Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions	)	WT Docket No. 12-268
	)	
	)	

COMMENTS OF T-MOBILE USA, INC.

Ari Fitzgerald
Trey Hanbury
AJ Burton
Hogan Lovells US LLP
555 Thirteenth Street, NW
Washington, DC 20004
(202) 637-5600

Attorneys for T-Mobile USA, Inc.

Thomas Sugrue
Kathleen O'Brien Ham
Steve Sharkey
Christopher Wieczorek
Joshua Roland
Indra Chalk
T-Mobile USA, Inc.
601 Pennsylvania Avenue, NW
Washington, DC 20004
(202) 654-5900

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EXECUTIVE SUMMARY

The 600 MHz band plan represents one of the most critical elements in the Incentive Auction – the country's best near-term opportunity to help satisfy exploding consumer demand for mobile broadband services. T-Mobile appreciates that, with this *Public Notice*, the Commission is taking the time to examine carefully the design of this band plan. Given the various operational and technical complexities of the Incentive Auction, there are trade-offs inherent in the selection of any band plan. There simply is no perfect band plan that dominates all others on all relevant criteria. However, T-Mobile continues to believe that its 35x35 MHz Down from 51 Band Plan represents the best balance between maximizing the amount of spectrum available for auction and minimizing the potential for harmful interference. While there are technical and practical challenges associated with the Down from 51 Band Plan, in T-Mobile's view those challenges are entirely manageable; at the same time, the benefits from such a plan are substantial.

Concerns about the ability of the Down from 51 Plan to accommodate lower-clearing scenarios may be exaggerated, considering how much spectrum is already available before the auction even commences. It appears that in a majority of television markets, there is not a single broadcaster operating above Channel 37; and in a substantial majority of such markets, there are no more than three television broadcasters operating that high in the band. Although some of the larger markets have the most television use above Channel 37, these are also the markets that are most valuable to wireless carriers and thus the markets most likely to fetch the prices required to entice broadcasters to part with their spectrum.

While the amount of spectrum already available is very promising, T-Mobile's 35x35 MHz Plan also provides substantial flexibility in accommodating markets where all the channels above Channel 37 fail to clear. Although some commenters have raised technical interference concerns regarding how T-Mobile's Down from 51 Plan addresses markets where less than 84

MHz of spectrum clears, these concerns are likely overstated. The introduction of television stations into the uplink channels of the Down from 51 Plan should not (assuming adequate guard bands) create material complications for either television broadcasters or broadband providers.

In lower spectrum clearing scenarios, moreover, T-Mobile's band plan produces nearly as much spectrum as any of the proposals outlined in the *Public Notice*. Although the plan will require some spectrum to be repurposed for guard band use in lower-clearing markets, this guard band spectrum is no more than required initially by, for example, the Down from 51 Reversed Plan. Rather than indiscriminately introducing a guard band under all clearing scenarios, T-Mobile's plan avoids adding a guard band until it is absolutely needed. This preserves a significant amount of valuable spectrum, offering over 16% more paired spectrum than the proposed Down from 51 Reversed Plan in markets where at least 84 MHz can be cleared. This 16% return can help compensate for any challenges associated with accommodating television channels above Channel 37 in lower-clearing markets.

Despite these assurances, if the Commission remains concerned that insufficient spectrum will clear in a substantial number of markets, it can adopt a backup, or "contingent," band plan. For example, the Commission could adopt a nationwide band plan that would apply to the auction if sufficient spectrum failed to clear in a substantial number of markets. Such a contingent band plan could enable the Commission to pursue the optimal band plan for a high-clearing scenario while having an alternative plan if the auction does not proceed as expected.

By maximizing the amount of sought-after paired spectrum available for bidding, minimizing guard bands and taking full advantage of the efficiencies associated with a relatively compact configuration, T-Mobile's 35x35 MHz Down from 51 Band Plan offers the optimum spectrum configuration for a successful 600 MHz auction next year and for robust competition in the wireless marketplace in the future. With so much promise in the incentive auction, the Commission should not, and need not, settle for a "second-best" band plan.

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I. INTRODUCTION

T-Mobile USA, Inc. ("T-Mobile") submits these comments in response to the *Public Notice* issued by the Federal Communications Commission ("FCC" or the "Commission") in this proceeding.[1] T-Mobile supports the Bureau's effort to solicit additional feedback regarding its efforts to design a band plan for the 600 MHz incentive auction. With this *Public Notice*, the Bureau is engaging the public exactly as it explained it would, and as it has done in other auction proceedings.[2] Given the complex nature of the incentive auction, and, in particular, the importance of the band plan to the overall success of the endeavor, the opportunity to offer further "comment[s] on [these] incentive auction design issues" is invaluable.[3]

With this *Public Notice*, the Commission seeks input on several alternative proposed band plans to the "Down from 51 Band Plan" that many commenters, including T-Mobile, have

[1] *Wireless Telecommunications Bureau Seeks to Supplement the Record on the 600 MHz Band Plan*, Public Notice, GN Docket No. 12-268 (May 17, 2013) ("*Public Notice*").
[2] *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Notice of Proposed Rulemaking, Docket No. 12-268, 27 FCC Rcd ¶ 36 (Oct. 2, 2012) ("*Notice of Proposed Rulemaking*") ("As is typical with FCC auction proceedings, we anticipate issuing a series of public notices in the future that will provide additional opportunities for interested parties to comment on incentive auction design issues").
[3] *Id*.

supported.[4] Citing the potential for interference, the Commission sought comment on alternative band plans – the Down from 51 Reversed and Down from 51 TDD plans – to determine whether those plans might better manage the potential for interference while "maintaining flexibility to offer different amounts of spectrum in different geographic markets."[5] While these proposed alternatives have certain benefits, they come with their own shortcomings: namely, they sacrifice significant amounts of valuable, paired spectrum. Consistent with its position in its comments[6] and reply comments,[7] T-Mobile continues to believe that its proposed 35x35 MHz Down from 51 band plan represents the best balance to maximize the amount of spectrum available for auction while minimizing the potential for harmful interference. These features will allow for a successful auction next year and help ensure robust competition in the wireless marketplace for years to come.

Based on the already significant amount of spectrum available through repacking alone and the significant value of the spectrum for mobile broadband uses (which should lead to vigorous bidding in a well-designed auction), it is reasonable to expect that 84 MHz will be cleared in most markets. Indeed, we think it likely that at the end of the day it will be possible to clear that amount of spectrum (or more) in a substantial majority of markets, including most major markets. In our view, the benefits of offering 70 MHz of paired spectrum in most markets outweigh the costs of less flexibility in those markets where 84 MHz of spectrum is not cleared. In markets where 84 MHz of spectrum is cleared, for instance, T-Mobile's plan offers over 16%

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[4] *See* Letter from Joan Marsh, AT&T, Peter Pitsch, Intel Corp., Rick Kaplan, National Association of Broadcasters, Dean Brenner, Qualcomm, Kathleen Ham, T-Mobile, and Charla Rath, Verizon Wireless, to Gary Epstein, Chair, Incentive Auction Task Force, and Ruth Milkman, Chief, Wireless Telecommunications Bureau, GN Docket No. 12-268 (Jan. 24, 2013).
[5] *Public Notice* at 2.
[6] Comments of T-Mobile USA, Inc., Docket No. 12-268 (Jan. 25, 2013) ("T-Mobile Comments").
[7] Reply Comments of T-Mobile USA, Inc., Docket No. 12-268 (Mar. 12, 2013).

more paired spectrum than the proposed Down from 51 Reversed Plan.[8] This 16% dividend can make up for any challenges associated with accommodating television channels above Channel 37 in lower-clearing markets.

