

**Before the  
FEDERAL COMMUNICATIONS COMMISSION  
OFFICE OF ENGINEERING AND TECHNOLOGY  
Washington, D.C. 20554**

In the Matter of	)	
	)	
Office of Engineering and Technology Seeks Comment on Measurements of LTE Into DTV Interference	)	ET Docket No. 14-14
	)	
Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions	)	GN Docket No. 12-268
	)	

To: The Office of Engineering and Technology

**COMMENTS OF THE  
NATIONAL ASSOCIATION OF BROADCASTERS**

July 11, 2014

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## SUMMARY

For well over a year, NAB has cautioned the Commission that adoption of a non-nationwide band plan would create the potential for inter-service interference between LTE operations and DTV service. The ongoing challenges surrounding 700 MHz wireless operations and DTV operation on channel 51 pale in comparison to the potential problems associated with co- and adjacent-channel LTE and DTV operation in the 600 MHz band. If, as the recently-released incentive auction order indicates, the Commission is committed to proceeding with a variable plan, it should commit to addressing the complexities associated with that decision in a transparent, comprehensive manner.

NAB commends the Commission's staff for conducting laboratory testing of actual equipment to measure wireless LTE interference into DTV receivers. This initial testing is a first step in studying the technical aspects of LTE and DTV operations in the same band. However, as the staff itself acknowledges, the testing was too limited for statistical analysis and, as a result, cannot form the basis for specific Commission conclusions. The testing itself also suffers from a number of methodological issues, and the results of the testing generally do not support OET's conclusions.

While this testing is a fine first step, unfortunately the Commission has given no indication that it has considered the numerous and substantial problems NAB and other broadcasters identified with the proposed methodology, which include incorrect assumptions about operating parameters for LTE operations, ignoring combined interference contributions, unprecedented use of inappropriate field strength prediction characteristics, and selective use of clutter loss, among others. Further, the Commission still has not provided clarity as to how it intends to use this proposed

methodology, and how the methodology will fit into rules designed to prevent harmful inter-service interference following the auction. Predicting inter-service interference for the purpose of identifying for wireless bidders in the forward auction which markets are impaired, and to what extent, is only one aspect of the inter-service interference issue. NAB has grave concerns that the Commission is either: (1) focusing on making predictions for purposes of the forward auction while overlooking the far more important question of how LTE and DTV operations will actually co-exist in the 600 MHz band *after* the auction; or (2) planning on using this proposed methodology as the sole basis for new rules intended to prevent harmful inter-service interference. The Commission has yet to propose and seek comment on rules for the protection of DTV operations from interference caused by LTE operation (or rules for the protection of LTE operations from interference caused by DTV signals), which will govern how LTE and DTV operations actually interact after the auction. It should do so promptly.

Ultimately, the most important criteria for measuring the Commission's success in both predicting and preventing inter-service interference will be whether consumers and service providers operating in real world environments are subject to interference. If over-the-air television viewers lose their signal due to LTE operations, or if wireless carriers, having successfully bid on expensive spectrum licenses in the forward auction, find themselves unable to actually deploy service where and how they expected in making billion-dollar decisions, the Commission's methodology for predicting inter-service interference will have proven unsuccessful.

Accordingly, while NAB supports additional testing and analysis, the Commission must move forward in a transparent process with proposing and seeking comment on

*specific rules* for inter-service interference protection. Both with respect to predicting impairment for the purpose of the auction and for the actual protection of DTV and LTE operations, we continue to believe an approach based on separation distances is far simpler and more appropriate in keeping with the FCC's desire to move forward expeditiously with the incentive auction.

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**COMMENTS OF THE  
NATIONAL ASSOCIATION OF BROADCASTERS**

The National Association of Broadcasters (“NAB”)<sup>1</sup> submits these comments in response to the Public Notice released on June 20, 2014 (“Public Notice”) seeking to supplement the record by inviting comment on measurements of wireless Long-Term Evolution (“LTE”) interference into digital television receivers.<sup>2</sup>

**I. INTRODUCTION**

On January 29, 2014, the Commission released a Public Notice seeking comment on a proposed methodology for predicting inter-service interference between

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<sup>1</sup> The National Association of Broadcasters is a nonprofit trade association that advocates on behalf of free local radio and television stations and broadcast networks before Congress, the Federal Communications Commission and other federal agencies, and the courts.

