Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Competitive Bidding Procedures for Broadcast Incentive Auction 1000, Including Auctions 1001 and 1002	)	AU Docket No. 14-252
	)	
Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions	)	GN Docket No. 12-268
	)	

COMMENTS OF AT&T

David L. Lawson
James P. Young
Christopher T. Shenk
Sidley Austin LLP
1501 K Street, N.W.
Washington, D.C. 20005
(202) 736-8000

Michael P. Goggin
Alex Starr
Gary L. Phillips
Lori Fink
AT&T Services, Inc.
1120 20th Street, N.W.
Washington, D.C. 20036
(202) 457-3048

Counsel for AT&T

February 20, 2015

TABLE OF CONTENTS

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Competitive Bidding Procedures for Broadcast Incentive Auction 1000, Including Auctions 1001 and 1002	)	AU Docket No. 14-252
	)	
Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions	)	GN Docket No. 12-268

COMMENTS OF AT&T

AT&T Services Inc., on behalf of itself and its affiliates (collectively "AT&T"), respectfully submits these comments in response to the Commission's December 17, 2014 Public Notice seeking comment on competitive bidding procedures for the broadcast incentive auction.[1]

INTRODUCTION AND SUMMARY

The Commission has consistently recognized that the success of this unique, first-of-its-kind incentive auction will depend on keeping the auction rules as simple, transparent, and fair as possible. The terms of the reverse auction must be easy to understand to encourage maximum participation by broadcasters. The spectrum included in the forward clock auction must be as unambiguously fungible and free from interfering uses as possible, to ensure that broadband providers bid top dollar for spectrum they perceive to be both "generic" and valuable. And the auction rules must promote fair and open competitive bidding, to facilitate the efficient transfer of spectrum to its highest-valued uses.

[1] Public Notice, Comment Sought on Competitive Bidding Procedures for Broadcast Incentive Auction 1000, Including Auctions 1001 and 1002, AU Docket No. 14-252, GN Docket No. 12-268, FCC 14-191 (rel. Dec. 17, 2014) ("*Notice*").

The Commission's *Incentive Auction Order* promised rules largely designed to promote these prerequisites to a successful auction. The Commission emphasized that it was "striving for simplicity," that it was "committed to removing barriers to . . . voluntary participation," that the auction would thus be "transparent and easy to participate in," and that it would "ensure that the spectrum blocks are as interchangeable as possible."[2] In a few respects, the Commission departed from these principles and proposed rules that are certain to harm auction outcomes. Most notably, the Commission proposed to "reserve" a portion of the spectrum from a fully open auction in an effort to steer spectrum to certain favored bidders. But even there, the Commission promised to put in place safeguards to ensure that spectrum was not simply given away at below-market rates and that the vast majority of the spectrum would always remain subject to open competitive bidding in the unreserved auction.

The new *Notice*, however, reneges on promises made in the *Incentive Auction Order* and proposes a byzantine and murky set of auction rules that is the polar opposite of simple, transparent, and fair. As Professors Haile and Kearns and Ms. Dworkin explain in their attached white paper,[3] the flaws in the newly proposed framework are both serious and unnecessary, and the introduction of so much more risk and uncertainty would foster the very outcomes the Commission hopes to avoid: reduced broadcaster participation, reduced forward auction revenues, and reduced spectrum clearing. At the same time, the proposed rules would bake in "optimization" routines that virtually guarantee that a very substantial portion of the population

[2] Report and Order, *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, GN Docket No. 12-268, 29 FCC Rcd. 6567, ¶¶ 2, 9, 45 (2014) ("*Incentive Auction Order*"); *see also id.* ¶ 13 ("[w]e [] are committed to an open, transparent process").

[3] Philip A. Haile, Michael Kearns, and Lili Dworkin, *Comments on the FCC's Current Incentive Auction Design Proposals*, attached hereto as Attachment A (Feb. 20, 2015) ("Haile-Kearns-Dworkin").

will be in areas where large portions of the newly allocated 600 MHz LTE spectrum are heavily impaired, destroying spectrum value and undermining the core Spectrum Act goal of reallocating from broadcast TV to mobile wireless use large amounts of *clean*, paired spectrum that can actually be used to meet soaring demand for mobile wireless services.

The Commission has yet to provide the underlying details for so many critical portions of its proposals that it is impossible even to fully analyze them at this point. What is clear today, however, is that this historic auction is much too important for the Commission to rush to adopt auction rules with such an unprecedented degree of complexity, uncertainty, and foreseeable harms. In these comments, AT&T focuses on four broad areas in which the Commission should change course: (1) the severe harms to auction outcomes stemming from the ill-advised proposal to place television stations in the 600 MHz band, even though such assignments appear to be neither necessary nor worth the exponential increase in auction complexity and uncertainty; (2) the wildly lopsided proposals for operation of the reserve auction; (3) unnecessary complexity and defects in the determination of prices in the reverse clock auction; and (4) revisions and clarifications to the extended round, joint bidding, activity and other auction rules necessary to maximize auction revenues, minimize strategic bidding, and maintain the integrity of the auction.

Harmful Market Variation. The Commission's proposed auction scheme tilts too far toward trying to maximize the amount of spectrum "cleared" at the expense of introducing interference that would destroy the value of spectrum licenses for broadband services. In an attempt to achieve the highest initial clearing targets possible across the country, the Commission proposes to place TV stations in the 600 MHz LTE band itself.

The resulting inter-service interference would be quite extensive. The Commission is proposing to prioritize assignment of such stations first in the uplink, then in the downlink, and

only as a last resort in the duplex gap and guard-bands. As the Commission recognizes, a TV station assigned to the uplink or downlink of the 600 MHz LTE band plan will typically displace two 5 MHz spectrum blocks (because TV stations require 6 MHz bandwidth) *and* cause substantial inter-service interference in two directions – in adjacent frequencies in the same PEA, and in the same frequencies in adjacent PEAs. And not all of these potential impairments are created equal: in some cases, a nearby TV station will degrade the quality of a licensee's broadband services, while in other instances the 600 MHz license will be subject to exclusion zones in which the provider cannot offer broadband services at all.

Under the Commission's proposal, then, TV stations would dot the 600 MHz LTE band plan all over the nation, because the Commission's proposed assignment methodology would allow impaired spectrum in up to 20 percent of the national spectrum-value-weighted population (and actually much more because the Commission proposes to "discount" uplink impairment by half). As Professors Haile and Kearns and Ms. Dworkin explain, the Commission's optimization methodologies, together with the Dynamic Reserve Auction ("DRA"), all but ensure a band plan with very substantial TV-to-mobile (and mobile-to-TV) interference that will destroy spectrum value because the Commission's methodology works down from the highest possible clearing targets until it finds one that will *just* satisfy the complex optimization constraints, which are not even designed to select the least harmful solutions within the 20 percent constraint.

Moreover, "baking in" this 20 percent permissible national impairment into the auction optimization routines can produce absurd results. It easily leads to very high clearing targets with less "auctionable" spectrum blocks than lower clearing targets would produce. For example, Professors Haile and Kearns and Ms. Dworkin show that there are many solutions for a 126 MHz clearing target (10 5x5 MHz pairs) with less than 20 percent impairment, yet where

half or more of those blocks are more than 50 percent impaired in major cities (*e.g.*, New York, Los Angeles, Philadelphia) and thus would not even be auctioned. In this case, an 84 MHz clearing target could actually result in *more* spectrum being available for sale in the auction.

Equally problematic, this nationwide checkerboard of "clean" and "impaired" spectrum would also eliminate the essential assumption on which the forward clock auction is based, which is that what is on offer is reasonably *fungible*. Indeed, from the standpoint of bidders in the forward auction, the Commission has turned the 600 MHz band plan into Forrest Gump's box of chocolates – no one knows what they're going to get. This loss of fungibility and predictability leads the Commission to propose a byzantine set of auction rules to try to counteract the negative effects of this problem, but the design and complexity of those proposals would only make matters worse. For example, the Commission now proposes to divide the spectrum into Category 1 ("clean") and Category 2 ("impaired"), and to permit participants to bid separately for these two classes of spectrum in the forward auction. But these categories are defined far too broadly to give bidders any meaningful idea of what they would be getting: Category 2 spectrum can have impairments that cover anywhere from 15 percent to *49 percent* of the weighted population of the license area. In addition, it matters greatly *where* these impairments occur in the relevant license area: an exclusion zone in the middle of downtown, in key suburbs, or along busy commuting routes could lower the value of spectrum dramatically. The Commission's categories (and proposed "fixes") do not account for any of these differences.

As Professors Haile and Kearns and Ms. Dworkin explain, this severe uncertainty will reduce revenues in the forward clock auction, because participants will discount their bids to account for the possibility that they will end up with lower quality spectrum. The Commission suggests that all of this will be worked out in an assignment phase that takes place *after* the

forward auction, in which the winning bidders can continue bidding to try to obtain the specific 600 MHz blocks they want. But a post-auction assignment phase cannot address the fundamental problem. The amount of spectrum that clears in any given PEA will be determined in the *clock* phase. The heterogeneity of the spectrum available will result in substantially reduced revenues in the forward clock auction, which in turn means that a smaller amount of spectrum may clear in the first place and thus will never even make it into the assignment round. And in all events, the *Notice* proposes an assignment round governed by a far more complex set of rules – which the Commission has yet to fully describe or explain – under which the highest bidder will not necessarily win the spectrum blocks it wants.

There is a relatively simple solution: the Commission should auction only Category 1 spectrum outside international border regions where temporary domain constraints imposed by foreign TV stations will cause some impairments. As Professors Haile and Kearns and Ms. Dworkin show, using the Commission's data and most recent feasibility checker, there is a very high likelihood that the Commission can clear at least 84 MHz of spectrum nationwide without having to assign TV stations to the 600 MHz band (except perhaps in border areas), and certainly without assigning stations covering 20 percent or more of the weighted population. Although it is too early to rule out the possibility that *some* assignment of TV stations may be necessary to achieve reasonable clearing targets, the Commission should make such a judgment only on the basis of robust, data-driven analysis that such measures are necessary. In all events, the Commission cannot lawfully pluck numbers like 20 percent out of thin air. Preliminary analysis suggests that the Commission should reasonably set any nationwide impairment cap, if one is necessary, much lower (and without the proposed arbitrary uplink impairment "discount").

The "Reserve" Auction. The *Notice* proposes to overturn the protections the Commission previously designed to keep the reserve auction within manageable limits. After extensive industry discussions prior to the *Incentive Auction Order*, the Commission promised to implement a series of protections to limit the foreseeable harms of a reserve auction.[4] The Commission thus made clear that the vast majority of spectrum in each PEA would be subject to unreserved bidding, that all bidders would have a fair opportunity to obtain unimpaired spectrum, and that a separate, market-based pricing trigger would protect the American taxpayer by ensuring that valuable spectrum was not simply handed to certain reserve-eligible competitors at below-market prices.

The *Notice* largely reneges on these promises, but the Commission still can and should restore the original parameters of the reserve auction. First, the *Notice* proposes to place only the best spectrum – *i.e.*, the relatively unimpaired Category 1 spectrum – in the reserve auction. All of the worst spectrum – the Category 2 spectrum which may be up to 49 percent impaired – would be placed in the unreserved auction. This is not only entirely unjustified, it is a surefire recipe for further depressing auction revenues in both the reserved and unreserved auctions. If the Commission adopts AT&T's proposal to auction only Category 1 spectrum, however, this issue largely resolves itself; otherwise, the Commission should fill the reserve allocation first with any Category 2 spectrum in the PEA, followed by any Category 1 blocks necessary to meet the reserve allocation.

Second, the proposed rules would repeal the mechanism limiting the reserved spectrum to a reasonable percentage of the entire amount available. Until now, the Commission has

[4] *See* Letter from Joan Marsh, AT&T, to Marlene H. Dortch, FCC, GN Docket No. 12-268, WT Docket No. 12-269 (May 9, 2014); Letter from Joan Marsh, AT&T, to Marlene H. Dortch, FCC, GN Docket No. 12-268, WT Docket No. 12-269 (May 14, 2014).

indicated that the "minimum" amount of spectrum that would be included in the unreserved auction would be a function of the total amount of spectrum that actually cleared under the final stage rule. This rule ensured that more than half of the spectrum in any PEA would be subject to full competitive bidding in the unreserved auction. The *Notice* states the amount of the reserve will now be fixed based on the *initial* clearing target. In other words, as long as the Commission *hopes* to clear at least 84 MHz as its initial clearing target (allowing forward auction sale of 70 MHz), the reserve auction default will be set irrevocably at 30 MHz, even if only a total of 50 MHz (or less) of spectrum is actually available for sale in a PEA in the final stage. The Commission should restore the rule linking the reserve allocation to the amounts of spectrum actually available for purchase.

Third, the Commission has set the market-based pricing trigger for the reserve auction far too low. In the *Incentive Auction Order*, the Commission recognized that a "reserve" auction ran the risk that reserved bidders would obtain valuable spectrum at prices well below market levels, which would give certain competitors an unwarranted competitive advantage and prevent American taxpayers from capturing the full value of the spectrum for deficit reduction. The Commission therefore adopted a final stage rule specifying that the reserve auction would not be triggered until the bidding rose to market-based price levels that exceeded a certain price per MHz-POP. But the trigger proposed in the *Notice* – $1.25 per MHz-POP *in the 40 largest PEAs* – does not remotely represent a fair, market-based price for this spectrum. Both Lower 700 MHz B Block spectrum that the Commission has noted is "most comparable" to the spectrum here and recently auctioned AWS-3 spectrum saw winning bids of triple that amount in the 40 largest PEAs (even though AWS-3 is "high-frequency" spectrum that will take years to clear of federal users). As Professors Haile and Kearns and Ms. Dworkin explain, the Commission should de-

couple the market-based pricing trigger from the final stage rule and adopt a much higher reserve trigger that reflects the competitive market value of comparable spectrum and that ensures that the Commission does not short-change taxpayers by giving valuable spectrum away to favored bidders at rock-bottom prices.

Fourth, the proposed bidding rules would further depress auction revenues by facilitating strategic behavior on the part of the reserve-eligible bidders. For example, the use of separate price clocks for reserved and unreserved licenses creates incentives for the reserve-eligible bidders to bid for unreserved licenses instead of reserved licenses even when the price of the latter is lower. This incentive arises because such strategic bidding may "stop the clock" for reserved licenses – thus locking in place the lower prices for the reserve blocks – even while the reserve eligible bidders' continued bidding drives up the prices that non-reserve bidders must pay. As Professors Haile and Kearns and Ms. Dworkin explain, the Commission should change the auction design to eliminate these incentives.

As detailed below, these proposals, singly and certainly together, push the reserve auction well over the line into a Spectrum Act violation. Although the Spectrum Act permits the Commission to apply rules of general applicability in this auction, these proposals are clearly *auction-specific* measures that reduce the amount and degrade the quality of spectrum available to disfavored bidders (*i.e.*, AT&T and Verizon) while giving the best spectrum away to reserve-eligible bidders at below-market prices (and even allow reserve-eligible bidders to manipulate the bidding to drive up their rivals' prices). These measures cannot be squared with the Spectrum Act or the Commission's own stated objectives in the *Incentive Auction Order*.

The Reverse Auction. The Commission has consistently recognized that it is vitally important for the reverse auction to be as simple and transparent as possible so broadcasters will

have ample incentive to participate and the confidence that they will receive full value for their spectrum rights. But the procedures outlined in the *Notice* are more likely to lead to confusion, uncertainty, and inefficient outcomes. For example, the Commission acknowledges that broadcasters should be able to seek prices in the reverse auction that account for the relative importance of their spectrum in the repacking process. As Professors Haile and Kearns and Ms. Dworkin show, however, the metric the Commission has proposed to account for this "repacking difficulty" is flawed and will both understate and overstate the opening prices needed to induce participation. The Commission should give further study to these and other reverse auction issues discussed below, because maximizing the efficient participation of broadcasters is crucial to the success of this unprecedented two-sided auction.

Other Bidding Rules. Finally, the Commission should make a few modifications to the proposed bidding rules to maintain the integrity of the auction and ensure that it facilitates the most efficient transfer of spectrum. For example, the recent AWS-3 auction vividly illustrates that the Commission should amend its joint bidding rules to prevent the types of "bid stacking" strategies that certain entities used in the AWS-3 auction to circumvent the Commission's activity rules, mask actual demand, artificially drive up prices, and drive out the true small businesses the Commission's designated entity ("DE") rules were designed to favor. Given that this incentive auction is already inherently more complex than a typical auction, it will be all the more important for the Commission to make sure the rules do not invite or allow such manipulation.

I. THE COMMISSION'S PROPOSAL TO ASSIGN TELEVISION STATIONS TO THE 600 MHZ BAND WOULD MASSIVELY INCREASE THE COMPLEXITY AND UNPREDICTABILITY OF THE AUCTION FOR NO DEMONSTRATED GAIN.

The *Notice* proposes to place TV stations in the 600 MHz LTE band based on the unproven assumption that it is necessary to achieve relatively high clearing targets. However, as Professors Haile and Kearns and Ms. Dworkin explain, it is not at all clear that placing TV stations in the 600 MHz LTE bands outside of border regions is needed to achieve high clearing targets. By contrast, as the *Notice* correctly acknowledges,[5] it is clear that doing so would introduce extensive inter-service interference into the 600 MHz LTE band, resulting in substantial variation in the quality and value of spectrum blocks. This loss of fungibility can only depress revenues in the forward auction. And the *Notice*'s proposed "fixes" to these problems would be ineffective and would create additional problems that would threaten the success of the auction.

As explained below, the solution is simple. The Commission should minimize the placement of TV stations in the 600 MHz LTE band plan, and auction *only* generally unimpaired spectrum blocks (as explained below, the unique issues related to interference at border regions could be addressed separately). Using the latest data released by the Commission, Professors Haile and Kearns and Ms. Dworkin show that it is highly likely that the auction will achieve relatively high clearing targets of at least 84 MHz without assigning TV stations to the 600 MHz LTE band, and the Commission can further reduce the need to do so with some simple modifications to its auction procedures.

[5] *Notice* ¶¶ 32-36.

A. Assignment of Television Stations in the 600 MHz Band Would Cause Extensive Impairments and Variability of the Spectrum Available in the Forward Auction.

The *Notice* proposes to place TV stations in the 600 MHz LTE band and to prioritize such placement first in the uplink blocks, then in the downlink blocks, and lastly in the duplex gap or guard bands. Placing high-powered TV stations in the uplink or downlink blocks would clearly cause the *most* harm – with the greatest harm occurring if TV stations are placed in the uplink – severely impairing service in many of the remaining spectrum blocks in that PEA, as well as spectrum blocks in surrounding PEAs. Although placing stations in the duplex gap would be less harmful, even those assignments would result in significant impairments to the mobile 600 MHz uplink and downlink blocks.[6] In short, there is really no "safe place" to put TV stations in the mobile 600 MHz band, and the *Notice's* proposal to favor uplink placement is the worst possible approach.