In those lower-clearing scenarios, T-Mobile's band plan holds together nearly as well (or as well) as any of the proposals outlined in the *Public Notice*. While lower-clearing markets will require some spectrum to be repurposed for guard band use, this guard band is no more than is required initially by, for example, the Down from 51 Reversed Plan. And although T-Mobile's plan contemplates the introduction of television stations into the uplink in lower-clearing markets (which we anticipate will be small in number), the technical concerns associated with accommodating broadcast operations at this frequency location are, in our view, entirely manageable. The introduction of television stations into the uplink channels of the Down from 51 Plan should not create material complications for either television broadcaster or broadband providers when sufficient interference protections are provided.

Commenters, moreover, have expressed some flexibility for accommodating market variation in the national band plan with their widespread support for fungible spectrum blocks.[9] By supporting fungibility, prospective bidders have indicated that they are more concerned with acquiring sufficient paired spectrum than with acquiring any specific frequency assignments. In other words, bidders are likely to remain largely indifferent to modest variations in the national band plan if it means that more spectrum will be available at auction.

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[8] *Public Notice* at 3.

[9] *See e.g.*, Comments of AT&T Inc., GN Docket No. 12-268, at 41 (Jan. 25, 2013) ("AT&T Comments"); Comments of Alcatel-Lucent, GN Docket No. 12-268, at 4 (Jan. 25, 2013); Comments of Qualcomm Incorporated, GN Docket No. 12-268, at 2, 5 (Jan. 25, 2013); T-Mobile Comments at 19; Comments of Verizon and Verizon Wireless, GN Docket No. 12-268, at 44-45 (Jan. 25, 2013) ("Verizon Comments").

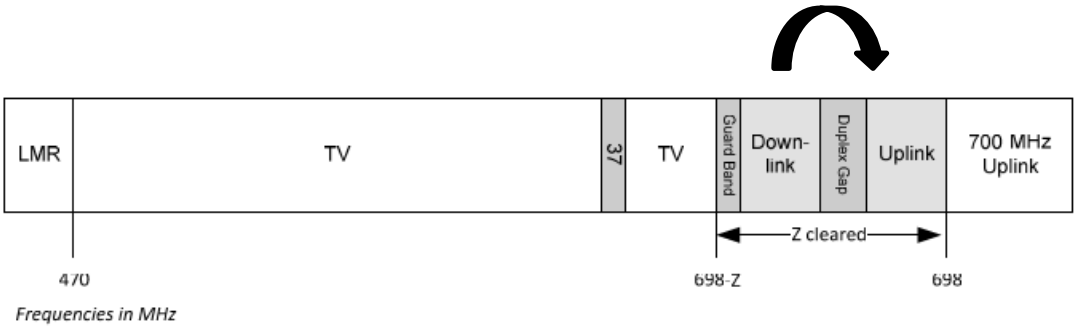
If, however, market variation remains a significant concern, the Commission could embrace a band plan with one or more variations contingent upon how much spectrum is cleared. By optimizing the band plan for the amount of spectrum cleared nationally in lower-clearing scenarios, the Commission could limit the number of variations that introduce guard bands or other complexities. Under a contingent band plan framework, the Down from 51 Plan could apply so long as at least 84 MHz of spectrum were available in most markets. But if the amount of spectrum cleared fell below a certain population threshold nationwide, the Commission could fall back to another national 600 MHz band plan tailored to a lower-clearing scenario – perhaps a nationwide Down from 51 Reversed Plan as proposed in the *Public Notice*, or a nationwide Down from 51 plan tailored to a lower-clearing scenario. With such a contingent plan, the Commission could accommodate lower-clearing scenarios while avoiding settling for a second-best band plan that would apply even if the auction generated a more successful clearing outcome.

II. THE "DOWN FROM 51 REVERSED" BAND PLAN VARIATION

The Down from 51 Reversed concept appears principally designed to address concerns about possible reverse order intermodulation interference arising from the Down from 51 Plan.[10] However, placing television operations in the duplex gap or, more accurately, placing television operations in one or more of the uplink channels above the duplex gap in the Down from 51 Plan, does not increase the risk of harmful interference.

[10] See Public Notice at n.8 ("A number of commenters assert that putting high power services in the duplex gap will cause unnecessary and strong intermodulation products, which will result in significant interference to mobile broadband units.")

The Down from 51 Reversed Plan is a variation on the Down from 51 Plan with the uplink and downlinks in the opposite configuration of the original Down from 51 proposal:



Like the Down from 51 Plan, the Down from 51 Reversed Plan allows for a consistent nationwide downlink swath and duplex gap.[11] And as in the Down from 51 Plan, the Down from 51 Reversed Plan uses uplink rather than downlink spectrum to accommodate television stations in markets where less than 84 MHz of spectrum is cleared. Unlike the Down from 51 Plan, however, the Down from 51 Reversed Plan has the ostensible benefit of avoiding the introduction of television channels into the spectrum *above* the duplex gap in lower-clearing markets. With the uplinks and downlinks reversed, the Down from 51 Reverse Plan positions any excess television stations *below* the duplex gap.[12]

Positioning any remaining television incumbents in broadband uplinks below the duplex gap eliminates the possibility of harmful intermodulation products falling into the receive frequencies of mobile broadband user equipment. Intermodulation interference can occur in a receiver if two or more strong signals are present and the signals mix to create an intermodulation product on a frequency that the receiver is trying to receive. Intermodulation interference is possible whenever the right combination of frequencies produce a radiofrequency

[11] *See Notice of Proposed Rulemaking* ¶ 131.
[12] *Public Notice* at 4.

product that lands in a relevant receiving band. Given the number of different frequencies in use for communications, these conditions occur quite frequently. In practice, however, intermodulation interference does not often result in harmful interference.

A. Placing Television Channels in Between Uplink and Downlink in a Down from 51 Plan is Unlikely to Create Intermodulation Interference

In the 600 MHz band, some commenters nonetheless contend that, in low-clearance scenarios where some television incumbents must be accommodated above Channel 37, harmful intermodulation interference might result if uplink spectrum is replaced with television incumbents that choose not to exit the band.[13] These commenters correctly note that downlink transmissions from LTE base stations below the duplex gap could theoretically combine with television broadcast signals above the duplex gap to produce a "reverse" intermodulation product that lands in the user equipment receive frequencies below the duplex gap. While this type of intermodulation interference is theoretically possible, harmful interference is unlikely to occur in the Down from 51 Plan under real-world conditions.

