Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
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Wireless Telecommunications Bureau Seeks Comment on Request by Cricket License Company for Waiver of Section 27.60 for Lower 700 MHz A Block License	)	WT Docket No 14-17

REPLY COMMENTS OF LASER, INC.

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Table of Contents

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Laser, Inc. ("Laser"), on behalf of itself and Leap Licenseco, Inc. ("Licenseco"), successor in interest to Cricket License Company, LLC, Cricket Communications, Inc. and Leap Wireless International, Inc. (collectively "Cricket"),[1] submits this reply to comments filed by Fox Television Stations, Inc. ("FTS"), the National Association of Broadcasters ("NAB"), and T-Mobile USA, Inc. ("T-Mobile") in connection with the above referenced waiver request filed by Cricket ("Waiver Request") regarding the Lower 700 MHz A Block license (call sign WQJQ707) (the "License") in the Chicago-Gary-Kenosha, IL-IN-WI-BEA (BEA064).

I. INTRODUCTION AND SUMMARY

The Commission has worked hard to remove obstacles to wireless broadband deployment in the 700 MHz A Block spectrum,[2] and, more broadly, to advance a spectrum

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1 On March 13, 2014, AT&T Inc. ("AT&T") completed its acquisition of Cricket, including *de jure* control over the License, which is now held by AT&T's indirect, wholly owned subsidiary, Licenseco. Upon the closing of that transaction, the former shareholders of Leap Wireless International, Inc. received a contingent value right ("CVR") entitling them to the proceeds from the eventual sale of the License to a third party. To effectuate this arrangement, the shareholders' representative, Laser, acquired *de facto* control over the License upon the closing. This filing is made by Laser and not by Cricket or any other party.

2 *See, e.g., Promoting Interoperability in the 700 MHz Commercial Spectrum; Requests for Waiver and Extension of Lower 700 MHz Band Interim Construction Benchmark*

policy agenda intended to confront aggressively the alarming intersection of spectrum scarcity and exploding wireless broadband demand in markets across the United States. Both the Commission and the Executive Branch have acknowledged the need to promote greater availability of spectrum for broadband services to ensure that all consumers have access to educational and employment opportunities, health care, and other basic needs through wireless connectivity.[3] Indeed, in his recent address to the Mobile World Congress in Barcelona, Chairman Wheeler emphasized that we are in the midst of history's "fourth great network revolution" that is "driven by the most powerful and pervasive platform in the history of the planet – the mobile device in the pocket or purse."[4] The Chairman cited the express policy objective of "harness[ing] the power of mobile to promote prosperity and opportunity," and

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Deadlines, Report and Order and Order of Proposed Modification, 28 FCC Rcd 15122 (2013) ("*Interoperability Order*"); *Amendment of Section 73.622(i), Post-Transition Table of DTV Allotments, Television Broadcast Stations (Greenville, North Carolina)*, Report and Order, 27 FCC Rcd 8865, 8866 (MB 2012) (expediting substitution of channel 26 for Channel 51 in Greenville "to make way for new wireless service by Lower 700 MHz A Block licensees").

3 *See, e.g., Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Notice of Proposed Rulemaking, Docket No. 12-268, FCC 12-118 ¶ 1 (rel. Oct. 2, 2012) ("*Incentive Auction NPRM*") ("Our country faces a major challenge to ensure that the speed, capacity, and accessibility of our wireless networks keeps pace with these demands in the years ahead, so the networks can support the critical economic, public safety, health care, and other activities that increasingly rely on them."); The White House, Office of the Press Secretary, Presidential Memorandum: Unleashing the Wireless Broadband Revolution (June 28, 2010) ("Expanded wireless broadband access will trigger the creation of innovative new businesses, provide cost-effective connections in rural areas, increase productivity, improve public safety, and allow for the development of mobile telemedicine, telework, distance learning, and other new applications that will transform Americans' lives.").

4 Prepared Remarks of FCC Chairman Tom Wheeler, GSMA Mobile World Congress, Barcelona, Spain, at 1 (Feb. 24, 2014) ("Wheeler Barcelona Remarks").

discussed how achieving this goal begins by "removing unnecessary barriers to mobile infrastructure investment and buildout."[5]

The recalcitrance of the Channel 51 licensee in this proceeding is one such barrier. FTS does not dispute – because it cannot – that Chicago is one of the densest urban areas in the United States. The spectrum constraint in the market is self-evident, and readily demonstrated by various market measures. And while FTS argues that Cricket has shown "no particular constraint in Chicago nor a pent-up demand for Cricket's wireless offering" that would justify relief in this case,[6] the views of a wide range of actual wireless users in the Chicago market who have already submitted filings in this proceeding – including residents, small businesses, farmers, religious and community organizations, and elected officials, all actually experiencing the real-world impacts of spectrum congestion and scarcity in Chicago – provide additional compelling evidence to the contrary.

In reality, the public interest benefits of making additional spectrum available in Chicago are indisputable. But rather than discuss a path forward that might reasonably accommodate and unleash these benefits, FTS, echoed by the broadcast trade association, instead simply protests that such benefits do not exist.[7] According to the NAB, Cricket must demonstrate "imminent public harm from an alleged lack of available spectrum in the Chicago market" before a waiver can or should be granted,[8] which of course is not the standard, and more fundamentally, is at complete loggerheads with the Commission's desire to promote the

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5 *Id*. at 2.

6 Comments of Fox Television Stations, Inc., Licensee of WPWR-TV, WT Docket No. 14-17, at 8 (filed Mar. 4, 2014) ("FTS Comments"); *see also* Comments of the National Association of Broadcasters, WT Docket No. 14-17, at 4 (filed Mar. 4, 2014) ("NAB Comments").

7 FTS Comments at 9.

8 NAB Comments at 4.

availability of additional spectrum for wireless broadband use. To be sure, any genuinely harmful interference to legacy Channel 51 broadcast television operations should be minimized. But it would subvert the public interest to impose a standard that demands protecting a station from any interference whatsoever, effectively discourages the station from engaging with other industries or operators, and/or ignores the benefits that more wireless capacity will bring to businesses and residents in Chicago. As the Chairman has noted, in this snapshot of history, "everyone will need to continue to think creatively to meet the world's spectrum needs"[9] – and that includes legacy incumbent broadcasters.

In this regard, FTS's and the NAB's misrepresentations of the purpose of the DTV protection requirements reflect an unreasonable expectation of absolute interference protection for broadcast signals that the Commission has previously acknowledged is *not* the intent of the rule. Furthermore, in its spotty and haphazard technical response – which (in spite of FTS's claims of "cooperation") was completed in June of last year but never provided to Cricket despite repeated requests – FTS concludes that nearly *the entire population* of Chicago will experience interference and service loss from wireless operations in the 700 MHz A Block spectrum. But FTS uses the wrong interference prediction model and numerous faulty assumptions to reach this incongruous and absurd result.[10] And overall, neither FTS nor the NAB has effectively rebutted the strong evidence that only a *de minimis* number of viewers in Chicago are likely to be affected by enabling 700 MHz A Block operations to commence, even if LTE service is provided by a successor carrier.

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9 Wheeler Barcelona Remarks at 4.

10 *See* Stephen Berger, TEM Consulting, LP *et al*., Comparison of Cricket and Fox Positions of the Potential for Interference from LTE Operations in the Lower 700 MHz A-block Band to DTV Reception on Channel 51 (Mar. 18, 2014) ("Supplemental Technical Report"), attached hereto as Exhibit A.

Finally, Laser wholeheartedly agrees with T-Mobile that the complex interference environment between the FTS and Cricket licenses "necessitates a collaborative approach to identifying and resolving potential interference issues."[11] That approach to date has not been part of the FTS playbook. The Commission can and should in this proceeding demand a more constructive approach from 20th century broadcasters interfacing with 21st century spectrum imperatives, and in any event should demonstrate a willingness to intervene and resolve issues when it serves the public interest to do so. As discussed in these Reply Comments and in the Waiver Request, Laser urges the Commission to take action to grant the Waiver Request and to make additional spectrum capacity available in Chicago on an expedited basis.

II. THE PUBLIC INTEREST – AND PARTICULARLY THE WIRELESS BROADBAND NEEDS OF CHICAGO RESIDENTS – WILL BE WELL SERVED BY THE PROMPT GRANT OF THE WAIVER REQUEST

The Commission has made a number of pronouncements in recent years regarding the urgent need for more spectrum to be made available for mobile broadband services.[12] To that end, the Commission has undertaken efforts on several fronts to make more spectrum available for wireless broadband services, including through new spectrum allocations and more

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11 Comments of T-Mobile USA, Inc., WT Docket No. 14-17, at 2 (filed Mar. 4, 2014) ("T-Mobile Comments").

12 *See, e.g., Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Notice of Proposed Rulemaking and Order, GN Docket No. 12-354, FCC 12-148 ¶ 2 (rel. Dec. 12, 2012) ("*3.5 GHz NPRM and Order*") (noting in a proposal to allocated spectrum for shared use for mobile and fixed wireless broadband services that "[d]emand for wireless broadband capacity is growing much faster than the availability of new spectrum" and that "some experts forecast a need for a thousand-fold increase in wireless capacity by 2020"); *see also* Remarks of Commissioner Jessica Rosenworcel, Wi-Fi in the 5 GHz Fast Lane, The National Press Club, Washington, D.C., at 1 (March 7, 2014) ("[D]emand for our airwaves is growing at a blistering pace. Indeed, the need for more licensed spectrum . . . has been widely recognized.").

intensive usage of spectrum achieved through sharing arrangements.[13] Grant of the Waiver Request would be wholly consistent with these initiatives, and as recognized in T-Mobile's comments, would promote the same public interest goals that the Commission has worked to advance since it began its implementation of the recommendations in the 2010 National Broadband Plan to promote access to unused and underutilized spectrum, including the planned broadcast television incentive auction.[14]

In general, spectrum constraints are particularly acute in densely populated areas. And there is no question in this case that Chicago's extremely dense population makes it one of the most spectrum-constrained markets in the United States, even while demand for wireless broadband in the market continues to surge, particularly among lower-income consumers.[15] That Chicago spectrum is a scarce commodity is evidenced by the prices that have been paid historically for spectrum in that market at auction. As observed in the attached declaration, spectrum scarcity has been manifested historically in the very high prices paid at auction for spectrum in that market relative to the other top ten markets in the United States.[16] This scarcity

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13 *See, e.g., Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, Notice of Proposed Rulemaking, ET Docket No. 13-49, FCC 13-22 ¶ 15 (rel. Feb. 20, 2013) (noting that "[w]ireless broadband services are in high demand by the public and that demand is expected to grow significantly in the coming years"); *3.5 GHz NPRM and Order.*

14 *See* Federal Communications Commission, Connecting America: The National Broadband Plan, at 75, 84-85 (2010) ("*National Broadband Plan*") (recommending that the Commission make 500 MHz of spectrum available for broadband use, emphasizing a priority for spectrum below 3.7 GHz); *see also* T-Mobile Comments at 5-6.

15 Declaration of Timothy Ostrowski, at ¶ 4 (Mar. 18, 2014) ("Ostrowski Declaration"), attached hereto as Exhibit B.

16 *Id.* ¶ 2.

is also demonstrated by actions that carriers have taken in the Chicago market to address the issue, whether by using innovative infrastructure deployments,[17] or acquiring more spectrum.[18]

The insatiable consumer demand for wireless broadband services is similarly obvious. As one author has noted:

> Today, Chicago, like other great cities of the world, relies on private sector broadband wireless infrastructure to support its vibrant commercial and entertainment hubs. Residents, workers, and tourists in the City of Chicago rely on wireless broadband at a tremendous and increasing rate. Professionals in The Loop use smart devices in the office and on the street to conduct business, which results in massive data transmission. Festival traffic, theatre goers, tourists, and shoppers frequently convene at a given moment, and strain wireless broadband capacity.[19]

Statements in the record by local user constituencies in Chicago of all types echo the point – including residents noting that more capacity would alleviate local congestion and provide a better user experience;[20] small businesses highlighting the importance of better and faster

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17 AT&T, for example, has been attempting to address the "exponential[]" growth of wireless data traffic on its network in Chicago by exploring the deployment of Distributed Antenna Systems in order to "offer the innovative broadband wireless services that consumers and businesses are demanding" in that market. Jim Gerber, *The City of Big Broadband Shoulders: Chicago and AT&T Lead the Way to Wireless Expansion with Outdoor DAS and Microtrenching*, OSP MAGAZINE, *available at* http://www.ospmag.com/issue/article/The-City-of-Big-Broadband-Shoulders ("*Big Broadband Shoulders*").

18 *See* Press Release, Sprint Nextel, Sprint Closes Transaction to Acquire U.S. Cellular Spectrum and Customers in the Midwest (May 27, 2013), *available at* http://newsroom.sprint.com/news-releases/sprint-closes-transaction-to-acquire-us-cellular-spectrum-and-customers-in-the-midwest.htm (stating that "[a]dditional spectrum will significantly increase Sprint's network capacity and further improve the customer experience in Chicago, St. Louis and other Midwest markets").

19 *See Big Broadband Shoulders*.