Uplink. Assignment of TV stations to spectrum blocks set aside for uplink transmissions can cause extensive and geographically widespread inter-service interference in two ways. First, it would create adjacent channel interference to other uplink blocks in the same PEA. Uplink involves the transmission of very weak signals from a battery-powered mobile device to a base station. Because these signals are so weak, base station equipment is highly sensitive. This increased sensitivity makes base station equipment especially susceptible to adjacent channel interference. A broadcast TV station, which can operate at power levels as high *1 megawatt*, could overwhelm base stations using adjacent channels and prevent them from operating effectively. In the typical scenario, the Commission's optimization and DRP procedures could

[6] *See*, *e.g.*, Report and Order and Order of Proposed Modification, *Promoting Interoperability in the 700 MHz Commercial Spectrum*, WT Docket Nos. 12-69 & 12-332, 28 FCC Rcd. 15122, ¶ 5 (2013) ("*700 MHz Interoperability Order*") (finding significant interference to mobile bands from broadcasts in the duplex gap).

assign a TV station somewhere in the middle of the uplink blocks. Because TV stations use 6 MHz of bandwidth (as opposed to 5 MHz for wireless services), the TV station would overlap with, and necessarily render unavailable, *two* spectrum blocks intended for mobile uplink. In addition, the adjacent channel interference would likely impair uplink in multiple additional 5 MHz blocks adjacent to the spectrum occupied by the TV station.

Second, TV stations can cause co-channel interference with broadband providers in *neighboring* PEAs. There are no filters or other technologies that can block such co-channel interference, and base stations are typically located high in the air where the TV station's broadcast signal is strongest. As a result, co-channel interference would extend hundreds of kilometers. For example, a station in New York could easily impede uplink operations in the same spectrum block in Philadelphia or even Baltimore.

Downlink. Assignment of TV stations in the downlink would also cause interference in many other spectrum blocks. In this scenario, the TV station would be transmitting high powered broadcasts using the same frequencies that mobile devices are using to receive signals from base stations. Full-power TV broadcast signals could easily cause front-end overload conditions in mobile devices, which means that devices could not use any 600 MHz downlink band.

Adjacent channel interference would be extensive. The Commission's proposed interoperability mandate would severely limit the ability to protect against such adjacent channel interference. With no effective filtering at all, large portions of the 600 MHz downlink blocks in any given PEA could be subject to substantial adjacent-channel interference from TV broadcasts.

It would be exceedingly impractical to attempt to deploy filters in mobile devices even if the Commission were inclined to permit it. The Commission would be assigning TV stations to

different spectrum blocks in different cities, and thus devices would need built-in filters for each block because different blocks would be subject to interference in different PEAs. Although real-world 600 MHz devices will likely have two overlapping filters covering the downlink due to the large size of the band, such filters would only be useful for the avoidance of interference if the Commission were to adopt an approach that ensured TV stations were all placed in frequencies where those filters could be effective (*e.g.*, only in the lower portion of the downlink band). But that would require constraining the placement of TV stations to a particular set of spectrum blocks throughout the nation, and in many cases it will not be possible to place TV stations in those frequencies. This approach may also require departures from the optimal filter sizes and design, resulting in reduced efficiency merely to cope with unnecessary interference. Moreover, such an approach would require filters that automatically turn on in areas where TV stations have been placed in the 600 MHz LTE band, effectively creating multiple band plans that could undermine the Commission's interoperability objectives.

Placement of TV stations in the downlink blocks would also (1) cause co-channel interference to devices attempting to use the same spectrum blocks in adjacent PEAs, and (2) necessitate the adoption of "exclusion zones" to protect TV receivers *from* interference caused by base station transmissions. Thus, placement of TV stations in the downlink will create areas where operators are impeded from even using the 600 MHz downlink.

Duplex Gap. Although placing TV stations in the duplex gap would likely be less harmful than placing them in the uplink or downlink, it would still cause significant interference to mobile spectrum. First, there would be adjacent channel interference to the uplink and

downlink mobile spectrum blocks. Second, as Qualcomm has explained, there is the potential for significant harmful interference to additional blocks caused by third order harmonics.[7]

Even placing much lower power unlicensed uses in the duplex gap would cause significant interference to mobile spectrum. Indeed, there is broad industry consensus that unlicensed uses will degrade service in adjacent spectrum blocks and reduce the value of that spectrum.[8] Thus, even to the extent Commission staff disagrees with this industry assessment, the bidders' perceptions are the only thing that matter in the auction, and it is clear that bidders will discount their bids in the forward clock auction to account for the possibility that they may end up with spectrum they believe may be degraded by unlicensed users in the duplex gap.

The Commission has previously acknowledged that TV stations and other broadcasts placed in mobile uplink, downlink, or duplex gap bands will cause precisely these sorts of harmful interference to mobile wireless operations. For example, such findings led the Commission to reduce permissible power limits for broadcast operations in the Lower 700 MHz D and E blocks. The Lower 700 MHz D and E blocks are located in the duplex gap for Band 12 (Lower 700 MHz A, B, and C blocks).[9] The Commission originally authorized licensees in the D and E Blocks to conduct broadcast operations with an Effective Radiated Power ("ERP") of up to 50 kilowatts within their authorized bandwidths. Based on a substantial evidentiary record, the Commission concluded that permitting such high-powered transmissions in the Lower 700 MHz D and E blocks could cause substantial adjacent channel interference to Band 12, including

[7] Comments of Qualcomm Inc., WT Docket No. 12-69 (June 1, 2012).

[8] *See, e.g.*, Comments of CTIA – The Wireless Association, ET Docket No. 14-165, GN Docket Nos. 14-166, 12-268 (Feb. 4, 2015).

[9] *700 MHz Interoperability Order* ¶ 5.

blocking the use of mobile spectrum altogether.[10] The Commission therefore adopted a new rule specifying that a Lower 700 MHz D and E Block base station transmitting a signal with an emission bandwidth greater than 1 MHz must not exceed 1 kW ERP per megahertz in non-rural areas or 2 kW ERP per megahertz in rural areas.[11]

The Commission's proposal here would result in interference far greater than the interference that led the Commission to adopt the revised rules for the Lower 700 MHz D and E Blocks. The TV stations here would often be transmitting at power levels many times higher than the D and E Block spectrum holders. At the same time, the adjacent licensees would have no protection from those signals. The Commission found that the 700 MHz D and E Block licensees would cause substantial adjacent interference to the B and C Blocks *notwithstanding* that filters could be used to attenuate interfering signals from the D and E Blocks.[12] Here, the separation will often be less and the use of filters would be not only ineffective (as in the 700 MHz context) but also extremely impractical.[13] With all of the other spectrum blocks in the uplink band fully exposed to the TV station's high-powered signals, any placement of a TV station in the uplink bands would likely cause serious impairments to uplink operations in the entire PEA.

---

[10] *700 MHz Interoperability Order* ¶ 21; *see also* Order, *Application of AT&T Inc. and Qualcomm Incorporated for Consent to Assign Licenses and Authorizations*, WT Docket 11-18, 26 FCC Rcd. 17589, ¶¶ 61-67 (2011) ("*AT&T-Qualcomm Order*").

[11] *700 MHz Interoperability Order* ¶ 21.

[12] *Id*.

[13] Since the Commission would be placing TV stations in different uplink blocks in different PEAs, providers would have to deploy different filters in each PEA to filter out TV signals from whichever spectrum blocks happened to have a station assigned in that PEA. In all events, uplink in that PEA would still be subject to interference from "roll-off" of the TV signal, and filters do nothing to stop co-channel interference from TV stations in adjacent PEAs.

B. The Complex Proposed Rules to Counteract the Negative Impact of Impairment Will Not Be Effective and Will Make Things Worse.

The introduction of extensive inter-service interference in the 600 MHz band will have serious negative impacts on the forward auction. An "essential" and "critical element" of the forward clock auction is that the spectrum on offer will be *fungible*.[14] If all of the available spectrum is essentially of the same quality, participants in the forward clock auction can confidently place bids that reflect the full value of the spectrum. The proposals in the *Notice*, however, would turn the 600 MHz band into a quilt of "good" and "impaired" spectrum, in which the degree of impairment will vary significantly from block to block, thus undermining this essential and critical element of the auction.

As Professors Haile and Kearns and Ms. Dworkin explain, this heterogeneity of the available spectrum will inevitably reduce revenues in the forward clock auction. Participants in the forward clock auction would have to bid without knowing which spectrum blocks they may ultimately receive and what the quality of that spectrum will be. Accordingly, "bids in the *clock phase* will certainly be suppressed," because all bidders will discount their bids to account for the possibility that they may ultimately end up with lower quality spectrum in the assignment round.[15] This could have disastrous consequences: "because it is the clock phase bids that determine satisfaction or failure of the final stage rule," the heterogeneity of the value of the licenses "risks causing failures of clearing targets that would have succeeded if 'generic' licenses were in fact generic."[16]

---

[14] *See Incentive Auction Order* ¶ 79 ("creating interchangeable spectrum blocks" is an "essential" and "critical element[] of the 600 MHz Band Plan to promote a successful incentive auction").

[15] Haile-Kearns-Dworkin at 7.

[16] *Id.* at 8.

Moreover, the artificially reduced amount of spectrum that will clear in the forward clock auction will not be allocated efficiently. As Professors Haile and Kearns and Ms. Dworkin explain, the Commission's proposal would change the function of the forward clock auction to a mere preliminary step "in which bidders compete for a good of highly uncertain value: admission to the 'real' auction in the assignment phase, where bidders can compete for specific licenses based on their actual values."[17] The assignment round, however, relies on a far more "complex auction design," and the uncertainty for bidders is exacerbated by the complex and, as yet, not clearly articulated, rules for determining which combinations of licenses a bidder will be able to pursue in the assignment phase.[18] Accordingly, bidding in the forward clock auction – which would now measure "[w]illingness to pay to enter the assignment phase" – will reflect "valuations for a lottery" rather than more precise valuations of the spectrum, and the "set of bidders willing to pay the most to enter this lottery need not include the bidders who value each license most highly."[19]

The introduction of substantial and variable degrees of interference into the 600 MHz band has led the Commission to propose extraordinarily complex forward auction rules that attempt to counteract the negative impacts of forcing participants to bid for heterogeneous spectrum blocks under conditions of severe uncertainty. None of the proposed measures will

[17] *Id.* at 6.

[18] *Id.* at 6-7. The assignment phase, at this point, is a black box and provides no guarantee that the highest bidder will obtain its preferred license. The *Notice* (¶ 200) states merely that "[i]n determining specific frequency assignments during the assignment phase of the forward auction, the auction system will take into account bid amounts as well as other efficiency objectives, such as maximizing contiguity for winners of multiple blocks in an area" and "these overall efficiency considerations will affect the way the auction system processes the bids to determine the optimal assignment of frequencies."

[19] Haile-Kearns-Dworkin at 7.

restore the conditions necessary for an efficient auction, and indeed, some of these measures are likely to exacerbate the problems.

Category 1 and Category 2. Recognizing that spectrum blocks with impairment levels ranging from zero to fifty percent are clearly not fungible, the *Notice* proposes to arbitrarily divide this spectrum into two "Categories" and auction the Categories separately. A "Category 1" license would have 0-15 percent of the population (weighted by spectrum values) subject to impairment from TV stations. A "Category 2" license would have 15-49 percent of the weighted population subject to such impairments. The *Notice* reasons that the licenses within these two categories will be sufficiently "fungible" to facilitate a successful forward auction. That is clearly incorrect.

Foremost, the impairment measures proposed by the Commission do not capture the true variation in impairment among spectrum blocks because they fail to account for the *type* of impairment. In some areas, the wireless operator must merely accept interference from the TV station, whereas in other areas the wireless operator is subject to an "exclusion zone," *i.e.*, the licensee is prohibited from providing mobile services in such areas *at all*. Contrary to the Commission's implicit assumption, a license subject to a 10 percent exclusion zone is not equivalent in value to a license in which 10 percent of the population may experience interference. Yet the Commission's proposal treats both the same, and bidders cannot tell the difference during the clock phase, which increases uncertainty and depresses bids.

Similarly, the *location* of the impairment has a significant impact on the value of the license. A license in which the impairment affects a dense downtown area may not be equivalent to a license with the same "percentage" impairment but where the impairment affects more peripheral areas. Indeed, even a Category 2 license with a 20 percent interference impairment in

less populated areas might be more valuable than a Category 1 license with a 10 percent exclusion zone covering a critical portion of the city.

The *Notice* acknowledges these issues and attempts to address them by using a population-weighted approach to computing impairment levels, but the Commission's methodology is very imprecise and will tend to understate the true level of impairment. For example, population levels tend to be low along major highways and railways and at major airports, and therefore the Commission's approach would give little weight to these areas when computing impairment levels. But the ability to offer reliable mobile services in these major commuting corridors is critical for mobile operators. Indeed, a license could hypothetically cover 85 percent of the weighted population but exclude 70 percent of the geography, including major highways.

In all events, the range of impairment for each Category is so broad that licenses within each Category clearly are not fungible. For example, Category 2 implausibly assumes that bidders would be indifferent when choosing between a license with 16 percent impairment and one with 49 percent impairment. These are very significant differences that would significantly affect any reasonable broadband provider's assessment of the value of a given license.

For these reasons, the Commission's two "Categories" do little to dispel the severe uncertainty that auction participants would face when attempting to bid in the forward auction. Prior auctions confirm that auction participants will bid lower for spectrum with significant impairment. The 700 MHz auction included Lower A Block spectrum, which was known to be subject to extensive exclusion zones and inter-service interference due to its proximity to Channel 51 and Lower D and E block broadcasts. The Lower 700 MHz A Block spectrum sold for far less than the similar but less impaired Lower 700 MHz B Block. Placing TV stations in

the 600 MHz band would cause substantially *greater* interference, affecting many more spectrum blocks and with much more variability, than was the case for Lower 700 MHz.

The 1 Percent Rule. The *Notice* also proposes that, if a bidder ends up with impaired spectrum in the assignment phase, the auction rules will give that bidder a discount of 1 percent for each 1 percent of impairment for that license. The Commission suggests that this measure should also help give auction participants the confidence to bid in the forward clock auction, knowing that they will not be forced to "overpay" in the assignment phase. As explained above, however, not all 1 percent impairments impose the same diminution in value, and the *Notice* provides no basis for assuming that the costs of any given impairment increases in a linear fashion with the increase weighted population affected.

The 20 Percent Rule. The *Notice* recognizes that placing TV stations in the 600 MHz band plan could easily result in impaired licenses covering large portions of the U.S. population. The *Notice* therefore proposes to use only band plans where no more than 20 percent of the U.S. population (weighted by available bandwidth and spectrum values) is covered by impaired spectrum. As explained by Professors Haile and Kearns and Ms. Dworkin, the proposed 20 percent rule is fundamentally flawed for a number of reasons.[20]

First, although the *Notice* implies that the approach to optimization and repacking may result in a national impairment substantially less than 20 percent, the appendices to the *Notice* confirm that a nationwide impairment level close to 20 percent is "baked in" to the proposed optimization and repacking routines. The Commission would begin the process with a very large clearing target, and if that clearing target cannot be met with a nationwide impairment of less than 20 percent, the Commission would move to the next lower clearing target, until the 20

[20] *Id.* at 22-26.

percent limitation can be met. This approach virtually guarantees that national impairments will be close to the 20 percent cap.[21] And to the extent there is any "headroom," the Dynamic Reserve Auction component of the reverse action – in which TV stations will be placed in the 600 MHz LTE band and paid lower prices – will most likely fill most or all of that headroom.[22]

Second, the proposed implementation of the 20 percent rule would not necessarily minimize impairment at a given clearing target. For a given clearing target, there may be multiple repacking solutions that result in less than 20 percent nationwide impairment. Under the proposed procedures, however, the Commission would not necessarily choose the solution with the lowest nationwide impairment. Instead, it would choose the solution with the smallest number of TV stations in the 600 MHz LTE band, even though there may be other solutions that produce lower nationwide impairment.[23] For example, if the solution with the least number of TV stations in the 600 MHz LTE band results in impairments in New York and Los Angeles, those impairments could cover far more MHz-POPs – and lead to a greater nationwide impairment level – than a solution with more stations in the 600 MHz LTE band but where the impairment is spread over peripheral areas. Relatedly, the Commission's methodology contains no mechanism that specifically seeks to avoid impairments in markets that are particularly important to the success of the auction, like New York.[24]

Third, the *Notice*'s approach would ignore potential better solutions at lower clearing targets. Under the Commission's approach, once it reaches a clearing target that can be satisfied

---

[21] *Id.* at 22-25; *see also id.* at 31 ("the clearing target maximization ensures that the [20 percent] impairment standard will be (nearly) saturated").

[22] *Id.* at 25-26 ("By its very nature, the DRP can only cause these impairment gaps to be filled further.").

[23] *Id.* at 20-24.

[24] *Id.* at 29-31.

under the 20 percent constraint, the Commission stops and uses that clearing target. This approach never considers whether there is an even better solution (significantly less impairment or even more total licenses for sale) at the next lower clearing target.[25]

Fourth, the 20 percent rule can facilitate absurd and highly undesirable results. For example, as Professors Haile and Kearns and Ms. Dworkin show, to attain a 126 MHz clearing target it will almost certainly be necessary to place a substantial number of TV stations in the 600 MHz LTE band.[26] They further show that there will likely be multiple solutions at these clearing levels under which the proposed national impairment number is under 20 percent (especially if the TV stations are placed in the uplink where impairments count only half as much as impairments to the downlink).[27] But although it appears that the 20 percent rule allows the Commission to reach 126 MHz clearing targets, these solutions include ones where half or more of the available blocks in major cities, *e.g.*, New York, Philadelphia, Los Angeles, and San Francisco, are more than 50 percent impaired and thus cannot actually be sold in the auction.[28] Indeed, more spectrum could actually be sold in these important cities using an 84 MHz clearing target, where very few, if any, TV stations would have to be placed in the 600 MHz LTE band.[29]

In addition, the 20 percent figure itself is entirely arbitrary. It is plucked from thin air. The *Notice* provides no basis for auctioning spectrum that would subject as much as one-fifth of the weighted population to inter-service interference. Nor has the Commission adequately explained why it chose to ignore the type or location of the impairment. And there is no

[25] *Id.* at 32.

[26] *Id.* at 31.

[27] *Id.* at 22-25.

