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

In the Matter of	)	
	)	
Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions	)	GN Docket No. 12-268
	)	
Office of Engineering and Technology Releases and Seeks Comment on Updated OET-69 Software	)	ET Docket No. 13-26
	)	
Office of Engineering and Technology Seeks to Supplement the Incentive Auction Proceeding Record Regarding Potential Interference Between Broadcast Television and Wireless Services	)	ET Docket No. 14-14

COMMENTS
OF THE CONSUMER ELECTRONICS ASSOCIATION

Julie M. Kearney
Vice President, Regulatory Affairs
Brian E. Markwalter
Senior Vice President,
Research and Standards
Michael J. Bergman
Senior Director, Technology and Standards
Alexander B. Reynolds
Senior Manager and Regulatory Counsel
Consumer Electronics Association
1919 S. Eads Street
Arlington, VA 22202
(703) 907-7644

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COMMENTS OF THE CONSUMER ELECTRONICS ASSOCIATION

I. INTRODUCTION AND SUMMARY.

The Consumer Electronics Association ("CEA")[1] submits comments regarding the *Inter-Service Interference Further Notice of Proposed Rulemaking* ("*ISIX FNPRM*").[2] Generally, larger than necessary exclusion zones reduce intensive use of spectrum. Exclusion zones should

[1] CEA is the principal U.S. trade association of the consumer electronics and information technologies industries. CEA's more than 2,000 member companies lead the consumer electronics industry in the development, manufacturing and distribution of audio, video, mobile electronics, communications, information technology, multimedia and accessory products, as well as related services, that are sold through consumer channels. Ranging from giant multinational corporations to specialty niche companies, CEA members cumulatively generate more than $223 billion in annual factory sales and employ tens of thousands of people.

[2] *See Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, Office of Engineering and Technology Releases and Seeks Comment on Updated OET-69 Software, Office of Engineering and Technology Seeks to Supplement the Incentive Auction Proceeding Record Regarding Potential Interference Between Broadcast Television and Wireless Services*, Second Report and Order and Further Notice of Proposed Rulemaking, GN Docket No. 12-268, ET Docket No. 13-26, ET Docket No. 14-14, FCC 14-157 (Oct. 16, 2014) ("*ISIX Second R&O and FNPRM*").

thus be minimized to the extent feasible while fully protecting licensed users. The Federal Communications Commission's ("FCC" or "Commission") proposed OET-74 framework takes an important step towards reducing exclusion zones.[3]

Several portions of the Commission's proposed framework, however, require further analysis or explanation. For example, the *FNPRM* does not adequately consider the risk of intermodulation interference to digital television ("DTV") receivers. Based on CEA's analysis of DTV receivers,[4] intermodulation interference from LTE and DTV operations into DTV receivers poses a substantial risk to DTV reception, not only for legacy receivers currently on the market, but also for future receivers that may need to continue receiving frequencies also used for LTE operations due to market variability. Similarly, intermodulation interference from two LTE signals, rather than an LTE signal and a DTV signal, is a distinct potential problem in the 600 MHz band plan and has not been adequately analyzed.

Another potential issue is the Commission's proposed threshold for the desired-to-undesired (D/U) signal strength ratio for DTV reception, which incorporates a scaling factor (α or "alpha"). While that scaling factor ensures that the D/U threshold remains accurate for very weak DTV signals at the edge of a DTV station's contour, it can introduce large variations in the permissible area for LTE operations based on arbitrary factors. In particular, how the two-kilometer grid used for interference analysis overlaps with the DTV station contour can introduce difference in separation distances of more than 13 kilometers, with an associated effect

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[3] *See Proposed OET Bulletin No. 74: Longley-Rice Methodology for Predicting Inter-Service Interference to Broadcast Television from Mobile Wireless Broadband Services in the UHF Band* (2014), *attached to ISIX Second R&O and FNPRM* ("OET-74").

[4] *See* Gary Sgrignoli, *A Report to the Consumer Electronics Association Regarding Laboratory Testing of Recent Consumer DTV Receivers with Respect to DTV & LTE Interference* (May 22, 2014) ("*CEA Measurements Report*"), *attached to* Letter from Julie M. Kearney, Vice President, Regulatory Affairs, CEA, to Marlene Dortch, Secretary, FCC, Docket No. 12-268 (May 22, 2014).

on hundreds of kilometers of LTE deployments, whether prohibited altogether or only permitted at lower power levels. Such arbitrary variation requires, at a minimum, further explanation and merits further analysis to determine if the arbitrary effect on LTE deployments can be minimized while nonetheless protecting DTV.

Portions of the *FNPRM* also require clarification before the Commission issues its final order. For example, the Commission has suggested that a broadcaster could request to expand its contour toward a wireless licensee if there was a sufficient separation distance, but it has not sought comment on that distance or elaborated on that proposal. Additionally, it is currently unclear whether this type of DTV contour expansion towards a wireless licensee is permissible as part of the repacking construction permit application process. Moreover, it remains unclear how a wireless licensee should determine potential inter-service interference with a broadcaster that has not yet repacked during the 39-month transition period.

The Commission should build on the strong foundation of its initial decision and FNPRM by continuing to minimize separation distances and promote coexistence between wireless broadband and DTV while providing further clarity and conducting necessary analyses.

II. CONSIDERATIONS REGARDING INTERFERENCE PROTECTION OBLIGATIONS BETWEEN BROADBAND LICENSEES AND TELEVISION LICENSEES.

A. LTE/DTV Intermodulation Interference Can Have a Substantial Negative Impact on DTV Signals and Requires Further Study.

CEA testing found that intermodulation interference from LTE and DTV operations poses a substantial risk to DTV reception.[5] Specifically, due to intermodulation interference

[5] *CEA Measurements Report* at 1 ("Receiver performance was impaired in the presence of intermodulation effects from N+k/N+2k interference pairs."). As CEA explained, "there was significant interference performance degradation (increased D/U threshold ratios) from that of the single interferer test results for both DTV-into-DTV and LTE-into-DTV. This was due to the generation of IM3

within the DTV receiver, signals at levels approximately 20 dB weaker than a single interfering DTV signal (i.e., signals much more likely to occur, particularly with ubiquitous wireless deployments) can cause interference.[6] As CEA's data illustrates, when there is only a single adjacent-channel DTV signal present (i.e., no intermodulation), the D/U signal strength ratio below which harmful interference occurs is between approximately -57 and -60 dB for the second to fifth adjacent six-megahertz DTV channels.[7]