<sup>2</sup> *Office of Engineering and Technology Seeks Comment on Measurements of LTE Into DTV Interference*, Public Notice, ET Docket No. 14-14, GN Docket No. 12-268, DA 14-852 (rel. June 20, 2014) (“June Public Notice”).

broadcast television and wireless services in the 600 MHz band.<sup>3</sup> In response to this January Public Notice, commenters raised numerous concerns regarding some of the assumptions the methodology used, the lack of empirical data supporting the proposed methodology, and the lack of transparency concerning the intended use of the proposed methodology.<sup>4</sup> In April 2014, the Office of Engineering and Technology (“OET”) tested the characteristics of LTE-into-DTV interference. In addition, the Consumer Electronics Association (“CEA”) submitted measurements of LTE-to-DTV interference on six newer model television receivers and two older model receivers.<sup>5</sup> OET now seeks comments on the measurements and observations discussed in the both reports, addressing only limited aspects of the concerns commenters previously identified. Specifically, OET seeks comment on whether its measurements, in conjunction with CEA’s measurements, support the desired-to-undesired signal (“D/U”) ratios, the off-frequency rejection (“OFR”) factor, and the assumed effective radiated power (“ERP”) adjustments that appear in Tables 8, 9 and 10 of its January Public Notice.<sup>6</sup> OET also seeks comments on the relevance of the measurements associated with older receivers.<sup>7</sup>

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<sup>3</sup> *Office of Engineering and Technology Seeks to Supplement the Incentive Auction Proceeding Record Regarding Potential Interference Between Broadcast Television and Wireless Services*, Public Notice, 29 FCC Rcd 712 (2014) (“January Public Notice”).

<sup>4</sup> See Comments of the National Association of Broadcasters, ABC Television Affiliates Association, FBC Television Affiliates Association, CBS Television Network Affiliates Association, NBC Television Affiliates, the Association of Public Television Stations, the Corporation for Public Broadcasting, and the Public Broadcasting Service, ET Docket No. 14-14, GN Docket No. 12-268 (filed Mar. 18, 2014); Comments of the Society of Broadcast Engineers, Incorporated, ET Docket No. 14-14, GN Docket No. 12-268 (filed Mar. 17, 2014).

<sup>5</sup> See Letter from Julie M. Kearney to Marlene H. Dortch, ET Docket No. 14-14, GN Docket No. 12-268 (filed May 22, 2014) (“CEA Report”).

<sup>6</sup> See June Public Notice at 2.

<sup>7</sup> *Id.*

NAB commends the FCC for its efforts to bring empirical data and information to bear on the inter-service interference issue. NAB believes that this initial testing provides a good first step in the study of the technical aspects of inter-service sharing between broadcast and wireless operations. However, the issue of inter-service interference goes well beyond the measurement of DTV receiver performance in the presence of LTE interference. Broadcasters' and viewers' concerns focus on how this information will be used and what rules and regulations will apply to wireless operations to protect TV viewers. Unfortunately, the FCC has shed little light on how it will use the result of these measurements to determine the technical rules and regulations that will eventual apply to inter-service sharing. Until the FCC proposes specific sharing rules, NAB must limit its observations to the testing methodology used to conduct these measurements and the validity of the data presented. We cannot adequately analyze the impact and use of such studies in developing inter-service policies and rules. NAB anxiously awaits the release of a Notice of Proposed Rulemaking addressing inter-service interference and sharing rules between the two services.

With respect to the specific issues on which the Public Notice seeks comment, NAB submits that the measurements do not support the interference protection levels identified in Tables 8 and 9<sup>8</sup> of the January Public Notice. We recommend that the FCC conduct additional testing and studies to better understand and address inter-service interference issues.<sup>9</sup> These new studies should take into account factors such as multiple LTE interferers, degradation of DTV receiver performance from third order

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<sup>8</sup> The OET report did not present measurement that relates to Table 10.

<sup>9</sup> See Comments of DIRECTV, LLC, ET Docket No. 14-14, GN Docket No. 12-268 (filed July 11, 2014). DIRECTV raises the issue of LTE interference into DIRECTV's local receive facilities, and indicates that it is collecting interference measurements for further analysis.



intermodulation (IM3) interference, and real-world transmitter splatter to determine the appropriate interference protection for both services. Clearly the results of both the FCC and CEA tests demonstrate significant variability in receiver performance and the need for more rigorous testing. Such testing should include an adequate sample size of old and new receivers, and must go beyond testing DTV receiver performance under best-case single impairment conditions to include real-world DTV signal reception conditions with multiple impairments.