First, intermodulation interference requires the presence of at least two other transmitting devices operating at the same time and located near the receiver. Second, while intermodulation interference is additive, the re-radiating signals tend to be fairly weak after travelling from their source, mixing with another signal, and resulting in a new frequency product. Third, both the receivers and the networks on which they operate tend to be reasonably robust and flexible: devices and network systems possess performance characteristics that can overcome the effects of intermodulation. As the radiofrequency engineering firm SoftWright has explained, "even

[13] *See, e.g.*, Comments of Alcatel-Lucent, Docket No. 12-268 at 14-16 (Jan. 25, 2013); Comments of CTIA – The Wireless Association®, Docket No. 12-268 at 25, 28 (Jan. 25, 2013).

when predicted interference studies indicate the possibility of problems," experience shows that careful design can avoid or eliminate "almost every type of intermodulation product problem."[14]

The 600 MHz band follows this typical pattern. In the Down from 51 Band Plan scenario, base station transmissions from the FDD downlink band could combine with television downlink operations to produce a "reverse" intermodulation product in the lower-frequency spectrum where broadband user equipment is trying to receive a signal; however, scant likelihood exists that the intermodulation product would rise to the level of harmful interference.

First, so long as there are no television stations above Channel 37, the possibility of the type of intermodulation interference identified by some commenters in this proceeding as potentially problematic does not exist in the Down from 51 Plan. As explained in greater detail below, many markets already have 84 MHz of spectrum available for broadband and many more are likely to clear this amount of spectrum for broadband use with modest participation from broadcasters; therefore, the Commission can reasonably anticipate that the conditions necessary to produce even theoretical intermodulation interference will only occur in, at most, a minority of markets. Even if intermodulation interference were likely, and even if it were challenging to manage in this case (it is not), the need for spectrum is critical. So long as intermodulation challenges are confined to a small number of low-clearance markets, additional challenges posed by the possibility of intermodulation interference in the 600 MHz would pale in comparison to the benefits of making additional low-frequency spectrum available for broadband use.[15]

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[14] SoftWright LLC, *Finding, Solving, and Preventing Intermodulation Problems* (last visited June 9, 2013), http://bit.ly/14qGHSX. As SoftWright further explains, "[t]he vast majority of such problems are remedied by the use of relatively simple filters and traps installed on the appropriate equipment and with proper grounding techniques." *Id*. Ultimately, "[t]he careful analysis of any problem which might arise will allow the logical application of the principles of good engineering practice." *Id*.

[15] All band plans proposed for the spectrum above Channel 37 must make some provision for incorporating broadcast incumbents in the band plan for those markets where less than 84 MHz of spectrum is cleared. Commenters addressing the issue agree with the Commission that losing uplink spectrum is preferable to losing

Second, the actual signal strength of broadcast stations received by near-adjacent broadband channels is relatively weak. Although broadcast transmitters are, of course, quite powerful, broadcast signals *on the ground* are relatively weak because they seek to provide the largest possible coverage with the fewest number of transmitters, most often a single, high-site transmitter located near the market's center. By comparison, mobile broadband operators employ much smaller transmitters throughout the market and usually include an antenna gain and down-tilt to focus signal strength on the ground surrounding the tower for optimum two-way communications. Laboratory and field tests of broadcast transmitters in the vicinity of 700 MHz LTE systems provided in the 700 MHz interoperability proceeding confirm this understanding of broadcast transmission performance characteristics.[16] The intermodulation products generated by the combination of weak broadcast signals and LTE broadband transmissions are not likely to prove meaningful enough to overwhelm the desired received signal by the receiving equipment. For purposes of intermodulation interference, therefore, even a "high-power" television transmitter is not likely to create an extensive enough intermodulation product in the 600 MHz receive band to overwhelm an LTE end user receiver.

Third, 3GPP specifications require user equipment (UE) to tolerate undesired high power signals. Under the specification, LTE user equipment can remain very sensitive to desired signals and minimally susceptible to intermodulation distortion through the selective use of automatic gain in response to the detection of intermodulation distortion. These standard LTE

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downlink spectrum due to traffic patterns (users consume more downlink traffic than they produce uplink traffic) and the desirability of maintaining a common downlink band to avoid having multiple receive filters in 600 MHz devices.

[16] In the context of the 700 MHz E Block broadcast transmission, Doug Hyslop and Paul Kolodzy found that "even though the broadcast tower has a radiated power level 19 dB higher than the typical LTE site, the differences in antenna height and directionality reduce this difference to 8 dB at ground level." Doug Hyslop and Paul Kolodzy, *Lower 700 MHz Test Report: Laboratory and Field Testing of LTE Performance near Lower E Block and Channel 51 Broadcast Stations*, WT Docket No. 12-69 at 26 (Apr. 11, 2012) ("Hyslop & Kolodzy Report"), http://bit.ly/11qVzwd.

user equipment specifications should be sufficient to prevent performance degradation in the limited areas where broadcast TV signals could be present in the LTE uplink.[17] Even if these specifications alone were insufficient, the actual performance of LTE receivers generally exceeds the specifications and would prevent performance degradation.[18] Laboratory and field measurements in the 700 MHz interoperability proceeding, for example, found that commercial LTE devices must be designed to overcome an adjacent channel signal that is 55 to 60 dB stronger than the desired signal. This real-world design criteria is about 28.5 dB more stringent than the 3GPP adjacent channel selectivity requirement of 31.5 dB.[19] An adjacent channel selectivity of 60 dB provides considerable margin to protect devices and strongly suggests a higher-than-standard level of intermodulation response rejection, which allows receivers to receive a desired signal even in the presence of potential intermodulation signals.[20]

In summary, for Down from 51 plans, intermodulation interference is only a theoretical consideration in a limited number of lower-clearing markets. And even if, however implausibly, intermodulation interference was a more generally applicable concern, the benefits of additional cleared spectrum outweigh the costs of theoretical interference. Moreover, the broadcast-broadband coexistence testing performed in the 700 MHz band demonstrates that the actual signal strength of broadcast stations received by near-adjacent broadband channels is relatively weak, and that the actual device performance exceeds the minimum specifications found in the LTE standard, meaning that LTE devices have an enhanced ability to select the desired signal

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[17] *See* European Telecommunications Standards Institute, *LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) Radio Transmission and Reception*, ETSI TS 136.101 V11.4 (2013), http://bit.ly/15K50KH.

[18] *See* Hyslop at Kolodzy Report at 30.

[19] *Id*. at 30.