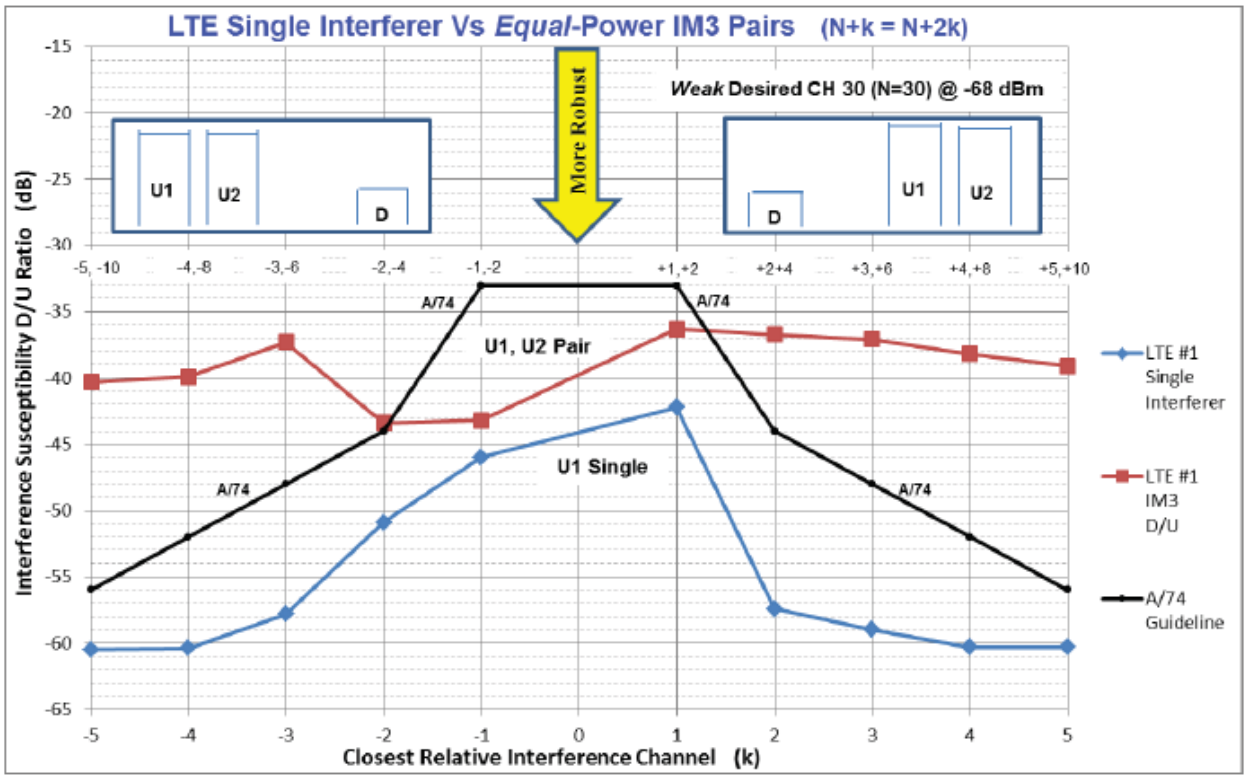

Figure H-5a LTE1 equal-power IM3 pair and single interferer interference comparison for a single DTV set: (N+k=N+2k).

Source: CEA Measurements Report at 93, Figure H-5a.

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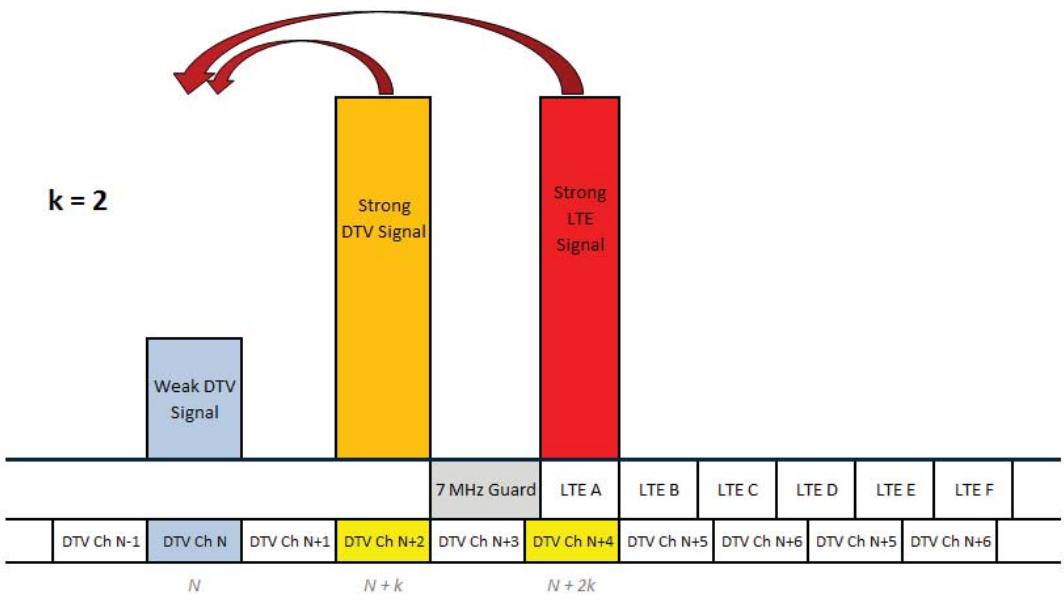
components from the specially paired interferer channels that cause noise-like interference to fall within the desired DTV channel due to the tuner's nonlinearities." *Id.* at 41.

[6] *CEA Measurements Report* at 93-94, Figures H-5a, H-5b, and H-5c; *see also id.* at 79-81, Tables G-8 to G-16.

[7] *See id.* at 93, Figure H-5a.

Assuming a desired DTV signal of -68 dBm, which is weak, but well above the theoretical threshold for DTV reception of approximately -84 dBm,[8] the single undesired signal must be at a very strong level to cause interference: -8 to -11 dBm.[9] However, when there is a second interfering signal at double the frequency separation (N+2k) of the first signal (N+k) and at an equal power level, then these signals can cause interference at a power level 20 dB less than the single interfering DTV signal, or at a power level of approximately -29 to -32 dBm when the DTV signal level is weak.[10] While these signal power levels are relatively high, they are not very unusual, so they can and do occur.

LTE/DTV Intermoduluation Interference: One of Many Potential Configurations under the 600 MHz Band Plan



[8] *Id.* at 11.

[9] The desired signal level (-68 dBm) minus the D/U interference threshold (-57 to -60 dB) equals the power level of the undesired signal required to cause interference (-8 to -11 dBm). *See id.* at 93, Figure H-5a.

[10] The desired signal level (-68 dBm) minus the D/U interference threshold (-36 to -39 dB) equals the power level of the undesired signal required to cause interference (-29 to -32 dBm). *See id.* at 93, Figure H-5a; *see also id.* at 79, Table G-10.

CEA found similar interference effects when the DTV and LTE interfering signals were not of equal power – for example, when the DTV signal, which is the interfering signal closest (N+k) to the victim channel, was 10 dB stronger than the LTE interfering signal (N+2k)[11] or was 10 dB weaker.[12] Although the interfering LTE and DTV signals must be stronger than in the equal power case, the difference was only approximately 1 to 7 dB,[13] requiring an interfering signal power level of approximately -28 to -22 dBm. These levels will also occur in real world deployments and pose a real threat of interference to DTV receivers.

The *ISIX Second R&O and FNPRM* does not adequately grapple with this potential for intermodulation interference. As part of its *Second R&O*, the Commission reasons that special provisions for intermodulation interference are not necessary because the current rules governing DTV-to-DTV interference do not consider multiple LTE interferers or third-order intermodulation, and yet "there is no evidence that the [current] rules fail to adequately protect DTV signals as a result."[14] Likewise, the decision further suggests that "there are situations under the current rules where multiple DTV signals occupy channels on broad bandwidths that are similar to the situation that concerns" commenters warning of intermodulation interference, and yet there are "no reports of verified interference from multiple interferers, [third-order intermodulation] or splatter."[15] The decision's rationale regarding a lack of intermodulation interference potential is inadequate for at least two reasons.

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[11] *See id.* at 93, Figure H-5b; *see also id.* at 80, Tables G-11, G-12, and G-13.

[12] *See id.* at 94, Figure H-5c; *see also id.* at 81, Tables G-14, G-15, and G-16.