NAB supports the need for additional testing and analysis. We also continue to believe that the simpler distance approach we originally proposed for inter-service sharing is far more appropriate, and ultimately more in keeping with the FCC's desire to move forward expeditiously with the auction.

## **II. NUMEROUS QUESTIONS REMAIN OUTSTANDING AS TO HOW THE COMMISSION INTENDS TO PREDICT AND PREVENT INTERSERVICE INTERFERENCE**

On March 18, 2014, NAB, together with a number of other broadcast interests (the "Joint Broadcasters"), submitted extensive comments on OET's proposed methodology.<sup>10</sup> In their March comments, the Joint Broadcasters demonstrated that the proposed methodology relied on plainly inaccurate inputs and assumptions, which systematically understated the potential for inter-service interference and would lead to inaccurate calculation of required separation distances. Among other things, the proposed methodology:

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<sup>10</sup> Comments of the National Association of Broadcasters, ABC Television Affiliates Association, FBC Television Affiliates Association, CBS Television Network Affiliates Association, NBC Television Affiliates, the Association of Public Television Stations, the Corporation for Public Broadcasting, and the Public Broadcasting Service, ET Docket No. 14-14, GN Docket No. 12-268 (filed Mar. 18, 2014) ("Joint Broadcaster Comments").

- assumes operating parameters for wireless base stations that are significantly reduced from the Commission’s proposed service rules, and inconsistent with available facts concerning actual deployments;
- ignores combined interference contributions from multiple wireless base stations;
- makes questionable assumptions concerning the interference potential for LTE emissions without testing to confirm such assertions;
- makes unprecedented use of inappropriate field strength prediction characteristics that understate the potential for inter-service interference; and
- selectively uses clutter loss in predicting interference to television service from wireless transmissions.<sup>11</sup>

The Joint Broadcasters also stated that the January Public Notice failed to provide meaningful information as to how the Commission intended to use OET’s new methodology, including whether or not the Commission intended to use it as a basis for interference protection following the auction – an outcome that would contravene the express provisions of the Spectrum Act and would prove legally unsustainable.<sup>12</sup> The January Public Notice expressly states that the “OET Methodology provides a technique for calculating the predicted interference to DTV service, but does not address what limits should be applied to such interference, whether wireless license areas should be auctioned if predicted interference exceeds some threshold, or whether interference

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<sup>11</sup> *Id.* at 3.

<sup>12</sup> *Id.* at 3-4.

from wireless facilities should be accounted for in calculating a DTV station's service area and/or population served.”<sup>13</sup>

Since that time, the Commission has released its initial Report and Order in this proceeding.<sup>14</sup> In that Report and Order, the Commission provided essentially no further substantive guidance as to how it would prevent inter-service interference, stating that “we plan to issue an order that establishes the methodology for preventing inter-service interference,” and that this “methodology will govern post-auction co- or adjacent-channel operation of television and wireless services, including operation of new 600 MHz licensees in these areas (i.e., additional rules for licensees that hold impaired 600 MHz licenses).”<sup>15</sup>

According to the FCC's recently released timeline of key events leading up to the incentive auction, the Commission intends to adopt its methodology for preventing harmful inter-service interference in the third quarter of 2014 – or by the end of September.<sup>16</sup> The Commission still has not proposed specific rules with limits or restrictions on inter-service interference and provisions for the protection of television service following repacking, and there is no indication on the timeline that the FCC intends to do anything further to prevent inter-service interference beyond adopting this methodology.

The instant Public Notice merely seeks comment on limited testing designed to examine only a few of the numerous substantive issues the Joint Broadcasters

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<sup>13</sup> January Public Notice at 7.

<sup>14</sup> *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, GN Docket No. 12-268, FCC 14-50 (rel. June 2, 2014).

<sup>15</sup> *Id.* at ¶ 84.

<sup>16</sup> See Estimated Timeline of Key Events Leading up to FCC's Broadcast Incentive Auction, available at: [http://wireless.fcc.gov/incentiveauctions/learn-program/Incentive\\_Auction\\_Timeline.pdf](http://wireless.fcc.gov/incentiveauctions/learn-program/Incentive_Auction_Timeline.pdf).

identified in their filing. The Public Notice states that several parties raised concerns about the assumptions which form the basis for the D/U ratios of Table 8, the OFR values of Table 9, and the assumed ERP in Table 10 of the January Public Notice. NAB respectfully reminds the FCC that the concerns raised in earlier comments with regard to the interference prediction methodology went *well* beyond those few issues addressed in the three tables cited.

