

# **A Dynamic Market Rule for the Broadcast Incentive Auction: Ensuring Spectrum Limits Do Not Reduce Spectrum Clearance**

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## **Summary**

We have developed a “Dynamic Market Rule” (“DMR”), which is a general auction framework for a contingent spectrum-aggregation limit that will allow the marketplace to determine if such a limit will impair auction revenues to the point of reducing the amount of spectrum cleared. This paper provides a set of straightforward steps for DMR that are discussed in widely accepted economic terminology. This framework would test the market with the spectrum aggregation limits in place and then provide a seamless relaxation of these limits if the forward auction does not meet the revenue target. Activity rules would diminish or eliminate potential incentives for strategic bidding that would frustrate the purpose of the limits. Additional competition induced by our proposed rules can lead to higher overall revenues in the auction as compared to rules with no limits.

The 600 MHz incentive auction will be comprised of two separate but related auctions: a reverse auction and a forward auction. In the reverse auction, broadcasters establish the price at which they will voluntarily relinquish their spectrum rights for a target amount of spectrum to be cleared. In the forward auction, parties interested in acquiring flexible-use licenses submit bids for the newly repurposed spectrum. As the Federal Communications Commission (“FCC” or “Commission”) has proposed, the FCC would first conduct either the full reverse auction, or a sufficient amount of the reverse auction to determine the amount of revenue necessary to relocate enough broadcasters to achieve a target amount of clearing.<sup>1</sup> The revenue required for broadcast clearing could then be added to any additional revenue targets for FirstNet and deficit reduction. Once the total revenue requirement for a specific target amount of spectrum clearing, say 120 MHz, is determined, the FCC would then proceed with the forward auction.

Under the Dynamic Market Rule, the Commission would conduct the forward auction according to the Milgrom et al.<sup>2</sup> clock design with the spectrum-aggregation limits in place.<sup>3</sup>

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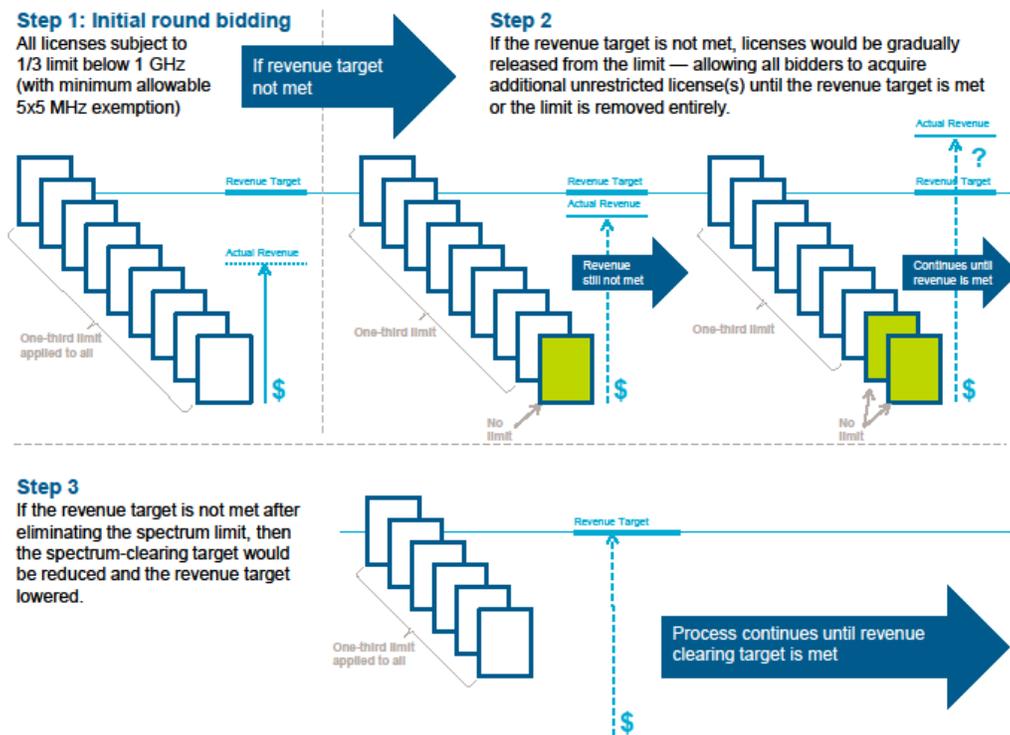
<sup>1</sup> See Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, WT Docket No. 12-268, *Notice of Proposed Rulemaking*, FCC 12-118 (rel. Oct. 2, 2012).