[13] The measured equal power D/U interference threshold is approximately -36 to -39 dB, while the unequal power D/U interference threshold is approximately -42 to -46 dB when the closer interfering signal is 10 dB greater and approximately -40 dB when the further interfering signal is 10 dB greater. *See id.* at 93-94, Figures H-5a, H-5b, and H-5c.

[14] *ISIX Second R&O and FNPRM* ¶ 46.

[15] *Id.* ¶ 46 n.162.

First, there are far fewer DTV transmitters than what will be ubiquitously deployed mobile broadband base stations at 600 MHz. For each DTV channel, there is typically just one DTV transmitter in a market, and the area in which the DTV signal is strong enough to cause interference is limited to a relatively small area around the transmitter. Thus, it is unlikely that a second DTV transmitter will happen to use an appropriately-spaced frequency and also happen to have a sufficiently strong signal in the same area to create intermodulation interference.[16]

Although DTV/DTV intermodulation is possible, it is much less likely than the future situation where LTE transmitters will be deployed ubiquitously at 600 MHz and transmissions will span a much wider frequency range than a single 6 megahertz DTV station. For any given DTV transmitter, it will be substantially more likely that there is a corresponding strong LTE signal at the appropriate frequency sufficient to cause intermodulation interference than is the case with DTV stations today. For example, as the Advance Television Broadcasting Alliance explains, "[g]iven the large number of base stations and handsets in a typical wireless deployment, the probability of having multiple interference sources and of this type of interference occurring is high."[17]

Second, intermodulation interference from LTE downlink and DTV poses less of a risk under the current band plan because DTV and LTE operations have substantial frequency

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[16] *See, e.g.*, Comments of Linley Gumm and Charles Rhodes, ET Docket No. 14-14, GN Docket No. 12-268 at 4 (Feb. 24, 2014) ("*Gumm and Rhodes*") ("Since the number of DTV transmitters is relatively small and because DTV transmitters tend to be grouped together, the number and size of these areas where receiver overload problems exist is presently relatively small.").

[17] Comments of Advanced Television Broadcasting Alliance, ET Docket No. 14-14, GN Docket No. 12-268 at 5 (July 11, 2014); *see also* Comments of the National Association of Broadcasters, ET Docket No. 14-14, GN Docket No. 12-268 at 14 (July 11, 2014) ("*NAB Measurements PN Comments*") ("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."); *Gumm and Rhodes* at 4-5 (discussing the substantially increased interference risk from wireless transmitters placed throughout a DTV station's service area).

separation. Currently, the closest widely deployed downlink frequency to DTV is Band 17, and at the closest point, Band 17 downlink (734-746 MHz) is the seventh adjacent channel to the nearest DTV station (Channel 51 – 692-698 MHz). Thus, the closest current case of LTE/DTV intermodulation interference due to N+k and N+2k spacing is the seventh and fourteenth adjacent channel. While CEA only tested the intermodulation potential out to the fifth and tenth adjacent channels,[18] larger frequency separations generally pose less of a problem than smaller frequency separations do. This uncontroversial starting point for analysis suggests the seventh and fourteenth adjacent channels represent less of a concern than would the more proximate channel uses that are likely to occur following the 600 MHz incentive repacking process. Given the considerable frequency separation that exists today between channels that could contribute to intermodulation interference, it is not surprising that there has been little issue with LTE/DTV intermodulation.

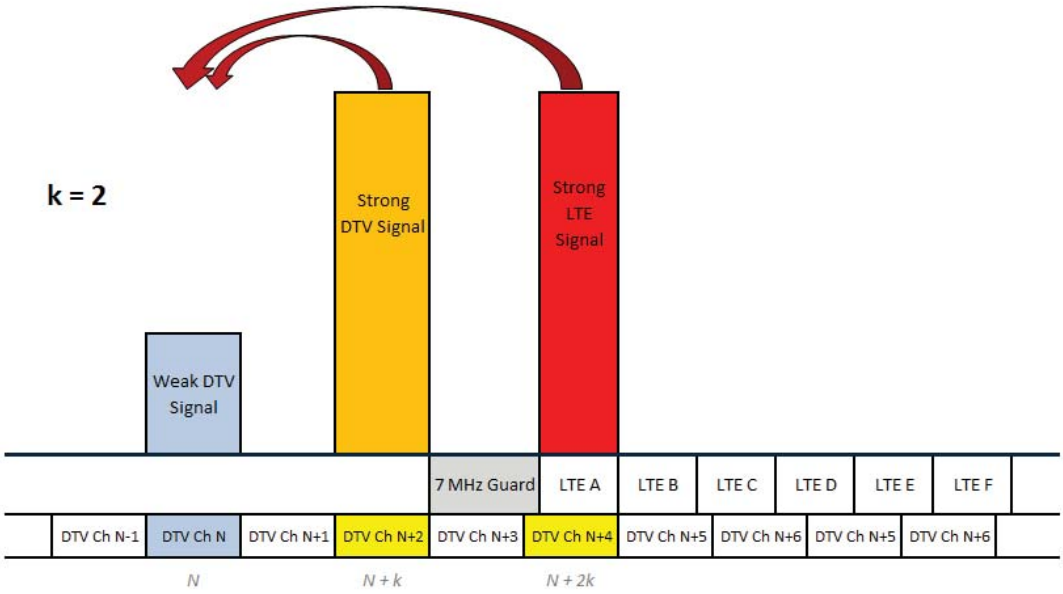
Unfortunately, however, the new 600 MHz band plan will position signals that could contribute to intermodulation interference in much closer proximity to DTV receivers. Specifically, the new 600 MHz band plan will readily produce scenarios where a DTV channel is the N+k channel (e.g., the second adjacent channel) and an LTE deployment is the N+2k channel (e.g., the fourth adjacent channel).[19] As illustrated in the below diagrams, potential LTE/DTV intermodulation configurations readily occur under any of the proposed guard bands, and there are many, many additional such potential configurations.

[18] *See CEA Measurements Report* at 93-94, Figures H-5a, H-5b, and H-5c.

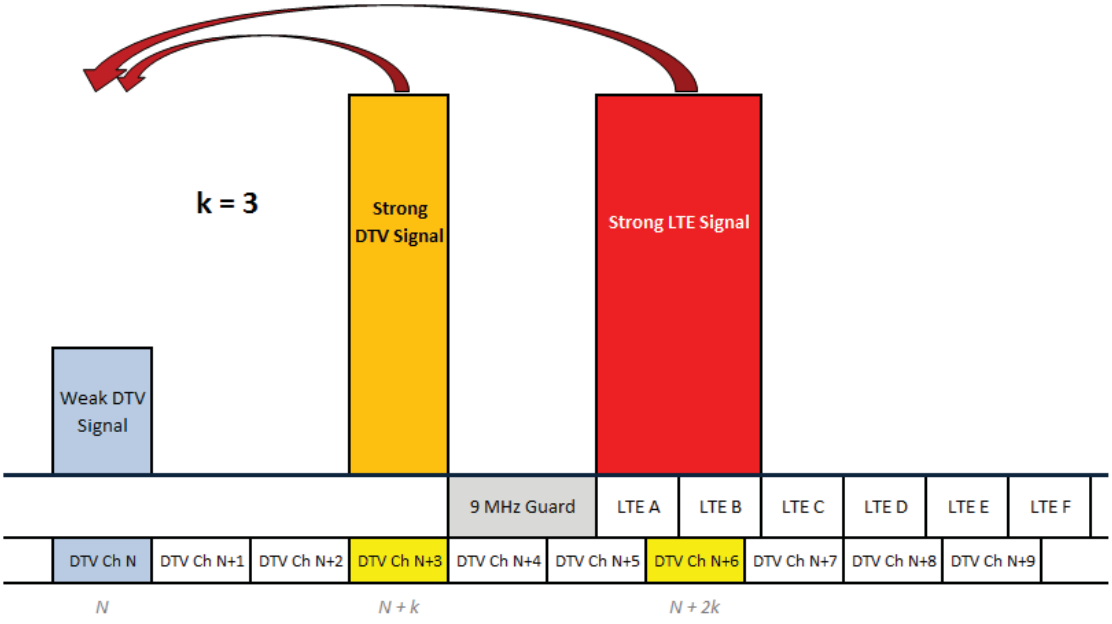
[19] As discussed below, the new 600 MHz band plan will also readily produce scenarios where LTE operations are in both the N+k and N+2k channels. *See infra* Section II.B.