NAB is concerned that the Commission may be overlooking the need to propose and adopt limits and rules for the prevention of harmful inter-service interference, or that it intends to adopt some form of OET's methodology as the *sole basis* for preventing inter-service interference. If the Commission intends to adopt specific rules based on the state of the record to date, without ever having proposed or sought comment on those rules, such action would clearly be arbitrary and capricious and subject to reversal.<sup>17</sup> That outcome will only lead to uncertainty and delay surrounding the incentive auction. Rather than proceed down this path, the Commission should promptly seek public comment on specific proposed rules so that both broadcasters and wireless carriers will more fully understand the regulatory environment that will govern their joint operation in the 600 MHz band following the auction.

### **III. THE SELECTION OF DTV RECEIVERS TESTED IS NOT REPRESENTATIVE OF RECEIVERS VIEWERS CURRENTLY USE AND ARE LIKELY TO USE FOLLOWING THE AUCTION**

The FCC tested LTE into DTV interference on just four DTV receivers, including one 2007 set-top box chosen "because its performance is typical of the coupon-eligible digital-to-analog converter boxes available during the DTV transition," and three 2013-

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<sup>17</sup> See, e.g., *Int'l Union, United Mine Workers of America v. Mine Safety and Health Administration*, 407 F.3d 1250, 1261 (D.C. Cir. 2005); *Lloyd Noland Hospital and Clinic v. Heckler*, 762 F.2d 1561, 1565-66 (11<sup>th</sup> Cir. 1985).

model DTV receivers.<sup>18</sup> OET conducted testing primarily to determine LTE-into-DTV co- and adjacent channel D/U protection ratios but included additional tests to determine DTV receiver threshold sensitivity or minimum signal level and DTV-into-DTV co-channel D/U protection ratios.

The CEA receiver tests were somewhat more extensive. Specifically, CEA performed laboratory testing on 14 consumer television receivers primarily from 2012-2013 with two sets from 2006 for comparison.<sup>19</sup> According to CEA, the newer sets “represented an estimated 85% of DTV (tuner) shipments in the U.S. for the period 2012-2013.”<sup>20</sup> The testing included general performance testing, as well as DTV-into-DTV interference and LTE-into-DTV interference tests. CEA testing also examined the effects of multiple signal interference and IM3 interference.

While NAB appreciates the introduction of empirical testing data into the discussion of inter-service interference, both sets of testing used extremely limited samples of receivers. First, the 2007 set-top box OET tested as “typical” of converter boxes associated during the DTV transition is just one of the 191 DTV set-top boxes the FCC approved, and OET provides no information as to how it determined the single tested box to be representative. Americans purchased *34.8 million* set-top boxes under the NTIA DTV coupon program that ran from January 1, 2008 to March 31, 2009, and the FCC should not rely on such limited testing in making policy determinations that potentially affect millions of viewers.

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<sup>18</sup> See *FCC/OET Report TA-2014-01, Measurements of LTE into DTV Interference, Tests on Four ATSC DTV Receivers of OFDM 64 QAM Co- and Adjacent Channel Interference*, Robert Weller, Martin Doczkat, Uri Livnat, Tho Nguyen, Barabara Pavon (June 17, 2014) (“OET Report”).

<sup>19</sup> Not all tests were conducted on all 14 receivers. Only six receivers were selected to conduct the DTV-into-LTE signal overlap interference.

<sup>20</sup> CEA Report at 1.

Moreover, the Public Notice seeks comments on the relevance of measurements of receivers that are more than seven years old, suggesting that these older receivers are no longer commercially available and will be approaching the end of their life cycle at the time of the wireless build-out in the 600 MHz band. In fact, it seems highly unlikely that all 34.8 million set-top boxes purchased under the DTV coupon program will suddenly stop working in the next year or two. These set top converter boxes continued to be sold after the 2009 DTV conversion date – many consumers purchased such converter boxes in 2010 or later without the subsidy. Indeed, DTV-to-analog TV converter boxes continue to be available even today at major retail outlets such as Best Buy and Walmart and on-line at Amazon and other outlets.<sup>21</sup>

