May 8, 2015

VIA ELECTRONIC FILING

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: *Amendment of Part 15 of the Commission's Rules for Unlicensed Operations in the Television Bands, Repurposed 600 MHz Band, 600 MHz Guard Bands and Duplex Gap, and Channel 37, and Amendment of Part 74 of the Commission's Rules for Low Power Auxiliary Stations in the Repurposed 600 MHz Band and 600 MHz Duplex Gap* (ET Docket No. 14-165)*; Promoting Spectrum Access for Wireless Microphone Operations* (GN Docket No. 14-166); *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions* (GN Docket No. 12-268)

Dear Ms. Dortch,

In the three years since the passage of the Middle Class Tax Relief and Job Creation Act of 2012 ("Spectrum Act"), CTIA – The Wireless Association® ("CTIA") and its members have been committed to helping develop a 600 MHz band framework that provides opportunities for both licensed and unlicensed spectrum users. CTIA has consistently supported rules that both maximize repurposing spectrum for licensed exclusive use in the 600 MHz band and provide for non-interfering unlicensed operations. To develop a sound engineering framework for unlicensed white space devices and wireless microphones that would also ensure protection of licensed services from interference, CTIA and its members commissioned V-COMM to test interference from these sources to mobile broadband devices and provided detailed test findings based on the performance of real-world LTE devices. In this testing, CTIA and V-COMM followed the Commission's charge to commenters to provide real-world testing data, rather than providing projections based solely on industry standards. The V-COMM tests demonstrate that the Commission's proposed technical rules for unlicensed operations in the 600 MHz guard bands and duplex gap would result in harmful interference to licensed services in violation of the Spectrum Act. The Commission should not now move the goal posts, but rather should adopt technical parameters that protect licensed services from harmful interference as is explicitly required by the Spectrum Act and necessary to ensure a successful auction.

In this letter and accompanying appendix, CTIA provides additional information demonstrating how the Commission's proposed framework would unlawfully result in harmful interference to primary 600 MHz band licensees. CTIA also takes this opportunity to respond to submissions in the record that oppose the wireless industry's well-supported findings in this proceeding. In particular, CTIA supplements the record to note the following:

- Based on the Spectrum Act and the Commission's own definition of "harmful interference," the framework proposed by the Commission is inappropriate because harmful interference would result to licensed 600 MHz operations.
- The metrics used by V-COMM in its testing and analysis are consistent with Commission precedent and protections provided to other similarly situated licensees. The Commission should therefore weigh these findings accordingly.
- The comments of parties opposing the V-COMM analysis reflect misunderstandings of key LTE technical characteristics, and the testing parameters used by V-COMM.
- V-COMM's interference path loss assumptions, out of band emissions ("OOBE") calculations, and OOBE interference simulation mechanisms rely on industry standard practices and operating characteristics of real-world LTE devices. Thus, the calculations made by V-COMM are rigorous and V-COMM's ultimate conclusions were grounded on sound engineering principles.
- If the Commission persists in adopting technical rules for unlicensed operation that cause harmful interference to adjacent 600 MHz services, the Commission should deem such affected licenses to be "impaired" and auction them pursuant to the procedures adopted for licenses that are impaired by the presence of co- or adjacent-channel broadcast television stations.

Contrary to the assertions of certain commenters in this proceeding, V-COMM's finding that unlicensed operations, as proposed, would cause harmful interference to licensed wireless services is based on real-world approaches to interference identification and prevention. Far from being overly conservative, the V-COMM testing parameters are reflective of the frequency environment and device performance that can be expected in the 600 MHz band. Indeed, the Commission has taken a more conservative approach to interference protection in other contexts. To properly reflect the primary status of 600 MHz licensees and to comply with the Spectrum Act, the Commission must take additional steps to protect licensed services from interference.

As demonstrated in CTIA's comments and reply comments and reaffirmed herein, the Commission's proposed technical parameters for unlicensed device operation will cause significant harmful interference to licensed 600 MHz services. This outcome has been affirmed by sound, real-world testing conducted by V-COMM in response to the Commission's request for additional data. For these reasons, CTIA urges the Commission to heed the results of V-COMM's testing and adjust its proposed technical rules for unlicensed 600 MHz operations in a manner that complies with the Spectrum Act and protects licensed services from harmful interference.

Pursuant to Section 1.1206 of the Commission's rules, 47 C.F.R. § 1.1206, this letter is being electronically filed via ECFS. Please direct any questions to the undersigned.