20 *See, e.g.*, Letter from Gerald and Susan Dandurand to Marlene H. Dortch, Secretary, FCC, WT Docket No. 14-17 (Mar. 15, 2014) ("More of us in the region could use our smart phones more effectively if excessive congestion didn't prevent a user experience similar to that of Wi-Fi, which 4G LTE should be able to provide reliably. In a city of almost 11 million individuals, it is important that your agency does everything in its

broadband to their success;[21] religious and other community leaders noting how more capacity will assist their congregations and their local missions and initiatives;[22] farmers explaining the increased reliance on mobile broadband for their daily operations;[23] and elected officials noting the need for improved broadband access for their constituents.[24] All such statements are market-

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power to alleviate the congestion caused by skyrocketing mobile usage and limited spectrum.").

21 *See, e.g.*, Letter from Ibrahim Bharmal, President, Adzia True Value Hardware, to Marlene H. Dortch, Secretary, FCC, WT Docket No. 14-17 (Mar. 7, 2014) ("Due to current levels of congestion, I sometimes experience slow speeds and buffering issues. The fact that I am inside of a building in an urban area may also contribute to the problem. Opening Cricket's 10 MHz of prime space could benefit millions in the region, businesses and consumers alike. It will cause congestion on the airwaves, and because of its low frequency, signals on this particular spectrum are more likely to penetrate the walls of my store. This is especially important when we realize that mobile usage is increasing steadily and is only expected to rise.").

22 *See, e.g.*, Letter from Pastor Lou Ramos, Storehouse Church, to Marlene H. Dortch, Office of the Secretary, WT Docket No. 14-17 (Mar. 11, 2014) ("Our congregation is made up largely of Hispanic families, and we appreciate any and all efforts to ensure that our population experiences the tremendous advantages that the Internet and wireless broadband offer. Chicago has the fifth largest Hispanic population in the U.S. with nearly two million Hispanics living within the metropolitan area. As our numbers have grown, so have the difficulties that arise from the spectrum constraints our city faces."); Letter from John Bartlett, Metropolitan Tenants Organization, to Marlene H. Dortch, Office of the Secretary, FCC, WT Docket No. 14-17 (Mar. 14, 2014) ("As an organization that caters to low-income renters, we are keenly aware of the need to have wireless broadband. MTO recently developed a renters' mobile phone app because the majority of our members and the people who use our services rely on their cell phones to get access to the Internet. The digital divide is real. Our constituents do not work at jobs that have Internet access and they do not have computers at home, let alone home phone lines. Their cell phone is their key to gaining access to social media and other forms of communication. We need to expand service in this area not limit it.").

23 *See, e.g.*, Letter from William Danker, IV, Owner, Danker Farms, to Marlene H. Dortch, Office of the Secretary, FCC, WT Docket No. 14-17 (Mar. 8, 2014) ("We are living in the 'digital age', and farming operations rely on mobile devices to help our businesses just as much as many operations in the city. Whether it's for personal use or for business purposes, we put up with awful Internet access out here. The slow download speeds and frustrating buffering make it hard to do anything online.").

24 *See, e.g.*, Letter from Alderman Will Burns, 4th Ward Office, to Marlene H. Dortch, Office of the Secretary, FCC, WT Docket No. 14-17 (Feb. 26, 2014) ("President Obama's urgent call to increase spectrum for mobile broadband services across the

specific, and illustrate the very real impact and consequences of the spectrum constraints plaguing Chicago, and the desire for more spectral capacity.

Despite the ubiquitous evidence of the spectrum crunch and exponentially increasing wireless broadband growth, FTS and the NAB ignore these trends entirely in asserting that Cricket fails to proffer any public interest benefits in support of the Waiver Request. FTS and the NAB each astonishingly attempts to characterize the establishment of a path for commercially viable 700 MHz wireless broadband operations as "not relevant" to the Commission's consideration of whether a grant of the Waiver Request is in the public interest.[25] They instead argue that Cricket should be estopped in perpetuity from seeking relief from the Commission because Cricket knowingly purchased an "encumbered wireless license in the Chicago area."[26] The argument makes no logical sense. Section 27.60 by its terms expressly permits wireless licensees to operate by, among other alternatives, securing the consent of the incumbent broadcaster or otherwise demonstrating to the Commission via an engineering study that there will be no harmful interference.[27] Regardless of whether either of these options is achievable (both should be here), an ostrich-like refusal even to acknowledge the enormous public interest benefits that would attend an expansion of the capacity available to provide affordable wireless broadband services in Chicago in the near term only enhances the broadcasters' lack of credibility.

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country is for good reason – to ensure America's future competitiveness and global technology leadership. Leap's spectrum will help further this goal by adding capacity and reducing pressure on Chicago's increasingly crowded spectrum. As more and more connected devices and services hit my constituent's hands, we urge you to ensure that we can all move forward in this mobile digital age without being hampered by the congestion caused by spectrum crowding.").

25 FTS Comments at 11-12; NAB Comments at 4.

26 FTS Comments at 12; *see also* NAB Comments at 4.

27 *See* 47 C.F.R. § 27.60(b)(1).

Ultimately, the FTS and the NAB denials of well-established spectrum scarcity in Chicago, and in markets throughout the country more generally,[28] fail to negate the significant public interest benefits of making spectrum available through the grant of the Waiver Request. A waiver is warranted in this case precisely because neither Cricket nor the Commission anticipated that a Channel 51 broadcast licensee would unilaterally and unreasonably obstruct deployment of A Block spectrum even in circumstances, such as those presented here, where sound technical analyses show that the potential for harmful interference is effectively nonexistent. As thoroughly demonstrated in the Waiver Request and reinforced below, LTE operations on the 700 MHz A Block in Chicago would be able to coexist with the Station's operations, consistent with the intent of Section 27.60, and in service of the public interest.

III. FTS FAILS TO REBUT CRICKET'S SHOWING OF THE *DE MINIMIS* LEVEL OF INTERFERENCE FROM 700 MHZ A BLOCK OPERATIONS

In the Waiver Request, Cricket provided a thorough and comprehensive analysis to determine the actual likelihood of interference from LTE handsets into DTV receivers. Using realistic assumptions and an interference prediction model that was based on actual test data and real-world operating scenarios, Cricket's analysis showed that approximately 20 viewers in the Chicago area may be impacted if they are watching the over-the-air ("OTA") signal of FTS's Channel 51 DTV broadcast station, WPWR-TV (the "Station") while using an LTE handset at a distance 1.5 meters or greater from the DTV receiver antenna. Cricket's engineering analysis also showed that, due to the mobile nature of LTE handsets, in instances where a viewer does experience interference, the problem can be resolved simply by reorienting the LTE handset.

In response to this analysis, FTS has offered a cursory rebuttal based on severely flawed assumptions and a report based on a predictive model that is entirely inappropriate for the

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[28] *See* FTS Comments at 8; NAB Comments at 4.

short-range wireless signals that are at issue in this case. Based on this deficient analysis, FTS reaches the conclusion that *virtually all* of the population within the Station's Grade B contour would be affected as a result of LTE deployment in the 700 MHz A Block.[29] This conclusion is absurd on its face and again highlights the lack of engagement and rigor that has characterized FTS's dealings with Cricket to date. The attached Supplemental Technical Report provides a detailed response to FTS's technical showing.

A. FTS's Analysis Is Based on Wholly Unrealistic Assumptions, and Its Rebuttal Focuses on Irrelevant Considerations

As an initial matter, FTS uses utterly unrealistic assumptions in its prediction analysis, yielding the facially implausible result that 99 percent of the population within in the Station's service area would experience interference. For example, FTS's prediction assumes that all LTE handsets operate at the maximum permissible output power of 23 dBm.[30] However, in Cricket's testing, the maximum power recorded in actual LTE handset operations was 19 dBm. As a practical matter, in actual usage scenarios, this observed maximum would occur only in limited circumstances. LTE systems use active automatic power control mechanisms that ensure that handsets operate at the lowest possible power level at which communications can be transmitted. This efficiency mechanism preserves battery power and maximizes overall network capacity to support multiple users.[31] In addition, any potential interference would only exist when the LTE handset is transmitting. In typical usage scenarios, wireless data transmissions

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29 FTS Comments at 3 (asserting that "Cricket's LTE operation will result in a population service loss of 99.84%").

30 Meintel, Sgrignoli, & Wallace, LLC, A Report to FOX Television Stations Inc. Regarding Severe Impairments to WPWR CH 51 Chicago, IL From Proposed Cricket Wireless Block "A" LTE Signals, at 26 (June 7, 2013) ("MSW Report"), attached as Exhibit A to FTS Comments.

31 Supplemental Technical Report at 12-13, 20.

would be intermittent and limited in duration to instances where the LTE handset user is uploading and sending data.[32]

FTS's analysis also suggests the illogical assumption that every single household in the Station's Grade B contour has an LTE device using the 700 MHz A Block spectrum.[33] There is no realistic possibility that such a scenario would ever exist because it would require every household in Chicago to subscribe to the single wireless carrier that is operating using the 700 MHz A Block spectrum. Equally irrational is FTS's assumption of 700 MHz A Block operations in the entire 6 MHz channel, when LTE operations across the 700 MHz band are configured to use a 5 MHz channel, and the most logical configuration based on 3GPP industry standards would be to employ a 1 MHz guard band adjacent to Channel 51.[34]

Moreover, FTS's analysis gives no effect to the predominant segment of the population in Chicago that views the Station's signal over a multichannel video programming distribution platform and would not be impacted by any interference to the over-the-air signal. Almost 90 percent of viewers of the Station subscribe to cable or alternative multichannel video distributors.[35] For this reason alone, FTS's claim that LTE operations would cause actual interference to 99 percent of the population in Chicago is obviously wrong. In fact, in recent proceedings, the Commission has acknowledged the diversion of a substantial portion of broadcast television's over-the-air viewing audience over the years, recognizing the high cable/DBS penetration rates and the fact that consumers increasingly turn to online and mobile

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32 Ostrowski Declaration ¶ 5.

33 MSW Report at 47-48.

34 Supplemental Technical Report at 16-18.

35 *See* TVB, Local Media Marketing Solutions, http://www.tvb.org/media_comparisons/4729/ads_cable_dma (viewed Mar. 18, 2014) (combined wired cable and alternate delivery system penetration in Chicago as of February 2014 was 87%).

broadband platforms to access news, information and video programming.[36] Any realistic and reasonable prediction model used in the instant case must account for the overwhelming segment of the population in Chicago that will not be impacted at any given time because they do not receive over-the-air signals and thus would not be at risk of experiencing interference. But as Cricket has shown and as further supported in the Supplemental Technical Report, even when compared to the population of viewers that watch the Station's over-the-air signal, the number of potentially impacted viewers is still *de minimis*.

Finally, in a number of instances, FTS's analysis focuses on irrelevant and unrealistic considerations. For example, FTS claims that Cricket's analysis is deficient because it does not take into consideration the reception of signals by mobile DTV receivers, when the Station is not currently transmitting mobile DTV signals and is in fact *prohibited* from seeking authority for such service due to the Commission's current freeze on all Channel 51 station modifications.[37] Similarly, FTS's analysis makes much of the fact that outdoor DTV antennas were not tested by Cricket,[38] but such antennas would have an even *lower* probability of interference from an LTE handset than the indoor antennas that Cricket actually tested, because an outdoor antenna would receive a stronger DTV signal than an indoor antenna and would typically be located farther away from an LTE handset than an indoor antenna (and in many cases would be separated by a ceiling or exterior wall). Further, as detailed in the Supplemental

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36 *See, e.g., Incentive Auction NPRM* ¶ 14 n.17; *cf. Carriage of Digital Television Broadcast Signals*, Fifth Report and Order, 27 FCC Rcd 6529 ¶¶ 13-14 (2012) (concluding that changes in cable subscribership and the ready availability of low-cost digital transport adapters justified allowing the viewability rule to sunset).

37 *See* Public Notice, General Freeze on the Filing and Processing of Applications for Channel 51, 26 FCC Rcd 11409 (2011).

38 FTS Comments at 4; MSW Report at 6.

Technical Report, in many instances, FTS criticizes the absence of certain factors and considerations that in fact are clearly addressed in Cricket's analysis.[39]

B. FTS's Interference Prediction Model is Inapplicable to Wireless Operations

Another major flaw in FTS's study is its use of the OET-69 Longley-Rice prediction model to simulate interference from mobile LTE handsets into DTV receivers. The Commission has long understood that Longley-Rice was designed for the static environment of broadcast transmissions, and does not accurately predict interference by mobile wireless transmitters or distances of less than one kilometer. In the case at hand, the relevant operating environment for the evaluation of potential interference has a distance within 10 meters, and in most instances the relevant distance is less than 2 meters. The Commission also has acknowledged that Longley-Rice is inappropriate for wireless signals or in an "inter-service context."[40]

More generally, the Commission has questioned whether Longley-Rice and currently-used prediction methodologies are appropriate for determining whether DTV operations and adjacent wireless operations can coexist. In the context of the 600 MHz incentive auction, the Commission has asked for proposals for modified methodologies to evaluate interference between DTV and wireless operations, spurred by concerns "that prescribing a pre-defined separation distance . . . may be spectrally inefficient and overly conservative."[41] Specifically, the Commission questions the reliability of an approach that is based on a worst-

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39 *See* Supplemental Technical Report at 23-25.

40 Public Notice, 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, GN Docket No. 12-268, DA 14-98, at 6 (rel. Jan. 29, 2014).