Seven years is not a reasonable life assumption for DTV receivers. Useful life of receivers for consumers, not commercial availability, is what matters in considering how viewers will be affected by inter-service interference. Even when consumers replace primary television sets, their older receivers are often still in working condition and are moved to another location in the home, where they continue to provide signals to consumers. Given this consumer behavior, a more reasonable expected lifecycle of a DTV receiver is 10-15 years from its last date of commercial availability. NAB strongly believes that many such older receivers are being used by the public and will continue to be used by the public at the time of the auction and the implementation of wireless

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<sup>21</sup> See, for example, [http://www.amazon.com/s/ref=nb\\_sb\\_ss\\_c\\_0\\_16?url=search-alias%3Delectronics&field-keywords=dtv%20converter%20box&srefix=dtv+converter+bo%2Caps%2C143](http://www.amazon.com/s/ref=nb_sb_ss_c_0_16?url=search-alias%3Delectronics&field-keywords=dtv%20converter%20box&srefix=dtv+converter+bo%2Caps%2C143); and, <http://www.bestbuy.com/site/insignia-digital-tv-converter-box/1239871.p?id=1219047791707&skuld=1239871&st=DTV%20analog%20to%20digital%20converter%20box&cp=1&lp=4>

operations, which could be early as 2016.<sup>22</sup> We also note that NTIA coupon-eligible set-top converter boxes were subject to *improved* DTV receiver standards that other DTV receivers at the time were not required to meet – meaning that the 2007 DTV set-top box receiver tested by the FCC most likely performed better than other DTV receivers available at that time.

Additionally, both the OET and CEA tests selected models of the same general vintage (2007 and 2013), but did not attempt to assess the performance of DTV receivers from 2008 to 2012. NAB strongly believes that the FCC should take all DTV receivers into account in developing interference protection standards. Consumers should not be forced to replace equipment that meets their needs and works satisfactorily today and simply because the FCC failed to provide adequate interference protection. OET should expand its testing program to include the performance of TV receivers from 2008 to 2012.

#### **IV. USING “CLEAN” LABORATORY GENERATED DESIRED AND UNDESIRED SIGNALS THAT DISCOUNT THE EFFECT OF REAL-WORLD TRANSMITTER SPLATTER AND NON-LINEARITY INDUCED BY THIRD ORDER INTERMODULATION PRODUCT UNDERESTIMATES THE INTERFERENCE PROTECTION LEVELS**

CEA correctly observes that the measurements used to determine the “undesired” interference signals were considered ‘clean’ in that they did not have the usual non-linear-induced third order intermodulation (IM3) energy that causes DTV splatter to occur in adjacent channels in practical commercial-grade transmitter equipment. Therefore, the DTV interference results obtained in this laboratory test ... may be

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<sup>22</sup> In many areas of the country, some spectrum may become available immediately for wireless operation without the need for repacking of broadcast stations.

reduced due to the presence [of] such splatter.”<sup>23</sup> CEA further states that the measurements were “designed to isolate receiver D/U performance, and so transmitter splatter was carefully filtered out. Consequently, care must be taken in applying these results directly to any planning in the spectrum allocation process.”<sup>24</sup> The same methodology and “clean” signals were also used in the OET measurements.

NAB wholeheartedly agrees with these cautionary statements, repeated in a number of places in the CEA Report, that clearly suggest that these measurements should not be blindly applied to determine or justify interference protection for spectrum allocation purposes. Ignoring real-world conditions when conducting interference testing will underestimate the interference measurement and the protection levels needed to protect both services. NAB, therefore, urges the FCC to conduct additional tests that take real-world factors into account.

## **V. THE EFFECT OF INTERFERENCE FROM MULTIPLE SOURCES MUST BE CONSIDERED IN DETERMINING DTV INTERFERENCE PROTECTION**

Neither the FCC nor CEA testing considered aggregate interference from multiple DTV or wireless sources. In fact, NAB is aware of no testing conducted to date of aggregate co-channel interference between broadcast and wireless signals. For example, all of the OET tests were made with a single interfering signal at the receiver.

In the real-world, consumers' DTV sets must be able to receive broadcast signals in the presence of background (white) noise, co- and adjacent-channel and other potential interfering signals, transmission impairments, such as multipath distortion and signal fading, and other interferences, such as impulse noise. It is widely recognized

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<sup>23</sup> CEA Report at p. 8.