[28] *Id.*

[29] *Id.* 31.

legitimate justification for counting uplink impairments only half as much as downlink impairments.[30] The *Notice* states that impairment of the uplink blocks still "might allow unimpaired use of the downlink portion of [the] paired 5+5 megahertz license."[31] Even if this were true, there is no evidence that an unpaired license or a paired license where the uplink is severely impaired is worth half the amount of a license that can be used for both uplink and downlink. To the contrary, to use downlink-only spectrum blocks, it would be necessary to equip mobile devices for supplemental downlink. This added cost – both in terms of direct equipment costs and opportunity cost of using up space and ports in the mobile device – will not likely be justified here, because the downlink-only blocks will be available only in certain PEAs scattered throughout the U.S., not in contiguous geographic blocks that can be used for supplemental downlink. Thus, the potential to use geographically isolated downlink spectrum for carrier aggregation is not at all likely to be valued at half the amount of usable paired spectrum.

C. The Commission Should Auction a Single Category of Spectrum That Is Relatively Unimpaired.

The Commission can vastly simplify both the forward and reverse auctions by including only one Category of fungible spectrum in the forward clock auction (as explained below, border regions would be treated slightly differently due to the unique but temporary cross-border interference challenges). With fungible spectrum, bidders would bid maximum amounts in the forward clock auction, which in turn will foster high clearing targets. There would be no need for a separate "Category 2" auction or determinations as to whether to place Category 2 spectrum

[30] *Notice* ¶ 29 ("we propose that rather than consider the uplink impairment above the threshold to be wholly impaired as we do with downlink impairments, we consider a county with uplink impairments above the threshold to be 50 percent impaired").

[31] *Id.*

in the reserved or unreserved auction. The reverse auction would be much simpler and more transparent, without the need for "black box" intra-stage and post-auction optimization procedures to ensure that nationwide interference remains below a prescribed cap. And the reduced auction complexity would reduce the potential for abuse that could undermine the integrity of the auction.

Given the enormous benefits of including only one Category of relatively unimpaired spectrum in the auction, the *Notice*'s proposals to develop an extraordinarily complex auction with multiple categories of spectrum sold in side-by-side auctions, with intra-bidding optimization to maintain impairment levels below certain levels, and the need to try to sort things out in the assignment phase, is perplexing and not supported by any data-driven analyses. There is no evidence that placing TV stations in the 600 MHz LTE band is needed to achieve large clearing targets and a successful auction (outside international borders areas, discussed below). To the contrary, preliminary analysis by Professors Haile and Kearns and Ms. Dworkin, based on the most recently available feasibility checker and related data released by the Commission, indicates that there is a very high likelihood that the auction will clear at least 84 MHz of spectrum nationwide without the need for placing TV stations in the 600 MHz LTE band, and certainly without the need for placing so many TV stations in the 600 MHz LTE band that licenses covering as much as 20 percent (or more) of the weighted population would be impaired.[32] Moreover, as discussed above, this solution may actually make more spectrum blocks available for sale in the auction compared to the ostensibly higher clearing targets in which TV stations are placed in the 600 MHz LTE band, because the impairments at those

[32] Haile-Kearns-Dworkin at 29.

higher clearing targets would actually exclude many spectrum blocks from the auction (as the impairments would exceed 50 percent).

To be sure, at this stage, there is insufficient data to rule out the need for some flexibility to place TV stations in the 600 MHz LTE band in the event it is needed to achieve reasonable nationwide clearing targets. But given the extraordinary harms associated with placing TV stations in the 600 MHz band, any decision to do so must be based on robust data-driven analyses demonstrating that it is necessary. And, if the data-driven analysis confirms a need to retain flexibility to place TV stations in the 600 MHz LTE band, the extent to which it will be permitted (*e.g.*, national impairment caps) must be based on a data-driven comparison of the costs (*e.g.*, impairments, lower auction revenues, potentially lower clearing targets) and benefits (*e.g.*, potentially higher clearing targets). As noted, analyses by Professors Haile and Kearns and Ms. Dworkin indicate that there may be no need at all to place TV stations in the 600 MHz LTE band to achieve reasonable nationwide clearing targets, and if there is a need, it will be small, thus justifying a much lower nationwide impairment cap.

In addition, before permitting TV stations to be placed in the 600 MHz band, the Commission should redouble its efforts to develop auction rules that reduce or eliminate the need to do so. For example, as Professors Haile and Kearns and Ms. Dworkin point out, under the proposed rules, the opening prices in the reverse auction will not accurately reflect the difficulty of repacking a particular TV station. Moreover, as the auction moves forward and TV stations begin to drop out of the auction (and thus require repacking), the Commission will gain substantial additional information as to how difficult it will be to repack the remaining TV stations remaining in the auction. The Commission could use these data to reduce clock price decreases for remaining TV stations that would be extremely difficult to repack, thus further

reducing the risk that TV stations will have to be placed in the 600 MHz LTE band to achieve desirable clearing targets.[33]

Adopting an approach that ensures a very small number of (or no) TV stations are placed in the 600 MHz LTE bands would eliminate the need to sell highly impaired Category 2 spectrum alongside relatively unimpaired Category 1 spectrum. Instead, because there would be very little or no Category 2 spectrum, the Commission need not include such spectrum in the forward auction. The auction would thus include only relatively "generic" Category 1 spectrum (defined based on a data-driven analysis, not necessarily the arbitrary "0-15%" proposed in the *Notice*).

Both the forward clock auction and the assignment phase would thus become vastly simpler and more effective, as bidders could bid confidently for generic blocks of spectrum. The reverse auction could also operate with much greater simplicity and transparency, as the Commission would no longer need much of the complex intra-stage and post-auction optimization procedures to ensure that nationwide interference remains below a prescribed cap. The vastly greater simplicity of such a scheme would also eliminate many of the "devil-is-in-the-details" complexities of the Commission's proposal that would invite manipulative bidding (discussed below). And, greater simplicity and transparency will almost certainly increase broadcaster participation, forward auction bids, and achievable clearing targets.

The Commission could address separately the spectrum that is impaired by TV stations operating in Canada and Mexico. This spectrum, while impaired today, is likely to be cleared of impairments in the future. It is thus reasonable to sell this spectrum in an auction. However, it could be auctioned separately in an ordinary SMR auction conducted after the incentive auction.

[33] *Id.* at 36-38.

Finally, to the extent that the Commission does find it necessary to place TV stations in the 600 MHz LTE band, it should do so in a manner that minimizes impairments to licensed spectrum and thus maximizes the amount of spectrum that could still be offered in the forward clock action. To this end, TV stations in the 600 MHz LTE band plan should only be placed in the duplex gap. This approach would preserve the maximum amount of spectrum blocks for the auction, provide a natural guard band between the TV station and licensed spectrum, and allow filters to more effectively protect licensed spectrum from adjacent channel interference. To the extent TV stations must be placed outside of the duplex gap, they should be placed in the downlink band. As discussed above, placing spectrum in the uplink interferes with highly sensitive base stations that are generally located high off the ground, which can impact a much larger geographic area than spectrum placed in the downlink.

II. THE PROPOSED REVISIONS TO THE SPECTRUM RESERVE WILL UNDERMINE THE SUCCESS OF THE AUCTION AND ARE FUNDAMENTALLY UNFAIR AND UNLAWFUL.

In the *Incentive Auction Order*, the Commission adopted a "reserve" auction in an effort to steer 600 MHz spectrum to favored bidders. Although AT&T explained at the time that a reserve auction would violate the Spectrum Act,[34] AT&T and other industry participants chose not to challenge the *Incentive Auction Order* because the Commission promised safeguards to minimize the most serious harms.[35] Specifically, the Commission promised that: (1) only a small portion of the total amount of spectrum in a PEA would be put in the reserve auction, such that at least half of the available spectrum would be placed in the unreserved auction; (2) there would be

[34] *See* Letter from Peter Keisler, Counsel for AT&T, to Marlene H. Dortch, FCC, GN Docket No. 12-268, WT Docket No. 12-269 (May 7, 2014) ("*AT&T 5/7/14 Legal Letter*").

[35] *See* Letter from Joan Marsh, AT&T, to Marlene H. Dortch, FCC, GN Docket No. 12-268, WT Docket No. 12-269 (May 9, 2014); Letter from Joan Marsh, AT&T, to Marlene H. Dortch, FCC, GN Docket No. 12-268, WT Docket No. 12-269 (May 14, 2014).

market-based triggers to prevent reserved spectrum from being sold at large discounts; and (3) reserve-eligible bidders would not be able to artificially inflate prices in the unreserved auction or otherwise manipulate the auction. As described below, the *Notice* proposes to renege on these promises and to add new rules that further disadvantage unreserved bidders – all in ways that would harm auction outcomes and render the reserve auction unlawful.

The Commission should return to its original plan by (1) adopting market-based pricing triggers that are higher than proposed in the *Notice* and not tethered to the final stage rules; (2) determine the amount of spectrum in the unreserved auction based on the total amount of spectrum actually offered for sale in each PEA; (3) ensure that unimpaired spectrum is allocated first to the unreserved auction; and (4) ensure that reserve bidders cannot engage in manipulative bidding.

A. The Commission Should Not Renege on Its Promises to Ensure That Reserve Spectrum Sells for Market-Based Prices.

The Communications Act requires the incentive auction to ensure "recovery for the public of a portion of the value of the public spectrum resource made available for commercial use and avoidance of unjust enrichment through the methods employed to award uses of that resource."[36] In the *Incentive Auction Order*, the Commission recognized that the reserve auction therefore must have appropriate safeguards to ensure that reserve spectrum is not sold at prices below market levels, because that would give reserve-eligible bidders an unwarranted windfall and deprive taxpayers of a "portion of the value" of the spectrum.[37] The Commission thus

[36] 47 U.S.C. § 309(j)(3)(C).

[37] 47 U.S.C. § 309(j)(3)(C); *see also Incentive Auction Order* ¶ 343 ("[a]n objective common to *all* FCC auction of spectrum licenses is that auction prices generally reflect competitive market values for comparable spectrum licenses" (emphasis added)).

promised in the *Incentive Auction Order* to adopt rules that would not place spectrum in the reserve auction until bid prices reached a "market-based" price per MHz-POP trigger.[38]

The *Notice*, however, proposes to set the market-based trigger at only $1.25 per MHz-POP based on bids in the top 40 PEAs. The *Notice* justifies this figure on the theory that it is consistent with the overall average price attained for 700 MHz spectrum, which was $1.36 per MHz-POP, not $1.25. Those 2008 700 MHz results are not a valid benchmark. First, the $1.36 per MHz-POP reflects the prices for two heavily encumbered blocks of spectrum, *i.e.*, the Lower A Block and Upper C Block.[39] As the Commission recently acknowledged, the prices for Lower 700 MHz B Block spectrum are "most comparable to the 600 MHz band plan," and those blocks sold for $2.65 per MHz-POP.[40] But even that figure is too low. The incentive auction trigger is to be computed based on bids in the top 40 PEAs. The average per MHz-POP price for Lower 700 MHz B Block spectrum in the top 40 PEAs in Auction 73 was about $3.75 – and as much as over $8.00 in Chicago. These prices are confirmed by the recent AWS-3 auction in which spectrum sold for an average of about $3.52 per MHz-POP in the top 40 PEAs, notwithstanding that it is high-band spectrum that is encumbered by various federal government users that cannot be cleared for years.

---

[38] Report and Order, *Policies Regarding Mobile Spectrum Holdings, et al.*, WT Docket No. 12-269, et al., 29 FCC Rcd. 6133, ¶ 194 (rel. June 2, 2014) (emphasis added) ("*Mobile Spectrum Holdings Order*") (explaining that its rules would "ensure spectrum is reserved only where there is demand at market-based prices.").

[39] The Lower 700 MHz spectrum was impaired by interference from broadcast stations and the Upper 700 MHz C Block spectrum was encumbered by experimental "open access" requirements. *See also* Statement of Comm'r Robert M. McDowell, FCC, *Before the Subcomm. on Telecomms. and Internet of the H. Comm. on Energy and Commerce* (April 15, 2008), *available at* https://apps.fcc.gov/edocs_public/attachmatch/DOC-281579A1.pdf.

[40] Greenhill, Incentive Auction Opportunities for Broadcasters, at 6 (October 2014), *available at*, http://wireless.fcc.gov/incentiveauctions/learn-program/docs/ia-opportunities-book.pdf.

As the Commission itself has recognized, adopting a trigger below market-based levels would undermine the objectives of the auction. The Commission previously emphasized that this "contingent nature of the reserve will create reserves only in PEAs where there is sufficient demand at the point where the spectrum reserve trigger is reached" and "[t]his will ensure spectrum is reserved only where there is demand at *market-based prices* and increase in the likelihood that the auction will close at a higher spectrum target."[41]

An improperly low market-based pricing trigger would also place too much spectrum in the reserve auction. The amount of spectrum placed in the reserve auction depends on the demand for spectrum by reserve-eligible bidders at the trigger price. If the trigger is set below market-based levels, reserve-eligible bidders will demand more spectrum at those levels, which could lead to more spectrum being placed in the reserve than would otherwise be the case (which would increase the amount of spectrum selling below market-based levels).[42]

Moreover, permitting spectrum to be sold at large discounts in the reserve auction would unfairly result in non-reserve eligible bidders subsidizing the cost of the auction. The Commission initially promised that a market-based pricing trigger "will ensure that all bidders, those eligible to bid on reserved spectrum and other bidders, contribute a *fair share* to the clearing costs identified in the reverse auction and other costs specified [by statute and Commission policy]."[43] If reserve-eligible bidders are given substantial discounts, the amount

---

[41] *Mobile Spectrum Holdings Order* ¶ 194 (emphasis added).

[42] Haile-Kearns-Dworkin at 12 ("by triggering the reserve too early the Commission would risk overshooting its goal, setting aside too much spectrum for [reserve eligible bidders]"); *see also Mobile Spectrum Holdings Order* ¶ 192 ("Under the market-based spectrum reserve rule, the amount of reserved spectrum in each individual PEA will be set at the level demanded by reserve-eligible entities at the time the spectrum reserve trigger is satisfied, up to the maximum amount of reserved spectrum at the beginning of the stage.").

[43] *Mobile Spectrum Holdings Order* ¶ 194 (emphasis added); *see also, e.g., id.* ¶ 186 ("the *actual* amount of spectrum available only to reserve-eligible bidders will be determined at a spectrum

they pay will not cover their fair share of the costs of clearing the spectrum they purchased, and the unreserved bidders would have to make up the difference and, in essence, fund most of the clearing of the spectrum that is made available for all parties.

It appears that the Commission may be proposing such a low market-based trigger because that trigger is also part of the final stage rule, which determines the amount of spectrum that is ultimately cleared in a PEA. Consequently, increasing the market-based trigger effectively increases the pricing threshold for the final stage rule as well and risks a decrease in the achievable clearing targets. As Professors Haile and Kearns and Ms. Dworkin explain, however, there is a simple solution: the reserve auction trigger should be de-coupled from the final stage rule.[44] Under this approach the final stage rule would be met when forward-auction prices can cover the cost of purchasing spectrum from broadcasters and any other costs that must be recovered under the Act. At that point, the forward clock auction would move forward with all bidders allowed to bid on all spectrum until prices hit the reserve auction trigger, at which time spectrum will be allocated to the reserve auction.[45]

B. The Commission Should Reaffirm That Reserve Spectrum Amounts Will Be Tied to Total Cleared Spectrum in a PEA.

The Commission should maintain the mechanism that limits the amount of spectrum allocated to the reserve auction based on the total amount of spectrum available in each stage. In the *Incentive Auction Order*, the Commission held that the "minimum" amount of spectrum

---

reserve trigger that fairly distributes the responsibility for satisfying the costs of the Incentive Auction among all bidders").

[44] Haile-Kearns-Dworkin at 14 ("these distortions are not necessitated by the Commission's objectives" but rather "are the result of an unnecessary and arbitrary choice to equate the reserve trigger criteria and the final stage rule criteria").

[45] *Id.*

placed in the unreserved auction and the "maximum" amount of spectrum placed in the reserved auction at each stage would be determined according to the table below.

Licensed Spectrum In the Initial Clearing Target (in megahertz)	100*	90	70	60	50	40
Minimum Unreserved Spectrum	70	60	40	40	40	30
Maximum Reserved Spectrum[46]	30	30	30	20	10	10

*The maximum amount of reserved licensed spectrum is 30 megahertz for initial clearing targets with more than 100 megahertz of licensed spectrum.

The *Notice* modifies this approach by proposing to fix the amount in the reserve auction based on the "initial" clearing target, not on the actual amounts of spectrum offered for sale: "if the initial clearing target is 70 megahertz, the maximum reserve will be 30 megahertz in the initial *and subsequent stages*, provided that reserve-eligible bidders continue to demand that amount."[47] For example, if the initial clearing target is above 70 MHz or higher (which it almost certainly will be), then 30 MHz can be placed in the reserve auction, regardless of whether the actual amount of spectrum cleared and available for sale (*i.e.*, the number of blocks that are less than 50 percent impaired) is lower. Thus, if the initial clearing target is set at 70 MHz, then 30 MHz would be placed in the reserve auction even if the final clearing level is 40 MHz – a level that would leave only 10 MHz for unreserved bidders to acquire.[48]

This is an unacknowledged and unexplained departure from the *Incentive Auction Order*. The *Incentive Auction Order* explicitly stated that "[u]nder the market-based spectrum reserve

[46] This is the maximum amount, because if demand by reserved bidders is lower, than that lower amount will be placed in the reserve auction.

[47] *Notice* ¶ 23 n.66 (emphasis added).

[48] The effect of this rule would be exacerbated by the Commission's proposal to place all of the Category 2 spectrum in the unreserved auction.

rule, the amount of reserved spectrum in each individual PEA will be set at the level demanded by reserve-eligible entities at the time the spectrum reserve trigger is satisfied, up to the maximum amount of reserved spectrum *at the beginning of the stage*."[49] The Commission therefore promised to tie the maximum reserve amount to the total amount of spectrum in each stage, not just the initial stage. Indeed, the Commission defended the reserve auction in part on the grounds that "under the market-based spectrum reserve, every bidder will have the opportunity to bid for, and win, at least half of the 600 MHz band spectrum in each market and at some levels of spectrum made available in the forward auction, significantly more than half."[50] But under the *Notice's* formulation, non-reserve eligible bidders could be denied the ability to bid for at least half the spectrum.

Even T-Mobile, a staunch proponent of increasing the amount of reserve spectrum, has recognized that the *Incentive Auction Order* tied the amount of reserve spectrum to the amount of spectrum that was ultimately cleared, not to initial clearing targets. T-Mobile has complained that the "reserve saves a maximum of thirty megahertz of spectrum in each license area for competitive carriers and . . . this amount steadily decreases at lower levels of spectrum clearing," and "the adopted framework ensures forty megahertz of unreserved spectrum remains at nearly all levels of clearing."[51]

---

[49] *Mobile Spectrum Holdings Order* ¶ 192 (emphasis added); *see also id.* ¶ 187 ("[t]he amount of reserved spectrum will be the smaller of: (1) the maximum amount of reserved spectrum *for that stage*, or (2) the amount demanded by reserve-eligible bidders at the trigger.").