[20] Similarly, LTE provides tools, such as A-MPR, that allows carriers to selectively reduce power in certain resource blocks. Because intermodulation only results from a combination of signals, having the option to reduce the power in the LTE transmission would allow the operator to reduce one of the combining signals, if necessary, which would, in turn, reduce the magnitude of the intermodulation interference.

over the undesired intermodulation product. Taken together, these considerations largely eliminate intermodulation interference as a concern and, in so doing, eliminate the single largest benefit that the Down from 51 Reversed plan sought to achieve.

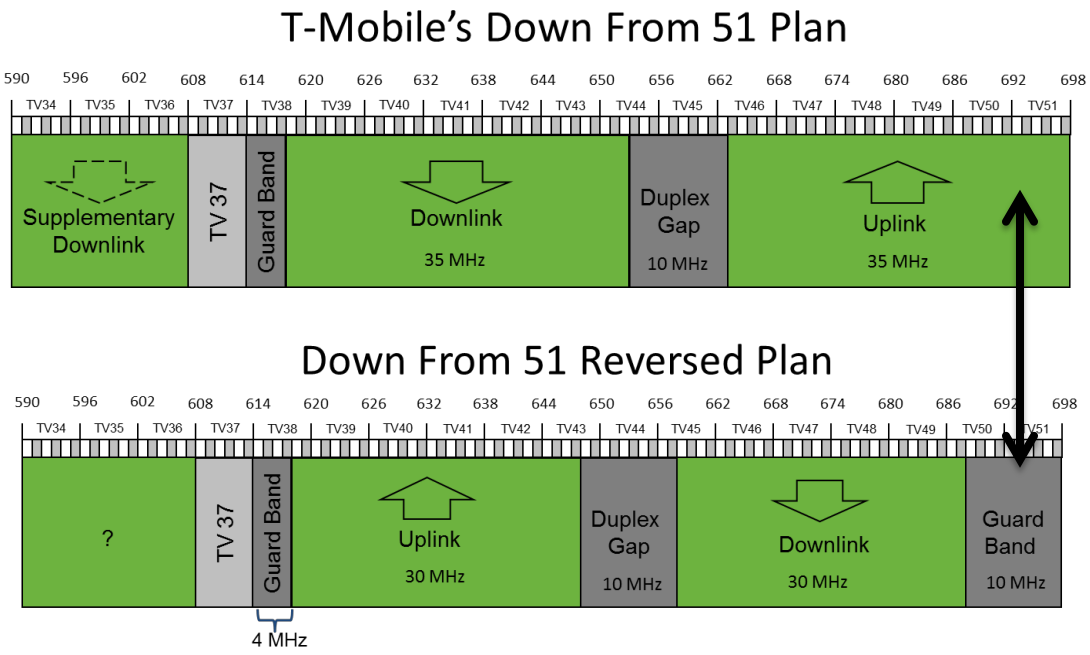
B. The Down from 51 Reversed Plan Sacrifices 10 MHz of Valuable Paired Spectrum

In addition to removing television channels from in between uplink and downlink allocations, the other ostensible benefit of the Down from 51 Reverse Plan is the ability to achieve more regular reductions in the number of channels available for broadband use. In the Down from 51 plan T-Mobile proposed, moving from 84 MHz to 78 MHz cleared reduces the total number of paired channels from seven to four – a substantial decrease. If envisioned as a staircase, the first step down in the number of paired channels from a pure 35x35 MHz to a variant that can accommodate broadcast incumbents is a large one. To make the reduction in available paired channels smaller or, to continue the metaphor, the steps more regular in height, the Down from 51 Reversed Plan sets a lower goal for paired broadband spectrum and requires an extra guard band in *all* clearing scenarios.

The greater regularity of the Down from 51 Reversed Plan, however, comes at a significant price: less paired spectrum available for auction to support consumer wireless broadband services in those markets where at least 84 MHz is cleared. The Down from 51 Reversed Plan steps down more smoothly than the Down from 51 Plan only because the latter plan waits to introduce a new guard band until it is necessary in a lower clearing scenario, rather than as an initial matter. Specifically, unlike the Down from 51 Plan, the Down from 51 Reversed Plan requires a guard band to separate 600 MHz downlink operations from 700 MHz uplink operations at the band edge. And this is a great sacrifice. The Commission sought input on precisely just how much spectrum would be lost by implementing the Down from 51

Reversed Plan.[21] T-Mobile's initial analysis suggests that a guard band of between 8 MHz and 10 MHz would be required to provide adequate separation between uplink and downlink operations at the upper end of the band.

The Down from 51 Reversed Plan, therefore, starts from a maximum available broadband bandwidth of 74-76 MHz. Thus, as compared to T-Mobile's proposal, the Down from 51 Reversed Plan immediately foregoes 10 MHz of spectrum, or a 5x5 MHz channel pairing. Rather than *seven* paired five-megahertz channels (in a 35x35 MHz plan), the Down from 51 Reversed Plan could only support *six* such LTE pairings (in a 30x30 MHz plan):



In other words, T-Mobile's proposal offers *greater than 16%* more spectrum than the Down from 51 Reversed Plan. Given the tremendous value of this low-band spectrum and the intense interest in it from all carriers in the market, and possibly from new players as well, the reduction in available supply of spectrum from the Down from 51 Reversed Plan is potentially

[21] *Notice of Proposed Rulemaking* at 4-5.

very significant. In T-Mobile's view, with this substantial of a difference between the two plans in spectrum availability, there would have to be a significant number of markets where 84 MHz cannot be cleared to justify the Down from 51 Reversed Plan.

C. Based on the Amount of Spectrum Already Available, Foregoing 16% of Paired Spectrum Under the Down from 51 Reversed Plan is Unnecessarily Pessimistic

In its reply comments in this proceeding, Intel provided a valuable, albeit preliminary, analysis regarding the number of available channels above Channel 37 in markets nationwide.[22] According to Intel's analysis, in 59% of markets, there are no broadcast television channels above Channel 37. Obviously, in those markets, 84 MHz can be made available without clearing or repacking any broadcasters at all.

In another 29% of markets, there is only one broadcaster above Channel 37, and in an additional 10% of markets, there are only two or three such broadcasters.[23] Put another way, there are three or fewer broadcasters above Channel 37 in 98% of all markets. Intel's analysis also suggests that there are significant numbers of channels available below Channel 37, some of which could likely serve as new locations for broadcasters currently operating above Channel 37 without requiring any stations to go off the air. Although Intel did not analyze interference concerns with neighboring markets for whether these existing channels above Channel 37 can immediately be repacked below Channel 37, its review of the data suggested that 84 MHz of spectrum can be cleared in a substantial number of these markets through repacking alone. It is

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[22] Reply Comments of Intel Corporation, GN Docket No. 12-268 at 9 (Mar. 12, 2013) ("Intel Reply Comments"). According to Intel:

59% of markets do not have a single TV channel above Channel 37
29% of markets have only one TV channel above Channel 37
7% of markets have only two TV channels above Channel 37
+ 3% of markets have only three TV channels above Channel 37
98% of markets have three of fewer TV Channels above Channel 37

[23] *Id*.

thus very likely that in a significant number of markets, no television station needs to be sold to get to a total of at least 84 MHz. And even in those markets where that is not possible, the number of stations that would have to go off the air to free up 84 MHz will often be quite low.[24] Hence, it appears that the full 35x35 MHz band plan that T-Mobile endorses should be achievable in most markets.