41 *Id.* at 4.

case scenario without considering any actual technical characteristics and "also fails to account for technologies and techniques that wireless licensees might employ to mitigate potential interference."[42] As detailed above, FTS's analysis essentially employs an extreme worst-case approach that is entirely implausible and wholly inappropriate.

IV. INTERFERENCE LIKEWISE WILL BE *DE MINIMIS* IN ANY OTHER FORESEEABLE USE CASE FOR 700 MHZ A BLOCK SPECTRUM IN CHICAGO

Any realistic and foreseeable successor to Laser of the 700 MHz A Block spectrum in Chicago would generate only a *de minimis* level of interference to the Station, further justifying a grant of the Waiver Request. Contrary to the broadcasters' assertions, there is no defect in the Waiver Request merely because of the uncertainty surrounding future ownership of Cricket's Chicago license. The relevant question is whether LTE transmissions using the 700 MHz A Block license would cause harmful interference, not the identity of the party that holds the license. Indeed, there is no future ownership scenario that materially increases the threat of harmful interference to the Station's viewers' receipt of broadcast signals, and there is no change whatsoever in the public interest benefits of enabling additional wireless broadband services in Chicago.

Even assuming a larger subscriber base than Cricket's, Laser's estimates demonstrate there would still be only *de minimis* interference into the Station's DTV operations, contrary to the NAB's unsubstantiated "logical conclusion" that a larger deployment with more subscribers and more devices would increase the potential for interference.[43] As illustrated in the Supplemental Technical Report, when considering the viewers of the Station's OTA signal and the percentage of subscribers of each of the four largest carriers in the Chicago market, for

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42 *Id.*

43 NAB Comments at 6.

example, the estimated number of potentially affected viewers using an LTE handset at a distance of 1.5 meters or greater from the DTV receiver does not exceed a *de minimis* level.[44]

Moreover, larger carriers likely would have a greater number of cell sites per square mile, which would result in their LTE handsets operating at lower power than those operating on Cricket's network, thereby reducing the potential for interference from the handset to DTV receiver.[45] Therefore, an increase in the number of subscribers would likely be offset by a reduction in the potential for interference resulting from greater cell site density of a larger carrier.

Importantly, the public interest need for a waiver in this case will remain even if the License is transferred to another carrier. As discussed above, the public interest benefits of enabling the deployment of LTE on the spectrum on an expedited basis are indisputable. The spectrum constraints in the Chicago market would still exist if the License were constructed by another operator, and the critical need for additional spectrum in Chicago will not change as a result of a new licensee. Given that the critical factors justifying a grant of the Waiver Request will remain the same even if the License is used by a larger carrier, the grant of the Waiver Request should apply equally to Laser's successor.

The Commission's grant of a transferrable waiver from interim construction benchmark deadlines in the *Interoperability Order* is an apt comparison to the transferability of the waiver requested in this case, contrary to the NAB's characterization that the precedent is a "poor fit."[46] In both cases, the strong public interest considerations warrant flexibility and predictability to ensure that the spectrum can be deployed on the 700 MHz A Block in Chicago.

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44 Supplemental Technical Report at 25-26.

45 *Id*. at 26.

46 *See* NAB Comments at 6.

The fact that a buildout deadline does not implicate interference issues has no bearing on the Commission's determination that the basis underlying the grant of the waiver remains the same regardless of the holder of the license. The Commission in other instances has specified that a waiver could be transferred to a successor in interest to the extent that the conditions attendant to the grant of the waiver are satisfied.[47]

V. BROADCASTERS SHOULD BE PREVENTED FROM HINDERING EFFORTS TO MAKE MORE EFFICIENT AND INTENSIVE USE OF RADIO SPECTRUM

Grant of the Waiver Request is warranted further because denial would only serve to embolden the positions that the broadcast industry has taken to impede more efficient and intensive use of radio spectrum. The broadcasters generally have sought to slow rather than accelerate the freeing up of spectrum in the 600 MHz incentive auction.[48] In that same vein, the NAB here seeks to slow any progress toward deployment on the 700 MHz A Block spectrum in Chicago by raising arguments that have been unsuccessful against similar waiver requests of the

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47 *Intek License Acquisition Corp. Request for Waiver and Consolidation of 220 MHz Construction Requirements*, Memorandum Opinion and Order, 16 FCC Rcd 16431 ¶ 14 (2001) (granting a waiver to consolidate certain buildout deadlines of licenses held by Intek to accommodate a nationwide network deployment and specifying that the waiver applies to a successor in interest that acquires the licenses to operate an integrated system); *see also National Rural Telecommunications Cooperative, LLC Request for Waiver and Consolidation of 220 MHz Construction Requirements*, Memorandum Opinion and Order, 15 FCC Rcd 13402 ¶ 12 (2000) (granting a waiver to consolidate certain buildout deadlines of licenses transferrable to a successor in interest provided that the licenses are used to operate an integrated system).

48 *See, e.g.*, Comments of Sinclair Broadcast Group, Docket No. 12-268, at 4 (filed Jan. 25, 2013) (urging the FCC to "not rush the auction," because Congress "gave the FCC more than ten years, until the *end of federal fiscal year 2022*, to complete the auction" and claiming that "there is no 'spectrum crunch' today or on the horizon"); Reply Comments of ABC Television Affiliates Association, CBS Television Network Affiliates Association, and NBC Television Affiliates, Docket No. 12-268, at 24-25 (filed Mar. 12, 2013) (calling "the Commission's apparent desire to get underway with the auction and repacking processes quickly … *puzzling*," decrying the FCC's intention to conduct the auction in 2014 in light of Congress's allowance of "more than ten years to complete the auction process" (emphasis added)).

DTV protection criteria. For example, the NAB asserts that a rulemaking proceeding is necessary to grant the relief requested in the Waiver Request, and that grant of the Waiver Request would only serve to facilitate a spectrum arbitrage opportunity.[49] The NAB made almost these precise arguments in the context of other waiver requests seeking relief from the Section 27.60 broadcast station protection criteria.[50] Significantly, the Commission has already rejected such arguments and has granted waivers of Section 27.60 under circumstances such as this one, where there was shown to be a *de minimis* level of interference.[51]

Further, as discussed, underlying FTS's entire line of argument is the faulty premise that incumbent broadcasters are entitled to absolute interference protection. Throughout its comments, FTS overstates the level of protection afforded to broadcasters under Section 27.60, characterizing the rule as "an absolute bar" on any adjacent wireless operations that have the potential to cause interference.[52] The Commission has already rejected the notion that broadcast incumbents are entitled to protection from *any* level of interference, and has acknowledged that inherent in Section 27.60 is the possibility of *de minimis* interference as a result of the predictive nature of all interference protection requirements.[53] The Commission has pointed to the language in the rule requiring wireless operators "to reduce the *potential* for

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49 NAB Comments at 1, 5.

50 Joint Reply Comments and Informal Objection of the Association for Maximum Service Television, Inc. and the National Association of Broadcasters to the Petition for Declaratory Ruling of Qualcomm Incorporated, WT Docket No. 05-7, at 5, 21-22 (filed Mar. 25, 2005) (calling for the Commission to "dismiss QUALCOMM's Petition or, in the alternative, treat it as a Petition for Rulemaking" and arguing that grant of QUALCOMM's request would allow it to "unjustly obtain a windfall").

51 *See Qualcomm Incorporated Petition for Declaratory Ruling*, Order, 21 FCC Rcd 11683 ¶¶ 39-40 (2006) ("*Qualcomm Order*").

52 FTS Comments at 1, 7.

53 *Qualcomm Order* ¶ 29.

interference"[54] in acknowledging that broadcasters will need to tolerate some level of interference, as opposed to being afforded absolute protection for broadcast operations. As detailed in the Waiver Request, where operations on adjacent spectrum are demonstrated to be able to coexist, the Commission has favored such use even where there would be some potential for interference.

Given FTS's pattern of unwillingness to work constructively with Cricket to resolve any potential interference issues, FTS's disingenuous claim that it has cooperated with Cricket is surprising. FTS's failure to engage in good faith discussions with Cricket is well documented. FTS's assertion that it "has done all, if not more, than it can be reasonably expected to do" is flatly contradicted by its outright refusal to provide its technical study to Cricket last year even after repeated requests.[55] Providing the full technical analysis, which was available to FTS at the time and could "reasonably" have been made available to Cricket, could have facilitated a continued dialogue between the operators aimed at resolving FTS's interference concerns. However, FTS unilaterally foreclosed the possibility of such a discussion by refusing to engage. It is even more troubling that FTS is operating under the flawed assumption that it is "under no requirement" to cooperate with Cricket. In its comments in support of the Waiver Request, T-Mobile recognizes the broader significance of the Commission sending a clear message to the broadcast industry that they are not entitled to unreasonably restrict wireless deployment in cases where co-existence is technically feasible.[56] Laser wholeheartedly agrees. Determining the appropriate terms of coexistence between the operators is not feasible without the reasonable cooperation of the broadcast licensee.

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54 47 C.F.R. § 27.60 (emphasis added).

55 FTS Comments at 12.

56 T-Mobile Comments at 5, 7.

VI. CONCLUSION

For the foregoing reasons, a waiver of the DTV protection criteria in Section 27.60 of the Commission's rules is warranted to expedite the availability of additional spectrum to increase the capacity of wireless broadband services for consumers in Chicago. FTS's hasty technical analysis fails to rebut the careful and thorough studies in the Waiver Request. Given the critical need for additional spectrum for mobile broadband services in Chicago and the similarly *de minimis* potential for interference of a larger carrier that may acquire the License, Laser requests that grant of the Waiver Request be transferrable to its successor in interest. Therefore, Laser respectfully requests a waiver of the DTV protection criteria, as described herein and in the Waiver Request.

Respectfully submitted,

/s/

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March 18, 2014

Exhibit A
Supplemental Technical Report

Supplemental Technical Report

Subject: **Comparison of Cricket and Fox Positions of the Potential for Interference from LTE Operations in the Lower 700 MHz A-block Band to DTV Reception on Channel 51**

Date: **March 18, 2014**

Prepared By: **Stephen Berger - TEM Consulting, LP**

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Table of Contents

Executive Summary

This Supplemental Technical Report analyzes the strongly contrasting positions presented in the analyses conducted by Cricket Communications, Inc. and Leap Wireless International, Inc. (collectively, Cricket)[1] on one hand, and Fox Television Stations, Inc. (Fox) on the other, regarding the potential for interference to WPWR-TV, D51 (V50), Gary, IN, from Long Term Evolution (LTE) user equipment (UE) operating under a deployment proposed by Cricket Wireless, in the Lower 700 MHz "A" block. Cricket filed a request for waiver of the Section 27.60 digital television (DTV) signal protection criteria to allow the deployment of commercial service using Cricket's WQJQ707 Lower 700 MHz A-block license (the "License") in the Chicago-Gary-Kenosha, IL-IN-WI Basic Economic Area 064 (the Market). Cricket has demonstrated in its technical analysis that the potential for interference into the adjacent Channel 51 DTV broadcast station, WPWR-TV operated by Fox is *de minimis*, and that the probability that viewers of the Station's signal will suffer from interference is highly unlikely.[2] However, after reviewing Cricket's analysis and contracting Meintel, Sgrignoli, & Wallace (MSW) to perform a separate analysis, Fox concluded that Cricket's LTE operation would result in "a population service loss of 99.84%."[3]

The reason that the Cricket and Fox results differ so dramatically appears to be primarily due to the failure of Fox to address the particulars of Cricket's LTE deployment proposal and the different methodologies/assumptions Fox used for analyzing interference. These differences are summarized below:

- The central feature of Cricket's proposed deployment is the creation of a voluntary 1 MHz guard band,[4] which is the characteristic of all 5 MHz wireless operations generally in the 700 MHz band. Although MSW mentioned the 1 MHz guard band several times in its report, it does not appear that MSW accounted for the impact of the guard band in its analysis. The failure to account for the benefit created by the 1 MHz guard band resulted in MSW analyzing the potential for interference without a guard band between channel 51 and the proposed LTE plan. MSW simulations were done assuming that the original FCC DTV band plan would be used, without any frequency separation and further, that

[1] This report was prepared on behalf of Laser, Inc. ("Laser") as successor-in-interest to Cricket. The relationship between these entities is described in more detail in the accompanying Reply Comments of Laser, Inc., footnote 1.

[2] FCC WT Docket 14-17, Petition of Cricket License Company, LLC For A Waiver Of DTV Protection Criteria, Filed December 6, 2013, pg. 3.

[3] FCC WT Docket 14-17, Comments Of Fox Television Stations, Inc., Licensee of WPWR-TV, Filed March 4, 2014, pg. 2.

[4] In reality the 1 MHz guard band would be closer to 1.25 to 1.50 MHz because what is called a 5 MHz LTE signal actually has a measured bandwidth close to 4.5 MHz.

the -23 dB desired-to-undesired (D/U) ratio in Section 27.60 of the FCC rules should apply to this case. However, the FCC created the -23 dB ratio based on a band plan without any frequency separation and before LTE technology even existed. In contrast, Cricket's testing focused on the effect of the *combination* of currently available consumer-grade DTV receivers and a voluntary 1 MHz guard band.