[50] *Id.* ¶ 162.

[51] T-Mobile Petition for Reconsideration, *Policies Regarding Mobile Spectrum Holdings*, WT Docket No. 12-269, at 8-9 (Aug. 11, 2014) ("TMO Recon. Pet."). *See also id.* at 10 (referring to the "Commission's decision to decrease the amount of reserved spectrum at clearing levels below seventy megahertz").

The Commission should not modify the method for computing reserve spectrum levels.[52] The Commission has already specifically concluded that any procedure that would "potentially reduce the amount of unreserved spectrum to 20 or even 10 megahertz" would result in unreserved spectrum levels that are "too low" and would not "provide all bidders with an adequate opportunity to acquire licenses in the 600 MHz band."[53] Moreover, proposals that would leave such small amounts of unreserved spectrum would effectively cap the amount of spectrum that AT&T and Verizon could obtain, and the Commission has expressly rejected such approaches, finding that they "have a greater risk of decreasing forward auction proceeds, and thus endangering our ability to repurpose spectrum, because it likely would lessen competition between the largest wireless providers for spectrum in amounts greater than the cap would permit."[54]

C. The Commission Should Not Place Only Category 1 Spectrum in the Reserve Auction.

As discussed above, the Commission's proposal to place TV stations in the mobile 600 MHz bands will create substantial interference and reduce the value of much of the spectrum on offer. The *Notice* proposes to conduct separate forward clock auctions for Category 1 and Category 2 licenses. Pertinent here, however, the Commission proposes to place *only* Category 1

---

[52] *See* Haile-Kearns-Dworkin at 10-12 ("the number of reserved licenses should be linked . . . to the actual number of licenses currently on offer in each PEA," because that approach "would enable the Commission to guarantee [reserve eligible bidders] access to a significant share of the available licenses without the threat of competition from non-[reserve bidders], but it would do so without the potential for substantially excluding non-[reserve bidders] from the auction").

[53] *Mobile Spectrum Holdings Order* ¶ 191. *See also id*. ¶ 160 ("the spectrum reserve gives mobile service providers significant latitude to bid on spectrum licenses they need in each area to meet their network requirements, including providers who are unable to bid for reserved spectrum in a particular PEA").

[54] *Id*. ¶ 161.

licenses in the reserve auction, with any remaining Category 1 licenses and all Category 2 licenses placed in the unreserved auction.

The Commission should reject this proposal because it would be fundamentally unfair and unlawful, and would lead to significantly lower auction revenues and correspondingly lower clearing targets. Category 1 spectrum will be the most valuable spectrum in this auction. Placing that spectrum in the reserve auction, where bidding will be limited to reserve-eligible bidders, will allow such bidders to win that spectrum at low prices, particularly in light of the extremely low proposed market-based trigger for the reserve auction ($1.25 per MHz-POP). An auction where the lowest prices are obtained for the highest valued licenses could easily result in lower clearing targets or even a failed auction.

The *Notice* suggests that the Commission expects the majority of spectrum to be Category 1 spectrum, and that this proposal will therefore have only a small impact on the amount of Category 1 spectrum left for unreserved bidders. The *Notice* offers no data or analyses supporting this assumption. And as explained above, that is unlikely to be the case. In areas where the Commission places a TV station in the 600 MHz band plan, a large number of surrounding spectrum blocks will be impaired. As a result, some PEAs very likely will have only very small amounts of Category 1 spectrum.

Of course, if the Commission adopts the proposal to auction only Category 1 spectrum as discussed above, then this issue will resolve itself. But if the Commission does adopt some form of its current proposal in which it auctions highly impaired Category 2 spectrum, it should fill the reserve allocation first with any Category 2 spectrum in the PEA, followed by any Category 1 blocks necessary to meet the reserve allocation.

D. The Commission Should Eliminate Features of the Auction That Enable Reserve Eligible Bidders to Artificially Bid Up Unreserved Spectrum Prices.

The *Notice* proposes bidding rules that would further depress auction revenues by facilitating strategic behavior on the part of the reserve-eligible bidders. The rules would offer reserve-eligible bidders two prices for Category 1 licenses in a PEA in the reserved and unreserved auctions, and would permit reserve-eligible bidders to bid for unreserved licenses instead of reserved licenses even when the reserved price is lower. As Professors Haile and Kearns and Ms. Dworkin explain, "[t]his is an unnecessary complication that introduces a new opportunity for manipulative bidding" because "such bidding can 'stop the clock' for reserved licenses while driving up the prices that non-[reserve-eligible bidders] pay."[55] The Commission should therefore modify the auction rules so that, "in the simplest terms, [reserve-eligible bidders] *should not be permitted to express a preference for high prices*."[56] Although there may be a number of possible solutions, Professors Haile and Kearns and Ms. Dworkin suggest a possible way of modifying the proposal so that reserve-eligible bidders cannot bid up unreserved spectrum while paying no penalty in the reserve auction.[57]

E. The Commission's Proposed Modifications to the Reserve Auction Would Render the Reserve Auction Unlawful.

Even if the reserve auction as originally proposed were lawful – and as AT&T previously demonstrated, it is not[58] – the Commission's new proposals make the reserve auction so one-sided that, if adopted, the auction would unquestionably violate the Spectrum Act. In the Spectrum Act, Congress specifically prohibits the Commission from adopting auction-specific

---

[55] Haile-Kearns-Dworkin at 14.

[56] *Id.* at 14-15 (emphasis in original).

[57] *Id.* at 15-16.

[58] *See generally, AT&T 5/7/14 Legal Letter*.

rules that would prevent otherwise qualified carriers like AT&T from participating in the auctions of the broadcast spectrum.[59] Section 309(j)(17)(A) provides that, "[n]otwithstanding any other provision of law, the Commission may not prevent a person from participating in a system of competitive bidding under this subsection" as long as the potential bidder meets certain technical and eligibility requirements that are not at issue here.[60] The Commission's approach is thus already on shaky ground, because it "prevents" AT&T from participating in a "system of competitive bidding" – namely, the reserve auction.[61]

Although the Spectrum Act permits the Commission to "adopt and enforce rules of general applicability, including rules concerning spectrum aggregation that promote competition,"[62] the Commission could not defend any of the proposals in the *Notice* as having any conceivable connection to rules of general applicability.[63] Indeed, on their face, the proposals to force AT&T to bid for the worst "Category 2" spectrum while the best "Category 1" spectrum is handed to its marketplace competitors for prices far below market levels are clearly *auction-specific* rules that have no life outside this proceeding and dramatically increase the barriers to AT&T's "participation" in this "system of competitive bidding."[64]

The Commission's modifications also cannot be squared with the Commission's stated goals for the reserve auction in the *Incentive Auction Order*. The Commission wanted to give certain bidders an enhanced opportunity to acquire below-1-GHz spectrum, but in ways that

---

[59] 47 U.S.C. § 309(j)(17).

[60] 47 U.S.C. § 309(j)(17)(A).

[61] *AT&T 5/7/14 Legal Letter* at 3.

[62] 42 U.S.C. § 309(j)(17)(B).

[63] The Commission has already held that permitting AT&T to win spectrum in the *un*reserved auction would raise no spectrum aggregation issue.

[64] 47 U.S.C. § 309(j)(17)(A).

ensured that all participants had a opportunity to bid for a majority of the spectrum and would "shar[e] the costs of the Incentive Auction on a fair and equitable basis."[65] The *Notice* departs from these objectives without explanation. As Professors Haile and Kearns and Ms. Dworkin show, the proposed rules constrict the amount and degrade the quality of the spectrum available to unreserved bidders, while ensuring that reserve-eligible bidders are simply given the best-quality spectrum at prices far below market levels (thus forcing AT&T to bear more than its "fair and equitable" share of the costs of the auction). The proposed rules therefore *undermine* the Commission's stated objectives, inviting reserve-eligible bidders to manipulate the bidding and permitting lopsided outcomes that have nothing to do with the Commission's spectrum aggregation related goals.

III. THE COMMISSION SHOULD NOT ADOPT PROPOSALS THAT THREATEN TO REDUCE PARTICIPATION BY BROADCASTERS.

Simplicity and transparency are also critical to the success of the reverse auction. The auction rules must ensure that opening prices offered to broadcasters are sufficient to attract participation of the broadcasters that will be most difficult to repack, and the procedures must make it easy for broadcasters to understand the benefits of the options available to them.[66] The procedures proposed in the *Notice* fail both criteria. While AT&T expects broadcasters to comment on these issues more extensively, it is clear that the proposed rules threaten to reduce broadcaster participation by sending inefficient pricing signals and adding immense complexity.

First, the *Notice*'s proposals are not well-designed to attract the broadcasters most critical to the repacking process. Opening prices will determine the outer limits of broadcaster

[65] *Mobile Spectrum Holdings Order* ¶ 154.

[66] *See, e.g.*, *Incentive Auction Order* ¶¶ 2, 9 (the Commission is "striving for simplicity" and is "committed to removing barriers to [] voluntary participation"); *id.* ¶ 13 ("[w]e [] are committed to an open, transparent process").

participation. As the Commission recognizes, some broadcasters will be especially difficult to repack (or represent the key to unlocking other, more extensive repacking possibilities), and thus the Commission must develop a robust method of calculating opening prices that are high enough to induce such broadcasters to participate in the auction.[67]

The *Notice*'s approach, however, appears to be flawed in multiple respects. The Commission proposes to account for the difficulty of repacking a broadcaster through a metric it calls "Volume," which is equal to the square root of the "population" covered by the broadcaster multiplied by the square root of "Interference" associated with the broadcaster.[68] "Interference," which is the factor intended to capture repacking difficulty, is the sum of maximum "pairwise constraints" (*i.e.*, co- and adjacent constraints) for each channel with other channels in the repacking process.

Focusing solely on pairwise constraints is inadequate, because, as Professors Haile and Kearns and Ms. Dworkin show, such a measure can dramatically under- or over-state how important a broadcaster's participation is to the achieving a clearing target.[69] For example, while failure to relocate a channel may create constraints in relocating another channel (a pairwise constraint), the constraints on the second channel can create constraints on yet additional channels, and so on.[70] The greater the cascading effects, the more difficult it will be to clear significant spectrum absent the broadcaster's participation.[71] By failing to account for these cascading effects, the *Notice*'s proposed method would generate incorrect pricing signals that

---

[67] *Notice* ¶¶ 95-96.

[68] The formula is written as "Volume = (Population * Interference)$^{0.5}$". *Notice* ¶ 95.

[69] Haile-Kearns-Dworkin at 33-36.

[70] *Id.*

[71] *Id*.

may fail to induce participation by the broadcasters most important to the clearing of a large amount of spectrum.[72] On the other hand, the Commission's method can also overstate a station's importance, which is also harmful to the auction. As Professors Haile and Kearns and Ms. Dworkin show, there are examples where a broadcaster has many pairwise constraints – which would indicate a difficult station to repack – when in fact, it could be relatively easy to repack the station.[73] Under the approach in the *Notice*, such broadcasters would be substantially overpaid for their spectrum rights, which increases the potential for auction failure. As Professors Haile and Kearns and Ms. Dworkin explain, "[t]here is no need to rely on [these] crude counting measure[s]; empirical data derived from the results of feasibility checks and simulations provides a more accurate measure of difficulty."[74]

Second, the procedures that broadcasters must follow in the reverse auction are unduly complex and opaque and, as a result, likely to deter participation. For example, the *Notice*'s "clearing target optimization" methodology provides that, after broadcasters provide the Commission with their preferences (go-off air, move to high-VHF, move to low VHF), the Commission "will determine an initial assignment of participation stations to relinquishment options consistent with the station's initial commitments made during the application process . . . and will attempt to assign as many stations as possible to their preferred option."[75] But broadcasters must declare these preferences under significant uncertainty. The optimization procedure's primary objective is to "minimize the total impaired weighted-pops nationwide," which the Commission will determine based on an extremely complex procedure that the *Notice*

[72] *Id.*

[73] *Id.*

[74] *Id.* at 33; *see also id.* at 34 ("any empirical measure based on the results of actual feasibility checks would be more accurate than simple constraint-counting").

[75] *Notice* ¶ 42.

does not provide. Moreover, the Commission proposes to add various as-yet-unnamed "secondary objectives" that would saddle broadcasters with yet another layer of complexity and uncertainty to the process.[76]

Third, the Commission should not adopt its "Dynamic Reserve Auction" proposal ("DRA"). The DRA is inextricably intertwined with the Commission's ill-advised decision to assign TV stations to the 600 MHz band. Absent the DRA, the reverse auction would continue until the clock prices reach a level where the number of broadcasters offering to relinquish their spectrum is equal to the amount of spectrum needed to satisfy the clearing target for that stage. Under the newly proposed DRA, however, the reverse auction would continue, and clock prices would keep falling, in an attempt to drive more broadcasters out of the auction on the theory that additional stations could be repacked into the 600 MHz band. According to the *Notice*, prices would keep falling as long as broadcasters participating in the auction could be placed in the 600 MHz mobile band plan without exceeding the national 20 percent impairment level.[77]

As explained above, the Commission should not adopt any auction rules that contemplate assigning TV stations in the 600 MHz band. But even apart from the manifest harms such assignments would cause both for consumers and the forward clock auction, the accompanying DRA procedures would add considerable complexity to the reverse auction for broadcasters. The *Notice* does not explain how the Commission intends to calculate whether clock prices have dropped to a level at which no remaining stations can be placed in the 600 MHz band without

---

[76] *Id.* ¶ 44. The Commission also proposes a hierarchy of bidding options for broadcasters but permits only a one-way ratchet during the bidding – bidders may move only from greater to lesser relinquishments. The Commission suggests that this approach simplifies the auction for broadcasters, but in fact it makes broadcasters' decisions more complex. Instead of simply being able to accept or reject prices for all relinquishment options at each phase, broadcasters must now game-plan around these bidding constraints.

[77] *Id.* ¶¶ 106-110.

exceeding national 20 percent impairment (indeed, it asks commenters for ideas),[78] but it is clear this will be an extremely complex computation no matter how it is done.

IV. THE COMMISSION SHOULD ENSURE THAT THE BIDDING RULES FACILITATE AUCTION INTEGRITY AND PRECLUDE THE SORT OF MANIPULATION THAT OCCURRED IN THE AWS-3 AUCTION.

The bidding rules should be simple and transparent to preserve the integrity of the auction. The AWS-3 auction vividly illustrates why. There, Dish Network ("Dish") exploited certain complexities in the auction rules to claim a discount of more than $3 billion at taxpayers' expense and to win spectrum for which T-Mobile and others were likely willing to pay more. The potential for such manipulation and the corresponding need for rules to avoid it are even greater here because this auction is far more complex.

Joint Bidding. In the AWS-3 auction, Dish established two new entities – SNR Wireless LicenseCo, LLC and Northstar Wireless, LLC – in which Dish held an 85 percent interest. These "Dish Entities" took advantage of the joint bidding rules to implement coordinated bidding strategies that artificially drove up prices and avoided activity rules designed to ensure that bidders reveal their demand for spectrum early in the auction.

For example, the Dish Entities used joint bidding to rapidly drive up prices for spectrum blocks in some of the largest markets, including Chicago, often bidding against themselves. These rapid price increases forced other bidders to choose between spending their bidding units in these markets or shifting them to other markets that were not being manipulated. It appears that these activities pushed T-Mobile and other bidders out of bidding contention in Chicago and other large markets in early rounds.

[78] *Id.* ¶ 109.

The Dish Entities also used joint bidding to avoid the activity rules. The activity rules require bidders to place bids for a certain portion of their bidding units or else lose bidding units in subsequent rounds. These rules prevent bidders from hiding their demand for certain spectrum in early rounds, thus preserving a more open and efficient auction.[79] But for spectrum blocks where one Dish Entity planned to bid aggressively, the other two entities could simply park bids with no risk of winning, yet effectively "participate" and thus maintain their bidding credits.[80] In some cases, the Dish Entities used this strategy to park their bidding units in less desirable and less expensive unpaired spectrum. In this way, the Dish Entities were able to disguise demand for the actual spectrum they were seeking until late in the auction.

The potential for unanticipated manipulation of joint bidding in the 600 MHz auction is far greater, because the 600 MHz auction is far more complex. Rather than being a single SMR auction, the 600 MHz auction (as currently proposed) would be subdivided into unreserved and reserved auctions and Category 1 and Category 2 auctions, where reserve bidders can move freely between all auctions whereas non-reserve bidders can only partially move between Category 1 and Category 2 auctions. There is also intra-round bidding and an assignment phase, providing yet additional opportunities for joint bidding manipulation. To protect against both foreseeable and unanticipated abuses of the joint bidding rules, the Commission should prohibit

[79] *See* Haile-Kearns-Dworkin at 18-19.

[80] The Dish Entities used a strategy called "bid-stacking." *See* Haile-Kearns-Dworkin at 18-19 ("Bid stacking provides a way of maintaining eligibility without making a serious bid. . . . [A] bidder who wishes to hide its intentions and maintain eligibility could stack arbitrarily many bids on top of a single serious bid.)" *Id.* (The Dish Entities' "joint-bidding consortium as a whole would be engage[ed] in . . . bid stacking . . . As a whole, the consortium could win only one unit, so the two extra units of demand [placed on the same spectrum by the other two Dish Entities] reflect a riskless way to hide the consortium's true intentions and maintain eligibility, defeating the activity rule").

joint bidding in this auction, and require bidders that wish to coordinate to form a joint venture or consortium.

Designated Entity Requirements. The recent AWS-3 auction highlights the need to revise the Designated Entity ("DE") requirements to ensure that auction subsidies are provided only to bidders they are intended to support. In the AWS-3 auction, Dish claims more than $3 billion in subsidies ultimately paid for by taxpayers. While there are challenges in designing a DE rule that block such conduct while ensuring that the small businesses obtain the benefits intended by those rules, AT&T has proposed an approach in its Comments filed today (in GN Docket No. 12-268) that balances the need to provide subsidies to small businesses against the types of conduct implemented by Dish.

Extended Round. The *Notice* proposes rules that permit extended round bidding, in which bidders will be given an opportunity to increase their bids between rounds to reach the final stage rules and thus avoid having unnecessarily to move to the next lower clearing target. AT&T agrees that permitting extended round bidding would be useful for this purpose. However, the Notice's proposal will undermine these objectives and should be modified.