<sup>24</sup> CEA Report at p. 1.



that DTV receiver performance in the presence of multiple impairments and interferers is significantly worse than in the presence of only a single impairment.<sup>25</sup> Susceptibility of DTV receivers to new additional interference from LTE co-channel signals should be measured by the real-world incremental impact of those LTE signal (or signals) on a DTV receiver already operating with multiple impairments.

A number of the CEA tests confirm that degradation of DTV receiver performance will occur in the presence of multiple signals. CEA's DTV-into-DTV multi-signal overload test showed that "the presence of two DTV interference signals (N+2 and N+3) is significantly worse than for a single interferer."<sup>26</sup> In this regard, CEA rightly points out the limitations of its testing. CEA states repeatedly that caution must be used in applying its results to spectrum allocation issues. For example, CEA notes that "testing was performed without first adjacent splatter; this splatter must be considered before applying these results to spectrum allocation."<sup>27</sup>

In its January Public Notice, the FCC asserts that its assumption of an ERP of 720W (or 120W/MHz times 6 MHz) adds an additional 0.8 dB of interference power in the wireless block to simulate operations of wireless base stations transmitting across contiguous adjacent wireless blocks that would affect one 6 MHz TV channel.<sup>28</sup> As the Joint Broadcasters stated in their comments, rather than providing "additional" interference power, this assumption severely underestimates the power that can be

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<sup>25</sup> See, e.g., OET Report FCC/OET 07-TR-1003, Interference Rejection Thresholds of Consumer Digital Television Receivers Available in 2005 and 2006, Stephen R. Martin, March 30, 2007; O. Bendov. "Interference to DTV Reception by First Adjacent Channels", *IEEE Transactions on Broadcasting*, vol 51, pp 20-30, March 2005.

<sup>26</sup> CEA Report at p. 38.

<sup>27</sup> CEA Report at p. 1.

<sup>28</sup> January Public Notice at 22, n.22.

used by wireless providers.<sup>29</sup> Further, no testing has been conducted to confirm that this 0.8 dB figure is appropriate.

In fact, this 0.8 dB factor was intended solely to simulate a base station transmitting across two contiguous adjacent 5 MHz wireless channel blocks. It was not intended to compensate for signals from multiple base stations. In a variable plan, however, multiple base stations may be operating co-channel with a TV station in the same channel block from different locations. The FCC's protection criteria should take this into account. As the Joint Broadcasters stated in their comments, in the absence of additional testing, interfering wireless signals should, at a minimum, be treated similar to Digital Television Distributed Transmission Systems, and the *combined* effects of interfering signals from all base stations should be taken into account using the root-sum-square method.<sup>30</sup>

## **VI. THE FCC MUST TAKE INTO ACCOUNT THE EFFECT OF IM3 INTERFERENCE**

The CEA report shows significant interference performance degradation due to the generation of IM3 components that cause noise-like interference within the desired DTV channel due to the tuner's nonlinearities.<sup>31</sup> This type of interference from LTE-into-DTV can arise and be particularly problematic under the FCC's variable band plan approach. For example, the CEA measurements found that for equal power IM3 paired interference there is 3 to 5 dB degradation at the first adjacent channel and significant degradation (up to 20 dB) occurs when a second IM3-paired taboo interferer is added.<sup>32</sup>

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<sup>29</sup> Joint Broadcaster Comments at 13.

<sup>30</sup> *Id.* at 16.

<sup>31</sup> See CEA report at 41.

<sup>32</sup> *Id.* at 42.

Given the large number of base stations and handsets in a typical wireless deployment, there is a high probability of multiple interference sources causing this type of interference under a variable band plan.<sup>33</sup> Other studies have also documented this degradation of DTV receiver performance from IM3 paired interference.<sup>34</sup> Clearly, with a variable band plan, the FCC should adjust DTV interference protection requirements to take into account IM3 interference effects.

## **VII. FCC AND CEA MEASUREMENTS AND TEST RESULTS DO NOT SUPPORT THE D/U PROTECTION VALUES OR OFF-FREQUENCY REJECTION VALUES IN TABLES 8 AND 9**

The Public Notice seeks comment on whether the FCC and CEA measurements support the D/U ratios and OFR values contained in Tables 8 and 9 of the January Public Notice. They do not. On the contrary, both test results show that, for at least one of the DTV receivers tested, the protection levels were inadequate. Further, these tests were done with “clean” signals that do not reflect DTV receiver degradation that would occur under real-world conditions, where receivers are subject to multiple interfering signals and other impairments. While NAB has no objection to the use of the OFR concept, the OFR values contained in Table 9 do not take into account the asymmetry in performance that occurs in a DTV receiver based on where the DTV/LTE