Sincerely,

/s/ Krista L. Witanowski

Krista L. Witanowski
AVP, Regulatory Affairs
CTIA – The Wireless Association®

The Commission's Proposed Unlicensed Operations Framework Creates a Significant Risk of Harmful Interference to Licensed Services

In this proceeding, the Commission has proposed to permit unlicensed white space device and wireless microphone operations in the 600 MHz guard bands and duplex gap, and has proposed a technical framework that it believes would permit such operations to coexist with licensed 600 MHz services. However, real-world testing conducted by V-COMM has demonstrated that, unless the Commission makes significant adjustments to its technical rules, these unlicensed operations will cause significant harmful interference to licensed 600 MHz services in violation of the Spectrum Act. Indeed, the V-COMM testing utilized parameters that are far from conservative and consistent with protections provided to other incumbents in similar circumstances.

This paper provides additional discussion of the Commission's statutory obligation to protect licensed 600 MHz services, as well as the Commission's implementation of rules protecting incumbent services from harmful interference. As explained below, the performance degradation observed by V-COMM falls squarely within the realm of "harmful interference" as articulated by the Commission. V-COMM's testing is based on parameters that are consistent with protections provided by the Commission to other primary licensees, and indeed are less conservative than parameters applied by the FCC to certain other similarly situated licensees. Thus, the metrics and assumptions used by V-COMM are entirely appropriate, and the Commission should give significant weight to V-COMM's findings. White Space proponents that assert that there will not be harmful interference have based their findings on theoretical assumptions that are inconsistent with the actual operations of real-world mobile devices. Should the Commission ignore the testing data provided by V-COMM and instead embrace the parameters suggested by White Space proponents it would violate the specific provisions of the Spectrum Act which require use of guard band spectrum by unlicensed operations to not cause harmful interference to licensed services.

Meanwhile, commenters that oppose the wireless industry's findings and assumptions demonstrate misunderstanding of LTE technical characteristics, as well as V-COMM's testing parameters. In conducting its testing, V-COMM relied upon industry standard practices and the operating characteristics of real-world LTE devices that are not overly conservative. Assertions to the contrary are incorrect or misleading, and should be rejected by the Commission. Further, the out-of-band emission ("OOBE") limitations dictated by V-COMM's testing (and the method by which OOBE were simulated) similarly rely upon testing of real-world devices under industry standard assumptions.

Finally, while CTIA urges the Commission to adjust its technical rules for unlicensed devices consistent with V-COMM's findings, if the Commission persists in adopting its proposals, it should formally designate affected licenses as "impaired" and subject them to the same auction rules and procedures as licenses classified as "impaired" due to inter-service interference.

I. The Metrics Used to Determine Harmful Interference from Unlicensed Operation in the 600 MHz Guard Bands and Duplex Gap Are Consistent with Commission Precedent and Protections Provided to Other Entities.

The Commission is Required by the Spectrum Act to Protect Licensed 600 MHz Services from Harmful Interference Caused by Unlicensed Use of the Guard Bands. Consistent with its past precedent, the Commission should reject the proposed technical rules for unlicensed 600 MHz band operations, as they will have a significant – and unlawful – adverse impact on licensed wireless services and the consumers who use them. While CTIA encourages the Commission to promote both licensed and unlicensed uses of 600 MHz spectrum, the Commission is constrained by the clear language of the Spectrum Act. 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."[1] 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 harmful interference concerns. Indeed, the Commission has found that in implementing the Spectrum Act's dictates with respect to harmful interference, its decisions must be governed by Section 2.1 of the Commission's rules, which defines harmful interference as "[i]nterference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with [the ITU] Radio Regulations."[2]

The Commission has generally based its finding of harmful interference on whether the introduction of a new use and/or service would disrupt the users of incumbent services. Specifically, the Commission has designed its interference parameters "such that the presence of the new operators' signals would not be perceptible to the [incumbent operator's] customer in most cases."[3] Harmful interference is interference that results in "noisy calls that would be annoying to [a] caller."[4] Similarly, service interruptions that rise to the level of being observed by consumers would be considered "harmful interference" under the Commission's precedent.[5]

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

[2] *Service Rules for Advanced Wireless Services H Block*, Report and Order, 28 FCC Rcd 09483, ¶¶ 18-19 (2013) ("We presume that Congress was aware of this rule, defining both interference and harmful interference, when it crafted the Spectrum Act and used the term harmful interference. Because the Spectrum Act offers no alternative to the Commission's pre-existing definition of harmful interference, we believe it reasonable to conclude that Congress intended for it to apply to the situation here.").