Under the *Notice*, extended round bidding is triggered at the end of a clock round if (i) demand for licenses in the "high-demand" PEAs does not exceed the available supply and (ii) the final stage rule has not been met. Moreover, bidding in the extended round is limited to bidding on licenses in the high-demand PEAs. As Professors Haile and Kearns and Ms. Dworkin explain, there are two problems with this approach.[81] "The first problem is that, once the extend round is triggered, bidders are not permitted to express higher willingness to pay for licenses outside the high-demand PEAs" which "could result in failure of a clearing target that would

[81] Haile-Kearns-Dworkin at 15-16.

have succeeded if the extended round permitted bidding on all licenses."[82] The *Notice* provides no reason for limiting bidding in this way.

The second problem is that the triggering mechanisms for the extended round are tied entirely to auction results for the high-demand PEAs. Suppose, for example, demand has equated in high-demand PEAs, that the final stage rule is not met, and that there is still excess demand for licenses in non-high demand PEAs. In this situation, permitting the clock phase to continue until demand equalizes with supply in non-high demand PEAs could very well result in the final stage rule being met. But under the proposed rules, this situation would trigger an extended round with no further bidding in the non-high demand PEAs, and where failure of the extended round would result in moving to the next lower clearing target. Obviously, permitting clock bidding to continue in non-high demand PEAs before moving to more risky extended round would increase the likelihood of satisfying the final stage rule.[83] The *Notice* justifies ignoring non-high demand PEAs on the grounds that waiting for market clearing in all PEAs could take additional time, but it is far from clear that any value from time savings is offset by the risk that lower clearing targets will be attained.

The Commission should modify the extended round to (1) permit extended round bidding for licenses in non-high demand PEAs and (2) structure the rule so the extended round is not triggered until demand and supply in all or (almost all) PEAS have equalized.[84]

Demand Reduction. The *Notice* proposes not to process reductions in demand for 5x5 spectrum licenses in a PEA as the price rises if the reduction would result in excess supply. This proposal could undermine incentives for bidders that want multiple 5x5 licenses. As explained

[82] *Id.* at 16.

[83] *Id.*

[84] *Id.*

by Professors Haile and Kearns and Ms. Dworkin, these bidders view 5x5 licenses as complements, and thus place a greater value on each 5x5 license when purchased in pairs than when purchased alone. Consequently, for these bidders prohibiting reductions in demand introduces the "risk [of] being forced by the Commission to buy a single license at a price that exceeds its standalone value," which would "be a further discouragement to aggressive participation by wireless providers whose valuations are heavily dependent on complementarities."[85]

The Commission should therefore reconsider this proposal to better balance concerns about undersell against the effect that additional exposure risk will have on bidders' willingness to accept high prices. As Professors Haile and Kearns and Ms. Dworkin explain, the proposal in the *Notice* is an "an extreme 'corner solution' that is unlikely to be optimal" and, "[a]t a minimum, bidders should be given waivers to allow a limited number of withdrawals of demand when such withdrawal would create (at least temporarily) excess supply."[86]

Bid Increments. The *Notice* proposes to adopt bidding increments between 5-15 percent. The Commission should use increments at the very bottom of this range, at least until price clocks have stopped for most licenses. Smaller bid increments permits bidders to more finely express demand and to make appropriate adjustments to their bids in response to changes in auction prices. As explained by Professors Haile and Kearns and Ms. Dworkin, "[a]ny restriction on the expression of demand adjustments in response to price adjustments is likely to result in conservative bidding and inefficient allocation. To minimize these adverse effects, the price increments between rounds should be kept as small as possible given reasonable concerns

[85] Haile-Kearns-Dworkin at 17.

[86] *Id.* at 18.

about completion time of the auction. We encourage use of increments at the bottom end of th[e] [proposed 5-15 percent] range."[87]

Activity Rule. AT&T supports the Commission's proposal to adoption an activity rule that requires significant participation. The 600 MHz auction, however, is far more complex than past auctions. To avoid unintended harmful consequences of excessively high activity requirements in early rounds, a better approach would be to adopt a lower activity rule in earlier rounds, and then higher requirements in later rounds.

Moreover, the Commission should reject the proposal in the *Notice* to deny bidders a certain number of activity rule waivers. These waivers are essential. Most fundamentally, they work as a mechanism to ensure that a bidder who makes an honest error during the bidding process that results in activity that does not satisfy the rule is not unduly punished. This is especially important here, where the auction rules will likely be far more complex than any prior auction creating much greater potential for inadvertent violations of the activity rules. Moreover, there are often instances where the application of an activity rule waiver can result in a more efficient bidding.[88] For these reasons, the Commission should provide each bidder with three activity rule waivers, as it did in the AWS-3 auction.

[87] Haile-Kearns-Dworkin at 20.

[88] *Id.* at 18.

CONCLUSION

For the foregoing reasons, the Commission should not adopt the proposals set forth in the *Notice* and should provide sufficient detail and data for the public to effectively assess the impact of these and other proposed auction rules.

Respectfully Submitted,

/s/ *Michael P. Goggin*

David L. Lawson
James P. Young
Christopher T. Shenk
Sidley Austin LLP
1501 K Street, N.W.
Washington, D.C. 20005
(202) 736-8000

Michael P. Goggin
Alex Starr
Gary L. Phillips
Lori Fink
AT&T Services, Inc.
1120 20th Street, N.W.
Washington, D.C. 20036
(202) 457-3048

Counsel for AT&T

February 20, 2015

ATTACHMENT A

Comments on the FCC's Current Incentive Auction Design Proposals

Philip A. Haile, Michael Kearns, Lili Dworkin*

February 20, 2015

1 Background and Summary

We have been asked by Counsel for AT&T to comment on features of the incentive auction design proposed in the FCC's Public Notice of December 14, 2014 (henceforth "PN"). The PN proposes several substantial modifications to the forward and reverse auction designs originally proposed by Milgrom, Ausubel, Levin and Segal ("MALS") in their appendix to the October 2012 Notice of Proposed Rule Making,[1] as well as additional detail regarding several important components. Although the Commission's schedule has allowed us only limited time to study the proposals, our initial review suggests several specific problems as well as a general concern that the new design introduces substantial complexity that may harm outcomes. We believe that many of these flaws are both serious and unnecessary.

*Haile is the Ford Foundation Professor of Economics at Yale University. Kearns is the National Center Professor of Computer and Information Science at the University of Pennsylvania. Dworkin is a doctoral candidate in Computer and Information Science at the University of Pennsylvania. Our comments are provided on behalf of AT&T.

[1]Paul Milgrom, Lawrence Ausubel, Jonathan Levin and Ilea Segal, Incentive Auction Rules Options and Discussion, Appendix C to the FCC's Notice of Proposed Rule Making, GN Docket No 12-268, October 2, 2012.

1.1 Forward Auction

The forward auction design originally proposed by MALS had important shortcomings, notably its neglect of the exposure problem arising from complementarities between licenses covering different geographic areas. However, the design did offer significant improvements over the traditional simultaneous multi-round ("SMR") auction through the use of price clocks for generic licenses covering substantial geographic areas.

The current proposals compromise these key features in several ways and introduce a great deal of complexity. Each Economic Area is to be divided into Partial Economic Areas ("PEA"s). Within a PEA, spectrum is to be split into "reserved" and "unreserved" licenses, with the latter split further into "Category 1" and "Category 2" spectrum. Licenses within a given category—particularly Category 2—may have substantially different values for mobile wireless use. Competition in the clock auction would therefore involve bidding under substantial uncertainty for the right to bid again for specific sets of licenses in the assignment phase. The assignment phase involves complex constraints (which will not be known in advance) and an opaque pricing rule that makes it difficult for bidders to allocate budgets.

These departures from the principles underlying the original MALS auction design create a range of problems. Two in particular stand out.

First, placing licenses of highly heterogeneous value in a single license category will elevate the importance of the highly complex assignment phase, depressing bidding in the clock phase. Because the quantity of spectrum cleared is to be determined by a final stage rule that accounts only for clock phase bids, this will lead to substantial risk of unnecessary failures of clearing targets. To reduce the severity of these harms, the Commission should seek to avoid introducing more license heterogeneity than necessary. The current proposal for determining which licenses are offered focuses too heavily on maximizing the *number* of licenses offered. The Commission should instead seek to maximize the total *value* of the licenses offered. In particular, the Commission should recognize that (a) placing a high power broadcast TV station in the 600 MHz wireless band can destroy spectrum value in other geographies and frequencies and, therefore, (b) maximizing the number of licenses offered in the forward

auction by allowing substantial "market variation" will compromise both auction revenue and the social value obtained from the spectrum resource. Clearly, the problem of excess license heterogeneity is closely linked to the priorities reflected in the Commission's proposals for the reverse auction, something we discuss further below. Reducing the impairment caused by placing TV stations in the wireless band would directly enhance the value of the spectrum offered while simultaneously reducing the harm to auction outcomes that is implied by treating highly heterogeneous licenses as if they were interchangeable. In addition, the Commission should develop an impairment index that is much more closely aligned with the actual effects of impairments on license values.

Second, the proposed rules for implementing the spectrum reserve would distort competition far more than is required by the Commission's stated objectives. In particular, the proposed approach (a) fails to link the size of the spectrum reserve to the quantity of spectrum actually cleared, potentially excluding from competitive allocation a majority—even all—of the 600 MHz spectrum ultimately assigned to mobile wireless use in a PEA; (b) would trigger the spectrum reserve when the price clocks are far below competitive market values for comparable spectrum licenses, increasing the likelihood of windfalls for reserve-eligible bidders at the expense of U.S. taxpayers; and (c) would introduce new opportunities for manipulative bidding by reserve-eligible bidders seeking to "stop the clock" for their own inframarginal licenses while driving up the costs of their downstream rivals. These three problems are easily corrected.

We discuss these issues further below, along with three additional problems with the proposed forward auction rules. First, a major proposed change to the bidding rules for the clock auction limits bidders' ability to reduce their demands when prices rises. This would introduce substantial new exposure risk. Second, the proposed rules for the extended round place undue focus on so-called "high-demand PEAs." As a result, the extended round may fail to do all possible to avoid an unnecessary failure of a clearing target and may even cause failure of a target that would have succeeded without an extended round. Third, the proposed rules leave an opportunity for bidding consortia to circumvent the Commission's

activity rule. Below we discuss all three problems and suggest solutions. We also respond to the Commission's request for input on the choice of bid increments for the forward auction.

1.2 Reverse Auction

The recent PN also specifies many new proposed details of the reverse auction that have greatly increased its complexity. These include the revelation of multiple optimization criteria for initial clearing targets and channel assignments; a hierarchy of bidding options for broadcasters, along with rules constraining the movement among these options; the introduction of potential impairments in the 600 MHz band, in which some broadcasters may remain in the wireless band subject to a nationwide impairment cap; Dynamic Reserve Pricing that may exacerbate impairment; and a formula for computing initial prices offered to broadcasters that combines a repacking difficulty factor with a population coverage factor.

We raise specific concerns with a number of these proposals below (and in some cases suggest improvements or alternatives), but we first note that the overall effect of these details is to make the reverse auction much more difficult for all parties to understand. Many portions of the PN are inscrutable to all but those with advanced mathematical training. While we acknowledge that a certain amount of complexity is necessary — for example, channel assignments must ultimately be made with precise objectives specified, and the specification must take the form of a mathematical optimization program — many of the new details amplify this complexity beyond what is necessary or advisable.

In particular, the new PN proposes a reverse auction that can no longer be defended as "transparent" or "simple" from the broadcaster perspective. From the choice of initial prices (based on formulae that are not justified or explained and have important flaws), to the potential exceptions to frozen bids introduced by Dynamic Reserve Pricing, to the virtual impossibility for a broadcaster to determine post-auction channel assignment in the case of repacking — the net effect is opaqueness and complexity. It seems the only remaining defense of the reverse is that "all" a broadcaster must decide is whether to accept or walk away from offered prices. But if the origins and rationale for these prices are inscrutable, as

are the detailed consequences of rejecting them, we fear that broadcaster participation may be reduced.

Below we focus on two PN proposals that we feel are particularly important and potentially damaging: the allowance (and therefore likelihood) of potentially widespread 600 MHz band impairments due to the proposed choice of initial clearing targets and Dynamic Reserve Pricing; and the choice of initial prices offered to broadcasters. Regarding impairments, we argue via mathematical analysis and extensive computational experiments (using the FCC's own data and feasibility checker) that permitting nationwide impairments in the choice of clearing targets and dynamic reserve pricing is unnecessary to clear large amounts of spectrum nationwide, and that the approach proposed in the PN is almost certain to produce substantial impairment that will destroy spectrum value and may even result in fewer licenses to sell in the forward auction than would be available at lower clearing targets with less impairment. Regarding the choice of initial clock prices, we demonstrate that the proposed "volume" formula suggested in the PN is flawed, in the sense that the constraint-counting repacking factor does not properly measure empirical repacking difficulty. We also suggest an alternative pricing scheme that can still be accommodated in the descending clock model, and would reflect dynamic or conditional difficulty rather than initial, static difficulty.

Forward Auction

2 Excess Impairment and Non-Generic Licenses

The PN proposes to offer licenses with substantial impairments.[2] Although the most severely impaired licenses generally would be placed in a separate license class ("Category 2"), within this class there is potential for a large range of impairment as measured by affected population.

Moreover, the Commission's population-based index of impairment is inadequate for quantifying the actual loss in value associated with impairment. We understand that the value of a license is highly dependent on both the type and location of impairments, yet these impairment characteristics are ignored by the Commission's index. The range of actual variation in license value is therefore likely to be much more extreme than the variation in the Commission's impairment index suggests. Likewise, the proposed price discounts based on percent impairment by population will poorly correct for the license heterogeneity. The bottom line is that within a given PEA and license category—and particularly within Category 2—licenses would be highly non-fungible, and the Commission's proposed "fixups" would do little to address this.

With non-fungible licenses, the clock phase of the auction becomes one in which bidders compete for a good of highly uncertain value: admission to the "real" auction in the assignment phase, where bidders can compete for specific licenses based on their actual values. The assignment phase uses a highly complex auction design that is subject to many constraints. The rules of the assignment phase would require bidders to make once-and-for-all bids under great uncertainty about which combinations of licenses they will ultimately win and what price they will end up paying for a given combination. Prior to the assignment phase bidders will be highly uncertain which combinations of licenses will even be available

[2] We discuss the origins of impairments in the section on the Reverse Auction below.

to them, due to the complex rules designed to maximize horizontal contiguity for winning bidders. (A separate issue is that the plan for doing this is only partially sketched in the PN. This makes it impossible to evaluate the merits of the plan.) This complexity would be made especially severe by the use of small geographic license areas (PEAs), since breaking apart natural geographic markets only adds to the complexity and risk associated with the final assignment a bidder may be able to obtain.

One important implication is that the set of winning bidders in a given PEA need not include those to whom assignment is efficient. Willingness to pay to enter the assignment phase will reflect valuations for a lottery—one whose outcomes depend in a complex way on the exact configuration of valuations among clock-phase winners in that PEA and others. The set of bidders willing to pay the most to enter this lottery need not include the bidders who value each license most highly. For example, bidders with relatively high valuations for the best licenses in a PEA but relatively low valuations for the worst licenses will be reluctant to bid aggressively in the clock phase. This is because they will anticipate that in the assignment phase they are likely to face a choice between (a) losing money by accepting a highly impaired license at a price above its value to them or (b) losing money by acquiring a high value license with an assignment phase payment that accurately reflects its differential value to them, but which results in a loss when added to the (sunk) clock phase payment. The situation is different for a bidder who cares little about the differences between licenses in the PEA, or who views the Commission's discount as accurately compensating for impairment levels. Such a bidder can safely bid up to nearly its full willingness to pay in the clock phase, knowing that it can obtain an acceptable license without making any additional payment in the assignment phase.

But even if the risks introduced by license heterogeneity somehow had no effect on bidder participation, on the licenses bidders pursue, on which bidders win some license, or on *final* auction prices, bids in the *clock phase* will certainly be suppressed. Bidders with high valuations for the best licenses in the pool will be forced to bid conservatively in the clock phase due to the need to win a second auction (the assignment phase) in order to obtain

these licenses. Because the proposed variation in impairment is large and the proposed measure of impairment used to adjust prices does not accurately account for this variation, the impact on the clock phase could be substantial. And because it is the clock phase bids that determine satisfaction or failure of the final stage rule, this means that allowing extreme heterogeneity in Category 2 license value risks causing failures of clearing targets that would have succeeded if "generic" licenses were in fact generic.

If highly heterogeneous licenses are to be offered, these should be divided into a sufficient number of categories for licenses within each category to be substantially fungible. But the Commission should first seek to avoid destroying spectrum value through the unnecessary introduction of impairments in the wireless portion of the 600 MHz band. Maximizing the number of licenses sold does not maximize the social value of the spectrum resource when introducing an additional license to the auction will often cause impairment of other licenses in nearby frequencies or nearby PEAs.

The Commission's plans for allowing market variation go too far in the direction of maximizing the number of licenses sold, giving insufficient consideration to the negative spillovers—across both frequencies and geographies—that would be created when a broadcast television station is located in the wireless band. The implications of such spillovers for the auction are particularly problematic due to the uncertainty bidders will face during the clock phase and the role of the clock phase in determining success of the incentive auctions. Consequently, what the Commission views as additions to the pool of spectrum offered for sale may in fact represent reductions in the total social value of the spectrum. Such destruction of spectrum value will drive down auction revenue and may cause failures of clearing targets.

Even when the choice of licenses to offer has been optimized, some license heterogeneity will likely remain in some PEAs. For example, this will be the case in border areas adversely affected by Canadian or Mexican television stations in the same 600 MHz frequencies allocated to mobile wireless in the U.S. To minimize the adverse effects this has on the auction, the Commission should reconsider its proposed index for measuring the degree of impair-

ment, both to improve the assignment of licenses to appropriate impairment categories and to provide price discounts that more accurately reflect the value lost to interference.

3 Spectrum Reserve

We understand that the Commission's goal in creation of a spectrum reserve is to ensure that bidders with limited low-band spectrum holdings are not prevented from obtaining a significant portion of the newly available spectrum as a result of other bidders' incentives to drive up auction prices and foreclose effective downstream competition.[3] There is good reason to doubt both the premise of significant foreclosure risk and the conclusion that the benefits of limiting auction competition serves the public interest.[4] However, even if one accepts the Commission's goals and the conclusion that a spectrum reserve is necessary, the details of the proposed implementation go too far: they would distort competitive bidding in favor of reserve eligible bidders ("REBs") more than is necessary to achieve the Commission's stated objective.

We see three distinct problems. First, the number of licenses placed in the spectrum reserve is not linked to the total quantity of spectrum sold in the forward auction. Under the proposed rules, a majority—in principle even all—of the spectrum sold could be available only to REBs. This cannot be justified by the Commission's stated goals. To correct this, the Commission should link the size of the spectrum reserve to the size of the actual number of licenses offered in each stage of the auction.