Potential Band Plan Configurations Illustrating that LTE/DTV Intermodulation Interference Is Readily Possible under Each Proposed Guard Band

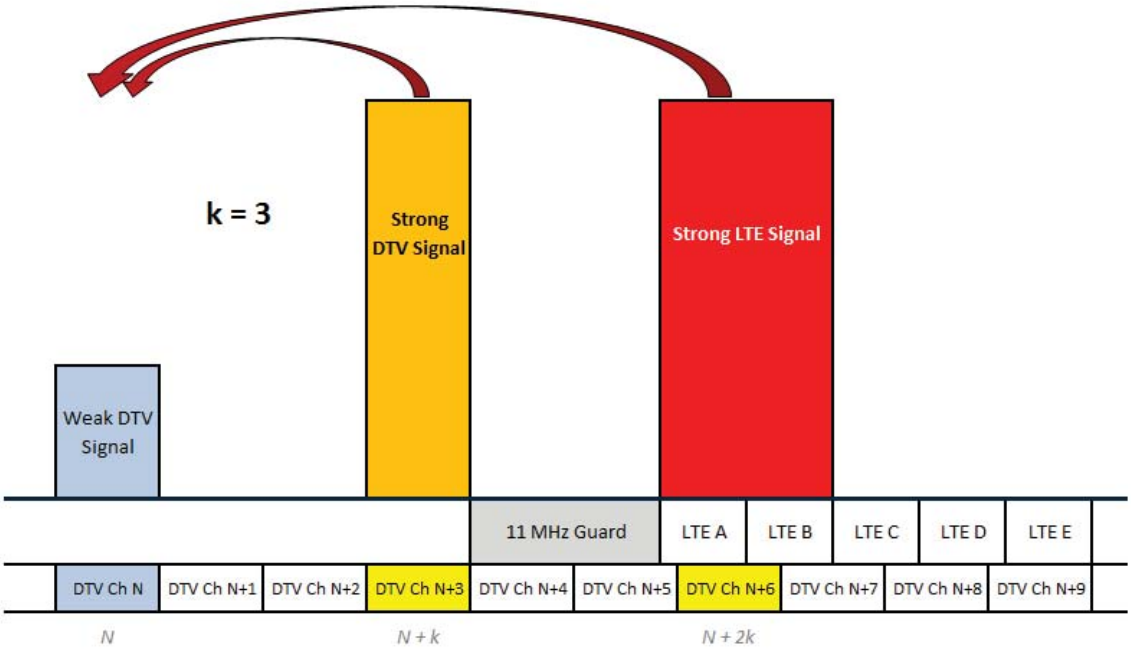
Potential Configuration for LTE/DTV Intermodulation Interference: Seven Megahertz Guard Band



Potential Configuration for LTE/DTV Intermodulation Interference: Nine Megahertz Guard Band



Potential Configuration for LTE/DTV Intermodulation Interference: Eleven Megahertz Guard Band



Indeed, the N+k, N+2k intermodulation spacing is substantially more likely to occur with LTE deployments because LTE, unlike DTV, will be deployed throughout a large contiguous swath of spectrum (e.g., thirty-five megahertz of downlink if only channels above Channel 37 are cleared), whereas DTV stations necessarily have frequency separations. Thus, the problematic intermodulation interference scenarios where a DTV channel is in the second adjacent channel and LTE is the fourth adjacent channel are very likely, as are the scenarios where DTV and LTE are the third and sixth; fourth and eighth; and fifth and tenth adjacent channels. In other words, these problematic scenarios do not currently occur, but they will occur quite often under the 600 MHz band plan. Moreover, the wide bandwidth of LTE operations, which can be aggregated over several five-megahertz channels, and the large width of the LTE downlink band (thirty-five megahertz if the eighty-four megahertz above Channel 37 is cleared) makes it possible for more than one of these combinations to occur simultaneously (and possibly involving multiple LTE

deployments), further exacerbating the potential interference in a manner that is not currently possible.

Indeed, contrary to the Commission's assertion, the "cellular nature of . . . LTE operations" does not "minimize the statistical likelihood that such interference effects would actually affect DTV services."[20] As discussed above, CEA's testing showed that intermodulation interference is possible at interfering signal strengths that are not unusual in actual LTE deployments (at locations close to base stations). Rather, the "cellular nature" of LTE operations suggests that there will be many base stations and therefore many locations where LTE signals will be sufficient to create intermodulation interference if there is a corresponding DTV interfering signal. Additionally, as discussed below,[21] the "cellular nature" of LTE operations suggests that there will be many locations where there are two LTE signals of sufficient strength and at the relevant frequency separation to create intermodulation interference.

This potential for intermodulation interference is not only a problem for current DTV receivers due to the potential of market variation in broadcast clearing, but also a problem for *future* DTV receivers, which will need to operate in all markets, even if some broadcasters remain on what are otherwise primarily LTE frequencies. In other words, if broadcast channels remain in the 600 MHz LTE frequencies in a certain limited number of markets, receiver manufacturers will likely have to produce receivers that operate on channels in which LTE also operates,[22] and those receivers would be open to LTE frequencies and susceptible to

[20] *ISIX Second R&O and FNPRM* ¶ 46 n.162.

[21] *See infra* Section II.B.

[22] This problem will be exacerbated if DTV receivers are placed in the uplink because that receiver will presumably be open to all of the downlink.

intermodulation interference.[23] Of course, even if there is no market variability, many legacy DTV tuners will remain on the market, which will necessarily be susceptible to this interference because they are designed to receive transmissions on the 600 MHz LTE frequencies. And unlike the DTV conversion, in which legacy analog tuners (which could tune up to Channel 69) were necessarily rendered obsolete because analog transmissions were terminated, the legacy DTV tuners will continue to remain operational for the foreseeable future.

B. LTE/LTE Intermodulation Interference to DTV Receivers Has Not Been Analyzed and Requires Further Study.

Intermodulation interference from two LTE signals, rather than an LTE signal and a DTV signal, is also a distinct potential problem in the 600 MHz band plan. While there is little direct test data on the effect of two LTE signals on DTV reception, CEA testing compared the effects of DTV (8-VSB) and LTE signals as interferers, and found that the two types of signals have equivalent effects, albeit with an LTE signal from a fully-loaded base station[24] presenting harmful interference approximately 1 dB earlier than a DTV signal.[25] Therefore, CEA agrees with the Commission that LTE signals can generally be considered similar to DTV signals in interference analysis,[26] and CEA relies on this conclusion in observing the potential for LTE/LTE intermodulation interference to DTV receivers in the discussion below.