[3] *Id.* ¶ 19, quoting *Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency With GSO and Terrestrial Systems in the KU-Band Frequency Range*, Memorandum Opinion and Order and Second Report and Order, 17 FCC Rcd 9614, 9641 ¶ 18 (2002), *Erratum*, ET Docket No. 98-206, RM-9147, RM-9245 (rel. June 4, 2002), *Erratum*, ET Docket No. 98-206, RM-9147, RM-9245 (rel. June 7, 2002), *Erratum*, ET Docket No. 98-206, RM-9147, RM-9245 (rel. Aug. 14, 2002), and *Erratum*, ET Docket No. 98-206, RM-9147, RM-9245 (rel. Sep. 17, 2004), *aff'd, Northpoint Technology, Ltd. v. FCC*, 414 F.3d 61 (D.C. Cir. 2005).

[4] *Aircell, Inc. Petition, Pursuant to Section 7 of the Act, for a Waiver of the Airborne Cellular Rule, or, in the Alternative, for a Declaratory Ruling*, Order on Remand, 18 FCC Rcd 1926, 1935-36 ¶ 22 (2003); *aff'd, AT&T Wireless Services, Inc. v. FCC*, 365 F.3d 1095 (D.C. Cir. 2004).

[5] *Northpoint Technology, Ltd. v. FCC*, 414 F.3d 61 (D.C. Cir. 2005).

CTIA and the wireless industry have provided detailed test findings, measured from real-world LTE devices, which demonstrate that the proposed technical rules for operations in the 600 MHz duplex gap and guard bands would cause harmful interference to licensed services in violation of the Spectrum Act.[6] V-COMM's testing showed that licensed 600 MHz services would be seriously degraded, obstructed, and repeatedly interfered with under regular conditions. Specifically, the 1 dB desensitization of an LTE receiver would result in a 14 percent loss in network coverage area, as well as a 10-15 percent loss in throughput.[7] It is inarguable that a 14 percent loss in coverage and/or 10-15 percent loss in throughput is "perceptible" or "noticeable" by consumers, and thus constitutes "harmful interference." As an example, consider the Baltimore-Washington Partial Economic Area ("PEA"). The population of this PEA is 7,842,134,[8] so a 14 percent loss of coverage in that PEA would affect approximately 1.1 million consumers.[9] CTIA believes that such a significant degradation in coverage would be "perceptible" or "noticeable" by those consumers.

The threat of harmful interference posed by the Commission's proposed unlicensed regime in the 600 MHz band will have a significant negative impact on the post-auction frequency environment, to the detriment of wireless consumers. As discussed in more detail below, the testing assumptions used by V-COMM are consistent with industry standard practices and model outcomes that are highly likely to occur in normal operations of a licensed 600 MHz system. The threat revealed by the V-COMM testing is therefore not hypothetical – it is a likely, foreseeable result. The harmful interference that would result from operations at the Commission's proposed parameters would significantly hinder operations in particular licensed blocks. Notably, this harmful interference will result in certain spectrum blocks becoming significantly impaired – undermining the Commission's stated goal of having fully fungible license blocks available for purchase in the forward auction.[10]

The Protection Requirement Utilized by the V-COMM Testing is Entirely Consistent with Protections Provided to Other Primary Licensees and Less Conservative than Applied to Other Similarly Situated Licensees. Not only did V-COMM's testing reveal a significant likelihood of harmful interference to licensed 600 MHz band services based on real-world parameters, the testing also relied upon protection criteria that are *less* conservative than what the Commission affords other similarly situated primary licensees. CTIA therefore believes that the appropriate course of action for the Commission is to apply the protection requirement used by V-COMM to its rules for unlicensed operation in the 600 MHz band.

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6 V-COMM Telecommunications Engineering, "Wireless Microphone and TVWS in 600 MHz Duplex Gap and Guard Band Test Results with LTE Devices" (Feb. 4, 2015) ("Test Report"), *attached to* Comments of CTIA – The Wireless Association®, ET Docket No. 14-165 (filed Feb. 4, 2015).

7 *Id*. at 96.

8 *See Wireless Telecommunications Bureau Provides Details About Partial Economic Areas*, Public Notice, 29 FCC Rcd. 6491, at Appendix A (2014).

9 This estimate assumes an even distribution of population over the market area.

10 *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Notice of Proposed Rulemaking, 27 FCC Rcd 12357, ¶ 61 (2012) ("*Incentive Auction NPRM*").