To be sure, Intel's initial analysis is not perfect and does not necessarily take into account all the ways in which the spectrum may remain encumbered in particular markets in the absence of any television channel assignments to the band. Moreover, some of the largest markets are those that have the most current broadcast operations located above Channel 37.[25] Nevertheless, the results of Intel's analysis, preliminary and somewhat over-simplified as they may be, are directionally very positive and provide a basis for optimism going into the auction. Clearing a few channels in each market appears readily achievable. And although some of the more congested markets are among the largest markets, these markets are also among the most valuable to wireless carriers, making the prospect of clearing them somewhat more likely. Economically irrational holdouts are certainly possible, but Intel's analysis suggests only limited clearing of broadcast incumbents would generate substantial areas where no broadcast encumbrances remain on the 84 MHz above Channel 37.[26]

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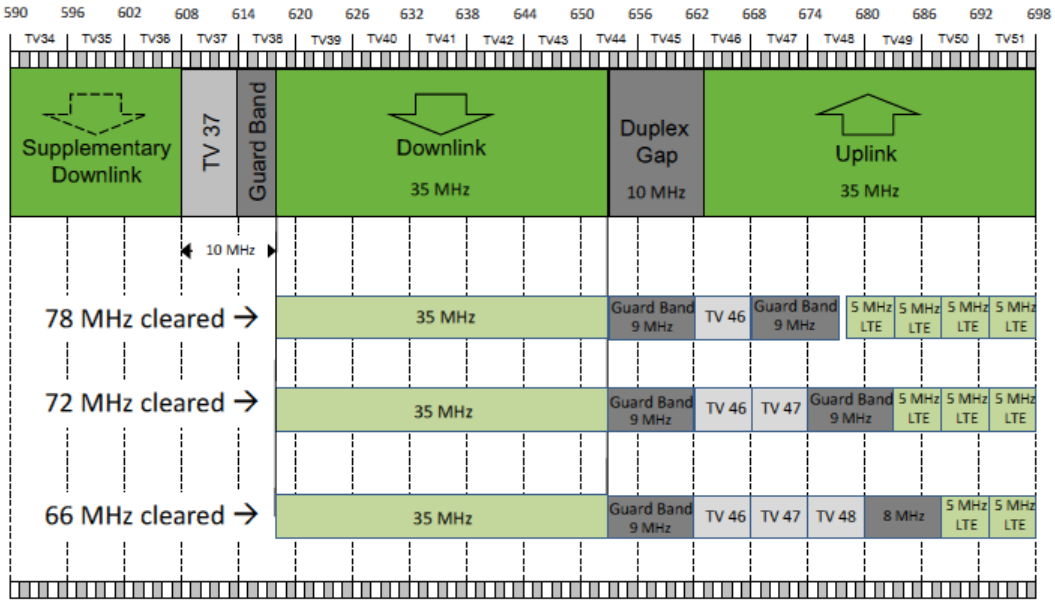
[24] Agreements with Canada and Mexico provide for cross border TV station allocations that also impact some major markets. *See, e.g.*, *Notice of Proposed Rulemaking* ¶ 34. Some of these TV allocations in Canada and Mexico are unused for broadcasting and may be able to be reused for mobile services on both sides of the border. T-Mobile is encouraged by the FCC's ongoing effort to collaborate with Canadian and Mexican authorities to resolve these cross border issues.

[25] Intel Reply Comments at 10.

[26] If Intel's preliminary analysis is insufficient to reassure the Commission and commenters that 84 MHz will clear in a substantial number of markets, the Commission should undertake a comprehensive analysis of the number of channels that can be cleared through repacking alone (and the number of channels required to be cleared in the remaining markets to achieve 84 MHz). Such a study should be the minimum required before pursuing a second-best band plan alternative and foregoing the 16% dividend offered by T-Mobile's 35x35 MHz Down from 51 proposal.

D. The Down from 51 Reversed Plan Never Allows for More Spectrum Than T-Mobile's Proposed Plan

In markets where less than 84 MHz has cleared, T-Mobile has proposed prioritizing a consistent nationwide downlink band and duplex gap.[27] In the first iteration of T-Mobile's proposed band plan, uncleared TV channels that could not be relocated below Channel 37 would be positioned immediately above the duplex gap, with additional guard band being drawn from frequencies that would have otherwise been available for uplink use, as shown here:[28]



While the amount of paired spectrum drops off significantly under T-Mobile's proposal if less than 84 MHz is cleared, in our view the band plan actually still performs better than Down from 51 Reversed. The reason is simple: whereas Down from 51 Reversed *always* requires a guard band in the upper part of the 600 MHz spectrum, T-Mobile's Down from 51 Plan only requires an equivalent guard band when less than 84 MHz of spectrum clears. Thus, what

[27] T-Mobile Comments at 11; T-Mobile Reply Comments at 15.
[28] When introducing television channels in between the uplink and downlink allocations in Channels 46, 47, or 48, lower power television channels should generally be introduced prior to higher power channels.

appears to be a precipitous drop in the amount of spectrum offered by T-Mobile's plan occurs only because T-Mobile waits to introduce the guard band. After it does so, the plan scales just as seamlessly as does the Down from 51 Reversed Plan. Moreover, the T-Mobile plan has an added benefit: the lower guard band is never more than 4 MHz. Once the Down from 51 Reversed Plan faces less than 84 MHz cleared, its lower-edge guard band must increase to 8 or more MHz.

The differences between the plans in low-clearing scenarios is best illustrated by the chart below; Down from 51 Reversed is *never* superior to T-Mobile's proposal for constrained markets:[29]

T-Mobile's 35x35 MHz Plan vs. Down from 51, Reversed										
	Paired MHz		**Supplemental Downlink MHz**		**Total MHz**		**How Much More Spectrum Does T-Mobile's Band Plan Provide?**			
MHz Cleared	T-Mo	Rvrs'd	T-Mo	Rvrs'd	T-Mo	Rvrs'd	Paired MHz	Supp. DL MHz	Total MHz	Total %
84	70	60	0	0	70	60	10	0	10	16.7%
78	40	40	15	10	55	50	0	5	5	10.0%
72	30	30	20	15	50	45	0	5	5	11.1%
66	20	20	25	20	45	40	0	5	5	12.5%

Indeed, this comparison does not reflect the true disparity between the two plans because the clearing scenario where Down from 51 most outperforms Down from 51 Reversed is the clearing scenario that is expected to be most common – 84 or more MHz cleared. Moreover, even in constrained markets, T-Mobile's proposal offers a significant spectrum dividend that should not be overlooked.[30]

[29] This analysis assumes a minimum of 8 MHz guard bands.