Second, the proposed trigger price for the spectrum reserve is far below the competitive market price of the spectrum. As a result, the proposed rules would ensure allocation of licenses to REBs regardless of their willingness to pay a competitive market price. This will result in unnecessary allocative distortions, reductions in auction revenue, and windfalls

[3]See *Policies Regarding Mobile Spectrum Holdings, Report and Order*, FCC 14-63, WT Docket No. 12-269 and Docket No. 12-268, (2014), paragraphs 146–195.

[4]See, e.g., *Supplemental Reply Declaration of Michael Katz, Philip A. Haile, Mark A. Israel, and Andres Lerner*, FCC WT Docket No. 12-269 (submitted June 13, 2013).

for REBs. These harms can be minimized without jeopardizing the Commission's goals by triggering the spectrum reserve only when prices have reached competitive market prices for comparable spectrum licenses. Estimates of these competitive market prices should be informed by the best available data, including the results of recent spectrum auctions and the terms of secondary market transactions.

Finally, the proposal to utilize separate price clocks for reserved and unreserved spectrum unnecessarily introduces new opportunities for manipulative bidding by REBs. With separate price clocks, REBs have the ability to stop the clock on their own inframarginal licenses while driving up the prices paid by non-REBs—an opportunity that would not exist under the original MALS auction design. This defect can be removed without jeopardizing the Commission's goals by making a small modification to the way the MALS design is extended to incorporate the spectrum reserve.

We discuss each of these issues and suggestions in more detail below.

3.1 The Number of Reserved Licenses is Not Linked to Actual Supply

The proposal to set the number of reserved licenses based only on the *initial* clearing target and REB demand at the reserve trigger goes farther than necessary to achieve the Commission's goals, potentially excluding from competitive allocation a majority of the 600 MHz spectrum ultimately assigned to mobile wireless uses.

Figure 2 (p. 11) in the PN shows the proposed number of reserved licenses for a range of possible clearing targets. That table may give the impression that the number of reserved licenses would adjust to the total supply of licenses in the 600MHz wireless band, with somewhere between 1/5 and 1/3 of the licenses designated as reserved. But the first row of the table corresponds to a range of *initial* clearing targets. Thus, an important question is whether the initial clearing target is likely to match the actual quantity of spectrum cleared. The Commission proposes to set "the highest clearing target possible from among the avail-

able options given broadcaster participation in the reverse auction."[5] This is appropriate. In order to maximize the value obtained from the spectrum resource, the Commission *should* set a very aggressive initial clearing target. However, such an initial clearing target is likely to exceed the quantity of spectrum actually cleared. Indeed, if the initial clearing target succeeds, this is likely a sign that the Commission was not sufficiently aggressive in its initial price offers in the reverse auction.

The Commission proposes to set the number of reserved licenses to be the lower of (a) the number of licenses in Figure 2 and (b) the demand of REBs at the reserve trigger price. The latter condition is unlikely to have any effect, due the exceedingly low reserve trigger price (see the following section). Thus, under the proposed rules the number of reserved licenses will almost certainly be invariant to the quantity of spectrum ultimately sold. Even if one accepts the goal of setting aside a substantial fraction of spectrum for REBs, this goes too far. There is nothing preventing the reserved spectrum from including the vast majority of the spectrum ultimately cleared.[6]

Allowing such possibilities is not required by the Commission's goals. Instead, the Commission should link the number of reserved licenses to the total number of licenses available in each stage of the auction. Under the Commission's proposal to allow substantial market variation, a given nationwide clearing target may overstate the number of licenses actually available in some PEAs (those suffering sufficient impairments to push some licenses beyond the 50% threshold). Thus, the number of reserved licenses should be linked not to the nationwide maximum associated with a given round, but to the actual number of licenses currently on offer in each PEA. This link should be as tight as possible given the integer constraints. Such a link would enable the Commission to guarantee REBs access to a significant share of the available licenses without the threat of competition from non-REBs, but it would do

[5] PN, paragraph 25.

[6] A separate point is that the Commission proposes to place Category 1 licenses in the reserve. Thus, the share of usable bandwidth set aside for REBs would be larger than the share of licenses set aside. In some PEAs non-REBs could be excluded from competing for most or all of the relatively "clean" Category 1 spectrum.

so without the potential for substantially excluding non-REBs from the auction. If the label "initial clearing target" in the Commission's Figure 2 were replaced with "number of licenses currently offered in the PEA," the resulting map between the quantities of total available licenses and reserved licenses would be appropriate for achieving the Commission's stated goals.

3.2 The Reserve Trigger Price is Much Too Low

The Commission proposes to split Category 1 licenses into reserved and unreserved categories immediately upon satisfaction of the final stage rule. It is wise that the spectrum reserve not be triggered before such satisfaction. Since the goal of the spectrum reserve is to limit prices faced by REBs, triggering the spectrum reserve earlier in the auction would create substantial risk that clearing targets fail due only to the constraints imposed on competition. Thus, the spectrum reserve must not be triggered before satisfaction of the final stage rule. However, there is no reason that the spectrum reserve must be triggered *immediately* upon satisfaction of the final stage rule. And an examination of the Commission's proposal reveals that doing so is not consistent with its stated objectives.

The choice of price at which the reserve is triggered is important. The number of reserved license in a PEA is to be the lesser of (a) the number of reserved licenses specified by Figure 2 in the PN, and (b) the number of Category 1 licenses demanded by REBs at the time of the reserve split. If the reserve were triggered only when prices have reached competitive market prices, condition (b) would ensure that the share of the spectrum set aside for REBs equals the share they would demand at such prices. Triggering the reserve too late would create the possibility of failing to allocate to REBs all the spectrum they should obtain under the Commission's objectives. On the other hand, by triggering the reserve too early the Commission would risk overshooting its goal, setting aside too much spectrum for REBs.

This implies that the trigger for the spectrum reserve must be chosen carefully: the spectrum reserve should be triggered at prices as close as possible to the true competitive market value of the 600 MHz spectrum. The Commission's proposal fails to do this, allowing

the spectrum reserve to be triggered too soon.

Triggering the spectrum reserve immediately upon satisfaction of the final stage rule means that the spectrum reserve could be triggered when average prices in "high-demand PEAs" are as low as \$1.25/MHz-pop. This is much too low. It is just over 50% of the average prices (over all markets) in the Commission's most recent (AWS) spectrum auction, even after adjusting for designated bidder discounts. Average prices for AWS spectrum in the high-demand PEAs are of course substantially higher. Competitive market prices for 600 MHz spectrum in high-demand PEAs should be of at least a similar magnitude—likely higher due to the lower buildout costs associated with establishing wireless service with low-band spectrum.

An example illustrates the implications of triggering the spectrum reserve too soon in the auction.

Example 1. *Consider a given high-demand PEA and suppose that the initial clearing target is 84 MHz, so that the maximum size of the spectrum reserve is 3 licenses. Suppose that REBs have valuations (per MHz-pop) for Category 1 licenses in this PEA of \$2.50, \$2.00, \$1.50, \$1.40, and \$1.30 (these may reflect the valuations of bidders with unit demands or the marginal valuations of bidders with downward sloping multi-unit demands). Suppose that the competitive market value for a license in this PEA is \$2.40, (roughly the overall average price, net of discounts, of AWS spectrum). Further, suppose that the spectrum reserve is triggered at the price of \$1.25. We should then expect 3 licenses to be allocated to the reserve. This contrasts with the single license that should be allocated to REBs under the Commission's stated goal of enabling REBs to obtain the licenses they would demand at competitive market prices.*

As the example illustrates, by triggering the reserve at too low a price, the Commission risks substantial distortions in license allocation. This distortion is not harmless. It implies denying licenses to bidders with the highest intrinsic values for the spectrum. Further, it creates the potential for substantial windfalls to REBs. In the example, we should expect the final price for reserve licenses to be approximately \$1.40 under the Commission's proposed

rule. This is far below the competitive market value of $2.40. Windfalls to REBs resulting from premature trigger of the spectrum reserve will come at the expense of U.S. taxpayers through reduced auction revenue.

Importantly, these distortions are not necessitated by the Commissions' objectives. Rather, they are the result of an unnecessary and arbitrary choice to equate the reserve trigger criteria and the final stage rule criteria. This problem is easily remedied by ensuring that the spectrum reserve is triggered only when the forward auction clocks have reached competitive market levels. Obviously these levels can only be estimated before holding the auction. But the Commission should utilize the best available information—including the results of recent spectrum auctions and generally held views on the relative value of different spectrum bands—to determine this important parameter of the auction design.

3.3 New Opportunities for Manipulative Bidding

The PN proposes to offer REBs two different prices for Category 1 licenses in a given PEA: the price of reserved licenses and the price of unreserved licenses. This is an unnecessary complication that introduces a new opportunity for manipulative bidding. In particular, the rules permit REBs to bid for unreserved licenses instead of reserved licenses even when the price of the latter is lower. REBs have an incentive to exploit this opportunity because such bidding can "stop the clock" for reserved licenses while driving up the prices that non-REBs pay. In the Appendix we provide an example that illustrates this possibility. In particular, even noisy signals about competitive prices can be enough to enable REBs to undertake—at little or no risk—manipulative bidding strategies aimed at stopping the reserve clock and driving up the costs of their downstream rivals.

Allowing this type of manipulative bidding does not serve any Commission objective and, as illustrated in the example, can lead to reductions in auction revenue. Fortunately, allowing this possibility is not necessary: a small change in the auction rules would eliminate this defect without compromising the Commission's stated objectives.

In the simplest terms, *REBs should not be permitted to express a preference for high*

prices. Rather, all REB demand for Category 1 spectrum in a given PEA should be assigned to the lowest price spectrum available. Imposing this restriction would not limit the ability of REBs to bid for and win unreserved licenses. Indeed, the only effect of this change would be to eliminate bidding behavior whose only purpose is to "stop the clock" or "raise rivals' costs."

Although the proposed restriction could be imposed directly as a minor addition to the clock auction rules proposed by the Commission, a better way to implement this restriction in practice is to make a modest change in the way the spectrum reserve is introduced to the MALS clock auction design. We provide details in the Appendix. The approach we propose there has the added advantage of simplifying the auction.

4 Extended Round Trigger and Bidding

The proposed extended rounds can provide a useful "last chance" for forward auction bidders to accept prices that would allow satisfaction of the final stage rule. But the details of the proposal would hinder this effort by focusing exclusively on "high-demand PEAs." The problem is created by the combination of three features:[7]

1. An extended round is to be triggered whenever at the end of a clock round (i) the demand for licenses in high-demand PEAs does not exceed the available supply, and (ii) the final stage rule has not been met.

2. Bidding in the extended round is only for licenses in high-demand PEAs.

3. If the final stage rule cannot be met in the extended round, the round ends and the clearing target is reduced.

By ignoring demand outside high-demand PEAs, the proposed extended round would not do all it could to avoid failure of a clearing target and could even cause failure of a target

[7]See paragraphs 189-190 of the PN.

that would have succeeded with no extended round.

The first problem is that, once the extended round is triggered, bidders are not permitted to express higher willingness to pay for licenses outside the high-demand PEAs. This could result in failure of a clearing target that would have succeeded if the extended round permitted bidding on all licenses. This represents a significant cost of limiting extended round bidding to high-demand PEAs, and we see no benefit from this restriction.

A second problem is the rule triggering an extended round. Once again, demand outside high-demand PEAs is ignored. Suppose that supply and demand have equated in high-demand PEAs but there is still excess demand for licenses in other PEAs. Allowing the clock phase to continue might then result in satisfaction of the final stage rule. But by stopping the clock phase and running the extended round, the final stage rule may or may not be satisfied—this depends entirely on factors different from those that would have led to achievement of the final stage rule had the clock phase simply continued. In particular, as noted above, the excess demand (and excess willingness to pay) outside high-demand PEAs is excluded altogether from the attempt to satisfy the final stage rule. The PN asserts (paragraph 191) that this approach obviates the need to wait for all bidding to stop in order to determine whether a new stage (clearing target) is needed. This is misleading. Triggering the extended round without waiting for market clearing prices on all (or almost all) licenses would speed up the auction; but this also risks jumping the gun and triggering a target reduction unnecessarily.

The Commission should modify the extended round rules. All licenses should be included in the extended round bidding. And the level of excess demand across all PEAs should play a greater role in the extended round trigger. Unless speed is a greater concern than efficient spectrum clearing, the extended round should not be triggered until the clocks stop in all (or almost all) PEAs.

5 Added Exposure Risk

We have previously discussed exposure risks present under the original MALS clock auction design due to its failure to allow bidders to safely express cross-market complementarities between licenses.[8] Since then, the Commission's proposed modifications of the MALS auction have only made the exposure risks worse.

The proposal to offer licenses at the PEA level rather than the EA level (or larger) implies that bidders seeking continuous coverage over any but the smallest geographic regions must assemble many licenses. But under the proposed rules, bidders must bid for each license separately, risking the possibility of winning some of the licenses at prices that were acceptable only under the expectation that other licenses would also be acquired. The lack of protection against exposure risk was the most severe shortcoming of the original MALS proposal, deterring aggressive bidding by carriers whose valuations are highly dependent on wide market coverage. Enlarging the geographic coverage of licenses (e.g., to MEAs) would partially mitigate this problem. The Commission's proposal goes in the opposite direction. Shrinking to the level of PEA makes a serious problem even worse.

The second problem is the new proposal to ignore (fail to process) reductions in demand as the price rises when such reductions would result in excess supply. This new rule would have little effect if bidders only viewed licenses within a PEA as substitutes. But for many bidders, licenses are complementary. Some may wish to pursue 600 MHz holdings only if they could obtain two 5×5 MHz licenses. For such bidders, the new proposal introduces substantial exposure risk. Such a bidder could not safely express its full willingness to pay for a pair of licenses, since doing so would risk being forced by the Commission to buy a single license at a price that exceeds its standalone value. Thus the proposed rule would be a further discouragement to aggressive participation by wireless providers whose valuations are heavily dependent on complementarities.

---

[8] Yeon-Koo Che, Philip A. Haile, and Michael Kearns, "Design of the FCC Incentive Auctions," Exhibit B to Comments of AT&T, FCC GN Docket No. 12-268, (Jan. 25, 2013).

The Commission should reconsider its proposal in order to better balance concerns about undersell against the effect that additional exposure risk will have on bidders' willingness to accept high prices. The Commission's current proposal represents an extreme "corner solution" that is unlikely to be optimal. At a minimum, bidders should be given waivers to allow a limited number of withdrawals of demand when such withdrawal would create (at least temporarily) excess supply.

6 Bidding Consortia and the Activity Rule

The Commission wisely proposes to use an activity rule during the forward auction, as it has in past spectrum auctions. An activity rule links a bidder's eligibility to pursue licenses in later rounds of the auction to that bidder's pursuit of a similar quantity of licenses earlier in the auction. Under an effective activity rule, a bidder can still shift its demand between licenses as the auction proceeds but could not increase its overall quantity demanded (as measured by eligibility points under the Commission's proposal) as prices rise. An activity rule encourages consistent bidding, facilitating price discovery and keeping the auction moving toward closure. One goal of an activity rule is to prevent a bidder from hiding its intentions (like a "snake in the grass"), revealing its true interests only late in the auction.

For the Commission's activity rule to be effective, a bidder must not be permitted to demand more units of a license than are actually available. For example, suppose that only one unit of a given license (i.e., a license in a given category in a given PEA) is available. Suppose that a bidder demands three units of this license at some price. Because this bidder could win at most one unit, the "extra" two units demanded could not possibly reflect the true intentions of the bidder, nor would they create any risk that the bidder wins an unwanted license. However, such "bid stacking" could be useful to the bidder, since this would allow the bidder to circumvent the activity rule. Bid stacking provides a way of maintaining eligibility without making a serious bid. Indeed, when bid stacking is permitted the activity rule would have no effect whatsoever: a bidder who wishes to hide its intentions

and maintain eligibility could stack arbitrarily many bids on top of a single serious bid. This is easily prevented, however: the quantity of a given license that any single bidder can demand should be capped at the total supply of that license.[9] Although we do not see that this restriction has been codified in the Commission's proposed rules, we suspect that it was intended. In any case, this cap is needed to ensure that the activity rule has its intended effect.

If joint bidding is to be permitted in the forward auction, an additional rule will be needed to prevent the same type of circumvention of the activity rule by bidding consortia. Similar to our example above, suppose that there is one unit of a given license available and that there is a bidding consortium of three bidders. If these three bidders coordinate and demand one unit each of the license, we have the same problem as before. Although there is no single bidder demanding more units of this license than are available, the joint-bidding consortium as a whole would be engaging in the same bid-stacking behavior described above. As a whole, the consortium could win only one unit, so the two extra units of demand reflect a riskless way to hide the consortium's true intentions and maintain eligibility, defeating the activity rule. This is not merely a theoretical possibility: we understand that a joint bidding consortium controlled by Dish engaged in exactly this type of behavior in the recent AWS spectrum auctions, stacking bids on thousands of occasions during the auction.

This behavior is easily prevented with a similar cap on demand at the level of the consortium: the sum of demand for a given license by members of a bidding consortium should be capped at the total supply of that license. In practice, this would mean that in each round the bids submitted by members of a bidding consortium would not receive final acceptance by the bidding system until all members of the consortium have submitted bids which are both individually valid and satisfy this additional constraint.

---

[9]Under our proposed modification of the reserve phase of the auction (see section 3.3), REBs would be limited to demand no more than the total quantity of licenses on offer in a given Category in each PEA.

7 Bid Increments Should Be Small

The proposed use of intra-round bidding will be useful for gaining some of the benefits of a continuous price clock when clocks actually move in discrete increments across rounds. But the proposed intra-round bidding design would permit only certain types of adjustments in response to changing prices. Across rounds of the clock phase, bidders can simultaneously adjust demand for multiple licenses in response to the evolving prices across all PEAs. However, an intra-round bid, even with the proposed "all-or-nothing" and "switch" bids, allows much cruder expressions of demand adjustments. For example, a bidder is unable to say to the intra-round bidding system "If the total price of coverage in the Atlanta EA (all Atlanta PEAs) exceed 120 while the total price of coverage in the Orlando EA stops at 100, switch my demands in Atlanta to Orlando." Such demands could be expressed with a continuous clock, but the proposed intra-round bidding rules do not (and probably cannot) allow a sufficiently rich "bidding language" to express all relevant intra-round demand adjustments.

Any restriction on the expression of demand adjustments in response to price adjustments is likely to result in conservative bidding and inefficient allocation. To minimize these adverse effects, the price increments between rounds should be kept as small as possible given reasonable concerns about completion time of the auction. The PN suggests increments in a range of 5 percent to 15 percent. We encourage use of increments at the bottom end of this range, at least until price clocks have stopped for most licenses (e.g., on 90% of licenses in high-demand PEAs).