V-COMM's testing made use of an interference protection requirement that has been used in numerous other Commission proceedings. Specifically, V-COMM assumed a 1 dB "desense" interference threshold to protect licensed LTE receivers.[11] This 1 dB desense interference threshold equates to an interference-to-noise ("I/N") protection ratio of -6 dB, which has been accepted and used by the Commission in its most recent efforts to model interference. In particular, the AWS-3 (1755-1780 MHz) and 3550-3650 MHz spectrum bands were analyzed by NTIA and its advisory committees to model the interference effects from potential LTE use of these spectrum bands. For AWS-3, NTIA found, based on recommendations from its spectrum advisory committees, that Federal incumbents should be protected based on an I/N protection ratio of -6 dB.[12] In turn, the FCC adopted these recommendations and required that new AWS-3 entrants coordinate their spectrum usage with respect to Federal incumbents based on this same I/N protection ratio of -6 dB.[13] For the 3550-3650 MHz band, NTIA presented analysis in its Fast Track Report of this spectrum and determined protection zones based on an I/N protection ratio of -6 dB.[14] The FCC noted this protection ratio and confirmed that this would be the protection requirement for incumbent Federal operations in the 3550-3650 MHz spectrum band.[15] As this protection level has been repeatedly accepted by the Commission, NTIA, and the wireless industry, CTIA believes that it is the appropriate metric for use in protecting licensed 600 MHz services from harmful interference caused by secondary unlicensed operations.

Notably, the protection ratio assumed by V-COMM in its testing and endorsed by key stakeholders in previous proceedings is not the most conservative approach to interference protection found in the Commission's rules. For example, the interference protection afforded to

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[11] Test Report at 95.

[12] *See e.g.*, Commerce Spectrum Management Advisory Committee, *Final Report, Working Group 1 – 1695-1710 MHz Meteorological-Satellite*, at Appendix 3-8 (July 23, 2013), *available at* http://www.ntia.doc.gov/files/ntia/publications/wg1_report_07232013.pdf ("WG-1 Final Report") ("Interference Criterion is 1 dB desense. This translates into a maximum interference = Noise Floor -5.87 dB (I/N = ~ -6 dB)"). *See also*, Commerce Spectrum Management Advisory Committee (CSMAC) Working Group 5 (WG-5), *1755-1780 MHz Airborne Operations Sub-Working Group Report (Air Combat Training System, Small Unmanned Aircraft Systems, Precision-Guided Munitions, Aeronautical Mobile Telemetry), Final Report*, at 12 (March 4, 2014), *available at* http://www.ntia.doc.gov/files/ntia/publications/wg5_final_report_posted_03042014.pdf ("For each receiver, a threshold interference to noise (I/N) ratio of -6 dB was selected as the value for which operational impact to the receiver would be minimal.").

[13] *See Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands*, Report and Order, 29 FCC Rcd 4610, ¶ 37 (2014) ("In light of these actions, we authorize the use of the 1755-1780 MHz band for commercial service in conformance with NTIA's endorsements, the DoD Proposal and the Spectrum Act.").

[14] *See* NTIA, *An Assessment of the Near-Term Viability of Accommodating Wireless Broadband Systems in the 1675- 1710 MHz, 1755-1780 MHz, 3500-3650 MHz, and 4200-4220 MHz,4380-4400 MHz Bands*, at 4-7 (Nov. 15, 2010), *available at* http://www.ntia.doc.gov/reports/2010/FastTrackEvaluation_11152010.pdf ("Fast Track Report") ("In this compatibility analysis, the interference threshold for the radar is based on an I/N criterion of -6 dB. An I/N of -6 dB corresponds to a 1 dB increase in the receiver noise.").

[15] *See Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Notice of Proposed Rulemaking and Order, 27 FCC Rcd 15594, ¶ 116 (2012) ("The Fast Track Report states that the interference-to-noise (I/N) protection criterion (*i.e.*, the I/N that results in the maximum rise in the noise floor of the receiver to maintain acceptable performance) for interference from wireless broadband to radars operating in this band is -6 dB.").

DTV service at the edge of a station's noise-limited service area is equivalent to an interference-to-noise ratio of -7 dB.[16] In light of the fact that the Commission has adopted more conservative interference protection criteria for other primary licensees in the 600 MHz band – broadcast television stations – the parameters proposed by V-COMM are highly appropriate and are necessary to ensure the 600 MHz wireless ecosystem envisioned by Congress in the Spectrum Act.

II. Commenters That Oppose the Wireless Industry's Findings and Assumptions Misunderstand LTE Technical Characteristics and Testing Parameters and, Importantly, Commenters' Suggested Changes Would Not Alter the Wireless Industry's Overall Conclusions.