<sup>2</sup> See Paul Milgrom, Lawrence Ausubel, Jon Levin, & Ilya Segal, Incentive Auction Rules Option and Discussion, *Notice of Proposed Rulemaking*, App. C (Sept. 12, 2012), available at [http://transition.fcc.gov/Daily\\_Releases/Daily\\_Business/2012/db1002/FCC-12-118A2.pdf](http://transition.fcc.gov/Daily_Releases/Daily_Business/2012/db1002/FCC-12-118A2.pdf) (“FCC/MALS”). FCC/MALS propose a clock auction format in which the prices are incrementally increased at each round and the bidders then indicate “the amount of spectrum in each area they wish to buy at the announced prices.” *Id.* at 3.

<sup>3</sup> The particular type of spectrum-aggregation limits the Commission selects would not matter for purposes of the general application of the rules we describe in this paper. Also, it is possible to implement a dynamic market rule if the Commission were to run the forward auction prior to the reverse auction.

If the bidding revenue with the limit imposed proved sufficient to meet or exceed the revenue target, then the auction would end and licenses would be assigned consistent with the outcome of the auction process. The revenue target, which represents a minimum threshold of auction proceeds, can be set at whatever level the Commission deems appropriate.

If the bidding revenue target is not met, however, the Commission would gradually relax the spectrum-aggregation limits by one 5x5 MHz license at a time. As the limits are relaxed or eliminated, prices increase consistent with the proposed clock auction format until every market clears with demand equal to supply. As discussed in detail below, the spectrum limits would be relaxed by one license in areas where there are bidders subject to and constrained by the limit. This process continues until the revenue target has been met or exceeded or until the spectrum limit has been completely removed for all bidders in all areas.<sup>4</sup> If the revenue target has not been met and the spectrum limit has been completely removed, the auction continues to the next phase with a lower spectrum-clearing target, lower revenue target, and the spectrum-aggregation limits re-introduced. The figure below shows an example of how the DMR could be implemented.



Competition in the marketplace and the socially efficient allocation of the spectrum resource should be the primary concern for spectrum policy.<sup>5</sup> That said, revenues are a secondary objective, and in the Broadcast Incentive Auction they are more important than in previous Commission auctions because the clearing rule imposes an auction-wide minimum revenue requirement to pay the broadcasters for relinquishing their spectrum, cover relocation costs

<sup>4</sup> It is important to note that complete relaxation of the limits may not maximize revenue.

<sup>5</sup> See, e.g., 47 U.S.C § 309(j)(7)(B); Paul Klemperer, *What Really Matters in Auction Design*, 16 Journal of Economic Perspectives 169-189, (2002).

for other broadcasters who switch channels, and contribute to a public safety network and other public expenses to the extent these goals are not met by other spectrum auctions.<sup>6</sup> By using the proposed Dynamic Market Rule, the Commission should not worry about spectrum aggregation limits leading to clearing an inefficiently low amount of spectrum, and the rule could lead to increased revenue relative to an auction with no spectrum aggregation limits.

In this paper, we provide technical details for how the Dynamic Market Rule could be seamlessly incorporated into the current FCC/MALS auction design. There is more than one way this rule can be implemented so long as the implementation satisfies two properties: 1) there are incentives for bidders who would like to have their limits removed to bid aggressively even when the limits are still in place; and 2) the limits are removed gradually, one license at a time, to create additional competition for the relaxation of the cap, which could increase revenues and hence improve the chances of the overall success of the auction. We present one set of specific rules that would accomplish these goals. In the Appendix we provide additional discussion of some alternative specific rules that could be used to modify our proposal.