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<sup>33</sup> In developing the original DTV Table of Allotments, the DTV-to-DTV IM3 interference situation was minimized through the use of spacing requirements that ensured that adjacent channel operations were either co-located or sufficiently distant to reduce the probability of equal power situations and thereby minimize IM3 interference. Any repacking of DTV should also implement similar spacing restrictions to reduce this situation from a DTV-into-DTV interference perspective. Such an approach would not work for wireless operations where the Commission does not restrict or authorize the location of base stations or handsets. In this case, new and added margin in the protection criteria is the only way to minimize interference.

<sup>34</sup> See, e.g., Interference to DTV Reception Due to Non-Linearity of Receiver Front-Ends, by Charles Rhodes, IEEE Volume 54, Issue 1, February 2008; Protection Ratios for ATSC Digital TV Receivers, Rhodes, C.W. ; Gumm, L.F. ; Knight, S.P., Consumer Electronics, IEEE Transactions, Volume 59, Issue 2, 2013.

overlap occurs, and depend ultimately on the use of more realistic D/U protection ratios based on real-world impairments.

While no specific rules have been proposed, the Public Notice appears to suggest that DTV-into-DTV protection ratios can be used for LTE. The OET Report states that “(g)enerally, the level of co-channel interfering LTE signal required to cause interference to DTV was *not very different* from the level of a co-channel interfering DTV signal.”<sup>35</sup> At the same time, the FCC tests also found that for one receiver model tested, “*the D/U protection ratio used for co-channel DTV interference was inadequate to protect against LTE interference when the desired signal is very weak.*”<sup>36</sup>

While OET may characterize the interference as “not very different,” the results clearly indicate that LTE operations create more interference to DTV than other DTV signals, as stated by the Joint Broadcasters in their comments. OET only tested DTV-into-DTV interference for two of the receivers.<sup>37</sup> The D/U values for LTE-into-DTV for a 5 MHz LTE signal for these same receivers was 2.7 and 0.6 dB worse than that measured for DTV-into-DTV. Similarly, CEA performed DTV-into-DTV and LTE-into-DTV co-channel interference testing on 12 DTV receivers. CEA co-channel testing was done with the desired signal at the moderate level (-53 dBm).<sup>38</sup> These tests showed that the *median* co-channel D/U value for LTE1 was about 0.9 dB worse than for DTV-

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<sup>35</sup> OET Report at 2 (emphasis added).

<sup>36</sup> *Id.* (emphasis added).

<sup>37</sup> OET Report at 6, Table 3.

<sup>38</sup> It is anticipated that “worse” interference results would occur with the desired DTV signal at the “weak” or “very weak” rather than at the moderate level. Thus, the CEA test results may be somewhat optimistic.

into-DTV interference, with the worst receiver having a D/U almost 2 dB worse.<sup>39</sup> Both of these test results show that DTV and LTE have somewhat different interference characteristics and suggest that DTV protections need to be adjusted to take such differences into account.

Other tests conducted by FCC and CEA also identify differences between DTV-into-DTV interference and LTE-into-DTV interference. One example is the “sliding” LTE interference tests both the FCC and CEA performed. These tests encompass “sliding” LTE interference where the D/U interference ratios were measured as the undesired LTE signal is shifted in 1 MHz increments providing varying amounts of overlap with the DTV signal. These tests were intended to support the values in Tables 8 and 9 of the January Public Notice. Again, as noted above, CEA wisely cautions the FCC about the uncertainty associated with these measurements. Specifically, CEA stated certain spectral alignments caused threshold of video (“TOV”) results to vary in some cases by as much as 3 to 5 dB.<sup>40</sup> The testing also suggests that DTV receivers have an asymmetric tolerance to co-channel overlap from lower and upper interfering signals. The OET interference test results validate earlier concerns raised by the Joint Broadcasters that the band-edges of the DTV signal are more fragile to interference than the middle of the signal; and further confirm that the lower sideband is particularly vulnerable, since it contains the critical pilot signal and timing energy in DTV's 8-VSB modulation.

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<sup>39</sup> See CEA report at 37, 74. Table G-2, on page 74, shows that for DTV Receiver #7 the difference in D/U for DTV-into-DTV and LTE1-into-DTV was 1.8 dB.