Reverse Auction

8 Clearing Targets and Impairments

The PN proposes a reverse auction design that will allow some broadcasters to remain in the 600 MHz band, thus creating "impaired" licenses for sale in the forward auction. Such impairments might arise from two distinct but related sources in the proposed design of the reverse auction:

- The determination of an initial clearing target explicitly allows for the possibility of impairments, in service of "clearing" a large amount of spectrum.
- The use of Dynamic Reserve Pricing (DRP) in the first stage of the reverse auction explicitly allows broadcasters that cannot be repacked to be assigned a channel in the 600 MHz band as long as nationwide impairment remains below a set threshold.

The receptiveness to impairments in the PN seems to arise from twofold motivation: first, the (unproven) hypothesis that allowing such impairments is necessary to clear significant amounts of spectrum, or that doing so would maximize the amount cleared;[10] and second, the belief that impairments resulting from DRP guard against the possibility of paying broadcasters their high initial clock prices due to repacking difficulties.[11]

In this section we show that:

- Widespread, national impairments are inevitable or quite likely given the methodology described in the PN for determining clearing targets. Furthermore, the proposed 20%

[10]PN, paragraph 11: "The 600 MHz Band Plan can accommodate variation in the amount of spectrum recovered in different geographic areas in order to prevent the most restricted market from limiting the quantity of spectrum we can offer generally across the nation."

[11]PN, paragraph 6: "By mitigating the risk that a station may be awarded its opening price merely because there is no channel to offer in its pre-auction band – a result that would have little or nothing to do with what the station would be willing to accept in exchange for relinquishing its spectrum usage rights – these procedures will increase the likelihood of a successful auction. This is because DRP procedures make it possible to offer higher opening prices, thereby attracting greater broadcaster participation, than would otherwise be the case. Absent DRP, lower opening prices would be necessary."

nationwide impairment threshold mathematically guarantees the existence of clearing target solutions having significant impairments in large metropolitan areas across the country, including the northeast corridor.

- DRP can only result in further impairments that "fill in the gaps" under the nationwide threshold left over from the initial clearing target optimization. Thus together, clearing target optimization and DRP will serve to saturate the allowed threshold for nationwide impairment.

- Such widespread impairments are *not* necessary in order to clear significant amounts of spectrum nationwide. Rather, impairments can be tightly limited to border regions, thus largely eradicating the need for impaired licenses and greatly simplifying both the forward and reverse auctions.

- Such widespread impairment may actually result in *less* usable spectrum than if impairments were limited only to border regions.

We support these findings with extensive computational experiments using the FCC's domain and interference constraints files, and its SATFC feasibility checker.

8.1 The Proposed Clearing Target Optimization Procedure Will Cause Significant Impairments

The PN describes the following process for the determination of an initial clearing target for the reverse auction:

- Starting from some high (but unspecified) clearing target of T MHz, consider all "feasible" solutions or assignments of each broadcaster to either a channel or to go off the air. Feasible assignments must obey all domain and interference constraints, and must assign non-participating broadcasters to a channel in their pre-auction band. Importantly, feasible assignments may include many assignments of broadcasters to the 600 MHz band.

- The set of feasible solutions is successively reduced by a number of additional constraints. The first of these demands that only solutions minimizing the number broadcasters assigned to channels in the 600 MHz band be considered. However, note that if the target T is sufficiently high, and thus the number of channels available for repacking is low, even such solutions may have many broadcasters remaining in the 600 MHz band. The remaining additional criteria require further minimization of the number of broadcasters assigned to VHF, maximizing the number that are assigned to their preferred relinquishment option, and maximizing the number that are assigned to go off-air.

- After the solution space is reduced by the additional constraints, the "primary" clearing target optimization is applied: among remaining solutions, minimize the sum of impaired weighted-pops across all forward auction licenses. If this sum falls below the near-nationwide threshold of 20%, clearing target T is confirmed and the reverse auction proceeds with this target. Otherwise, the value of T is reduced and the entire process above is repeated.

This procedure thus consists of an "outer loop" over successively lower values of T, *inside* of which is a series of reductions to and optimizations of the solution space. While these "inner" optimization steps appear to attempt to reduce the amount of impairment (specifically, in the reduction to only those solutions with the minimum number of UHF assignments, and the final comparison of impaired weighted-pops to the threshold), these attempts are *subordinate to the outer loop over clearing targets*.

More precisely, imagine that T is initially set to some very high value, thus leaving very few channels available for repacking. Then despite the attempts to minimize 600 MHz impairments in the inner optimization steps, it will be inevitable that many broadcasters remain assigned to UHF, and the impaired weighted-pops threshold will be violated. The value of T is then decremented and we repeat the loop. *There is no reason to believe that the first successful value of T will result in impairment that is not significant and close to the nationwide threshold,* because the value immediately before resulted in impairments

greater than that threshold (by definition), and it has been decremented only slightly. In other words, the *true primary optimization is over the amount of partially impaired spectrum cleared*, and the minimization of impairment below the threshold is secondary.

Of course, the precise amount of impairment that will occur from the procedure above depends on details not specified in the PN, such as the starting value of T and the amount T is decremented with each pass through the outer loop, and on details unknowable today, such as which broadcasters will choose to participate. But if the last unsuccessful value of T had a nationwide impaired weighted-pops of (say) 25%, there is no reason to believe that the first successful value of T (the next decrement) would have impairment close to 0% — the reasonable default belief would be that it is just below the 20% threshold.

In fact, at least up to the level of details provided in the PN, it is furthermore not difficult to see the mathematical inevitability of feasible clearing target solutions that result in extensive nationwide impairment. Consider the following hypothetical scenario. Let Z be the number of licenses available (where the exact value depends on the chosen clearing target). Suppose that in each PEA, Y of these licenses are so impaired that they will not be sold in the auction, and are therefore considered 100% impaired[12], and the remaining $Z - Y$ licenses are completely unimpaired. Furthermore, assume that all impairments occur in the uplink portion of the license, and therefore only count as 50% impairment. Let W_P denote the weighted-pops of PEA P. Then according to the PN, the amount of impairment nationwide is:

$$\frac{0.5 \cdot Y \cdot \sum_{\text{all PEAs}} W_P}{Z \cdot \sum_{\text{all PEAs}} W_P} = \frac{0.5Y}{Z}$$

Note that since $Y \leq Z$, the right hand side above can assume a *maximum* value of only 0.5, not 1.0. Thus a threshold of 0.2 should not be considered "20 percent" impairment, but some much larger percentage due to the normalizing factor being much smaller than 1.

Now consider a clearing target of 126 MHz, for which $Z = 10$. Finally, suppose $Y = 4$. Thus, in this scenario, *almost half* of the licenses in *every* PEA across the country are

[12]PN, Appendix C, Section 2.7.

considered 100% impaired and are not offered for sale in the forward auction. But applying the equation above, we see that the PN-computed impairment amount is exactly 0.2 and would therefore be considered acceptable.

The point is not to claim that this undesirable solution is likely, but rather to show that the current PN proposal would indeed permit such solutions, and many other undesirable ones as well. For instance, calculations similar to the above yield permissible solutions that instead have even greater impairment concentrated in only certain regions, such as the northeast corridor, in exchange for less impairment elsewhere. Given that the clearing target determination process will be algorithmic and automated, and applied to currently unknown inputs, it will choose an unknown solution among the permissible ones. We thus believe it is undesirable for that solution space to include many with extensive nationwide impairments, as the PN proposal currently does.

8.2 DRP Will Further Increase Impairment

In addition to the clearing target optimization process, the PN also allows the possibility of additional impairments due to Dynamic Reserve Pricing (DRP) in the first stage of the reverse auction. As per the discussion above, we believe that the proposed clearing target optimization will already "bake in" a great deal of nationwide impairment. But the resulting impairment may be geographically "lumpy" due to the discrete nature of domain and interference constraints and the repacking process. Thus there may be "impairment gaps" in some PEAs that could still permit additional assignments to the 600 MHz band without exceeding the allowed nationwide impairment threshold.

By its very nature, DRP can only cause these impairment gaps to be filled further. Under DRP, participating UHF stations that cannot be repacked due to the outcome of clearing target optimization would not have their clock prices frozen (as under normal, non-DRP bidding), but reduced anyway. If they rejected the reduced price they would remain in the 600 MHz band, creating additional impairment. DRP would remain in effect until the total impairment (from both clearing target optimization and DRP itself) from subsequent DRP

reductions would violate the nationwide threshold. Thus like the clearing target optimization process, DRP ensures that further impairments will be generated.

8.3 Impairments Are Unnecessary for Large Clearing Targets

Given the apparent inevitability of significant 600 MHz impairment in the currently proposed reverse auction design, it is important to ask what positive purpose this impairment serves — in particular, whether such impairment is necessary in order to clear significant amounts of spectrum. In this section, we shall show strong experimental evidence that it is not. In particular, we show that it is likely that large amounts of spectrum could be cleared with no 600 MHz impairments except in markets extremely close to the international borders with Canada and Mexico. Our experiments strongly suggest that successful reverse auction designs that do not permit nationwide impairments to forward auction licenses are possible and desirable.

We begin by noting that currently it appears impossible or extremely difficult to run experiments that directly measure the amount of spectrum that could be cleared subject to a given nationwide impairment threshold. There are several reasons for this. First, the feasibility checker currently provided by the FCC (SATFC, released November 2014) entirely ignores the possibility of the impairments discussed so extensively in the PN. Rather, this checker requires as input a set S of broadcasters to repack, and sets of channels $\{C_i \mid i \in S\}$ on which each member of S can be repacked, and determines whether there is a feasible assignment that does not violate any domain or interference constraints, without permitting *any* impairments. Second, even if one used a more general satisfiability engine that permitted a more general formulation of clearing — i.e. "clear T MHz subject to at most $X\%$ impairment in the 600 MHz band" — it is not obvious how to precisely measure the amount of impairment given the data and tools currently provided by the FCC. At a minimum it would seem that incorporation of the TVStudy software package would be required, but it is not obvious this is sufficient to determine (for example) the amount of impairment to nearby wireless licenses that a particular broadcaster remaining in the UHF

band would inflict.

However, it is possible to do experiments with the currently provided FCC data and feasibility checker that still demonstrate the likelihood that (a) significant and attractive amounts of spectrum can be cleared without nationwide impairment, and (b) the currently proposed clearing target optimization, started from a sufficiently high target, will be considerably more likely to result in widespread impairment.

Our methodology extends the *minimal blocking set* notion from an earlier whitepaper.[13] We define a *blocking set for a clearing target of T MHz* to be a set B of broadcasters whose simultaneous non-participation makes it impossible to clear T MHz nationwide (in particular, in the geographic region of the blocking set itself). The notion of clearing here remains impairment-free. Thus if B is a blocking set for T, it means that the domain and interference constraints render it infeasible to repack the stations in B on the available channels. A *minimal* blocking set is a blocking set B that cannot be reduced in size and still remain a blocking set — thus the removal of any single broadcaster in B now renders repacking feasible. Minimal blocking sets constitute the hard "kernels" for the repacking process.

What is the relationship between blocking sets and impairment? If impairment is allowed, and a blocking set B for clearing target T occurs,[14] then *one of the broadcasters in B must be left in the UHF band,* thus creating an impairment. Smaller blocking sets are more likely to create impairments, since they are more likely to occur under any given model or assumptions about broadcaster participation. Thus by examining the sizes and geographic distribution of minimal blocking sets at different clearing targets, we can obtain a relative and quantitative assessment of the amount and locations of nationwide impairment at these different targets.

We run our experiments on the domain and interference constraint data files released by

---

[13] "A Computational Study of Feasible Repackings in the FCC Incentive Auctions", M. Kearns and L. Dworkin, white paper filed with Federal Communications Commission, June 2014. `http://apps.fcc.gov/ecfs/document/view?id=7521328899`

[14] For the purposes of initial clearing targets, this means all broadcasters in B do not participate in the auction.

the FCC in May 20, 2014, using the SATFC feasibility checker released in November 2014. For simplicity, we only consider the 1670 broadcasters currently assigned to UHF channels (14-51). We first fix a clearing target T, which determines the number of channels available for the repacking process. Then given an initial seed broadcaster i, we attempt to find a corresponding minimal blocking set using the process below:

1. Initialize a set $B = \{i\}$ of non-participating broadcasters.

2. Identify the broadcaster j not currently in B that has the greatest number of constraints with members of B, and add j to B.

3. Check if B can feasibly be repacked. If B cannot feasibly be repacked, we have found a blocking set, but not necessarily a minimal one, and proceed to the next step. Otherwise, if B can be feasibly be repacked, we repeat steps 2-3, and continue until we either find a blocking set, or B is of size 50, in which case we terminate this trial without having found a blocking set.

4. Once we have found a blocking set B, it remains to reduce B to a minimal blocking set. For each $i \in B$, we check if $B - \{i\}$ can be feasibly repacked. If so, we set $B = B - \{i\}$.

Note that while there are many ways of finding minimal blocking sets — for instance, we could instead start with a seed set consisting of *all* broadcasters, and gradually reduce to a minimal blocking set — steps 1 and 2 above are deliberately designed to find *small* minimal blocking sets, since these are most likely to result in impairments.

We repeat the above procedure at least once for each broadcaster, using clearing targets of both 84 and 108 MHz. Let us first describe and interpret the results at clearing target $T = 84$ MHz. First note that at this target, there are 23 UHF channels available for repacking (14 through 36). If it were not for the domain constraints, there would not exist any minimal blocking sets of size 12 or less, since by simply assigning broadcasters to only even-numbered channels and leaving odd-numbered channels unassigned, we would not violate any co- or adjacent-channel constraints. Thus intuitively the origins of the smallest

minimal blocking sets must involve the domain or border constraints. The main question or concern is whether small blocking sets originating near the borders might significantly "drift" into large metropolitan areas away from the borders.

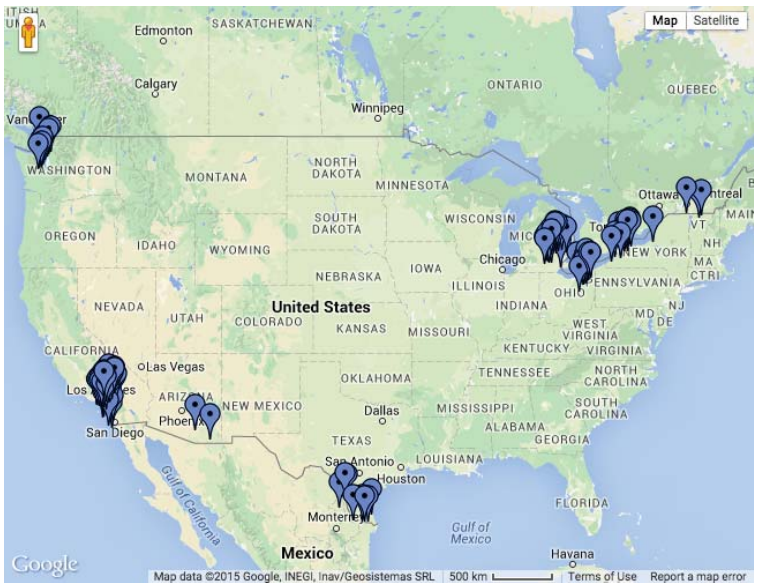
Our experiments strongly suggest that for an 84 MHz target, such drift would not occur, and small blocking sets (and consequently impairments) would be restricted to border regions. At this target, we found 809 different blocking sets of sizes ranging from 1 to 41; focusing on sets of size 11 or smaller (for example), we find they are located exclusively in border regions (see Figure 1(a)). Because small blocking sets are more likely to occur than larger ones (indeed, exponentially more likely under a simple random participation model[15]) this suggests that the impairments necessary to reach an 84 MHz clearing target will almost certainly be restricted to these regions. On the other hand, at a 108 MHz clearing target, we now find many small blocking sets located in large non-border metropolitan regions — in particular, in the northeast corridor and northern California (see Figure 1(b)). Thus, at this higher clearing target, we are considerably more likely to see impairments intruding into these areas.

We can perform a more formal probabilistic analysis using the following methodology. We first assume that each broadcaster participates in the auction with some common but independent probability p, and thus generate a distribution over all possible broadcaster participation decisions. We then repeatedly draw from this distribution, and in each draw, determine which blocking sets occurred (i.e. sets in which all members were chosen as non-participating) and therefore where impairment must occur. Finally, we average over all draws to make probabilistic statements about the geographic distribution of impairment.

In Table 1 we show, for various values of p and for clearing targets of both 84 and 108 MHz, the probability (over 500 random draws) that a *non-border* blocking set[16] occurs, and

[15]If each broadcaster participates in the auction with probability p, the probability that a size x blocking set occurs is $(1-p)^x$. Thus for instance at $p = 0.5$, a blocking set of size 5 is $2^6 = 64$ times more likely to occur than one of size 11.

[16]We define a non-border blocking set as one in which no members are located in a border city.



(a) 84 MHz Clearing Target

(b) 108 MHz Clearing Target

Figure 1: Locations of minimal blocking sets found of size 11 or smaller for both 84 and 108 MHz clearing targets. (Qualitatively similar figures result from other upper bounds on sizes.) At a 108 MHz clearing target, all of the 84 MHz blocking sets (which are located exclusively in border regions) remain blocking sets, and additionally we find new small minimal blocking sets far from the border, including along the northeast corridor and in northern California. Thus it is likely that the non-border impairments would result at the larger clearing target under the PN proposal, and this situation would be amplified at even higher clearing targets. (Note: Some map pins have been jittered slightly to reduce occlusions.)

p	84 MHz	108 MHz
0.5	0%	6%
0.45	1%	15%
0.4	4%	30%

Table 1: For varying probabilities p of broadcaster participation, and for clearing targets of 84 and 108 MHz, we show the probability that impairment will occur in a non-border region.

therefore that impairment will occur in a non-border region. At 84 MHz, these probabilities are all quite small, but at 108 MHz, the values are significantly larger — roughly an order of magnitude.[17] Relating this back to the PN, recall that the clearing target maximization ensures that the 0.2 impairment standard will be (nearly) saturated. We have now shown empirically that, when impairment occurs at a high clearing target, the affected regions are likely to include metropolitan regions far from the border. This argument is supported mathematically by our analysis in the previous section. The bottom line is that, under the current PN proposal, a high target that causes significant impairment in highly populated regions would be likely chosen during the initial optimization. An argument could be of course be made that this is preferable to clearing less unimpaired spectrum, a topic we discuss in the next section. For now we simply note that this is a nontrivial tradeoff that warrants more careful attention.