The Mobile Device Power Levels Tested by V-COMM Are Appropriate and Consistent with Operating Characteristics for LTE Systems. Some parties have questioned the power levels for the LTE devices tested. In particular, these parties argued that V-COMM should have conducted all testing at the maximum operating power for the mobile LTE device (23 dBm).[17] These assertions demonstrate the parties misunderstand and/or grossly mischaracterize the impact of the LTE device transmit power levels in receiver OOBE tests. The transmit power level of the LTE devices under test had negligible impacts to the receiver OOBE testing results and interference assessments, as shown in the V-COMM 600 MHz Test Report. Additionally, given the tight power control used by LTE network operators, the vast majority of LTE devices are operated at 0 dBm or less – a point that has been documented during the Commerce Spectrum Management Advisory Committee ("CSMAC")[18] process and accepted by the Federal government to model compatibility between LTE and Federal incumbent operations.

As an initial matter, it is critical to note that changing the nominal power level for the LTE devices under test from 0 dBm to 23 dBm would have had nearly no effect on the results of the tests.[19] The LTE transmit power level used in the V-COMM testing had negligible impact to the measured sensitivity levels. Similarly, the expected OOBE test results attained if devices were transmitting at maximum power levels rather than nominal power levels would have been marginal (0.4 dB difference).[20] Therefore, increasing the LTE device transmit power level

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16 47 C.F.R. § 73.616(e)(1)(i) ("At the edge of the noise-limited service area, where the signal-to-noise (S/N) ratio is 16 dB, this value is +23 dB."). A signal-to-noise ratio of 16 dB minus the D/U value of 23 dB translates to an interference-to-noise ratio of -7 dB.

17 *See* Reply Comments of Google Inc., ET Docket No. 14-165, at 11 (filed Feb. 25, 2015) ("Google Reply Comments"); *Unlicensed Device Operation in Guard Band(s) and Duplex Gap and Location Accuracy Requirements in 600 MHz*, at 5 (Mar. 24, 2015), *attached to* Letter from Scott Blake Harris, Counsel, Broadcom Corporation, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 14-165, GN Docket No. 12-268 (dated Mar. 26, 2015) ("Broadcom *Ex Parte*").

18 *See* NTIA, CSMAC, http://www.ntia.doc.gov/category/csmac (last visited Apr. 23, 2015).

19 The average receive sensitivity results of all LTE devices operating at nominal power level (0 dBm) and at maximum power level (23 dBm) was -105.2 dBm and -104.8 dBm, respectively. After rounding to whole units, both test results for nominal and maximum power are the same value at -105 dBm.

20 The OOBE test results for the LTE devices operating at nominal power levels was -127.1 dBm/100 kHz on average, and if tested at maximum power levels would be expected at approximately -126.7 dBm/100 kHz on average. This is a negligible 0.3 dB difference from the -127 dBm/100 kHz results. We also note the free-space

would have an insignificant impact on the OOBE testing results and would not have changed the testing results or conclusions as submitted by CTIA.

Nonetheless, Google and Broadcom have asserted that: (1) OOBE tests with LTE devices operating at 0 dBm power levels would exhibit sensitivity far in excess of real-world performance; and (2) that the V-COMM tests "inconsistently" set the LTE power levels at 0 and 23 dBm during testing.[21] CTIA agrees that the testing that was performed by V-COMM used different power levels for measurements – 0 dBm for OOBE and blocking performance and 23 dBm for intermodulation testing. However, these settings were completely appropriate and, more importantly, have no real meaningful effect on the results of testing. As background, LTE devices operate with a wide dynamic power level range (-40 dBm to 23 dBm) and the nominal power level of 0 dBm was selected for receiver blocking and OOBE testing to characterize the impacts to LTE devices under normal operating conditions. The transmit power level of 0 dBm was selected as the vast majority of devices operated in an LTE network are operated at power levels of 0 dBm or *less*. Indeed, this fact was presented to Federal incumbents during industry discussions modeling compatibility between LTE and Federal operations – and was accepted and used to model the interference between commercial and Federal systems.[22] The cumulative distribution function ("CDF") provided below shows that 65 percent of LTE user equipment ("UE") is operated at power levels of 0 dBm or less. Moreover, NTIA accepted and endorsed these findings and indicated that the UE power levels would be assigned in accordance with this CDF – demonstrating that the government agreed that LTE user equipment power levels were generally at 0 dBm or less.[23] The use of 0 dBm power levels to measure receiver blocking and OOBE performance is therefore completely appropriate and representative of real-world operating power levels for LTE devices – a fact endorsed and agreed to by both NTIA and the Federal incumbents in the context of modeling compatibility with LTE devices.