<sup>40</sup> *Id.* at 46.

Results taken from Table 6 of the FCC tests shown below indicate that there are very large differences in DTV receiver D/U levels from interfering signals with a 1 MHz overlap on either the upper or lower portion of the DTV signal.<sup>41</sup>

DTV Receiver	Lower D/U	Upper D/U	Difference (dB)
RX1	7.5	-3.5	11
RX2	-4.5	-12.4	7.9
RX3	-2.1	-8.7	6.6
RX4	1.9	-6.6	8.5

For example, the test results for RX1 and RX4 at moderate signal level (-54.7 dBm) demonstrate a very large 11.0 and 8.5 dB difference in DTV receiver tolerance to interfering signals in upper and lower frequency offsets, respectively. The Table 9 OFR values do not provide for differences where the interfering signal overlaps the DTV signal but only considers the absolute spectrum overlap value.<sup>42</sup>

#### **VIII. TABLE 10 ASSUMES UNREALISTIC WIRELESS BASE STATION TRANSMITTING SPECIFICATIONS**

Table 10, contained in the January Public Notice, lays out “hypothetical” wireless base station transmitting specifications, including transmitter power and antenna height.<sup>43</sup> OET asserts that its assumption of using an ERP of 720W or 120W/MHz in a full 6 MHz channel provides an additional 0.8 dB of interference power to simulate operation of wireless base stations transmitting across contiguous adjacent wireless blocks affecting one 6 MHz TV channel.<sup>44</sup> The Table 10 specifications also assume that the transmitting antenna height of all base stations is 30 meters. To the extent that the

<sup>41</sup> OET Report at 10.

<sup>42</sup> There is a slight difference in the Table values depending on whether overlap is from the wireless downlink or uplink. However, in a variable plan, such overlaps can occur in the upper or lower portion of the DTV signal from both downlink and uplink operations.

<sup>43</sup> January Public Notice at 22.

<sup>44</sup> See *id.* at note 22 and June Public Notice at 1.

FCC and CEA have done additional testing on DTV receivers, there is nothing in these new tests or in the language contained in the Public Notice that provides new information or insight into the assumptions contained in Table 10 with regard to wireless base station operations.

The Joint Broadcasters addressed this issue extensively in their earlier comments.<sup>45</sup> The FCC's newly-adopted rules permit operation at significantly higher transmit power and significantly taller transmitting antenna facilities than those identified in Table 10. In addition, the Joint Broadcasters identified hundreds of existing wireless facilities with transmitting antennas higher than 30 meters set forth in Table 10.<sup>46</sup> Given these facts, NAB does not understand how the Table 10 assumptions regarding LTE operating parameters can be seen as reasonable. There is simply no basis in fact for the assumption that wireless operators will operate in a band that has been touted for its ability to cover wide areas in a manner that significantly reduces their wireless coverage and therefore their interference potential. Interference protections should be based on assumptions about wireless transmitting facilities that are consistent with the recently adopted rules and better reflect actual wireless operations. The use of plainly incorrect values that ignore the record would be arbitrary and capricious, and NAB urges the Commission to update the assumptions regarding LTE operations to comport with the rules for operation in the band.

## **IX. CONCLUSION**

The FCC has proposed that the repacking of television broadcast spectrum will include some variation in the amount of recovered spectrum. As a result, there will be

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<sup>45</sup> Joint Broadcaster Comments at 13.

<sup>46</sup> *Id.* at 13-14.

signals from co-channel and adjacent channel LTE operations into DTV signals in certain markets. To avoid harmful inter-service interference to viewers, clear rules must be in place governing the obligations of wireless carriers operating in the 600 MHz band. To date, the FCC has proposed no such rules. While NAB is pleased that the FCC has taken some steps to introduce empirical testing into its analysis of inter-service interference, work in this proceeding is far from complete. The FCC cannot adopt legally sustainable rules based on its procedures and the record to date.

The FCC has also repeatedly indicated that it intends to hold the auction in mid-2015. NAB is eager to work with the Commission to conduct further analysis and testing. However, given the FCC's urgency to move forward with the auction, NAB respectfully submits that a far simpler approach to interference protection, based on conservative separation distances, is likely to be just as accurate as OET's complex methodology, without sacrificing meaningful efficiency in terms of the amount of spectrum recovered.



Respectfully submitted,

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A handwritten signature in black ink, appearing to read "Rick Kaplan", with a long horizontal flourish extending to the right.

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