## **Discussion**

It is difficult to evaluate prior to or even after an auction the effect of spectrum-aggregation limits on revenues. Standard economic models show that revenues can either go up or down depending on the particular valuations of the bidders.<sup>7</sup> Our Dynamic Market Rule addition to the FCC/MALS proposed clock auction would allow the market to determine what level of aggregation limits would be compatible with clearing the largest amount of spectrum.

The rules we propose to accomplish this goal are quite general and can be readily adopted to a variety of auction designs (for example, if the FCC decides to deviate from the FCC/MALS proposal or modify it with some measures to reduce the exposure or fixed-cost problems) and to a variety of spectrum limits (for example, a spectrum-aggregation limit that applies to a set of bidders rather than the individual-bidder limits we discuss here).<sup>8</sup>

We do not take a position on which auction/limit design is best. For purposes of this paper, we use the FCC/MALS clock auction proposal and the sub-1 GHz aggregation limit with a 1-license exception as proposed by T-Mobile USA, Inc.<sup>9</sup>

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<sup>6</sup> See Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, § 6401, 126 Stat. 156, 222-224 (identifying other auctions whose proceeds are designated for funding FirstNet and other public purposes).

<sup>7</sup> See Peter Cramton, Evan Kwerel, Gregory Rosston & Andrzej Skrzypacz, *Using Spectrum Auctions to Enhance Competition in Wireless Services*, 54 J.L. & ECON. S167 (2011), available at <http://www.stanford.edu/~skrz/spectrum-auctions-and-competition.pdf>; Paul Klemperer *Using and Abusing Auction Theory*, 1 Journal of the European Economic Association, 272-300 (2003); Paul Milgrom, *PUTTING AUCTION THEORY TO WORK*, Cambridge University Press, Cambridge (2004).

<sup>8</sup> Certain proposed band plans include unpaired spectrum. While paired or unpaired spectrum (or a mixture of both) can also be addressed under our approach, we discuss only paired spectrum in this paper.

<sup>9</sup> See *Ex Parte* Notice of T-Mobile USA, Inc., WT Docket No. 12-268 (filed May 30, 2013), available at <http://apps.fcc.gov/ecfs/comment/view?id=6017445245> (proposing a one-third limit

### Dynamic Market Rule Details:

We focus on the forward auction since the reverse auction will not be affected directly by the limits. Each bidder is either unconstrained or has an aggregation limit on the number of licenses it can purchase in each area.<sup>10</sup>

We propose the following specific rules that would be incorporated into the auction design and software (and discuss possible variations in the Appendix):

1. The forward auction starts with each bidder having a pre-specified limit on the number of licenses it would be allowed to bid for in any area based on whatever spectrum-aggregation rule the FCC chooses. (The amount can vary across areas). The auction follows according to the FCC/MALS clock design.
2. When there is no excess demand in any area, the bidding revenue is compared to the revenue target and if the revenue target is met, the auction ends, as described in the clearing rule of the FCC/MALS proposal. If the revenue target is not met, the auction proceeds to *supplementary rounds* with altered limits as we discuss below. In the ensuing process, we call the bids/prices received during the first phase with the spectrum-aggregation limits in place the *anchor* and refer to the subsequent phases with the same clearing target as the *supplementary rounds*, which are different from the *extended rounds* proposed in the *Milgrom et al. Supplement* ("MALS2"),<sup>11</sup> but follow similar rules and can be combined with the extended rounds proposed in MALS2.
3. If there are some areas with excess supply, the spectrum aggregation limits are first relaxed in these areas according to the procedure described below until either each area no longer has excess supply or all limits have been removed in those areas. If the revenue target is still not met after the spectrum limits are fully removed in all areas with excess supply, the supplementary rounds are applied to all remaining areas.
4. During the supplementary rounds bidders cannot move their demand between areas; they can only reduce demand in a given area or bid for additional licenses as described below.<sup>12</sup>

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on spectrum holdings below 1 GHz but proposing an exception such that a bidder could always acquire at least a single 5x5 MHz block of spectrum in every geographic area at auction).