- MSW's analysis assumed that D/U ratios of -23 dB or worse (*i.e.*, more negative) between a desired DTV signal and an undesired UE signal result in interference. In contrast, Cricket commissioned Intertek to perform testing to determine the actual D/U ratio that would cause interference when using LTE transmissions with a 1 MHz guard band. The testing demonstrated that for the proposed 5 MHz LTE deployment and with a 1 MHz guard band, DTV consumer equipment currently on the market can tolerate substantially stronger adjacent band LTE signals, resulting in D/U ratios in the range of -35 to -40 dB, before actual interference is caused.

- MSW argued that the only way to evaluate the impact of LTE UE into DTV broadcast receiver interference is by using the Longley-Rice model, also known as the irregular terrain model (ITM), and OET Bulletin 69, *Longley-Rice Methodology for Evaluating TV Coverage and Interference*. Longley-Rice was developed for evaluating interference between stations at fixed locations, where the intervening terrain can be modeled. It is not accurate for evaluating mobile LTE UE into DTV broadcast receiver interference, which would occur over very short distances.

  In fact, MSW itself was unable to use the Longley-Rice model for this analysis. MSW used Longley-Rice to estimate the DTV signal strength, but for estimating the LTE UE signal MSW instead used a free space equation, not Longley-Rice. MSW then realized that Longley-Rice is not equipped to deal with the complexity of propagation through or within buildings and so MSW made modifications, based on its own research. In the end, MSW used a custom adaptation with Longley-Rice only as a starting point. The fact that the MSW was unable to use Longley-Rice unmodified for this analysis is further evidence that Longley-Rice is not the right method for the analysis.

- The MSW calculations, on which Fox based its conclusion of prohibitive interference, were built on inaccurate assumptions and simplifying generalizations of a number of factors that, in an actual-use case, would reduce or eliminate the potential for interference. Likewise, MSW's analysis misunderstood the purpose of Cricket's analysis and focused instead on unrealistic interference scenarios. For example the MSW analysis assumed that:

  - Every household in the exclusion zone is simultaneously watching WPWR-TV and is also utilizing an A-block handset.
  - The A-block UE is always transmitting with its maximum permissible power of +23 dBm.
  - The orientation of the UE is such that it is coupling the maximum power into the DTV receiving antenna, and the DTV antenna is oriented to pick up the maximum possible signal from the UE.
  - There are no obstructions (walls, furniture, people, etc.) between the UE and the DTV receiving antenna that attenuate the UE signal.

Cricket, on the other hand, sought to present a realistic but conservative evaluation. Among the factors that reduce the potential for interference are:

- Only Cricket customers within the exclusion zone are simultaneously watching WPWR-TV and are also utilizing a handset on A-block frequencies.
- LTE UEs utilize rigorous power control, keeping their power as low as possible. This is to preserve battery life and maximize the network handling capacity. Additionally, as documented by the Intertek study, and also in FCC equipment certification measurements on file with the FCC, band-edge A-block UEs are only able to transmit up to 19 dBm ERP, as opposed to the 23 dBm ERP allowed by the LTE standard.
- There typically will be misalignment between the UE transmitting antenna and the DTV receiving antenna, reducing the potential for interference. The probability that the relative positioning of the LTE UE and DTV receiving antenna will be aligned for maximum coupling is less than 2%.[5, 6]
- Many DTV viewers use a roof top antenna and therefore the LTE UE and DTV antenna would not operate in close proximity. This is particularly true in weak signal areas.

- MSW's analysis asserted that Cricket's analyses failed to incorporate/consider certain factors such as multipath impairments, fast motion video, and variations of out-of-band emissions (OOBE). These factors were, in fact, explicitly addressed in Cricket's analyses.
- Fox based its conclusion solely on simulations and calculations while Cricket reached its conclusions based on a tiered approach: Utilizing third parties who performed both conducted and radiated testing in a laboratory, followed by an interference probability analysis. Because of the complexity of a mobile environment, calculations and simulations do not accurately predict interference between DTV receivers and LTE handsets. Fox simply ignored how these devices would interact in the real world.

The remainder of this report discusses these and related factors in more detail. The report discusses the difference in the approaches, which result in contrasting conclusions. It will show

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[5] As the Intertek report demonstrates, mere relative positioning ensures that there is a greater than 98% probability that the experienced interference distance will be less than half of the absolute, maximized worst-case distance. The original Intertek report page 9.

[6] The amount of energy an LTE UE will couple into the antenna port of a DTV broadcast receiver was overestimated by orders of magnitude in the MSW simulation. This is particularly due to the inappropriate use of a free space estimate, which does not account for the impact of objects in the environment such as walls and furniture. In addition, MSW ignored a number of other losses and inefficiencies that reduced the LTE UE energy that arrives at a DTV antenna port, despite the fact that such factors will be significant in actual use.

that by using actual testing and examining the continuing validity of past conclusions, the Cricket approach is far more accurate and predictive of the actual (and *de minimis*) interference that would accompany the co-existence of DTV Channel 51 operations and a 5 MHz LTE deployment in Chicago.

Finally, this report also discusses the considerations that support the conclusion that a carrier that acquires the 700 MHz A-block license from Cricket would similarly be able to operate without impacting a significant portion of the viewer population in Chicago. By extrapolating the results of the probability analysis in the Chicago Channel 51 Interference Probability Study prepared by Newfield Wireless, this report demonstrates that the likelihood of interference based on a larger successor carrier using the 700 MHz A block would also be *de minimis*. Even though the potentially affected viewers of the Channel 51 signal may be slightly higher – in the range of 100 to 150 viewers – there are mitigating factors associated with the network configuration and deployment density of a larger carrier that would decrease the potential for interference in a number of circumstances compared to the potential interference that would result from Cricket's proposed deployment.

Deficiencies of the MSW Analysis

Methods for Determining Potential for Interference

There are three different methods for determining the interference potential of a given situation:

- Calculations and computer simulation using a theoretical model;
- Laboratory measurements; and
- Field measurements.

Each method has strengths and weaknesses, but when performed properly, all three should converge on the same answer. When different methods do not converge, then there is a problem with how one or perhaps all of the methods are being applied, or the study may be looking at different problems or using fundamentally different assumptions. Recognizing this principle of good research and engineering analysis, Cricket presented two independent analyses of possible LTE UE interference with DTV operations in Chicago, using different methods and prepared by different organizations. Both came to similar conclusions.

Indeed, if one looks at the FCC Office of Engineering and Technology's own work on the issue, it has used similar test methods in evaluating the interference potential.

FCC OET Report 07-TR-1003, DTV Converter Box Test Program - Results and Lessons Learned was particularly helpful to Cricket's testing approaches, and its "lessons learned"

portion provided important information for the Intertek effort.[7] In fact, the Intertek engineers who conducted Cricket's interference testing talked early in the process to the FCC engineers who performed earlier FCC testing, seeking to thoroughly understand the FCC's test methods and to gain insights on how best to test for DTV interference. During those conversations there was no hint that the Intertek approach was fundamentally in error. Rather, the conversations covered a number of detailed technical points, consistent with a technical discussion of good engineering research and the specific technical issues of interest here.

In contrast Fox stated:

> The OET-69 Longley-Rice analysis as conducted by MSW is the proper engineering analysis to use here and was found acceptable by the FCC in both cases (*Qualcomm* and *New York State)* that Cricket cited for support of its Waiver Petition. Cricket did not properly use or conduct an OET-69 Longley-Rice analysis in either of its engineering studies. The Commission cannot grant the Waiver Petition when Cricket's proposed operation would destroy the over-the-air (OTA) signal of WPWR-TV within its service contour and Cricket's own studies did not use proper or Commission-approved engineering methodology.[8]

In fact, MSW, the engineering firm directed to perform the evaluation for Fox, did not perform a pure OET-69 analysis either, but rather a custom derivative version starting with OET-69, but using OET-69 for only a portion of the analysis. Specifically, while the signal strength of the DTV channel 51 signal was estimated using Longley-Rice, the signal strength of the LTE UE was not estimated based on Longley-Rice but rather by using a free space equation. In Section 8.2, *Procedure for Analyzing Impact of LTE to DTV*, MSW stated:

> Since the field strength of the DTV signal has been previously determined, it is necessary to determine the field strength of the LTE device using the *free space* formula employed by the FCC.
>
> Field Strength (dBμV/m) = 106.92 + 10*log (ERP in kW) - 20*log (DISTANCE in km) [7][9]

The use of this free space equation to estimate field strength is not in OET-69, and other FCC guidance advises that its use is inaccurate over any shorter distances and particularly for indoor environments.[10]

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[7] Intertek Testing Services NA, Inc. Report, Evaluation Of The RF Coexistence LTE Operation On 700 MHz A Block (formerly channels 52 / 57) and TV Channel 51 Reception, Report: G1002WX445LEX-02 (January 14, 2013) (filed as an Exhibit to Cricket Petition).

[8] Comments of Fox Television Stations, Inc., Licensee of WPWR-TV, WT Docket No. 14-17 (filed March 4, 2014).

[9] Meintel, Sgrignoli, & Wallace, LLC, A Report to FOX Television Stations Inc. Regarding Severe Impairments to WPWR CH 51 Chicago, IL From Proposed Cricket Wireless Block "A" LTE Signals, pgs. 47-48 (June 7, 2013) (filed as an Exhibit to Fox Comments).

[10] Unlicensed Operation in the TV Broadcast Bands, Additional Spectrum for Unlicensed Devices Below 900 MHz in the 3 GHz Band, Second Report and Order and Memorandum Opinion and Order, ET Docket 04-186, FCC 08-260, pg. 62 (released Nov. 14, 2008).

When evaluating indoor locations, MSW observed that OET Bulletin 69 does not address such locations and then applied its own custom approach in its simulations:

> The criteria used to determine which locations would likely be suitable for *indoor* DTV reception was based on an extensive study performed by and reported on by MSW. While outdoor service requirements have been determined by the FCC in OET-69, this relatively recent planning factor document from MSW identified three types of indoor sites described as best case, typical case and worst case. For each of these cases, a minimum outside field strength was established that would allow successful indoor DTV reception based on a number of receive site planning factors including antenna height loss, building penetration loss, antenna gain, cable loss, mismatch loss (antenna and receiver), multipath fading level, and multipath receiver noise enhancement. Each of these parameters was determined from research, and the best estimates of the appropriate value were selected.[11]

MSW came up with three factors not found in OET Bulletin 69—10 dB, 21 dB and 34 dB—which it applied to estimate the indoor DTV signal strength. These factors are based on MSW's own research.

Thus, MSW was unable to perform an analysis of predicted interference using OET-69 but rather developed its own customized methodology for the analysis. The record in GN Docket 12-268 (regarding the 600 MHz incentive auction design) and ET Docket 14-14 (regarding potential interference issues between broadcast television and wireless services) shows that the FCC does not feel that OET Bulletin 69 and Longley-Rice are fixed and unchangeable. Indeed for more than a year the FCC has been actively and appropriately improving Longley-Rice and has released no less than five versions of its software since June 2013.

What Is the Right Model for Mobile to DTV Interference?

Fox had an engineering analysis prepared by MSW and based its conclusions on a flawed analysis. MSW started its analysis with the Longley-Rice terrain dependent propagation model, using FCC OET Bulletin 69 for its criteria. However, to apply Longley-Rice to this analysis MSW had to modify the method and make some simplifying generalizations. Thus, in reality, MSW used a customized approach based on its modifications of Longley-Rice. While it would have been possible for MSW to have performed its own, independent testing to determine how well the Longley-Rice model predicts the actual outcome, this was not done. The important question to ask here is whether the right model is being used for predicting Mobile LTE UE to DTV interference. In Annex A to IEEE Standard 1900.2:2008, *Recommended Practice for the Analysis of In-Band and Adjacent Band Interference and Coexistence Between Radio Systems*, the standard discusses propagation models and states:

> **Annex A - Propagation modeling**
>
> **A.1 General**
>
> Propagation modeling is an integral component of estimating the interaction of differing radio systems on each other. Unfortunately, propagation is a complex function of many variables

[11] MSW report, pg. 48.

making it one of the most controversial areas when analyzing radio system coexistence. This annex gives an introduction to propagation modeling and some guidance on using the propagation modeling tools most applicable to a particular coexistence case.

The received power depends on the transmit power and the channel gain, denoted path loss Lp. The path loss depends on four high-level variables, as follows:

- Scale: What are the communication distances relative to the environment and to the wavelength?
- Terrain and environment: Is this indoors or outdoors? Is it an urban, suburban, rural, mountainous, marine, aeronautical, or space environment?
- Signal: What is the frequency? Is the signal narrowband or wideband?
- **Mobility: How fast does the signal vary because of transmitter, receiver, or environmental mobility?**

This annex describes each of these variables, their role in propagation modeling, and some commonly used propagation models.[12]

Significantly, IEEE 1900.2 standard does not even mention the Longley-Rice model, but goes on to discuss the relative merits of several other models, including:

- Advanced Refractive Effects Prediction System (AREPS)
- Okumura-Hata propagation model
- JTC path loss model

What IEEE 1900.2 makes clear is that there are a variety of propagation models, and it is important to understand the underlying assumptions of each and question the appropriateness of applying it to a specific problem. **Significantly the IEEE 1900.2 clause A.6 warns that mobile environments bring in new variables that must be addressed when using any propagation model.**

As will be shown, there are serious questions about the appropriateness of the Longley-Rice model for the mobile environment being analyzed by MSW. As discussed below, MSW modeled using the wrong tool for an interference analysis of a mobile and largely indoor environment, resulting in the flawed assertion by Fox that the proposed deployment of the License would cause a population service loss of 99.84%.