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[23] Potential workarounds that would allow receivers to operate on only certain frequencies (e.g., a software-defined radio) or to change by geography (e.g., a GPS-defined radio) are likely cost-prohibitive or impractical under current technologies.

[24] DTV stations broadcast at full power at all times while LTE base stations only operate at full power when there is sufficient user demand (i.e., when the station is "fully loaded"). However, it is not unusual for an LTE base station to be fully loaded – LTE systems strive to provide the best experience to all users at all times, and it does not require many users to fully load a base station.

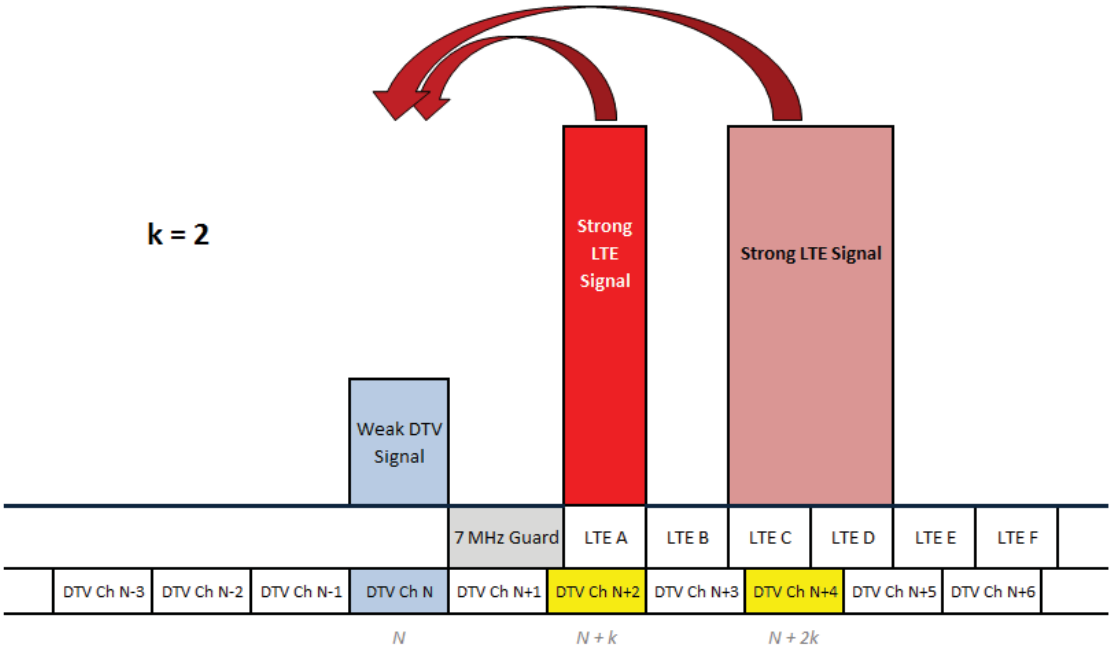
[25] *See CEA Measurements Report* at 2. Based in part on CEA's testing, the Commission adopted slightly higher D/U ratios (by 1 dB) for co-channel LTE operations. *See ISIX FNPRM* ¶ 42.

[26] *See, e.g.*, *Office of Engineering and Technology Seeks to Supplement the Incentive Auction Proceeding Record Regarding Potential Interference Between Broadcast Television and Wireless Services*, Public

As illustrated in the below diagrams, just as with potential LTE/DTV intermodulation, potential LTE/LTE intermodulation configurations readily occur under any of the proposed guard band configurations, and there are numerous such potential configurations exhibiting the same or similar effects.

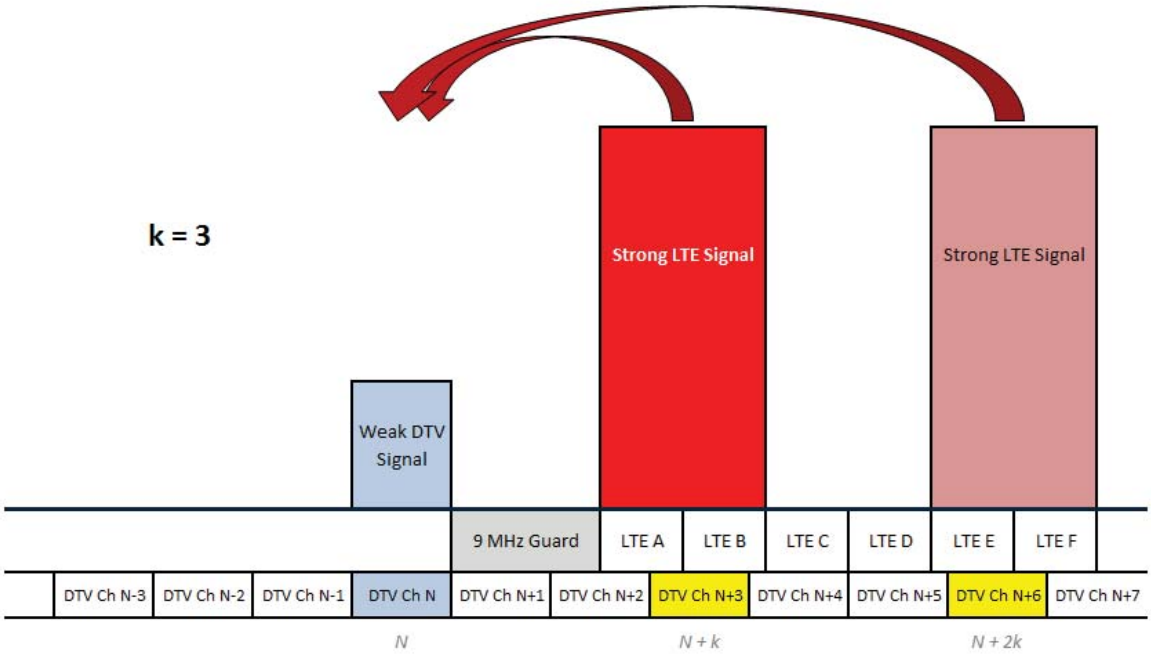
Potential Band Plan Configurations Illustrating that LTE/LTE Intermodulation Interference Is Readily Possible under Each Proposed Guard Band Configuration

Potential Configuration for LTE/LTE Intermodulation Interference: Seven Megahertz Guard Band