[30] Even if there are some concerns regarding a 1 MHz sliver of TV broadcast in the duplex gap (there should not be), those concerns would have to decrease the value of the spectrum by more than a *de minimis* amount to even be merited.

Ultimately, T-Mobile remains optimistic about the amount of spectrum that can be cleared at auction. Based on the amount of channels that can be opened through repacking alone, even if only a disappointing three channels were auctioned in each market, the vast majority of markets would have 84 or more MHz available for mobile wireless spectrum, subject, of course, to cross-border and adjacent market constraints.[31] If the reverse auction is as successful as anticipated, the 16% spectrum dividend in the Down from 51 Plan should be realizable in the lion's share of markets around the country, which will provide a spectrum benefit that is simply too great to sacrifice.

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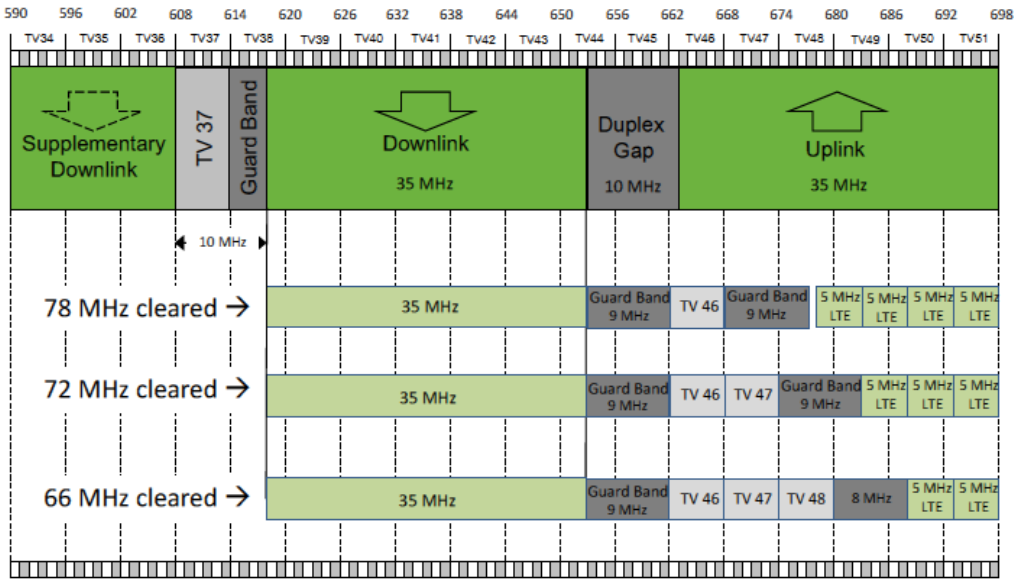
[31] The Commission also suggests a plan where uplink bridges across Channel 37. *See Public Notice* at 3-4. This proposal is simply not feasible for many of the same reasons that *no* commenter suggested having the downlink allocation bridge channel 37. For one, such a plan will require the development and use of at least two low-frequency antennas, which poses significant problems for designing reasonably-sized handsets. *See, e.g.*, T-Mobile Reply Comments at 12; Motorola Comments at 9; Qualcomm Comments at 6; RIM Comments at 8; Verizon Comments at 8; AT&T Comments at 5, 20, 30. Non-contiguous uplink bands, moreover, are technically difficult to engineer and require increased battery consumption and complexity in timing. Finally, splitting the uplink would presumably require two separate, non-overlapping duplexers impairing the ability to achieve interoperability and ensure fungible spectrum.

III. MODEST MODIFICATIONS TO THE 35X35 MHZ PLAN CAN FURTHER ENHANCE EFFICIENCY AND REDUCE THE SIZE OF THE INCREMENTS BETWEEN BAND-CLEARING SCENARIOS

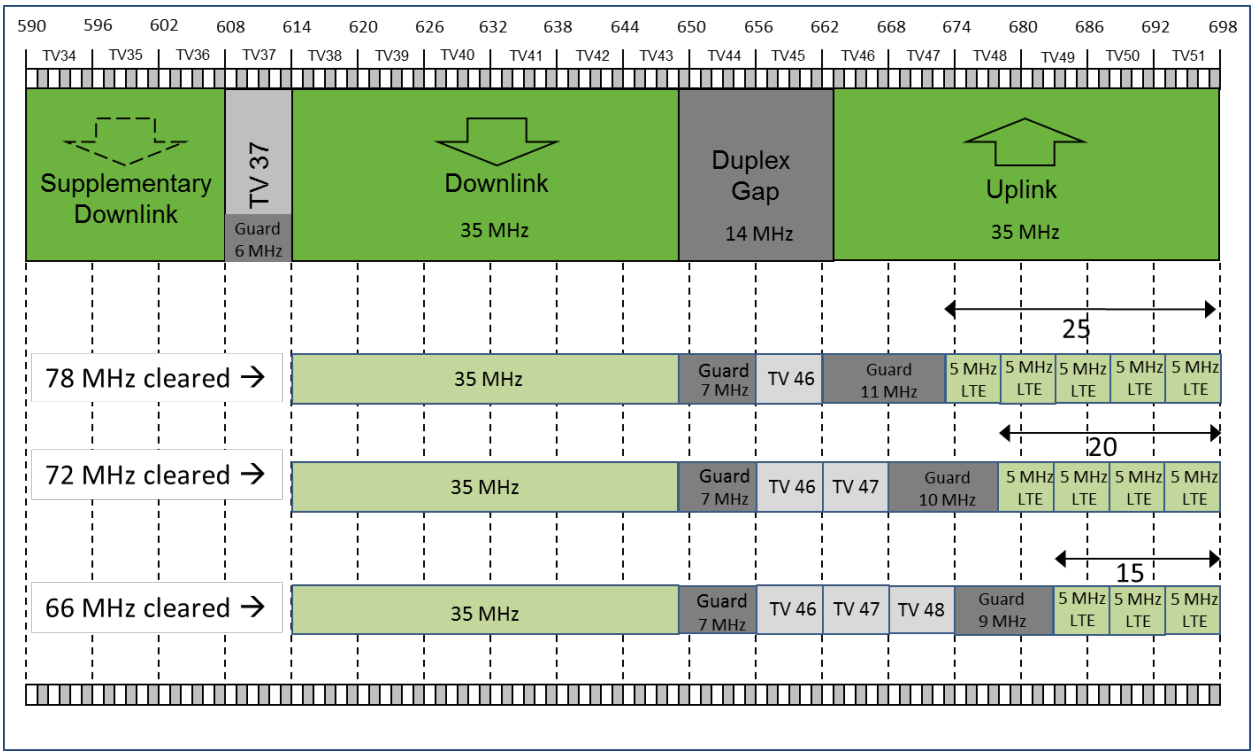
As discussed, T-Mobile's proposed Down from 51 Plan, and many other Down from 51 plans, introduce television channels into the uplink in lower-clearing scenarios and potentially could cause interference concerns.[32] In these lower-clearing markets, there is a three-channel decline in the paired spectrum offered between 84 MHz cleared and 78 MHz cleared:



While some fall-off is unavoidable in accommodating television operations above Channel 37 (whether it is done as an initial matter, as under Down from 51 Reversed, or introduced later), further modification to T-Mobile's proposal may help ease this transition.