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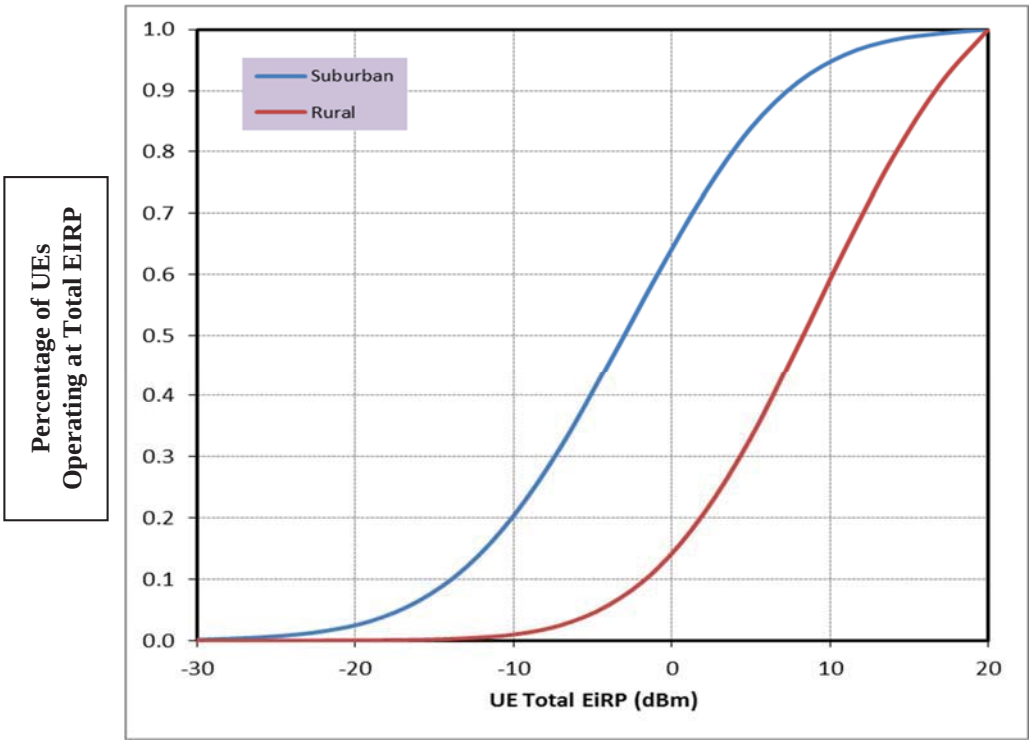
propagation loss at 650 MHz is actually 28.7 dB *(i.e.*, for 84 MHz clearing scenario), or 0.3 dB below the assumed 29 dB for 1 meter separation. Thus, combining these results, along with 9 dB additional path losses, the required OOBE limit is the same at -89.0 dBm/100kHz.

21 Google Reply Comments at 11; Broadcom *Ex Parte* at 5.

22 *See* WG-1 Final Report at Appendix 3-3.

23 *Id*. at Appendix 3-4.



In its intermodulation tests, V-COMM utilized LTE devices operating at maximum power levels (23 dBm) to capture the third order intermodulation impact from the combination of the LTE transmitting signal and the interfering signal in the duplex gap. For intermodulation measurements, the LTE device was required to transmit at the maximum power level to ensure measurement of the intermodulation impacts (rather than the receiver blocking impacts that would have been captured if these measurements were done at lower power levels). Rather than being "inconsistent" as alleged by parties, these power level settings were utilized to measure different interference issues.

The Interference Path Loss Assumptions Used in the V-COMM Testing Are Based on Industry Standard Practices and Operating Characteristics of Real-World LTE Devices. In addition to questioning the power levels used by V-COMM testing, several parties have argued that additional antenna gain, shadowing, and propagation losses are needed to model the interference environment between unlicensed and licensed services. These assertions are incorrect, misleading, and should be rejected by the Commission.

Antenna Gain. Google, Microsoft, and Broadcom assert that V-COMM ignored or underestimated antenna losses when conducting its testing.[24] The industry standard for LTE device antenna gain is 0 dBi,[25] which is the value used in the V-COMM interference analysis. In its testing, V-COMM assumed 0 dBi for LTE device antenna gain, 3 dB user body loss, and 3 dB

[24] *See* Google Reply Comments at 7; Broadcom *Ex Parte* at 5; Reply Comments of Microsoft Corporation, ET Docket No. 14-165, at 6-7 (filed Feb. 25, 2015) ("Microsoft Reply Comments").