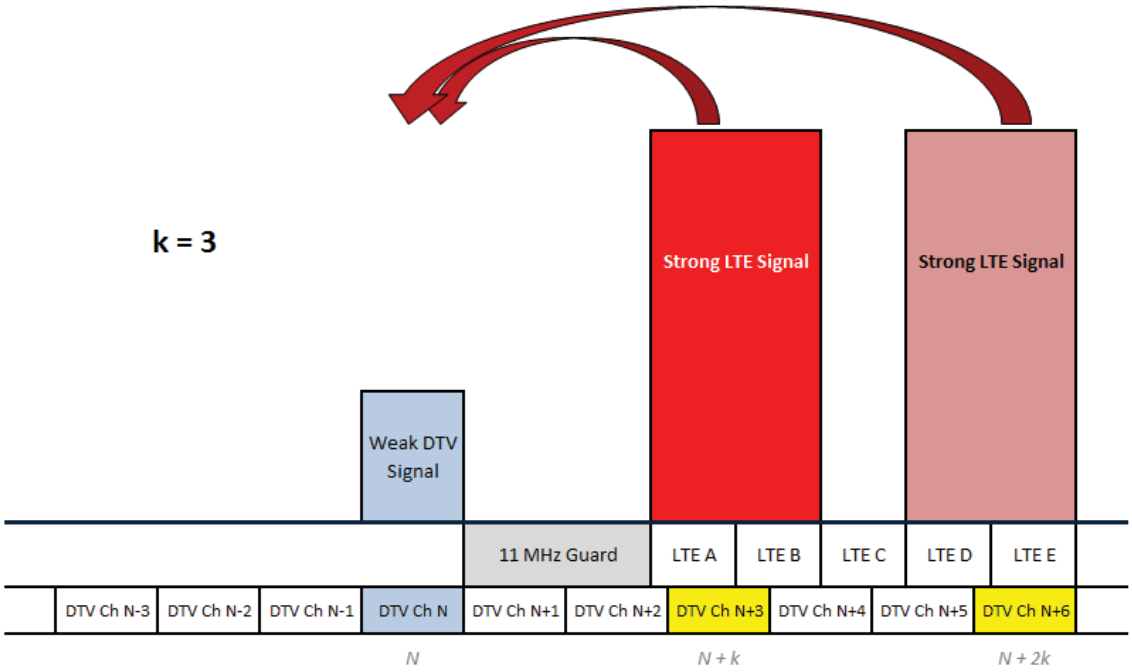


Notice, 29 FCC Rcd 712 at 17 (2014) ("Because wireless services are expected to be noise-like and studies have shown that noise-like signals have interference potential nearly identical to DTV, the existing DTV protection criteria can generally be applied with some adjustments.").

Potential Configuration for LTE/LTE Intermodulation Interference: Nine Megahertz Guard Band



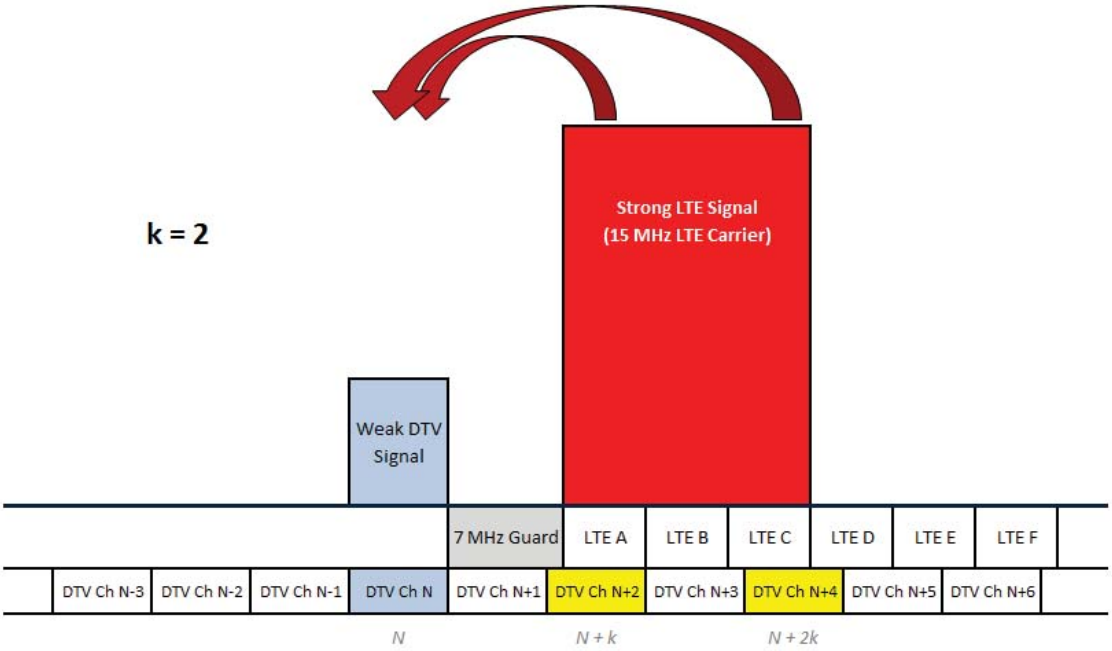
Potential Configuration for LTE/LTE Intermodulation Interference: Eleven Megahertz Guard Band



In particular, the broadcasters operating in the DTV channel located just below the guard band could be especially vulnerable to intermodulation interference because a single operator may deploy an LTE channel spanning the N+k and N+2k frequency separation in the second and fourth channels, making the power levels that would create harmful intermodulation interference especially likely.[27] For example, if the guard band is only seven or nine megahertz, a fifteen or twenty megahertz LTE channel will introduce the potential for LTE/LTE intermodulation interference with equal power LTE operations in the second and fourth adjacent channels.

A Broadcaster Located Just Below a Seven Megahertz Guard Band May Be Especially Likely to Experience Intermodulation Interference

Single Fifteen Megahertz LTE Carrier Creates Large Risk of Intermodulation Interference



[27] *See, e.g., Gumm and Rhodes* at 4-5 ("Due to the expense of creating…so many wireless sites, it's to be expected that each site will emit as many wideband signals as possible. It's then very plausible that many sites will be configured to emit spectrums similar to the N+K and N+2K situation that DTV receivers are most sensitive to.").

While the potential for LTE/LTE intermodulation interference from a single LTE deployment may be somewhat mitigated if there is no opportunity for a large contiguous LTE channel adjacent to the guard band or if there is an eleven megahertz guard band, there could nonetheless be a threat of intermodulation interference if two operators are co-located on the same tower or utilizing towers that are sufficiently close together. These various potential configurations that present potential LTE/LTE intermodulation interference require careful consideration to ensure continued DTV receiver performance following the 600 MHz Incentive Auction.

C. The Current "Alpha" Scaling Factor for the D/U Ratio Threshold Introduces Large Variations in the Permissible Area for LTE Operations Based on Arbitrary Factors.

In adopting D/U ratio thresholds for each spectral overlap scenario, the Commission has incorporated a scaling factor, α ("alpha"):[28]

Spectral Overlap (MHz)	5	4	3	2	1	0	-1 to -5
Downlink into DTV D/U Required (dB)	16.0 + α	15.1 + α	13.8 + α	12.1 + α	9.3 + α	-2.0 + α	-18 + α

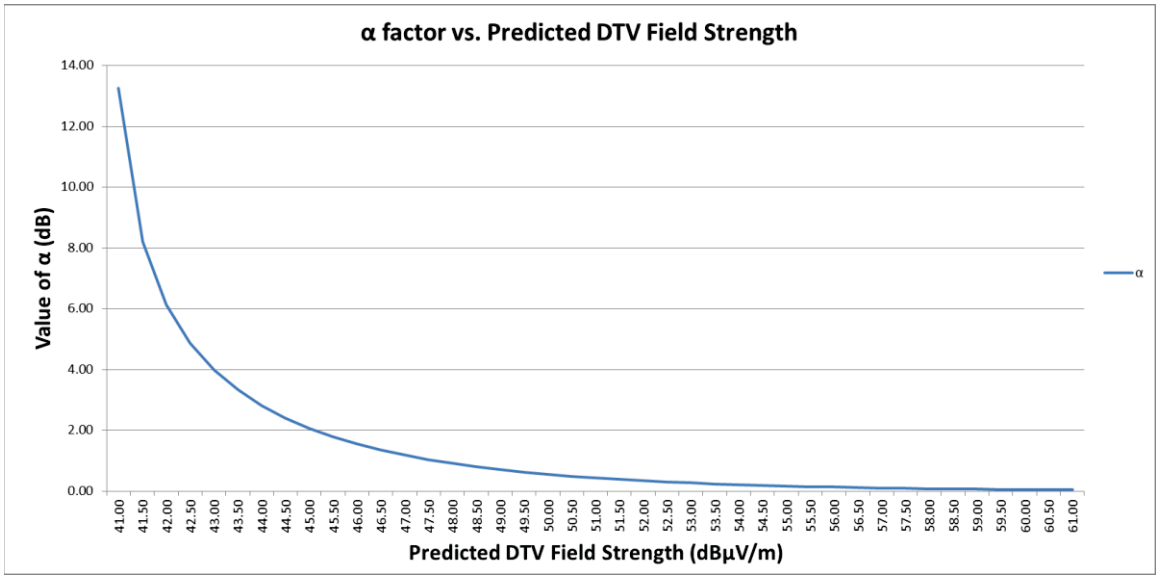
Table 1. Threshold interfering D/U ratios for wireless base station into DTV