Longley-Rice Model

The Longley-Rice model, also known as the irregular terrain model (ITM), is a radio propagation model developed for predicting the strength of radio signals over an area.[13] Longley-Rice has

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[12] IEEE Std 1900.2-2008, IEEE Recommended Practice for the Analysis of In-Band and Adjacent Band Interference and Coexistence Between Radio Systems, pg. 40.

[13] The Longley-Rice model was published in two U.S. government documents:

been used between 20 MHz to 20 GHz. Longley-Rice was created as a frequency planning tool in television broadcasting in the United States in the 1960s. It has also been used extensively for preparing the tables of channel allocations for VHF/UHF TV broadcasting.

The model provides generalization of the received signal power without a detailed characterization of the channel. Statistical methods are used for the characterization of the channel, which will vary for each scenario and environment, based on their specific characteristics.

The FCC is in the process of updating the model in preparation for the 600 MHz incentive auction and recently released an eighth revision in that process. The FCC engineers clearly understand the limitations of any method and are seeking comment on the best methods to use in the future to determine interference involving wireless spectrum and DTV broadcasts. In its public notice dated January 29, 2014 (DA 14-98) in the 600 MHz incentive auction proceeding, the FCC's Office of Engineering and Technology (OET) stated:

> **Methodology to Determine DTV Interference to Wireless**
>
> We seek comment on the approach described to determine wireless license impairments. Are there other methods to determine wireless market impairments in the 600 MHz band?
>
> **Methodology to Determine Wireless Interference to DTV**
>
> We seek comment on the approach described to determine interference to DTV stations. Should we instead set one or more simple separation distance requirements? Will calculation of the D/U ratio values on a 2-kilometer grid with base stations spaced uniformly at 10-kilometer intervals provide sufficient resolution when determining possible interference?
>
> We request comment on the extent of predicted interference to DTV reception based on our gridbased approach. Should we define areas within a wireless market, such as county boundaries, where if the operations of any given hypothetical wireless base station cause predicted interference to a DTV station, regardless of population impacted, we would infer that all wireless operation in that area would cause interference to that station?
>
> **Technical Assumptions**
>
> The OET methodology makes certain assumptions about the characteristics of DTV transmission facilities and DTV receivers as well as wireless transmission facilities and receivers based mostly on existing industry standards and available technical data. For digital television, the DTV planning factors[6] underlie the definition of service. Receiver performance expectations were used to develop the interference criteria in the Commission's rules.[7] Because 600 MHz wireless services are expected to be noise-like and studies have shown that noise-like signals have interference potential nearly identical to ATSC digital television,[8] we believe that the existing DTV protection criteria can be applied with some adjustments for frequency offsets as discussed

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- "Prediction of tropospheric radio transmission loss over irregular terrain. A computer method-1968", A. G. Longley and P. L. Rice, ESSA Tech. Rep. ERL 79-ITS 67, U.S. Government Printing Office, Washington, DC, July 1968; and
- "Transmission loss predictions for tropospheric communication circuits", P.L. Rice, Volume I & II, National Bureau of Standards, Tech. Note 101.

below. Similarly, for wireless systems operating at 600 MHz, industry standards[9] define reception thresholds and provide receiver performance criteria. The methodology assumes a uniform distribution of wireless base stations. We seek comment on whether these assumptions are appropriate. We also seek comment on whether the criteria for service and interference are appropriate for use in a predictive model to establish locations of likely interference between TV broadcast and wireless services operating co-channel or adjacent-channel.[14]

OET's proposal in the 600 MHz incentive auction proceeding does not take into account handset-to-DTV receiving antenna distances and warns against using OET Bulletin 69 for short handset-to-DTV receiving antenna distances. This is because handset-into-DTV interference (Case 4, below) is assumed to involve distances of less than 1 km, and, per Footnote 15, "the Longley-Rice model may not be suitable for such short distances." See Figure 1 below from DA 14-98, which only proposes using Longley-Rice for Cases 1 through 3. That is, DTV transmitter-into-base station interference (Case 1), DTV transmitter-into handset interference (Case 2), and base station-into-DTV receiver interference (Case 3).

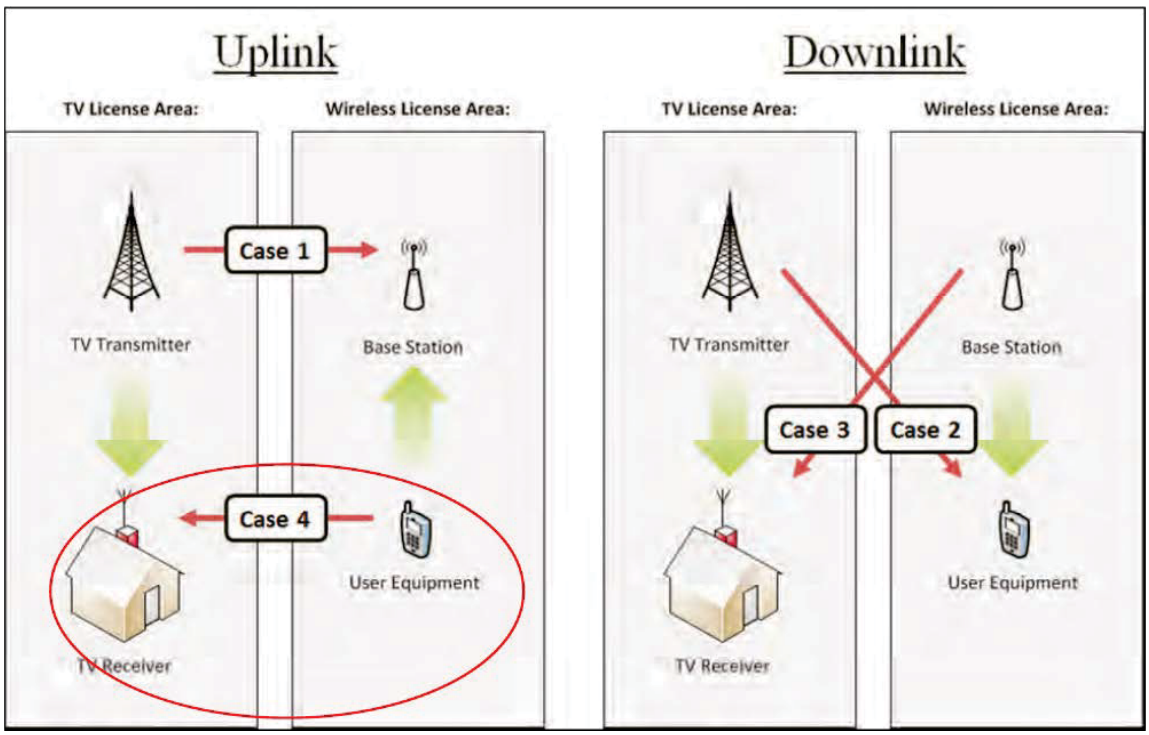

Figure 1 - Four cases addressed in DA 14-98[15]

[14] 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 & GN Docket No. 12-268, DA 14-98 (released January 29, 2014).

[15] DA 14-98, Figure 1.

FCC OET Bulletin 69

The FCC understands that it must deal with dynamic environments with constant changes, due to technology development and market factors. As a result, FCC staff conducts ongoing studies and publishes their findings in a variety of documents.

FCC OET Bulletin 69, cited prominently by Fox and MSW, was first published in 1997 but updated in 2004. A footnote to the table presenting D/U ratios, Table 5A, states:

> The adjacent-channel D/U ratios given in this table for interference from DTV transmissions are corrections of those published with the July 1997 version of this bulletin. The values given here agree with those used in the *Sixth Report and Order* and with the computer program now used by the Media Bureau to evaluate applications for new and modified stations as well as predecessors of that program.[16]

The D/U ratio is not fixed but varies by the services involved. Notably the D/U ratios for LTE signals are not provided. This is for the simple reason that LTE did not exist at the time FCC OET Bulletin 69 was initially prepared and further, cellular-to-broadcast interference was not a topic under consideration. FCC OET Bulletin 69 was prepared to evaluate interference between stationary television stations, not between TV and commercial mobile radio service (CMRS) operations.

Table 5A from OET-69 - Interference Criteria for Co- and Adjacent Channels[17]

Channel Offset	D/U Ratio, dB			
	Analog into Analog	DTV into Analog	Analog into DTV	DTV into DTV
-1 (lower adjacent)	-3	-14	-48	-28
0 (co-channel)	+28	+34	+2	+15
+1 (upper adjacent)	-13	-17	-49	-26

In its analysis, MSW applied FCC OET Bulletin 69 to analyze a situation that the bulletin never addressed—cellular service to broadcast service interference with a 1 MHz guard band between them—without examining what changes are required to make the application appropriate. In contrast, the testing Cricket presented specifically looked at the D/U ratios at which an LTE UE employing a frequency offset caused interference to the current generation of DTV broadcast receivers. What was found is that DTV broadcast receivers have improved significantly over the years and are more tolerant of adjacent channel transmissions than older models. While we do not know with certainty what the sensitivity of previous receiver generations might have been to

[16] OET BULLETIN No. 69, Longley-Rice Methodology for Evaluating TV Coverage and Interference, footnote 1, pg. 8 (February 06, 2004).

[17] ibid, table 5A, pg. 8.

LTE transmissions, because LTE did not exist and has not been tested against older technology receivers, we do know that DTV broadcast receivers currently on the market are quite tolerant of LTE transmissions in an adjacent band when a frequency offset is used: That is, when the LTE signal is placed to the top of its channel, giving it a 1 MHz guard band with respect to the DTV channel.

MSW Modification of Longley-Rice

In Section 8.2 of its report MSW explained the procedure it used to modify Longley-Rice and apply it to the present situation**.** A number of modifications and overly simplistic assumptions were made by MSW. Among them are the following:

- While a 0.5 km cell size may be the smallest allowed by the FCC in evaluating broadcast station to broadcast station interference, it is too large when dealing with a mobile and largely indoor environment. However, it is correct that 0.5 km is the smallest cell size allowed by the FCC for simulations using Longley-Rice. This was established on December 31, 2007, in MB Docket 07-91, the Third Periodic DTV Review R&O, at paragraph 155.[18] This is a further indication that the FCC intended for Longley-Rice to be used in large-area assessments and not for the short interference distances between a low-power UE and an indoor DTV receiving antenna. Figure 2 illustrates how unrealistic it is to use a 0.5 km cell size for a mobile transmitting at 19 dBm ERP or lower. The LTE UE transmission is not strong enough to cause interference at distances of more than a few meters in the worst possible case.[19] Based on Intertek's testing, in the majority of the cases the interference distance was less than 2 meters.

[18] Third Periodic Review of the Commission's Rules and Policies Affecting the Conversion To Digital Television, MB Docket No. 07-91, FCC 07-228, para. 155 (released Dec. 31, 2007).

[19] The original Intertek report page 14 Figure 6.

Figure 2 - The use of a 0.5 km cell size covers 4 blocks and treats a wide variety of different houses and locations as all having the same probability of interference

- When determining the field strength from the LTE UE, MSW abandoned Longley-Rice and used a free space formula. However, an urban environment, and indoor environments in particular, are almost never free space.
- MSW based its decision about what locations would use indoor versus outdoor antennas on its own studies but offered no evidence that its assumptions represent what viewers actually do.
- MSW applied an arbitrary signal loss for indoor locations but made no allowance for losses of the LTE UE signal due to walls and other interior obstructions that absorb RF energy.
- MSW made the generalizing assumption that the LTE UE will be at 3 m separation distance indoors and 10 m separation outdoors, and then calculated the field strength using a free space formula. In reality, there often could be one or more intervening walls between an LTE UE and a DTV indoor antenna at 3 m indoors. Outdoors, there will almost always be a ceiling and roof between the LTE UE and an outdoor DTV antenna. Also, outdoor antennas would receive a stronger DTV signal, reducing the potential interference impact from the LTE signal.
- MSW then assumed that the maximum possible LTE power of 23 dBm, a conducted power specification in the 3GPP standard, is radiated without loss, and that there is no variation in the LTE UE antenna pattern. In fact, the realities of designing antennas in small phones, which must support multiple frequency bands and pass the strict FCC rules for specific absorption rate (SAR), almost always results in significant inefficiencies between the conducted power inside the LTE UE and the power radiated by the handset. Given these factors, the output power will be less than 23 dBm. Further, there is significant variation in the pattern, with the user blocking the signal from approximately half the area, resulting in a body loss. Additionally, to preserve battery life and network capacity, LTE networks keep the LTE UE power at

the lowest possible level to establish a particular path: That is, they operate at maximum power only when absolutely necessary. Manufacturers are required to submit device test reports to the FCC as part of the equipment approval process, and these are placed in a public database and are available for anyone review.[20] Intertek's test results show that Total Radiated Power (TRP) never reaches the permissible max power for any 700 MHz A-block LTE device. The devices Intertek used for testing are all available in the FCC database with their test reports based on their FCC IDs.