[25] *See* 3GPP TS 36.101 Sections 6.1 and 7.1.

for antenna polarization mismatch loss or other miscellaneous losses, which is a combined loss of -6 dB per LTE device. Contrary to the assertions of Google and Microsoft, Qualcomm's approach was similar (within 1 dB) to the one utilized by V-COMM. Qualcomm used an LTE device antenna gain factor of -7 dBi; however, Qualcomm did not include other path losses associated with the use of the LTE device, such as LTE device user body loss, LTE device antenna polarization mismatch loss, or other miscellaneous losses. Thus, Qualcomm used a combined user device and antenna loss of -7 dB per LTE device. Broadcom, Google, and Microsoft inappropriately use an LTE device antenna gain of -6 dBi while *also* adding in other user device losses, effectively double-counting 6 dB of losses in real-world device operation.[26]

Shadowing Loss. Broadcom, Google, and Microsoft assume 3 dB additional path losses over free-space for shadowing loss. The use of propagation shadowing loss is not supported by any technical data or explanation, nor is it appropriate for devices used in close proximity. Propagation shadowing losses are not appropriate for short distances (*e.g.*, 1-2 meters), where free-space line of sight conditions would prevail and be more predominant. For devices used in close proximity, the free-space model is the accurate and appropriate model for propagation, and is well supported by others in the industry as well as the FCC in its own analyses of the mobile-to-mobile interference environment. Shadowing losses could be more appropriate for some situations indoors when the separation distances are much greater (*e.g.*, 20 meters), but not when devices are used in close proximity.

Separation Distance. The one meter separation distance between LTE devices and white space devices is consistent with the industry standards for determining compatibility between two mobile devices.[27] Broadcom, rather than relying upon the industry practice, inexplicably asserts that the appropriate assumptions should be 2 meters for client devices and 3 meters for access points without providing any supporting material or rationale for these assumptions.[28] CTIA strongly disagrees with this argument. Given the expected ubiquity of white space devices and the pervasive use of LTE devices, the assumption of 1 meter separation between devices is actually quite conservative and completely appropriate.

As shown in the table below, the assumptions made by V-COMM and Qualcomm are consistent: within 2 dB of one another. In contrast, Google, Microsoft, and Broadcom have injected 14-15 dB of additional propagation losses without any sound engineering basis. While V-COMM and Qualcomm relied on well-settled industry standards and demonstrated that these assumptions are consistent with real-world measurements, Google, Microsoft, and Broadcom appear to be engaging instead in results-oriented reverse engineering (*i.e.*, determining what result is desired and modifying the path loss assumptions to reach their desired outcome).

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[26] Indeed, Qualcomm agrees with the methodology used by V-COMM for its testing assumptions. *See* Reply Comments of Qualcomm Incorporated, ET Docket No. 14-165, at 7, FN 13 (filed Feb. 25, 2015).

[27] *See* 3GPP TR 25.942 v. 12.0.0 at 4.2.1(d), *available at* http://www.3gpp.org/ftp/Specs/archive/25_series/25.942/25942-c00.zip.

[28] *See* Broadcom *Ex Parte* at 5.

	V-COMM	*Qualcomm*	*Google/Microsoft/Broadcom*
Device/UE Antenna Gain	0 dBi	-7 dBi	-6 dBi
Transmit Device Antenna Loss	3 dB (held in hand)	0 dB	3 dB
Receive Device Antenna Loss	3 dB (held in hand)	0 dB	3 dB
Antenna Polarization Mismatch and Misc. Losses	3 dB	0 dB	6 dB
Separation Path Loss	29 dB (1 meter)	29 dB (1 meter)	35 dB (2 meters)
Total Losses	**38 dB**	**36 dB**	**53 dB**

The OOBE Limitations Dictated by the V-COMM Study Rely Upon Testing of Real-World Devices Under Industry Standard Assumptions as the Commission Requested. Google asserts that the interference threshold found by the V-COMM testing greatly exceeded their calculations using 3GPP standard values.[29] As CTIA has consistently noted, however, the Commission asked that the wireless industry *not* rely solely upon industry standards. Instead, the Commission asked that the wireless industry provide real-world testing data to document the operating parameters of LTE devices.[30] This is exactly what V-COMM did when it tested 10 different LTE devices and measured their actual performance (rather than the performance dictated by the 3GPP standards). Therefore, the harmful interference protection requirements should be sure to protect the actual operating characteristics of the LTE devices tested, rather than theoretical performance provided by Google and others to support their OOBE protection positions. Google and others should not now criticize the use of this methodology or the results it attained when the data came from the precise real-world testing the Commission requested in the first place.

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[29] *See Ex Parte* Presentation of Google Inc., ET Docket No. 14-165, filed March 24, 2015 at 10. ("According to CTIA's test results summary, the devices it tested experienced 1 dB of desensitization when the interfering co-channel signal was an average of only -127 dBm/100 kHz, and 3 dB of desensitization with an interfering co-channel signal power of -121 dBm/100 kHz. Integrated across the 4.5 MHz LTE channel, these limits translate into -110.5 dBm and -104.5 dBm, respectively. These results are far below the -98.5 dBm co-channel interference threshold that both Broadcom and Qualcomm cited, based on 3GPP-imposed reference sensitivity requirements.").