The scaling factor is intended to adjust the required D/U ratio threshold for DTV reception to correspond with the predicted strength of the DTV signal. Hence, as the predicted strength of the DTV signal decreases, the necessary D/U threshold increases. However, as the desired signal approaches the minimum needed for DTV reception, this scaling factor, alpha, and thus the D/U ratio threshold, increases exponentially.[29] In other words, the D/U ratio approaches infinity as the desired signal approaches the minimum necessary for DTV reception.

[28] *See* OET-74 at 83, Table 5.

[29] *See id.* at 82.

Although this approach is sound in theory, the exponential and asymptotic nature of the D/U ratio does not reflect real-world DTV and LTE deployments. Apparently recognizing the shortcomings of a D/U ratio that approaches infinity, the Commission adopted planning factors[30] that do not allow this outcome, assuming the service contours defined in OET-74.[31] However, as shown in the chart below, the current assumptions still include portions of the alpha curve that are extremely steep and thus extremely sensitive to minor changes in DTV signal strength near the edge of the contour.



The alpha factor is highest when the predicted DTV signal is closest to the minimum signal required for reception, such as at the edge of the DTV station contour. Using the Commission's proposed planning factors, the maximum value that alpha can achieve is nearly 14

[30] *See id.* at 83, Table 6.

[31] *See id.* at 78, Tables 1 and 2.

dB.[32] Because of the steepness of the alpha curve close to the contour, an increase of only a half decibel in the predicted DTV signal strength when that signal is weak results in a 5.5 dB reduction in alpha, and thus a 5.5 dB reduction in the D/U ratio threshold and a 6 dB reduction in the allowable path loss.[33] Using the Longley Rice model in Area Mode, the OET-74 Longley-Rice parameter values,[34] and a delta height of 90 meters (i.e., the terrain irregularity parameter, with 90 meters representative of average terrain),[35] this half decibel increase in the predicted signal strength results in a reduction in the separation distance of more than 13 kilometers, from 87.6 kilometers to 74.3 kilometers. In other words, a minor, nearly trivial, increase in power of 0.5 dB can result in a massive 13 kilometer increase in the required separation distance. This outsized protective measure strongly suggests that the analysis must control the alpha variable when using it would lead to excessive disparities in separation distances.

Unfortunately, the alpha trigger seems to produce unexpected results fairly often and in ways not readily subject to prediction. Far from a theoretical problem, the widely variable nature of alpha can trigger these large disparities in separation distances based on potentially arbitrary factors, such as the precise overlap of the two-kilometer grid on the service contour. Under OET-74, the Commission plans to calculate the potential inter-service interference from the population centroid of each 2x2 kilometer cell inside of the DTV protected contour.[36] The

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[32] The FCC's rounding of the dipole factor from -130.8275 to -130.8 has a relatively significant effect – 0.6 dB – on the value of alpha. Using the FCC's rounded value gives a maximum alpha of 13.26 dB; however, the unrounded value would give 13.86 dB.

[33] Because the desired signal increases by 0.5 dB and the D/U ratio increases by 5.5 dB, the path loss required for the undesired signal to meet the new D/U ratio threshold increases by 6 dB.

[34] *See* OET-74 at 80, Table 3.

[35] *See, e.g.*, NTIA, *A Guide to the Use of the ITS Irregular Terrain Model in the Area Prediction Mode*, NTIA Report 82-100 at 8, 20-22 (April 1982), *available at* http://1.usa.gov/1HsnOj4 ("[A] world-wide average value for Δh is about 90 m.").

[36] *See* OET-74 at 77.

population centroid of any given 2x2 kilometer cell at the edge of the service contour will be offset from the contour by varying distances – from a minimum of 0 kilometers to a maximum of 2.8 kilometers (the largest theoretical separation between two points in a 2x2 kilometer square). Given this potential distance, the predicted value of the DTV field strength at the service contour and at the population centroid could easily vary by a half decibel or more, and the resulting effect on the required separation distance will vary by tens of kilometers, which will in turn affect hundreds of square kilometers of area where LTE may be deployed – whether limiting the height and power of deployments or effectively prohibiting it altogether. Thus, the precise overlap of the two kilometer grid will have large effects on potential LTE deployments, and any precise placement of the two-kilometer grid will necessarily arbitrarily influence which centroid points are close to the edge of the contour and which are not. Of course, such large variation of separation distances and the resulting deployment area for LTE should not be based on mere chance.

Because of this substantial potential for arbitrary variations in permissible areas for LTE deployment, the Commission should examine alpha and explain its effect on the variation of separations distances based on the overlap of the two-kilometer grid. In considering solutions, the Commission should maximize the co-existence of LTE and DTV while fully protecting DTV receivers.

D. Considerations Related to Placing DTV Stations in the LTE Downlink or Uplink.

Although placing DTV in the downlink minimizes the separation distance necessary for coexistence, and thus will generally be the preferred solution, there may be situations in which

repacking in the uplink is preferable for impaired markets.[37] For example, if constrained markets represent only a portion of the spectrum cleared nationally, then sharing with uplink may be more desirable than sharing with the downlink because sharing with downlink would eliminate any mobile broadband in the most constrained markets. If the entire uplink band is needed and used for DTV, then at least the downlink band could still be used for supplemental downlink; however, the opposite is not true (unless there is a need for supplemental uplink in the future).

Moreover, placing DTV in the downlink poses its own device-related challenges. A single DTV station in the mobile receive pass band of a duplexer will negate the use of all of the downlink spectrum covered exclusively by that duplexer.[38] Given that custom filters for base stations are much more easily implemented than custom filters for end-user devices, and given that unpaired downlink spectrum is still potentially usable, the amount of spectrum "lost" by sharing with uplink may be less than the amount "lost" by sharing with the downlink, even though the separation distance required to ensure coexistence will be greater for downlink sharing than for uplink sharing. The ultimate balance of costs and benefits will depend on the precise results of the incentive auction. Until more is known about the outcome of the incentive auction, including the amount of spectrum recovered, the amount of variation required, and the number of duplexers required, among other considerations, making a definitive assessment of the optimal tradeoff between different sharing configurations is hazardous. The Commission may be best served by identifying the costs and benefits of the two basic options identified here,

[37] The Commission rightly continues to consider interference scenarios related both to DTV in the uplink and in the downlink because it is not possible to know in advance whether any market will be so significantly constrained that it is necessary to place DTV in the uplink. In any event, the Commission must consider the effect on US licenses from Canadian and Mexican TV stations. *See, e.g.*, *ISIX Second R&O and FNPRM* ¶ 64.

[38] The term "exclusively" is used here intentionally because multiple overlapping duplexers could mitigate the amount of spectrum lost as a result of placing DTV in the downlink.

establishing criteria to judge between them, and then committing to adopt the optimal scenario as identified by those criteria once the outcome of the incentive auction is known.