<sup>10</sup> After the target spectrum is determined in the reverse auction (including any "impaired" areas), the spectrum-aggregation limits can determine the amount of spectrum each bidder can acquire in each geographic area.

<sup>11</sup> See Auctionomics/Power Auctions Supplement, "Auctionomics/Power Auctions Option for Forward Auction," WT Docket No. 12-268, at 6 (filed Feb. 1, 2013), *available at* <http://apps.fcc.gov/ecfs/document/view?id=7022116356>.

<sup>12</sup> While we believe limiting demand switching provides an important safeguard against gaming the spectrum-aggregation limit, we discuss alternatives in the Appendix

5. In the supplementary rounds, the spectrum-aggregation limits are relaxed in the following way:
- a) When in a given area the supplementary rounds call for a relaxation of the limit by one license, the Commission creates two categories of licenses in that area: “regular” licenses subject to the limit and “no limit” licenses that are not. One license is put into the “no limit” category while the rest of the licenses remain in the “regular” category. Prices for the two categories start at the same point, which is the final clock price in the regular rounds. We denote prices for the two categories as  $P_R$  and  $P_{NL}$ . If additional relaxations are needed, additional licenses are moved from the “regular” to the “no limit” category and the  $P_R$  and  $P_{NL}$  prices are set as described below.
  - b) Any bidder at its limit for the “regular” licenses is allowed to express demand for the “no limit” licenses. Importantly, only bidders currently bidding at their limit for the “regular” licenses in that area are eligible to bid for the “no limit” licenses. This activity rule is intended to reduce incentives to manipulate the auction by under-reporting demand. Note that if in some area no bidder is at its limit, there would be no relaxations of the limits in that area.
  - c) If at the time one license is moved from the “regular” to “no limit” category the demand for the “no limit” licenses is at least equal to supply, then prices  $P_R$  and  $P_{NL}$  start increasing at the same rate (note that at the time one license is moved from the “regular” to “no limit” category there is excess demand of one unit for “regular” licenses).
  - d) The auction uses the FCC/MALS clock design with intra-round bidding to avoid creating excess supply in any area. Prices  $P_R$  and  $P_{NL}$  increase until one of the following two events happens:
    - i. If the demand for the “no limit” licenses drops below supply before the demand for “regular” licenses drops by one (to equal supply), both clocks stop because there is enough supply to cover whole demand (summed over the two categories). If the auction reaches this point, it means that no bidder is willing to pay the current clock price to obtain additional licenses above its limit in that area. Therefore, there will be no additional relaxation of limits in that area.
    - ii. If the demand for the “regular” licenses drops by one, which would create market clearing for the “regular” licenses then:
      - If at that point the demand for the “no limit” licenses equals supply, the price clocks in this area stop until the possible decision to relax the limits further.
      - If at that point demand for the “no limit” licenses is more than supply, then the  $P_R$  clock stops and the  $P_{NL}$  clock continues rising until demand is equal to supply for the “no limit” category.

- e) If at the time a license is moved from the “regular” to the “no limit” category, the demand for the “no limit” category is short of supply, the last move is reversed and the price clocks and allocation of licenses to bidders returns to the point just before that move. (The reason is that excess supply of the “no limit” licenses indicates that no limited bidder is willing to pay the current clock price,  $P_R$ , to get an additional license).
6. The relaxation of spectrum limits is done first as one unit per area. Once the procedure in point 5 is completed in every area, the total revenue is compared with the revenue target. If the revenue target has been met or surpassed, the auction ends. If the revenue requirement is not met, the spectrum-aggregation limits are relaxed further and the auction continues as above. Note that  $P_{NL} \geq P_R$  at this point.
- a) If  $P_{NL} = P_R$ , the process resumes as described above, with one more license moved from the “regular” category to the “no limit” category.
- b) If  $P_{NL} > P_R$  at the end of the last relaxation (case 5.d.ii, second bullet point), then, to keep uniform prices within an area when an additional license is moved from the “regular” to “no limit” category, the clock for  $P_{NL}$  is reduced to equal  $P_R$  and the process as described above is followed with the “no limit” category having one more license.<sup>13</sup>
- c) The process for a limit relaxation continues until either the clearing rule is met or the process ends in every area.
7. If the revenue target is still not met despite all limits being removed, the auction moves into extended rounds, for example as described in MALS2 or as proposed by T-Mobile as a take-it-or-leave-it offer.<sup>14</sup>
8. If the clearing rule is not satisfied during the extended rounds, the forward auction is reset to the last anchor (*i.e.* to the last regular round before any limits had been removed) and the supply target is reduced. The forward auction then continues as in the FCC/MALS proposal with the addition of the supplementary rounds.