- MSW simplified its testing to include 54 different computer simulation studies (3 DTV reception scenario types x 6 LTE transmit powers x 3 interference D/U ratios). Presumably, MSW believed that this presented a wide variety of scenarios. In reality, it is an insignificant sampling of the variation in use scenarios. MSW's method was not designed to deal with probabilistic, multi-variable distributions. Hence, MSW was trapped by the limitations of its method, which resulted in inaccurate conclusions. Instead, MSW should have selected methods that were designed to address multi-variable, probability distributions.
- The MSW analysis can be summarized as having three key levels, determined by the threshold at which MSW assumes users will change from an indoor to an outdoor antenna and the limit of the equivalent grade B contour, Table 1. **The fact that the entire MSW analysis can be summarized in this way is a demonstration of how it over-simplified the situation rather than dealing with the complexity created by real-world environments.**

[20] https://apps.fcc.gov/oetcf/eas/reports/GenericSearch.cfm.

Table 1 - Key MSW Analysis Levels

Key MSW Analysis Levels			
	DTV Signal (dBu)	**LTE UE (dBu)**	**D/U (dB)**
High Signal, > 75.5 dBu • assume indoor antenna with 21 dB of signal loss, field strength is 54.5 dBu at the perimeter • Assume indoor LTE UE at 3 m with free space, line of sight to DTV antenna.	**54.5**	**120.4**	**-65.9**
Low Signal, < 75.5 dBu • Assume outdoor antenna • Assume outdoor LTE UE at 10 m with free space, line of sight to the DTV antenna.	**75.5**	**109.9**	**-34.4**
Equivalent Grade B contour, > 41.0 dBu • Assume outdoor antenna • Assume outdoor LTE UE at 10 m with free space, line of sight to the DTV antenna.	**41.0**	**109.9**	**-68.9**

Coupling Efficiency

According to the MSW analysis, at the outer edge of the strong signal viewing area, the DTV signal strength will be 75.5 dBu, but the viewer is assumed to use an indoor antenna and have 21 dB of loss within his/her building, resulting in a 54.5 dBu DTV signal at that indoor antenna. An LTE UE is modeled as being at 3 m from the antenna and delivering to it 120.4 dBu of LTE signal. The D/U ratio would be 54.5 dBu - 120.4 dBu = -65.9 dB.

MSW then assumed that at any D/U ratio of -23 dB or worse, there will be interference. So, to avoid interference, MSW assumed that the LTE signal would have to be reduced by (-23) – (-65.9) = 42.9 dB. Based on free space path loss, this would require that the LTE UE be more than 418.9 m away to avoid causing interference.

It is helpful to recall that dBu can be converted to dBm by subtracting 107 dB. So a 54.5 dBu DTV signal would convert to 54.5 - 107 = -52.5 dBm, which is close to the -53 dBm that Intertek used as one of its test levels. Therefore, the Intertek testing and MSW simulations at this level can be compared.

In contrast to MSW's assumption that interference will occur out to a distance of 418.9 m, Intertek found at DTV signal strengths in this range that the UE had to be closer than 1.2 m for some DTV receivers and closer than 0.5 m for other DTV receivers to cause interference, as shown in Table 2. **This difference is a factor of 350! With differences of this magnitude, it is not hard to determine which results are more accurate. Either an LTE UE operating within hundreds of meters will cause interference to any channel 51 viewer in the area or it will not.**

Table 2 – Difference in Assumptions and Testing

	MSW	Intertek	Comments
DTV Signal	**54.5 dBu** (-52.5 dBm)	**54 dBu** (-53 dBm)	Comparable Assumptions
Interference Range	**418.9 m**	**1.2 m to 0.5 m**	Distance
Difference Between Assumptions and Actual testing	**Factor of 350**		Comparing Interference distance

The question must be asked, what could account for a difference in LTE UE coupling efficiency by a factor of 350? For guidance, we turn to the previously discussed IEEE 1900.2:2008 standard, which states:

> The free-space region is where the propagation does not have significant interaction with the ground or surrounding objects. Consider the line connecting a transmitter and receiver of length d. The first Fresnel zone is the ellipse with foci at the transmitter and receivers such that the distance from the transmitter to any point on the ellipse and on to the receiver is d + λ/2. As long as objects do not intersect this ellipse, the attenuation can be considered as line of sight and attenuating as in free space. For example, assuming two antennas over a flat surface, the ellipse will touch the ground when:
>
> $$d > d_f = \frac{4h_{tx}h_{rx}}{\lambda} \quad (1)$$
>
> where h_{tx} and h_{rx} are the height of the transmitter and receiver above the ground. If the ground is not flat then a careful analysis would need to show if any portion of the ground intersects the first Fresnel ellipse. **Beyond d_f, the path-loss is typically much worse than free space. If the line-of-site path from transmitter antenna to receiver is obstructed then other variables come into play, depending on the obstructions.**[21] *(emphasis added)*

For a frequency of 700 MHz and heights of between 0.25 and 0.5 m d_f will be between 0.6 and 2.3 m. Further, with indoor environments it is common to have obstructions and other variables impacting the path loss. As IEEE 1900.2 advises under these circumstances: "**Beyond d_f, the path-loss is typically much worse than free space.**"

It is important to remember that the 23 dBm specification in the 3GPP standards is measured on a test connector inside the LTE UE. There are losses and inefficiencies coupling into and then radiating out of the LTE UE, and there are similar losses and inefficiencies in the DTV receiving

[21] 1900.2:2008, IEEE Recommended Practice for the Analysis of In-Band and Adjacent Band Interference and Coexistence Between Radio Systems, sub-clause A.2, pgs. 55-56.

antenna, particularly with common consumer-grade indoor models. These losses are not insignificant and must be appropriately included to arrive at an accurate assessment of the impact of LTE UE on DTV broadcast receivers.

The amount of energy from an LTE UE that will arrive at the antenna input terminal of a DTV broadcast receiver is easily measured. LTE UE handsets or dongles operating in these frequency bands are being sold on the market today. It is reasonable to acquire samples and measure the amount of RF energy actually arriving at the F-fitting antenna input port of a DTV broadcast receiver under a variety of circumstances. Intertek did this and demonstrated that those measurements are representative of what will be experienced. If MSW followed a similar approach and used input values for its simulations that are in the range of what can actually be measured, the D/U ratios estimated in MSW's simulations would have improved by 20-30 dB.

Applicability of the -23 dB D/U ratio

A central issue to the differing results of the Fox and Cricket analyses is the appropriateness of the -23 dB D/U ratio found in Section 27.60 of the FCC rules. All would agree that at or below that ratio there will not be any significant level of interference. Cricket's testing, however, demonstrated that the -23 dB D/U ratio is too conservative and is unnecessarily wasteful of spectrum given the capabilities of modern LTE UE and DTV broadcast receivers and for the specific deployment Cricket proposed, which creates a 1 MHz guard band to keep the LTE UE signal removed in frequency from the DTV signal.

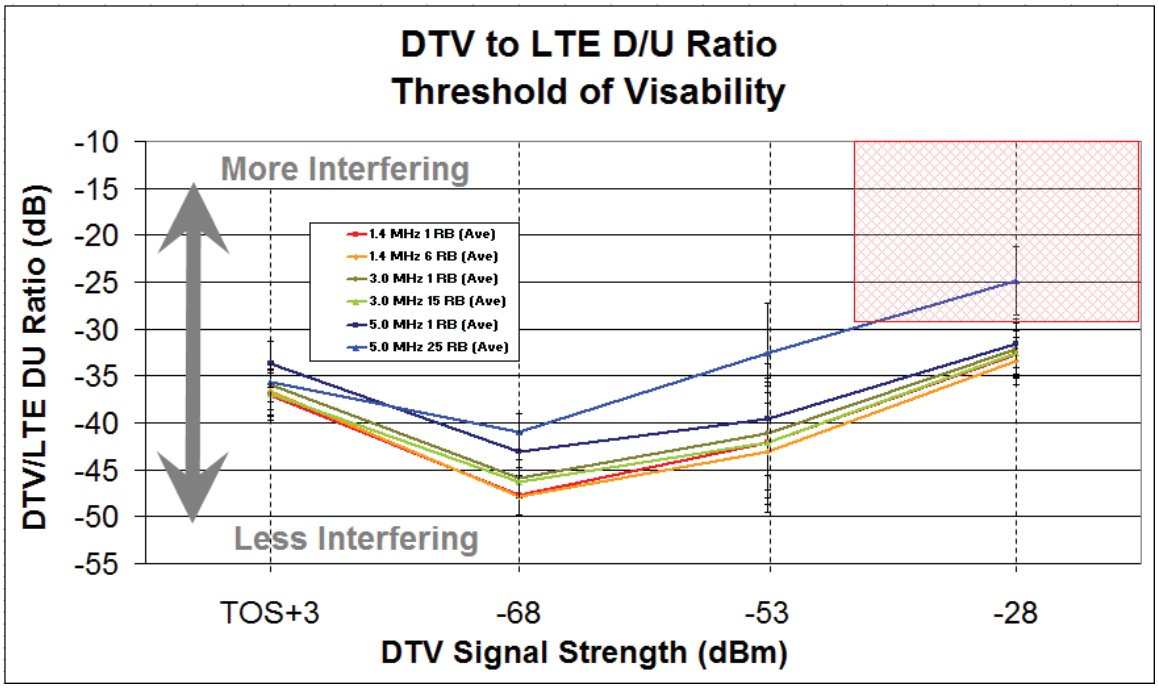

Figure 3 – Desired-to-Undesired (D/U) Ratio as a function of DTV Signal Level

The -23 dB D/U ratio necessitates unnecessarily large geographic separation distances between services. Cricket instead proposed a 1 MHz guard band. With this separation distance, modern DTV broadcast receivers are able to operate with a D/U ratio of the order of -35 to -40 dB, as shown in Figure 3. In Figure 3 the higher DTV receive signal level values mean that the DTV receivers are more sensitive to LTE. As can be seen, DTV receivers are more sensitive to

interference under weak signal conditions and strong signal conditions, but are tolerant in the middle of the DTV signal range, which would be the case for most of the Chicago viewing area. The increase in interference sensitivity with strong signals may at first be surprising but it should be remembered that since D/U is a ratio, this means that if the DTV broadcast receiver is being subject to a strong DTV signal and a strong LTE signal, it starts to experience overload. The LTE signal must be much stronger to have the same D/U ratio for a stronger, -28 dBm, DTV signal than for a weaker, -68 dBm, signal. For a LTE signal to be stronger, the UE must be right next to the DTV's receiving antenna and also transmitting at or near its maximum power, which is an unlikely scenario. During the Intertek testing, interference could not be caused with a strong DTV signal even with the phone at its maximum power and placed very close, at times even touching, the DTV antenna. As reported, at lower DTV signal levels, interference could be created at closer distances, and for very weak signals at distances up to, but no more than, 10 meters.

To be clear, this report is making no statement about the appropriateness of the -23 dB D/U ratio for other implementations or with other RF protocols. But with skilled network design, it is possible to operate with minimal interference in the same geographic area as a TV Channel 51 station, even with a zero separation distance, thereby making A-block spectrum available in a BEA with a TV Channel 51 station.

The issue can be viewed as presenting two choices. The first choice utilizes the -23 dB D/U ratio as a fixed requirement that requires geographic separation to achieve compliance; this is the Fox/MSW position. Under this approach the entire DTV threshold contour plus 8 km, as required by FCC Part 27.60(b)(2)(ii)(C), would be excluded from use.

The second choice, presented by the Cricket position, is to use a 5 MHz LTE signal in the 6 MHz channel placed at the high end of the channel (thereby leaving a 1 MHz guard band), and then to derive the appropriate D/U ratio to provide interference protection. This configuration presents the most logical placement of the 1 MHz guard band based on 3GPP standards.

At page 21, footnote 21, of the Appendix to DA 14-98 regarding potential interference between DTV and future 600 MHz band wireless services, the Commission recognized the 3GPP standard and assumed a -33 dB D/U ratio for defining adjacent-channel interference.[22] This ratio is consistent with the D/U ratio found by the Intertek study for a 5-MHz wide 3GPP signal.

[22] DA 14-98, Appendix footnote 21 pg. 21.