III. CLARIFICATION REGARDING WHETHER AND HOW A BROADCAST TV LICENSEE CAN REQUEST TO EXPAND ITS CONTOUR TOWARDS A WIRELESS LICENSEE.

As the Commission recognizes, repacked broadcasters should be allowed to expand their noise-limited or protected contours consistent with the Commission's rules if doing so does not increase the potential for interference to a wireless licensee's service area.[39] At the same time, as the Commission proposes, broadcasters should not be permitted to expand their contours if doing so would increase the potential for interference to a wireless licensee.[40] Ensuring that the rights that wireless companies obtain at auction cannot later be diminished instills the necessary confidence in wireless operators regarding the licenses they seek to purchase at auction.

The *FNPRM*, however, is less than clear regarding whether and to what extent a broadcaster can expand its broadcast contour in the direction of a wireless licensee. On the one hand, the *FNPRM* "tentatively conclude[s] that broadcast television stations should be allowed to demonstrate non-interference to a wireless licensee's service area by showing that a proposed modification will not expand its contour *in the direction* of a co-channel or adjacent channel wireless licensee."[41] On the other hand, the *FNPRM* "propose[s] to allow broadcast television stations in the 600 MHz Band to modify their facilities only to the degree that doing so does not extend their contours in the direction of a co-channel or adjacent-channel 600 MHz Band wireless license area *within a set distance*."[42] The *FNPRM* does not define or specifically seek

[39] *See id.* ¶ 79.

[40] *Id.*

[41] *Id.*

[42] *Id.* ¶ 62.

comment on the quantitative "set distance" from a wireless license area where it would be permissible for a broadcaster to expand toward the wireless license area.

Setting a specific threshold distance between the edge of a wireless license area (i.e., the partial economic area ("PEA")) and a broadcast contour that would allow a broadcaster to expand towards a wireless service area if its contour remained in excess of that distance could ensure that co- and adjacent channel broadcasters are not unnecessarily constrained while fully protecting wireless broadband operator expectations. This threshold "set distance," which would only allow broadcast contour expansion if the distance between the contour and the license area exceeded the threshold, should be kept to the minimum necessary to protect LTE operations. For example, there may be potential for broadcasters to expand their contours so long as they do not cause any harmful interference and they accept all interference from wireless companies. In other words, wireless companies would only be required to engage in culling distance calculations based on the original contours, not the newly-expanded broadcast contours allowed under the proposed rule. Such a policy would "ensure that wireless providers that acquire spectrum through the forward auction can rely on the information available at the time of the auction as to the existence and contours of a co-channel or adjacent television station, and rely on their modeling using OET Bulletin 74 for as long as the such television station is operating."[43]

The *ISIX FNPRM* is also somewhat unclear regarding whether a broadcaster may have an opportunity to expand its contour in the direction of the wireless licensee as part of its broadcast construction permit application process.[44] For purposes of the proposal not to permit broadcast licensees to expand their contours towards a wireless licensee, the Commission "propose[s] that

[43] *Id.* ¶ 79.

[44] *See id.* ¶¶ 79-80.

the contours of such stations be deemed to be those described in their *initial construction permit* for their new channel."[45] This language suggests that as part of its initial construction permit application, a broadcaster may request up to a one percent coverage contour increase, and that request will be deemed its contour for purposes of the proposed rule preventing a broadcaster from expanding its contour in the direction of wireless licensee.[46] At the same time, the *ISIX FNPRM* indicates that the impact of allowing broadcasters "such flexibility would be negligible because . . . the increase may not be in the direction of the wireless licensee."[47] Thus, it is unclear whether a broadcaster can request to increase its contour in the direction of a wireless licensee as part of its initial construction permit application. To maintain wireless bidder confidence, the Commission should clarify this ambiguity.

IV. CLARIFICATION REGARDING INTERFERENCE ANALYSIS WITH YET-TO-BE CONSTRUCTED BROADCAST STATIONS DURING THE 39-MONTH BROADCASTER TRANSITION PERIOD.

The Commission's proposal to require wireless licensees to rely on the ISIX methodology, including OET-74, requires clarification.[48] In particular, the *FNPRM* does not address how a wireless licensee should determine potential inter-service interference with a station that will pose potential inter-service interference once it is repacked. For example, a wireless licensee's spectrum may be fully clear of all stations, and thus authorized to commence operations,[49] but a broadcaster could be scheduled to relocate in an adjacent channel within relevant culling distances. The *FNPRM* provides little guidance regarding how the wireless

[45] *Id.* ¶ 80 (emphasis added).

[46] *See id.*

[47] *Id.*

[48] *See id.* ¶¶ 86-87.

[49] *See id.* ¶ 85 (citing *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, 29 FCC Rcd 6567 ¶ 525 (2014) ("*Incentive Auction R&O*")).

operator should treat the future deployment. Should the wireless provider employ the ISIX methodology using the broadcaster's contours as indicated in the *Channel Reassignment Public Notice*?[50] Should the wireless licensee rely instead on the broadcaster's construction permit application, which, as discussed above, may or may not indicate a different contour?[51] Or is the wireless licensee free to wait to conduct the ISIX analysis until the broadcaster has successfully repacked? The Commission should remove the ambiguity surrounding the interference analysis that applies to broadcast stations that are subject to relocation. To prevent disruption during the 39-month long transition period, the Commission should clearly define the obligations of wireless licensees and the reasonable expectations of TV licensees in each of the possible scenarios for the timing of new broadband deployments and broadcaster relocations that will occur following the 600 MHz incentive auction.

V. CONCLUSION

CEA supports the Commission's efforts to minimize the separation distances between DTV broadcast and wireless broadband operations. However, certain portions of the Commission's proposal require further analysis and clarification. In particular, the potential for intermodulation interference – both DTV/LTE intermodulation and LTE/LTE intermodulation – requires further analysis to ensure interference-free DTV receiver operations. Similarly, the large and arbitrary variations to separation distances introduced by the Commission's alpha scaling factor for the DTV D/U signal thresholds requires further consideration.

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[50] *See id.* ¶ 80 and n.259 (citing *Incentive Auction R&O* ¶ 525) ("The contours of broadcast television stations that will be reassigned to new channels in the 600 MHz Band as a result of the repacking process will be specified in the *Channel Reassignment PN*.").

[51] *See supra* Section III.

The *FNPRM* leaves open certain ambiguities. For example, ambiguity exists regarding whether and how a broadcaster can request to expand its contour toward a wireless licensee, including whether it may do so if there is a sufficient separation distance and whether it is permissible as part of the repacking construction permit application process. Likewise, the Commission's final decision requires further guidance regarding how, during the 39-month transition period, a wireless licensee should determine potential inter-service interference with a broadcaster that has not yet repacked.

By conducting additional analysis and providing further guidance, the Commission can promote a successful 600 MHz Incentive Auction and reduce the likelihood of harmful interference between broadcast and mobile wireless services in the 600 MHz Band.

Respectfully submitted,

CONSUMER ELECTRONICS
ASSOCIATION

/s/ Julie M. Kearney

Julie M. Kearney
Vice President, Regulatory Affairs
Brian E. Markwalter
Senior Vice President,
Research and Standards
Michael J. Bergman
Senior Director, Technology and Standards
Alexander B. Reynolds
Senior Manager and Regulatory Counsel

Consumer Electronics Association
1919 S. Eads Street
Arlington, VA 22202
(703) 907-7644

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