[30] Comments of CTIA – The Wireless Association®, ET Docket No. 14-165, GN Docket Nos. 14-166 and 12-268, at 7 (filed Feb. 4, 2015) ('CTIA Comments").

The Use of Additive White Gaussian Noise Signal Sources To Simulate OOBE Interference Is Consistent with Standard Industry Testing Practices. Google takes exception to the use of co-channel additive white Gaussian noise ("AWGN")[31] during the V-COMM testing.[32] Use of AWGN is a well-accepted practice and indeed was used and endorsed by the FCC during the testing between AWS-1 and M2Z proposals.[33] As the OOBE from white space devices would be five to nine megahertz from the 600 MHz downlink band, these emissions will be fairly constant at that point (similar to AWGN) and therefore the V-COMM testing was representative of the interference expected from white space device OOBE. In addition, Qualcomm's testing used white space device interfering signal sources that met the FCC's proposed OOBE mask and provided similar results to what V-COMM measured using AWGN.[34] Therefore, the Qualcomm test results support the methodology used by V-COMM as appropriate and accurate for modeling OOBE interference from white space devices.

III. If the Commission Inadvisably Adopts its Proposed Technical Rules for Unlicensed Operation, it Should Designate Impacted 600 MHz Licensees as "Impaired" for Purposes of the Auction.

As explained herein and in CTIA's filings in this proceeding, more stringent technical rules for unlicensed operation are required to comply with the Spectrum Act's requirements that harmful interference not be caused to 600 MHz licensed operations. To the extent the Commission nevertheless adopts its proposed rules, the impact on certain 600 MHz licensees will be similar to inter-service interference caused by broadcast television stations that results in licenses being designated as "impaired" for purposes of the auction. If licenses subject to inter-service interference are to be designated as "impaired" and auctioned, the same should be done with licenses subject to interference caused by adjacent-channel unlicensed operations.

When the Commission adopted rules in this proceeding, it envisioned a mechanism under which forward auction participants could bid on "generic" blocks, with specific frequencies to be assigned later.[35] This approach was premised on the notion that individual spectrum blocks

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[31] Additive white Gaussian noise is a generally accepted model for thermal noise in communications channels, and mimics the effect of many random processes that occur in nature. It is premised on the assumption that: (1) noise is additive, and that the receive signal equals the transmit signal plus some noise that is statistically independent of the signal, (2) noise is "white" – it consists of all frequencies and is uncorrelated, and (3) noise samples have a Gaussian or "normal" distribution as defined in probability theory. *See, e.g.*, "Additive White Gaussian Noise," *at* http://www.wirelesscommunication.nl/reference/chaptr05/digimod/awgn.htm (last visited April 24, 2015).

[32] CTIA Comments at 12.

[33] Federal Communications Commission Office of Engineering and Technology, *Advanced Wireless Service Interference Tests Results and Analysis*, at 3 (Oct. 10, 2008), *attached to The FCC's Office of Engineering and Technology Releases Analysis of AWS-3 Interference Tests*, Public Notice, DA 08-2245, WT Docket Nos. 07-195, 04-356, at 3 (rel. Oct. 10, 2008).

[34] *See* Comments of Qualcomm Incorporated, ET Docket No. 14-165, at 8-12 (filed Feb. 4, 2015).

[35] *Incentive Auction NPRM* ¶ 61 ("Bidding for generic blocks would be expected to speed up the forward auction, reducing the time and, therefore, the cost of bidder participation, since bidders would no longer need to iteratively bid on the least expensive of several specific but substitutable licenses, as in a typical FCC SMR auction.").

would generally be fungible.[36] Later, however, recognizing that the presence of inter-service interference would render true fungibility impossible, the Commission proposed procedures that would designate affected spectrum blocks as "impaired" and discount them accordingly.[37] Now, however, the Commission has proposed to create additional license impairments in the 600 MHz band by proposing rules for unlicensed operation that would similarly limit a 600 MHz licensee's use of affected blocks. There is no basis for the Commission to discount and formally designate as "impaired" licenses subject to interference caused by television stations and not take the same action with respect to impairments caused by unlicensed operation. Thus, if the Commission adopts its proposed technical rules, principles of equity dictate that the Commission quantify the degree of impairment to each impacted license and treat those licenses similarly to those licenses impaired as a result of inter-service interference.

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[36] *Id*. ¶ 64.

[37] *Comment Sought on Competitive Bidding Procedures for Broadcast Incentive Auction 1000, Including Auctions 1001 and 1002*, Public Notice, 29 FCC Rcd 15750, ¶¶ 142-148 (2014).