We note that our choice of 84 and 108 MHz as the two clearing targets of comparison, as well as the choices of broadcaster participation probabilities p, are unimportant in an absolute sense; what matters are the *relative* trends highlighted by our experiments. We have shown that (a) healthy clearing targets can likely be reached nationwide with no or minimal 600 MHz band impairment outside of border regions, and (b) the current PN proposal of "baking in" impairment as part of the clearing target maximization is likely to create impairments in large metro markets that are far from the border.

[17] Again, the disparity would be even greater for higher clearing targets.

8.4 Impairments May Actually Reduce Usable Wireless Spectrum

Above we have highlighted the tradeoff between smaller amounts of largely unimpaired spectrum and larger amounts of significantly impaired spectrum. But an additional concern concern is that the amount of usable spectrum provided by a higher target with impairment might actually be *less* than that provided by a lower target without impairment. For instance, suppose we can reach a clearing target of 84 MHz without impairment (as suggested by our experiments), but can reach a clearing target of 108 MHz if we allow 20% impairment,[18] and therefore provide two additional licenses. It is possible, however, that the impairments effectively render the some of the *previously unimpaired* 84 MHz licenses unusable due to interference from the nearby presence of a television broadcaster. In this case, the added benefit of the additional 108 MHz licenses is more than canceled out. Evaluation of the likelihood of such possibilities would require extensive simulation and detailed calculations of actual impairments. But our experiments suggesting that an 84 MHz clearing target can be reached without nationwide impairments, combined with the calculations in Section 8.1 demonstrating the existence of permissible clearing target solutions with widespread impairments, raise serious concerns over the PN clearing target and DRP proposals.

9 Initial Prices and Repacking Difficulty

The PN proposes that initial and subsequent prices be determined by a "base clock price" (that will fall from its initial value during subsequent clock phases) times a broadcaster-specific "volume" factor. The suggested volume formula multiplies a *population* factor with an *interference* factor, which is meant to measure "a station's potential impact on repacking."[19] While there are also valid concerns regarding the definition and use of the population factor, we restrict our attention here to the choice of interference factor. The PN proposes

[18] Or potentially much higher impairments at even higher clearing targets, as shown in our calculations at the end of Section 8.1.

[19] PN, paragraph 96.

to define this factor as the sum of a broadcaster's co- and adjacent-channel constraints. This metric is an inaccurate measure of repacking difficulty, both because propagation effects and domain constraints are ignored, and because a static measure cannot reflect changes in difficulty that occur as the auction proceeds. We address these two concerns by describing an alternate empirical metric derived from actual feasibility checks, and proposing a dynamic pricing model that allows for conditional adjustments to the metric.

9.1 Constraint Counts Inaccurately Measure Repacking Difficulty

The PN proposal assumes that the difficulty a broadcaster presents to the repacking process is proportional to (square root of) the number of its co- and adjacent constraints. No evidence is provided to support this assumption, which crucially ignores the interaction of multiple broadcasters in the interference graph. There is no need to rely on a crude counting measure; empirical data derived from the results of feasibility checks and simulations provides a more accurate measure of difficulty.

In particular, we suggest an alternate metric based on a broadcaster's participation in minimal blocking sets (as defined in the previous section). Recall that we used feasibility checks to generate a list of these sets, which have the following useful property: if all broadcasters in a minimal blocking set choose not to participate (or exit during the reverse auction), and therefore need to be repacked in their pre-auction band, then feasibility can only be achieved by introducing impairment in the 600 MHz band. The smaller the blocking set, the more likely that (under any probabilistic model of participation) all of its members will need to be repacked. Thus, broadcasters who belong to small blocking sets are more threatening to the repacking process, in the sense that their non-participation is more likely to lead to impairments or infeasibility. We therefore propose using an interference factor that is inversely proportional to the average size of the blocking sets to which the broadcaster belongs. We shall refer to the PN proposal as the *constraint-counting* difficulty measure, and ours as the *blocking set* measure.

We emphasize that our proposal is just one suggestion; there are a variety of empirical

measures one could use, including: the size of a broadcaster's smallest (rather than average) blocking set, the number of a broadcaster's blocking sets, and the probability that a blocking set containing the broadcaster occurs (given some participation model). We computed all of the above rankings and found moderately strong correlations between them, suggesting that these measures all share some notion of "ground truth." Indeed, any empirical measure based on the results of actual feasibility checks would be more accurate than simple constraint-counting. To support this argument, we next describe several ways in which the constraint-counting proposal can provide misleading results.

One major concern with the constraint-counting factor is that domain constraints are entirely ignored. Because border stations often have a much smaller domain than average as a result of international treaties, these stations can be very difficult to repack. Yet such stations might not have many co- or adjacent-channel constraints, and so the proposed measure does not reflect their true difficulty. It is of course possible that international negotiations will mitigate this hardship before the auction occurs, but for the sake of consistency with the currently released domain file (which is considered extensively elsewhere in the PN, including for clearing target optimization and feasible assignments), the proposed measure should not assume the disappearance of these constraints. Any empirical measure will necessarily take these constraints into account, and therefore rank the border broadcasters highly. Indeed, the top 100 stations according to our blocking set measure are all border stations.

A second concern is that constraint-counting computes a broadcaster's difficulty factor in isolation, without geographic context. As a result, there are notable stations whose ranks according to the constraint-counting approach are much higher than the ranks according to our blocking set approach. For instance, there is a station located in Georgia whose constraint-counting rank is 26 and blocking set rank is 745, and another station in Indiana whose constraint-counting rank is 19 and blocking set rank is 682. Both of these stations have large numbers of co- and adjacency- constraints due to their high HAAT and ERP. Yet because the *neighbors* of these stations have few constraints, neither actually presents a significant repacking challenge. As a concrete example, for either station described above,

suppose that neither this station nor any of the broadcasters with whom this station has maximum interference[20] participates in the auction. Using a feasibility check, we can verify that it will still be possible to reach an 84 MHz clearing target with no impairment in the 600 MHz band.

Conversely, there are some stations (not located on the border) whose ranks according to the constraint-counting approach are much *lower* than the ranks according to the blocking set proposal. For example, we can identify a station in New Jersey whose constraint rank is 661 and blocking set rank is 147, as well as a station in Pennsylvania whose constraint rank is 740 and blocking set rank is 153. Although these stations have relatively few constraints themselves, they are each located in heavily congested areas, and many of their neighbors in NYC and Philadelphia have large numbers of constraints. As a result, these stations belong to small minimal blocking sets. Thus, the lack of participation of either station can still threaten the repacking process by significantly increasing the probability of infeasibility or impairment.

More generally, there is little correlation between the constraint-counting and blocking set measures. Even excluding border cities, the number of broadcasters that appear in the top 20 under both rankings is only 1, and the number that appear in the top 100 under both rankings is only 25. Thus there is minimal overlap in the rankings generated by these two repacking difficulty measures, a cause for concern by itself.

Inaccuracies in the repacking factor may result in the clearing of less spectrum due to early exit of difficult broadcasters in response to low prices, or the overpayment of easy broadcasters and subsequent failure to meet the final stage rule. As a result, it should be a priority to choose the metric carefully. While constraint-counting might seem appealing due to the fact it can be computed without a feasibility checker, it still requires a computation, and is no more transparent or intuitive than something closer to the actual difficulty of repacking under feasibility checking. Certainly if repacking difficulty factors will be computed

[20]By maximum interference, we mean that there is at least one channel on which the two stations have all three possible co- and adjacency- constraints.

once and for all initially, and then used to determine clock prices from the base factor, there seems to be no reason not to move to a more accurate repack factor based on actual feasibility experiments: these numbers can be precomputed and advertised in advance, just as with the current constraint-counting proposal in the PN.

If for some reason a measure avoiding actual feasibility checking and simulation is nevertheless preferred, we can still propose alternatives that more accurately reflect the difficulty a broadcaster poses to the repacking process than does constraint-counting. As is evidenced by the examples described above, one problem with the current proposal is that a station's rank does not depend on the constraint counts of its neighbors. A station with many constraints but whose neighbors have few constraints might actually be easy to repack, and similarly, a station with few constraints but whose neighbors have many constraints might pose difficulty. Thus, one alternative is to compute a station's difficulty factor by taking a weighted average of its own constraint count and the constraint count of the stations with which it has interference.

9.2 Repacking Difficulty Depends on the Provisional Assignment

The discussion so far has treated repacking difficulty as a static quantity. But the right metric is of course actually a dynamic one: the difficulty a broadcaster presents depends on the precise set of broadcasters who have already exited (or not participated in the first place), and this set changes as the auction proceeds. Thus the relative difficulty of broadcasters will also change during the auction. Failing to acknowledge or model this in prices offered may again result in less spectrum being cleared.

As an illustration, consider the following simple example. Suppose broadcaster A has domain $\{1, 2, 3\}$ and broadcaster B has domain $\{4, 5, 6\}$, and both broadcasters interfere maximally with broadcasters C and D on all channels. Initially, broadcasters A and B pose equal difficulty to repacking. But if broadcasters C and D exit early and are provisionally assigned to channels 1 and 2, respectively, then broadcaster A becomes more difficult to repack, and its interference factor should be adjusted accordingly.

We therefore propose that at each round of the reverse auction, broadcaster repacking factors be recomputed conditioned on the committed repackings so far. These factors could be mapped to real values in the range $[0, 1]$, where values near 0 indicate a broadcaster that is most difficult to conditionally repack, and values near 1 indicate a broadcaster that is easiest to conditionally repack. The decrement to a broadcaster's clock price would then be their conditional value times the base clock decrement (i.e. the amount by which the base clock price is reduced from the previous round, which the PN proposes to set between 3% and 10% percent).

For example, if the current base clock decrement is 7%, and a broadcaster has a conditional repacking value 0.8 (relatively easy to currently repack), its price would fall by 0.8 times 7% in the next round. In comparison, a broadcaster with conditional repacking value 0.3 (relatively difficult) would see a price reduction of only 0.3 times 7%. Thus, broadcasters who have become increasingly difficult to repack would receive more encouragement to remain in the auction.

This proposal preserves two desirable properties of the mechanism described in the PN: (1) we still have a descending clock auction, since a broadcaster's price can only decrease at each round, and (2) all broadcaster decrements are still tied to a single base clock decrement. But now we have the significant added benefit of tying current prices to current repacking difficulty, rather than pre-auction difficulty.

It is easy to describe dynamic, conditional versions of our previously proposed alternate repacking factors. Recall our proposal to use the inverse of the size of the smallest minimal blocking set. As the auction proceeds, certain blocking sets may "disappear" due to the exit of one of their members. Thus, we can recompute the factor in every round, using only those blocking sets that still pose a threat, and then normalize the values accordingly. More sophisticated approaches can be used as well; for instance, we can sample from the set of (remaining) possible auction outcomes to compute probabilities of reaching infeasibility (or high impairment solutions), conditioned both on the exit and continued participation of the broadcaster in question. Then we can compare the two values to see how much additional

difficulty the broadcaster introduces to the repacking problem.

Dynamic, feasibility-checking based repacking factors such as these might not be computationally practical, as they involve sampling many solutions for each broadcaster during the live auction (as opposed to doing so just once offline, prior to the auction). But even if one kept the current constraint-counting proposal (or the weighted variant we proposed earlier, which considers the constraints of neighbors as well), it would still be an improvement to do so dynamically. In this case, constraint-counting would be done only between *active* broadcasters, rather than all broadcasters. In other words, we would exclude broadcasters those who have already exited or been frozen and thus provisionally cleared, because they are irrelevant to further repacking computations.

Appendix

In this appendix, we first provide an example illustrating how the Commission's proposed implementation of the spectrum reserve would introduce new opportunities for manipulative bidding (see section 3.3). We then describe a narrowly targeted proposal that would correct this problem in a way that actually simplifies the auction.

An Example

Suppose there are 3 reserved and 3 unreserved Category 1 licenses in a given PEA and that bidder valuations are as in the following table where, as in the remainder of this example, values are expressed in dollars per MHz-pop:

bidder number	valuation of first license	valuation of second license
	Non-REB	
1	3.00	2.50
2	2.60	2.10
	REB	
3	2.70	1.70
4	2.30	1.60
5	2.00	0
6	1.50	0
7	1.20	0

Suppose that the final stage rule will be satisfied when the price for Category 1 spectrum in this market reaches $1.30. Under unconstrained competition for the 6 Category 1 licenses, the market would clear at a price no lower than $2.00. Now consider bidding

under the proposal to initiate the spectrum reserve at a price of $1.30. If bidders were to bid straightforwardly, demanding a unit (of the lowest-price license available to them) whenever this price was below their corresponding marginal valuation, the auction would proceed as follows (we let P_U and P_R denote the unreserved and reserve prices, with D_U and D_R denoting total demand at these prices):

reserve round	P_U	D_U	P_R	D_R
1	1.30	4+3	1.30	3
2	1.40	4+0	1.30	6
3	1.50	4+0	1.40	6
4	1.60	4+0	1.50	5
5	1.70	4+0	1.60	4
6	1.80	4+0	1.70	3
7	1.90	4+0	1.70	3
8	2.00	4+0	1.70	3
9	2.10	3+0	1.70	3

Here we represent each entry in the D_U column explicitly as the sum of demand of non-REBs and REBs. For example, in round 1, "4+3" indicates 4 units demanded by non-REBs and 3 demanded by REBs, consistent with the Commission's proposed rule for allocating demand at the initiation of the spectrum reserve. One possible concern is that even under straightforward bidding, total revenues are substantially lower. But in fact we should not expect straightforward bidding by REBs. To see why, suppose that REBs have at least a noisy indication of the likely range of prices at which reserved and unreserved spectrum would clear if all bidders compete. In particular, suppose that they know that with competitive bidding, the reserved licenses would not clear at a price below $1.50 and unreserved licenses would not clear below $2.40. With such beliefs, bidders 6 and 7 need not bother bidding

at all, and bidders 3 and 4 can profit by withholding demand for a second reserved license once the reserve is triggered, instead demanding an unreserved license until the price reaches \$2.40—a strategy they pursue merely to drive up the costs of their downstream competitors. Under this behavior, the auction would instead proceed as follows:

reserve round	P_U	D_U	P_R	D_R
1	1.30	4+3	1.30	3
2	1.40	4+2	1.30	3
⋮	⋮	”	”	”
8	2.00	4+2	1.30	3
9	2.10	3+2	1.30	3
10	2.20	3+2	1.30	3
11	2.30	3+2	1.30	3
12	2.40	3	1.30	3

By withholding demand, bidders 3, 4, 6, and 7 stop the reserve clock at the minimum price of \$1.30. Compared to straightforward bidding, bidders 6 and 7 lose nothing by this strategy, while bidders 3 and 4 are (correctly) certain that they will gain: they believe that by competing, the price for acquiring a second license would be at least \$1.50, leaving at most a small marginal surplus (\$0.20 for bidder 3, \$0.10 for bidder 4) on a second license. But by stopping the clock, each expects to save at least \$0.20 (and in fact saves \$0.40) on its first license. Further, the strategy drives up the costs of non-REBs, benefiting all winning REBs (bidders 3, 4 and 5).

A Modification of the Reserve Phase Clock Auction

In the text we proposed that REBs be prevented from expressing a preference for high prices by demanding an unreserved license when an identical reserved license is currently offered at a lower price. This restriction could be imposed directly within the clock auction mechanism proposed by the Commission. However, here we propose an alternative approach for imposing this same restriction through a change in the way that the spectrum reserve is accommodated by the MALS clock auction design. Although our proposal requires detailed explanation, it would in fact simplify the auction.

To describe the suggested modification, we henceforth focus on the rules that would apply once both the final stage and spectrum reserve triggers have been satisfied. For simplicity we ignore intra-round bidding, although this is easily accommodated using the Commission's proposed design. Indeed, intra-round bidding strategies would be simplified for REBs, since REBs would not need to consider intra-round movements of demand between reserved and unreserved licenses.[21]

In each clock round a given bidder would see a single price for Category 1 spectrum in each PEA. For a REB, this would be the price on the reserved clock; a non-REB would see the price on the unreserved clock. Each round, a bidder would express the quantity it demands at the currently offered price. At the end of the clock phase, the payment made by each winning bidder (excluding additional payments in the assignment phase) for each license won is the price on that bidder's clock. Thus, from a bidder's perspective, the auction would look like a simplified version of that under the Commission's proposed design.

The two price clocks for Category 1 spectrum in a given PEA would be controlled as follows:

- If total demand (REB + non-REB) is less than or equal to total supply (reserved + unreserved), clock prices do not adjust;

[21] This could be especially important since the proposed intra-round bidding rules would not allow full flexibility in how demands are adjusted in response to changes in *relative* prices of different licenses.

- Otherwise,
  - if non-REB demand exceeds the unreserved supply, the unreserved clock ticks up;
  - if REB demand exceeds the reserved supply,
    - the reserved clock ticks up;
    - if current prices on the reserved and unreserved clocks are equal, the unreserved clock also ticks up;
- When both clocks tick up in a given round, the same dollar increment applies to both.

Under these rules, the price on the unreserved clock could be higher than that on the reserved clock, but never lower. When total demand exceeds total supply, one or both of the clock prices would rise.[22] If the total demand of non-REBs exceeds the supply of unreserved licenses at this point, the unreserved price would rise. If the total demand of REBs exceeds the reserved supply at this point, the reserved price would rise. Further, when the reserved and unreserved clock prices are equal and REBs still demand more licenses than the reserve supply, the unreserved clock price would rise, allowing competition among all bidders to determine the allocation of unreserved licenses.

Under these rules, the auction would have the following features:

1. Reserved licenses would be allocated only to REBs.
2. Unreserved licenses could be allocated to REBs, non-REBs, or both.
3. A winning REB would pay the reserved price for all licenses it wins, even when this includes unreserved licenses.
4. Adjustments to the reserved clock price would reflect only competition between REBs.

[22] As in the Commission's proposal, if total demanded equals total supply but the number of reserved licenses demanded by REBs is less than the number of reserved licenses, the number of reserved licenses would be reduced to the number of licenses demanded by REBs.

5. The unreserved price would reflect competition between all bidders and would, therefore, never be lower than the reserved price.

With the exception of item 3, these features are just as in the Commission's proposal. However, two important differences are that:

6. A REB could no longer "stop the clock" through its choice of which type of license (reserved or unreserved) to demand. In each round, all bidders would express a single quantity of generic Category 1 licenses demanded.

7. Although REBs could drive up the price offered to non-REBs, they could not do so without driving up the reserved price as well. Although bidders could demand as many units of a generic license as they want, each would pay the same price for all units it wins.

Thus, our proposed adjustment to the rules appears to retain all the Commission's desiderata while avoiding the introduction of new opportunities for strategic manipulation by an REB seeking to either stop the clock for its inframarginal licenses or drive up the costs of downstream rivals.