* services outside the guard bands.⁵⁴ As such, the Commission should reject all calls to

⁵² White Space Alliance Comments at 20-21 (“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 by allowing white space devices to use the guard bands and duplex gaps free of spurious emissions from the licensed devices, and vice versa.”).

⁵³ 47 C.F.R. § 15.5.

⁵⁴ Spectrum Act § 6407(b).

limit the use of licensed 600 MHz spectrum for purposes of protecting unlicensed, lower priority operations.

IV. WIRELESS MICROPHONE ENTITIES' REQUESTS TO ENHANCE USE OF THE DUPLEX GAP AND/OR GUARD BANDS WOULD NOT PROTECT LICENSED SERVICES.

The Commission should reject various requests by wireless microphone entities to alter the Commission's proposals for 600 MHz spectrum use in a way that would enhance wireless microphone use. These commenters have not provided any testing or technical data to demonstrate that grant of their proposals would comply with the Spectrum Act's requirement that licensed 600 MHz services be protected from harmful interference. In particular, the Commission should reject calls for higher power limits, to reduce frequency buffers between wireless microphones and licensed downlinks, and to dedicate space in the duplex gap for licensed wireless microphones.

Real-world testing demonstrates that the Commission's proposed 20 milliwatt power limit for wireless microphones has the potential to result in interference if appropriate protections are not adopted, and any higher power limit should only be adopted if necessary steps are taken to prevent interference. Several parties have called for the Commission to increase the power limits for wireless microphones to 50 milliwatts, as commenters claim that Commission's proposed 20 milliwatt power limit will preclude effective wireless microphone operation.⁵⁵

⁵⁵ Comments of Audio-Technica U.S., Inc., WT Docket No. 14-165, GN Docket Nos. 12-268 and 14-166, at 9-10 (Feb. 4, 2015) ("Audio-Technica Comments") ("A reduction in power to 20 mW will effectively prevent wireless microphones from making use of the guard bands or duplex gap."); Comments of Lectrosonics, Inc., GN Docket Nos. 14-166 and 12-268, at 10-11 (Feb. 4, 2015) ("Lectrosonics Comments"); Comments of Sennheiser Electronic Corporation, ET Docket No. 14-165, GN Docket No. 12-268, at 15 (Feb. 4, 2015) ("Sennheiser Comments") ("A maximum power of 20 mW creates a low carrier-to-noise ratio and therefore impaired range, subjecting wireless microphones to much more interference compared to operating at 50 mW (or 20 mW on a clean channel)."); Comments of Shure Incorporated, ET Docket No. 14-165, GN

These wireless microphone operators have failed to provide any empirical evidence that this higher power limit would satisfy the Spectrum Act's requirement that unlicensed operations in the 600 MHz band not cause harmful interference to licensed services. Furthermore, V-COMM and Qualcomm's testing demonstrated that even wireless microphones at or below the proposed 20 milliwatt power limit would cause harmful interference to licensed operations under the Commission's proposals for the duplex gap and guard bands.⁵⁶ Should the Commission consider increasing the power limit to 50 milliwatts, testing would need to be completed at these higher power levels to determine the appropriate frequency buffers between wireless microphones and licensed downlink spectrum.

Similarly, V-COMM's testing indicates that frequency buffers significantly greater than 100 kHz are needed to protect licensed services. Both Shure and Sennheiser have argued that wireless microphones can operate as close as 100 kHz from licensed LTE services without causing harmful interference.⁵⁷ These parties have provided no real-world testing data to support this finding. Meanwhile, V-COMM has demonstrated that significantly larger frequency buffers are necessary to protect 600 MHz licensed downlinks from interference caused by wireless microphones.⁵⁸ In the absence of additional testing data, there is no basis for the Commission to reduce the frequency buffers between wireless microphones and licensed 600 MHz services, and

Docket No. 12-268, at 19-20 (Feb. 4, 2015) ("Shure Comments") (stating that "the NPRM fails to offer any technical analysis or cite any incidents of interference that would warrant adopting a greatly reduced power limit that deviates from the existing 50 mW power limit.").

⁵⁶ CTIA Comments at 25; Qualcomm Comments at 10-11.

⁵⁷ Sennheiser Comments at 14; Shure Comments at 16.

⁵⁸ CTIA Comments, Appendix B at 78, 80.

indeed the record shows that the Commission should adopt buffers significantly greater than those proposed in the *Unlicensed NPRM*.

Finally, licensed wireless microphone operators in the duplex gap would cause harmful interference to licensed services unless the Commission's proposal for the duplex gap is amended.⁵⁹ NAB seeks to have the middle of the duplex gap reserved solely for licensed wireless microphones and include "reasonable guard bands" on either side of the allocation to protect wireless mobile receivers and base stations.⁶⁰ NAB has not provided any detail regarding the size of these "reasonable guard bands" or the technical parameters at which licensed wireless microphones would operate. Nor has NAB provided testing data demonstrating that its proposed duplex gap framework would comply with the Spectrum Act's non-interference requirement. CTIA notes, however, that V-COMM's testing demonstrated that a five megahertz guard band would be necessary between wireless microphone operations and the 600 MHz downlink band.⁶¹ Further, CTIA notes that the Spectrum Act only permits non-interfering unlicensed operations in the duplex gap and guard bands, and does not authorize the Commission to insert *licensed* wireless microphone operations in the duplex gap.⁶² Absent more concrete proposals from NAB, including operating parameters, specific buffers and testing data to validate its arguments, CTIA does not believe NAB's proposal could be adopted by the Commission.

Based on the testing performed by the wireless industry, CTIA believes that its band plan proposals to ensure the protection of licensed operations from interference are required. Further,

⁵⁹ CTIA Comments at 16-20.

⁶⁰ Comments of the National Association of Broadcasters, ET Docket No. 14-165, GN Docket No. 12-268, at 14-16 (Feb. 4, 2015) ("NAB Comments").

⁶¹ CTIA Comments at 18.

⁶² Spectrum Act at § 6407.

CTIA's proposed framework for the duplex gap and guard bands is supported by the technical record in this proceeding. As such, the Commission should reject arguments to enhance wireless microphone rights that would threaten interference-free operations in licensed portions of the 600 MHz band.

V. CONCLUSION

The real-world testing data submitted to the Commission in this proceeding speaks for itself. While the 600 MHz band can accommodate both licensed and unlicensed operations, there are several steps the Commission must take if it is to comply with the Spectrum Act's requirement of non-interference from unlicensed to licensed services. The Commission should closely heed the test data submitted by V-COMM, Qualcomm, and CEA in this proceeding, and should make the technical adjustments advocated by these technical experts. Further, the Commission should reject arguments that do not reflect this level of analysis or merely restate previous technical arguments that have been rebutted by real-world testing.

Respectfully submitted,

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