[32] The Commission has also recognized that that there could be some concerns with co-channel interference to broadcasters if broadcast channels are placed in between uplink and downlink allocations. *See Public Notice* at 3 n.17; *see also* Comments of National Association of Broadcasters, Docket No. 12-268 at 39-45 (Jan. 25, 2013); Letter from Gordon H. Smith, National Association of Broadcasters, to Julius Genachowski, Chairman, FCC, Docket No. 12-268 at 1-2 (May 10, 2013). While T-Mobile understands these concerns, the potential for co-channel interference between geographically adjacent wireless and broadcast operations should be manageable. *See* Roberson & Associates, LLC, *Technical Analysis of the 35x35 MHz Band Plan*, *attached to Ex Parte* Presentation of T-Mobile USA, Inc., GN Docket No. 12-268 (Apr. 17, 2013). Specifically, siting wireless base stations at a sufficient distance outside of a broadcast station's contour should avoid any potential harmful interference to broadcast transmissions. *Id*. at 17. Siting wireless base stations sufficiently outside of broadcast contours will avoid the potential for a wireless handset to transmit an interfering signal because handsets only transmit at a relevant frequency when a base station is in range. *See id*.

For instance, under the Down from 51 Plan, television stations could also be placed in part within an expanded duplex gap to reduce the loss in uplink spectrum that accommodating broadcast stations would require in outlier markets:



This strategy offers an additional 5 MHz of uplink spectrum in each of these low-clearing scenarios and thus enables an additional 5x5 MHz pairing.

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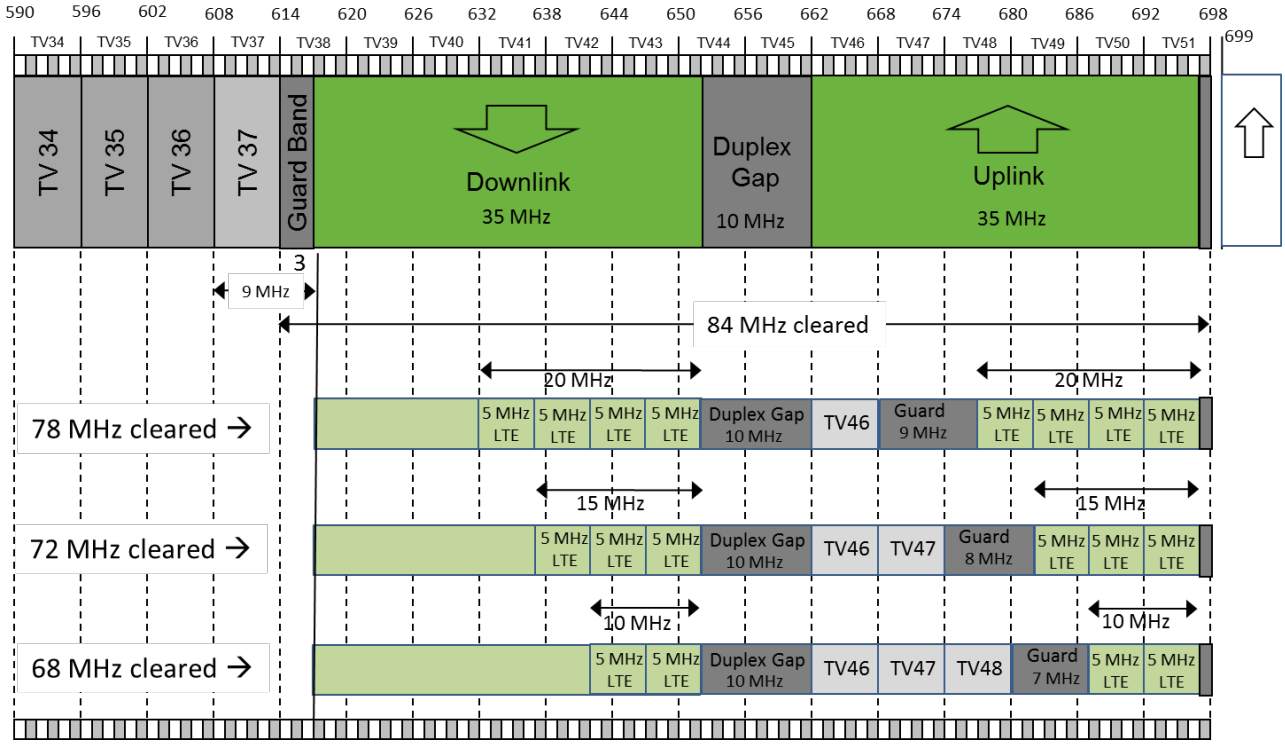
Additional variations could be incorporated into the Down from 51 Band to further enhance efficiency. For example, simply stepping down the plan from the 698 MHz band edge by one megahertz would align the upper guard band edge with the legacy broadcast channel scheme, while maintaining a 10 MHz duplex gap:[33]



As these alternatives illustrate, the 35x35 MHz Down from 51 Band Plan offers significant flexibility to address Commission concerns regarding efficiency and reducing the size of the steps between lower-clearing scenarios.

[33] T-Mobile opposed the introduction of television incumbents in the duplex gap principally because the Commission's original proposal would have increased the size of the FDD passband. As T-Mobile explained, an increase in the FDD passband at these frequencies would require either the use of an additional antenna ill-suited to the thin format of most modern user equipment, or tolerance for fairly substantial performance losses resulting from an antenna not properly configured to work with the full passband. As a result, incorporating broadcast operations in the broadband spectrum in ways that expand the FDD passband is not desirable and should not be undertaken as a systemic element of the band plan. To the extent broadcast incumbents do not expand the passband and occupy the uplink (rather than the downlink) band, however, the arrangement offers a reasonable accommodation to broadcasters that are unwilling or unable to exit the band or relocate to other spectrum while still maximizing the available spectrum and minimizing the effects on device performance characteristics.

IV. THE COMMISSION COULD ADOPT AN ALTERNATIVE BAND PLAN IF LESS THAN 84 MHZ IS CLEARED IN MOST MARKETS NATIONWIDE

The Commission typically designs its band plans to make the most use of the spectrum available. Band plan designs can vary widely, depending on how much spectrum is available, the types of uses in neighboring bands, whether the available spectrum is paired, and, if paired, how large a separation exists between the paired segments. The challenge of designing a band plan for the 600 MHz band, however, is that no one knows in advance precisely how much spectrum will be available for broadband use or exactly what frequency combinations will emerge from the auction. The lack of information about spectrum supply – both in its quantity and in its configuration – poses a challenge for the Commission because the Commission must hazard a guess about the spectrum resources likely to become available. Without substantially more information about the likelihood of clearing, the Commission could well over- or under-estimate the actual amount of spectrum cleared, which could introduce inefficiencies in band plan design.