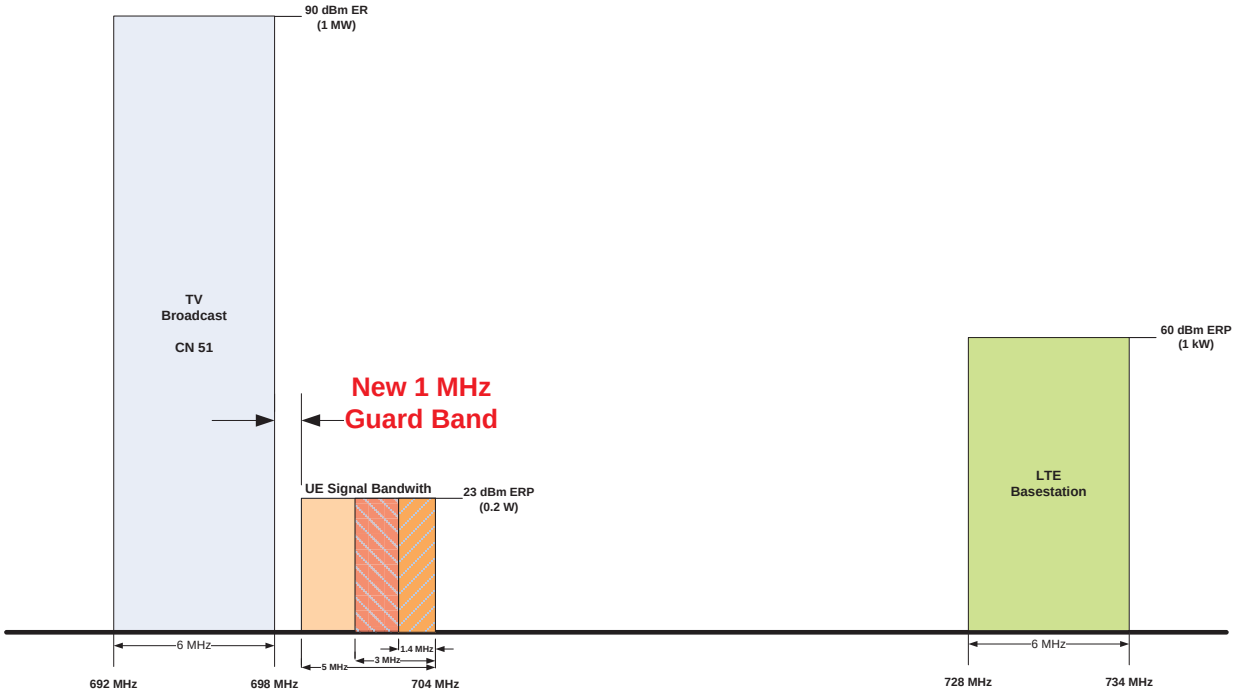

Figure 4 - Proposed LTE Deployment Plan

The LTE signal occupies a 5 MHz bandwidth, which if placed as far from the DTV channel as possible, leaves a 1 MHz guard band in the 6 MHz channel. Cricket's testing and analysis demonstrated that a 1 MHz guard band provides sufficient protection for the 5 MHz LTE deployment proposed, as illustrated in Figure 4. This proposal was not available for consideration at the time OET Bulletin 69 was written or when the current requirements in Section 27.60 of the FCC rules were established.

Justification for Cricket Analysis

10 m Protection Distance

MSW criticized Intertek's citation to the FCC's 10 m protection distance:

> *Also, Intertek relies on a 1979 FCC rule protecting analog televisions (which have graceful interference degradation) from computer interference for justification of using a 10-meter "interference distance" value for indicating that LTE devices within this distance would likely be within the same household.*

The 10 m distance provides the basis for Part 15 emission limits for consumer electronics devices and has been in place for decades.[23] Cricket's analysis used the 10 m separation distance as the benchmark for a reasonable distance within which consumers can resolve and mitigate interference on their own. To change the 10 meter distance now would have far reaching implications for all consumer electronics.

Moreover, NAB is aggressively arguing in the 600 MHz incentive auction proceeding that no changes to the OET-69 methodology should be allowed, so as to maintain a valid coverage comparison. Shortening the established 10-meter distance benchmark would create a changed comparison baseline, and thus would be inconsistent with broadcasters' overall position in the 600 MHz incentive auction proceeding.

Flexibility of the LTE System

The LTE system is extremely flexible. It is designed to be adaptable to a number of spectrum scenarios. This flexibility allows the system to be modified as required by local conditions and different spectrum environments.

The LTE structure is based on Orthogonal Frequency-Division Multiplexing (OFDM) modulation with QPSK, 16 Quadrature Amplitude Modulation (QAM) and 64 QAM subcarrier modulation. The OFDM technology allows individual carriers to be used or left unused.[24] Hence, the system is adaptable. In the LTE signal, each resource block is made up of 12 subcarriers and each subcarrier is 15 kHz wide. A resource block (RB) is therefore 12x15 kHz or 180 kHz wide. RBs can be dynamically allocated for upstream data transfers. A maximum of 6 RBs is available for a 1.4 MHz bandwidth, 15 for a 3 MHz bandwidth, and 25 for a 5 MHz

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[23] First Report and Order in Gen Docket 20780, FCC 79-555, released October 11, 1979, 44 Fed. Reg. 59530 (October 16, 1979), Appendix C.

[24] OFDM is a digital multi-carrier modulation scheme, which uses a large number of closely-spaced orthogonal sub-carriers. Each subcarrier is modulated with a conventional modulation scheme (such as QAM) at a low symbol rate, maintaining data rates similar to conventional single-carrier modulation schemes in the same bandwidth. In practice, OFDM signals are generated and detected using the Fast Fourier transform algorithm.

(continued)

OFDM has developed into a popular scheme for wideband digital communication, for wireless as well as over copper wires.

The primary advantage of OFDM over single-carrier schemes is its ability to cope with severe channel conditions—for example, attenuation of high frequencies in a long copper wire, narrowband interference and frequency-selective fading due to multipath—without complex equalization filters. Channel equalization is simplified because OFDM may be viewed as using many slowly-modulated narrowband signals rather than one rapidly-modulated wideband signal.

bandwidth. Hence, the signal can be crafted in response to local RF requirements and operating conditions. The LTE RBs are small 180 kHz subcarriers, which when measured for full RB allocation will not take the whole bandwidth. For example, a 5 MHz LTE with 25 RBs will occupy only 4.5 MHz of spectrum (180 kHz * 25 = 4.5 MHz), providing an extra 250 kHz of guard band for a total of 1.25 MHz guard band towards DTV channel 51 for the proposed 5 MHz LTE deployment.

Automatic Power Control

LTE systems use aggressive automatic power control processes. A number of benefits come from this, including the fact that using the lowest possible power for communication saves LTE UE battery power and maximizes the network capacity to support multiple users. This is a very strong incentive to keep the LTE UE power as low as possible.

The automatic power control used in the LTE system means that while it is possible that an LTE UE handset will operate at its maximum power, it will do so as seldom as possible. The required handset power will be constantly monitored by the network and reduced to the lowest possible level. When a handset is close to a cell site or has good channel condition, the handset will be directed to transmit at a reduced power level. This means that if Cricket were to transfer its 700MHz A-block spectrum license to a larger network operator, which is likely to have a network with greater cell site density, the handsets would typically transmit at a significantly reduced power level.

All testing performed by Intertek was done with the LTE UE forced to operate at maximum power. As subsequently discussed in the *LTE Device Operating Power* section of this response, the suggestions in the MSW report that UEs were not tested at their maximum power are incorrect. In fact, full handset power will only occur a small fraction of the time (*i.e.*, only when the link budget requires full-power handset operation. For the majority of the time, a LTE UE will operate below, often far below, its maximum power level.

Testing of Mobile DTV Receivers

MSW claimed that not addressing mobile DTV was a "serious omission." In fact, the Jensen JDTV-1020 and Vizio VMB070 are mobile DTV devices, and were included in the units tested.

The Intertek testing was designed to determine the worst-case interference. This can be seen in the discussion of how Intertek treated mobile DTV devices. Where choices presented themselves for use of test time, the focus was to identify the worst-case conditions. Intertek did test a selection of mobile DTV receivers. It was quickly apparent that mobile DTV devices were less susceptible to interference. Further, channel 51 is not currently authorized to provide mobile DTV service in the Chicago area, and under current FCC rules, cannot be, given the freeze on Channel 51 modification. Due to these factors, mobile DTV was deemphasized in test priorities. The priority for time and focus of the testing was placed on evaluating indoor antenna DTV

receivers, which were judged to have the greatest risk for interference.[25] However, Cricket notes that if more mobile DTV receivers had been included in the testing, the results would have looked even more favorable to Cricket. Testing all 25 of the currently available mobile DTV receivers would have skewed the data more in Cricket's favor and potentially could have become a source of criticism of the testing. Thus, testing of mobile DTV receivers was de-emphasized, and instead, testing focused on the more sensitive population of fixed DTV units.

The Mobile DTV Signal Is More Robust

The mobile DTV signal is more robust than the legacy ATSC signal that was tested, since mobile DTV trades spectral efficiency for robustness: At 1/4 rate coding there are four error correction bits for every content bit. At 1/2 rate coding there are two error correction bits for every content bit. While the legacy 8-VSB A/53 signal needs a signal-to-noise ratio (SNR) of at least 15 dB, M/H A153 needs only a 7.4 dB SNR for 1/2 rates coding, and only a 3.4 dB SNR for 1/4 rate coding. Whereas legacy A/53 signals can tolerate a Doppler shift of no greater than approximately 10 Hz (depends on the receiver), A/153 M/H at 1/2 rate coding can tolerate a Doppler shift of 150 Hz; for 1/4 rate coding, it can tolerate a shift of 180 Hz. Thus, the tested legacy A/53 DTV signal, at full 1080i HD with motion, was a far more fragile signal than even A/153 mobile DTV with just 1/2 rate coding.

This conclusion was stated at page 21, in the third paragraph of Section 3, of the Intertek report:

> Testing was conducted using the most complex 1080 60i DTV signal. This was done for two reasons. First, the analysis of the signal types concluded that this is the most fragile DTV signal type. Second, the FCC's studies of DTV interference found it to be the most sensitive signal type.

By including not only the ATSC A/74 "strong" (-28 dBm), "moderate" (-53 dBm) and "weak" (-68 dBm) receive signal levels (RSL), but also a Threshold of Sensitivity (TOS) + 3 dB RSL, the true worst-case performance for each tested legacy ATSC A/53 receiver was investigated.

WPWR-TV is NOT Currently Transmitting Mobile DTV

The NAB Mobile DTV Station Guide web page shows that WPWR-TV, D51 (V50), Gary, Indiana, is NOT currently transmitting mobile DTV,[26] whereas Fox's also-owned Chicago flagship station, WFLD(TV), D31 (V32), is shown as transmitting mobile DTV.

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[25] In the Intertek report, Table 6 is captioned "Table 6 - Tested Mobile DTV receivers", but should have been captioned "Table 6 - Candidate Mobile DTV receivers." As stated previously, it was quickly observed that mobile DTV devices were less susceptible to interference (because of the greater amounts of signal reserved for error correction) and so these were deemphasized in order to gather more data on fixed DTV receivers.

[26] See http://www.mdtvsignalmap.com/.

WPWR-TV is Not a Likely Candidate for Mobile DTV

WPWR-TV transmits only with horizontal polarization, using a directional antenna. To change to elliptical or circular polarization, that is, to add the vertically-polarized signal necessary for viable mobile DTV, would require a minor-change modification. But minor-change modifications of TV Channel 51 stations are prohibited by the August 21, 2011, Channel 51 Freeze Order. Therefore WPWR-TV would not be a good candidate to add a mobile DTV signal. (Whereas WFLD has elliptical polarization, at 25% VPOL.)

The limitation of mobile DTV testing was therefore not a "serious omission."

Testing Only Indoor Antennas

The MSW report stated:

> *No outdoor or attic antenna nor any amplified antenna interference was evaluated, which is believed to be one limitation of the Intertek report since LTE devices are expected to be used on upper floors of buildings (i.e., close to outdoor or attic antennas) as well as lower floors.*

The indoor antenna was judged to be the worst-case and most likely scenario for an LTE device to come into close proximity to a DTV receiving antenna. Therefore, this was the focus of the testing. It is possible that, at times, LTE devices may come relatively close to outdoor antennas; however, it is more likely that LTE devices and such DTV antennas will be separated by greater distances. In addition, normally the outdoor antennas will be receiving a stronger DTV signal, reducing the potential impact of the LTE signal. Hence the testing focused on the scenario judged most likely to experience interference.

The probability of an LTE handset being used near an outdoor antenna was judged to be significantly less than such use near an indoor antenna. The results obtained by studying indoor antennas completely inform the outdoor antenna situation, in that once the interference threshold at the DTV antenna terminals is known, the same threshold will be independent of the location of the antenna.

To summarize, the objective of the Intertek testing was to determine the true D/U ratio defining interference between DTV and LTE devices. The next objective was to determine the interference distance between LTE UE and DTV receivers under different DTV receive signal conditions. The DTV antennas were chosen because they were the most common brand and model in the commercial market and so the most likely to be used by consumers.

It should also be noted that no new factors are introduced by outdoor antennas. Interference will be determined by both the ratio of desired-to-undesired signal being delivered to the receiving antenna terminals of the DTV and any multipath distortions in that signal. The DTV receiver will respond the same regardless of the source of the signal it is receiving. Knowing the response of indoor antennas also gives insight to the response of outdoor antennas. The only difference is that, for outdoor antennas, the analysis should include estimates of the probability distribution of LTE UE distances and intervening objects to outdoor antennas. MSW recognized that the distances will almost certainly be greater than 3 m for an outdoor antenna and so increased the distance it assumed from 3 m to 10 m. What MSW did not do was then estimate the probability and impact of other objects in the environment, such as ceilings and roofs, which most of the time would be between the antenna and the LTE UE.

Amplified Antennas Not Tested

MSW criticized the Intertek report because antenna amplifiers were not tested:

> *Likewise, consumer amplified antennas are on the market for viewers to purchase, which they often do.*

The decision not to test TV amplifiers was based on fact that the amplified antenna will amplify both the desired and undesired signal equally, leaving the D/U ratio unchanged. Unlike a base station, a low-power handset is unlikely to be capable of generating sufficient power to cause brute force overload (BFO) to an amplified antenna.

LTE Device Operating Power

The MSW report incorrectly concluded that the tested Lower 700 MHz A-block devices were not operating at full power, and therefore that the measured OOBE were not worst-case. This is incorrect. Care was taken to test each A-block device at its maximum power, to ensure that worst-case OOBE was captured. This was explained at page 31, Section 4.4.1; at page 52, Section 6.4; and again at page 77, Section 8.3 of the Intertek report. The MSW report appears not to recognize that the reason the TRP reported for the tested A-block devices was not the +23 dBm allowed by the 3GPP standard was because devices operating at the edge of the 700 MHz band are incapable of generating the full allowable power, still operating in the other frequency bands, and meeting other technical specifications. That is, contrary to MSW's suggestion, the tested A-block handsets were NOT being operated at reduced power in order to improve their OOBE. This, in turn, means that the conclusion in the MSW report, at page 5, that the measured threat distances were not worst-case, is incorrect.

Antenna Orientation

The conclusion in Item 7, on page 6 of the MSW report that the orientations between the A-block handheld device's transmitting antenna and the indoor Channel 51 receiving antenna were not worst-case, is incorrect. Care was taken to find the worst-case orientations between the handset device and the indoor Channel 51 receiving antenna that maximized the magnitude of the undesired A-block signal coupled into the DTV receiving antenna. This was documented at page 52, Section 6.3 of the Intertek report.

Impact of Multipath & Error Vector Magnitude

In Item 10, on page 6, MSW criticized the Intertek report for not taking into consideration that reception of the DTV signal is not only a function of signal strength, but also of multipath impairments. This very point was addressed at page 77, Section 8.3, of the Intertek report, and again at pages 81 and 82, Section 9.

Not just multipath but other variables that influence the fidelity of the DTV signal were included in the signal Error Vector Magnitude (EVM). This was specifically addressed in the report, at pages 43 and 44, Section 5.7, and at page 46, Figure 22. It was a consideration in the testing.

Fast Motion Video

In item 11, on page 6, MSW criticized the Intertek report because it did not consider broadcasts that include "fast-motion sports." The intentional use of the high-motion "fireworks" video for the full-HD threshold-of-visibility (TOV) tests, as documented at page 21, footnote 8 of the

Intertek report, shows that this allegation is incorrect. (The need to test using a high-motion digital signal was one the FCC “lessons learned” issues.)

Field Strength Values

At page 7 of the MSW report, fifth paragraph, the field strengths of 53.3, 75.5 and 98.8 dBu, corresponding to "best case, typical case, and worst-case" reception of the DTV signal using an outdoor, rooftop antenna, were reversed. The order of the dBu values should be 98.8, 75.5 and 53.3. The MSW report did not explain where these field values came from, although we agree that a field strength of about 100 dBu should be available in order to ensure adequate reception indoors, using a physically small receiving antenna.

Variation of OOBE

MSW stated:

> *From this data, it appears that these interference tests were performed with the LTE source not operating at maximum power which is when the greatest amount of OOBE occurs in the RF output amplifier, and would require further investigation to determine if this was in fact the case.*

Intertek recognized that OOBE might change as a function of transmit power. This was specifically studied and commented on in the report. Pages 12 and 13, Section 1.2, of the Intertek report stated:

> The interference level can also be analyzed in terms of D/U ratios, Figure 5. As LTE signal strength increased some degradation can be seen in the D/U ratios shown in Figure 5. This may be due to non-linearities in the OOBE (Out-of-Band Emissions) from the LTE UE or adjacent channel selective of the DTV receiver, producing in-band mixing products. However the degradation appears to be reasonably mild in the mid-signal range, becoming more pronounced with very weak and very strong DTV signals, and correspondingly very weak and very strong LTE signals.

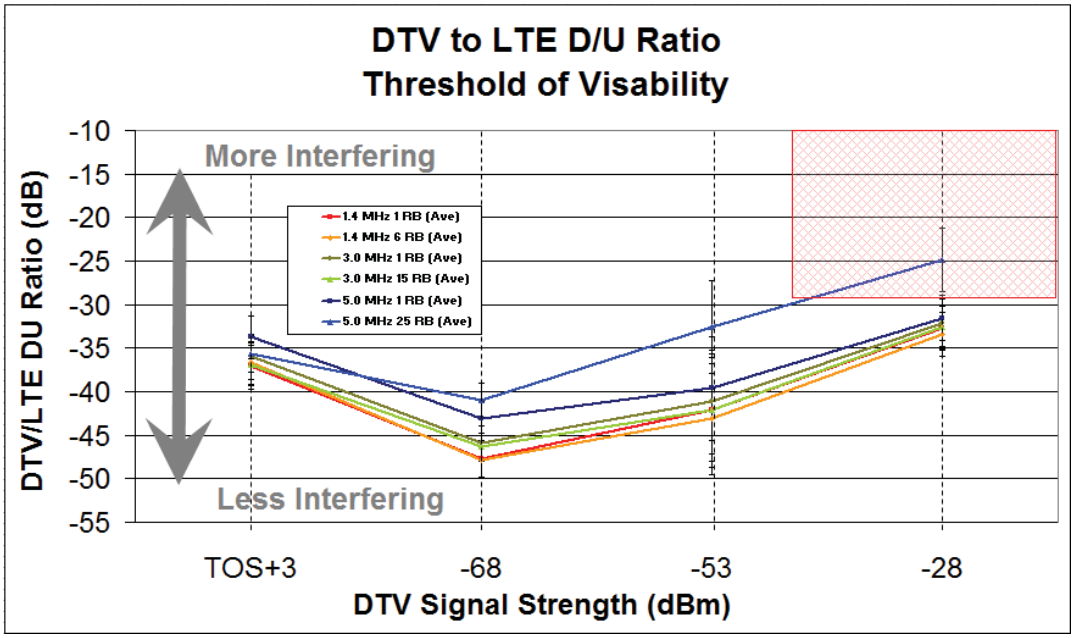

Figure 5 – Desired-to-Undesired (D/U) Ratio as a function of DTV Signal Level

In Section 3.1.2, Out-of-Band Emissions data was presented on the OOBE of the devices used. It was found that the OOBE varied only mildly as a function of signal power. Further testing was performed with the devices at full power and, as a result the DTV's were exposed to the worst-case OOBE.

It is important to consider that OOBE is more of a concern for the LTE network operator than for the adjacent channel DTV broadcasters. The LTE network operator dynamically allocates resource blocks among its users to maintain service to all of them. Since these resource blocks are immediately adjacent to each other their OOBE will be a significant and potentially limit factor on how well the LTE network can serve its users. For this reason, both the FCC and the 3GPP set OOBE limits. Future LTE devices cannot and will not have more splatter than e 43+10logP since the out of band emission limit is regulated by the 3GPP standard. Operators will not accept devices into their networks which disrupt LTE operation with their OOBE. These concerns put the LTE operator and the DTV broadcaster on the same side when it comes to OOBE.

Impact of a Successor Carrier

The analysis in the Chicago Channel 51 Interference Probability Study prepared by Newfield Wireless estimated that there would be approximately 20 potentially affected viewers using an LTE handset at a distance of 1.5 meters or greater from the DTV receiver and assumed that each Cricket subscriber had an LTE handset operating on the 700 MHz A-block spectrum. Although the number of potentially affected viewers could be greater if a larger carrier deployed LTE on the A-block spectrum, the number of potentially affected viewers likely would still be *de minimis*.

A conservative analysis of the potentially affected viewers, assuming the subscriber base of the four largest carriers in the WPWR-TV grade B contour with a population of approximately 9.8 million yielded the following estimates:

Table 3 – Larger Carrier Extrapolation

		Channel 51 Viewers Affected			
Carrier	**% Increase**	**R > 0 m**	**R ≥ 0.5 m**	**R ≥ 1 m**	**R ≥ 1.5 m**
Cricket	0%	1,207	268	182	19
T-Mobile	445%	6,583	1,462	993	104
Sprint	503%	7,276	1,616	1,098	115
Verizon	531%	7,622	1,693	1,150	120
AT&T	646%	9,008	2,001	1,359	142

R = Separation distance of LTE device from DTV receiver

These estimates were calculated by extrapolating the number of potentially affected viewers determined for Cricket's proposed LTE deployment by the percentage increase in subscribers for each of the largest carriers. The subscribers of AT&T, Sprint, T-Mobile and Verizon were estimated based on the market share estimates from Nielsen Data for Q3 2013, and applied to the same estimated population living inside the exclusion zone used in the original Cricket analysis.

Because this calculation is based on the analysis of Cricket's proposed deployment, the calculations for each of the larger carriers conservatively assume that it (1) has the same network design and cell density as Cricket, (2) has the same geographical pattern of subscribers as Cricket, and (3) is transmitting at the same power as Cricket.

However, the potential for interference actually would be reduced for larger carrier network configurations because larger carriers' networks have greater cell density, and thus, the LTE handsets in such a network would generally operate at a lower power. While the geographical pattern of the subscribers of the larger carriers may be different, the distribution of subscribers would not necessarily increase the potential for interference by individual LTE handsets into a DTV receiver.

Errata

In its Appendix C Intertek Report Errata, MSW identifies that, of the 624 values reported in Tables 32 to 55 of the Intertek report, 30 entries had errors in the calculated D/U ratios. Of these errors, 14 made the value higher while 16 made it smaller. Together they average -0.87 dB.

In the tables 51 to54, which report the most critical 5 MHz data, the basis for the waiver request, no errors were identified. Therefore, while any error is regrettable, we believe these have no substantive impact on the overall report and testing.

Conclusion

The primary issues raised in the MSW report have each been addressed in this response. As discussed above, the Intertek report submitted by Cricket sought to develop an accurate estimation of the potential for interference from LTE devices to DTV receivers when considered in conjunction with the use of a 1 MHz guard band. MSW, however, failed to identify or analyze the Intertek report in proper context. While MSW's report relied on outdated methodology and unrealistic assumptions, Cricket provided analyses based on conservative assumptions and real-world interference potential of LTE operations using the 700MHz A block license. Developing an accurate interference estimate required looking at how technology and devices have changed over time. It also required actual measurements to determine the worst-case conditions for interference. It then required an understanding of the probability distributions that exist in actual use and the variables that influence the potential for interference. Thus, our review and comparison of MSW's report and the Intertek study lead us to conclude that Fox advanced speculative and highly inaccurate conclusions regarding interference that are not supported by reliable and robust analysis.

Exhibit B
Declaration of Timothy Ostrowski

DECLARATION OF TIMOTHY OSTROWSKI

I, Timothy Ostrowski, hereby declare as follows:

1. I am currently Secretary and Treasurer of Laser, Inc. As Vice President of Business Development at Cricket Communications, Inc. ("Cricket") for many years, I led the company's efforts to secure spectrum in markets around the country, both by purchasing it at FCC auction and through after-market acquisitions. I am very familiar with the valuation metrics for spectrum, including the factors and considerations that impact consumer and carrier demand for spectrum. I am authorized to make this declaration on behalf of Laser, Inc.

2. Spectrum is a scarce commodity in Chicago. One distinct way this fact is evident is by observing the prices that have been paid for spectrum at auction in this market over time. Spectrum scarcity in Chicago has manifested historically in the very high prices paid at auction for spectrum in that market. Thus, in general, when compared to spectrum in the top 10 U.S. markets, the price per MHz*POP for spectrum in Chicago has been notably higher, as illustrated by the table below.

Price Per MHz*POP[1]

Spectrum Band[2]	700 MHz B Block	AWS A Block	AWS B Block	AWS C Block
License Area	CMA	CMA	BEA	BEA
Auction	73	66	66	66
Chicago License ($/MHz*POP)	$9.19	$1.57	$1.10	$1.57
Top 10 Market Avg (($/MHz*POP)	$6.06	$0.81	$0.61	$0.74
Percent Increase over Average	52%	94%	80%	112%

3. The higher spectrum prices in Chicago are in part correlated to the high population density in the market. Based on calculations using 2014 population estimates, the Chicago CMA (CMA003) is the third most densely populated CMA, and the Chicago-Gary-Kenosha, IL-IN-WI BEA (BEA064) ranks fifth.

4. Making the 700 MHz A Block spectrum available for wireless broadband services likely will bring the greatest benefits to low income consumers in Chicago. Based on data collected by Nielsen Mobile Insights, the fastest growing segment for smartphone subscriptions in the past year has been the low-income demographic.

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1 Calculated based on auction data available at http://wireless.fcc.gov/auctions/. *See* FCC Spectrum Auction Data compiled by The Center for the Study of Auctions, Procurements and Competition Policy, http://capcp.psu.edu/FCC/.

2 700 MHz Lower C, D and Upper C blocks, and AWS D, E and F blocks, were auctioned off by REAG and therefore are not comparable to spectrum available only in Chicago. Prices for 700 MHz Lower A and E blocks were constrained in certain markets due to uncertainty regarding potential interference issues (that have since been addressed by the FCC's interoperability order) and therefore, auction prices across markets for those spectrum blocks are not comparable.

5. Based on recent 4G data usage patterns of Cricket customers, LTE handsets are used predominantly to download data. LTE handset transmissions to upload data constitute a small percentage of user traffic. Thus, any potential for interference to Channel 51 DTV signals would be intermittent and limited in duration.

I certify under penalty of perjury that the foregoing is true and correct.

Timothy Ostrowski

Executed March 18, 2014