Band plan design involves a series of tradeoffs among numerous competing goals and rests upon a series of explicit and implicit assumptions about the requirements and design of filters, duplexers, antennas, receivers, amplifiers, and end user equipment, as well as considerations of the likelihood of harmonization on a national and international basis. If, for example, the Commission assumes the incentive auction will clear 84 MHz in most markets, as seems likely to T-Mobile, then the Commission should not adopt a band plan that is optimized for clearing only 60 MHz of spectrum. Doing so would leave billions of dollars of valuable low-frequency spectrum unsold and likely under-used to the detriment of consumers, competitors, and the U.S. Treasury. Likewise, the Commission would want to avoid adopting a band plan optimized for clearing 120 MHz of spectrum when 84 MHz seems more likely to be cleared in

most markets. Doing so would impose potentially costly design impediments on 600 MHz auction winners, such as additional antennas and filters, and auction winners will, in turn, either pass these costs along to consumers in their service offerings or deploy fewer or less extensive broadband services than they would have had the Commission chosen a band plan design better tailored to the amount of spectrum recovered at auction.

To avoid the risk of guessing incorrectly about the amount of spectrum that is likely to be cleared in most markets, the Commission could pursue a contingent band plan based on how much spectrum clears in most or all markets. Verizon proposed just such a plan in its comments.[34] As Verizon explained, the band plan that will best promote the Commission's goals "will depend on the amount of spectrum that clears in various markets around the country."[35]

Although incorporating a contingency around the nationwide band plan introduces a measure of uncertainty, the process itself would be fairly straightforward: the nationwide 600 MHz band plan would change from one pre-specified band plan to another if the target level of spectrum declined below a pre-determined minimum threshold. For a contingent band plan to function, all bidders would need to know prior to the auction: (i) the possible band plan designs, and (ii) the trigger for moving from one band plan to the other. So long as bidders have ample opportunity to plan for a discrete, clearly defined contingency prior to the auction, bidders can benefit from a nationwide band plan optimized to the amount of spectrum that the reverse auction actually clears.

An example demonstrates how the contingency would function. If, for instance, the clearing target were 84 MHz or more, the Commission would use a national band plan optimized for delivering the most paired spectrum at a high level of spectrum clearing, such as T-Mobile's

[34] Verizon Comments at 7-14.
[35] *Id*. at 7.

35x35 MHz plan. But if the clearing target fell well below 84 MHz – to 60 MHz, for example – the Commission would use a band plan optimized for delivering the most paired spectrum at that lower level of spectrum clearing (e.g., a Down from 51 Reversed or a 20x20 MHz Down from 51 band plan). Since each phase of the forward auction would start with a target amount of spectrum to be cleared (having failed to raise enough revenue in the previous round to clear that round's incrementally higher target), the forward auction band plan could be introduced before the start of each new round. Bidders would simply accommodate the variable band plan design because each phase of the auction allows bidders to reset their expectations and adjust their bids accordingly. In addition, the presence of largely fungible spectrum blocks across band plans would allow bidders to concern themselves principally with the total number of blocks, rather than their precise frequency configuration. Allowing the actual amount of 600 MHz spectrum cleared to determine which band plan design will govern the 600 MHz band greatly reduces the risk that a priori uncertainty about the eventual clearing results will lead the Commission to incorrectly guess on the optimum design for the spectrum.

Even a straightforward contingency in the band plan design could nevertheless introduce risks and complications. For instance, if the band plan variations were too dissimilar, the auction could fail to attract and retain a full set of bidders. Suppose, for example, that the Commission auctioned the 600 MHz band plan using an FDD plan if the clearing target were high, but a TDD plan if the clearing target were low. Because FDD and TDD technologies are dissimilar and may involve different business models and bidding strategies, FDD-oriented bidders might not participate in the TDD phase of the auction and TDD-oriented bidders might not participate in the FDD phase of the auction. The dissimilar band configurations could lead to insufficient demand at both the high- and low-clearing target phases of the auction and would also raise

complicated questions of how best to maintain bidding eligibility during auction phases as widely dissimilar band configurations are sold. As a result, any band plan contingencies are best limited to variations in the *amount* of spectrum available under the plan, rather than in more fundamental distinctions, such as FDD and TDD.

Even assuming that band plans would only vary in degree, not kind, however, complications would remain. For instance, certain wireless carriers might have an incentive to withhold bidding in the early, high clearing-target rounds of the forward auction in hopes of reducing the overall amount of spectrum recovered as a means of frustrating competition. The Commission would, therefore, need to introduce mechanisms to ensure that bidders submit only sincere bids and do not game the contingent plan in ways harmful to the auction or to competitors.

While not without risks, a contingent band plan format could provide the Commission with some measure of assurance that the band plan will roughly match the available spectrum resources. The important point here is that deciding on a lead band plan, such as the 35x35 MHz Down from 51 Plan, need not be an all-or-nothing proposition. The Commission merely need announce that it will pursue a lead plan if a certain clearance is reached in a sufficient number of markets. A contingency plan can allow the Commission to pursue the plan with the most consumer value (the 35x35 MHz Down From 51 Plan), while maintaining the flexibility it seeks in lower-clearing scenarios.

V. CONCLUSION

The Bureau's public notice offers an important contribution to the ongoing analysis to determine the best configuration of the 600 MHz spectrum for consumers. By maximizing the amount of sought-after paired spectrum available for bidding, minimizing guard bands and taking full advantage of the efficiencies associated with a relatively compact configuration, the Down from 51 Band Plan continues to offer the optimum spectrum configuration for a successful spectrum auction next year and for robust competition in the wireless marketplace in the future.

If the Commission nevertheless has concerns about how a 35x35 MHz band plan would perform if the incentive auction were to clear much less spectrum nationally than is currently anticipated, the Commission might consider a contingent band plan design. A contingent band plan simply recognizes that knowledge about the outcome of the reverse auction is imperfect and thus formulates alternate band plans for either a high-clearance or a low-clearance incentive auction. Although a contingent band plan is not as definitive as a single band plan, a contingent band plan could introduce more efficiency or bring more spectrum to market than a single band plan could.

Respectfully submitted,

/s/ Thomas Sugrue

Thomas Sugrue
Kathleen O'Brien Ham
Steve Sharkey
Christopher Wieczorek
Joshua Roland
Indra Chalk
T-Mobile USA, Inc.
601 Pennsylvania Avenue, NW
Washington, DC 20004
(202) 654-5900

Ari Fitzgerald
Trey Hanbury
AJ Burton
Hogan Lovells US LLP
555 Thirteenth Street, NW
Washington, DC 20004
(202) 637-5600

Attorneys for T-Mobile USA, Inc.

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