## **Conclusion**

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<sup>13</sup> Note that as the spectrum-aggregation limit is relaxed, the supply of the “no limit” licenses goes up, they become less scarce and it may reduce total revenue. If so, one may be tempted not to re-set the  $P_{NL}$  price to avoid that reduction. However, discriminatory prices for different “no limit” licenses would make bidding more complex and strategic since bidders would have to make a decision which “no limit” license they should try to acquire. For example, one might not bid to win the first “no limit” license knowing that the second “no limit” license would be no more expensive and could be cheaper.

<sup>14</sup> See Reply Comments of T-Mobile USA, Inc., WT Docket No. 12-268, at 78-80 (filed Mar. 12, 2013). It might be possible to interleave the extended rounds and/or take-it-or-leave-it offer prior to each spectrum aggregation limit relaxation, but we have not investigated the strategic implications of such an alternative.

The Dynamic Market Rule would allow the 600 MHz auction to proceed first with spectrum aggregation limits and then without any limit if the auction failed to meet or exceed a specified revenue target. This approach allows the market, rather than assertions of predicted market behavior, to determine the effect of spectrum limits on spectrum clearing. Allowing for a seamless relaxation of a spectrum limit during the 600 MHz auction would create a market test without requiring material additional time or process in the bidding for spectrum licenses. The Dynamic Market Rule could simply be incorporated into the forward auction software and bidders would face similar constraints as they will with eligibility requirements in an unconstrained forward auction. As a result, the auction should not be much more complex nor substantially longer than an auction without the Dynamic Market Rule.

## **Appendix. Alternative Implementations of the Dynamic Market Rule:**

We have proposed a set of detailed rules that seamlessly incorporate the Dynamic Market Rule into a clock auction design. However, there may be other specific ways to implement the DMR that the FCC can choose, as long as they satisfy two key elements of the DMR discussed in the introduction: 1) there are incentives for bidders who would like to have their limits removed to bid aggressively even when the limits are still in place; and 2) the limits are removed gradually, one license at a time, to create additional competition for the relaxation of the limit, which could increase revenues and hence improve the chances of the overall success of the auction. In this Appendix we discuss some possible alternative detailed implementations of the DMR.

**Clearing Rule.** In point 6 above, the auction revenue is compared to the target only once every market clears for the current relaxation of spectrum-aggregation limits. However, the revenues may satisfy the clearing rule before demand equals supply in every area in every category.

An alternative rule would compare the overall revenue to the target continuously. Once the revenues clear the target, then:

- a) If in a given area demand for the “regular” licenses is higher than the supply of those licenses, the price clock  $P_R$  stops and one “no limit” license is moved back to the “regular” category, creating market clearing in the “regular” category.
- b) The price clock  $P_{NL}$  continues increasing until demand for the “no limit” licenses equals the remaining supply (if there is any).

**Substitution.** Point 4 above states that in the supplementary rounds bidders are not allowed to move demand between areas. That restriction is intended to provide incentives for a bidder who at the current price would like to win more licenses than it is allowed by the limit to truthfully declare that demand by bidding at the limit in the given area.

An alternative rule would allow bidders some limited substitution constrained by activity rules. For example, when the limits are relaxed the first time, every bidder at the limit in a set of areas would be asked to express demand for the “no limit” licenses in those areas. That demand establishes eligibility points for that bidder for the “no limit” licenses. As  $P_R$  and  $P_{NL}$  change, the bidder would be allowed to express demand for the “no limit” licenses subject to activity rules as in the FCC/MALS proposal with the added constraint that it can bid for a “no limit” license in an area only if it is still bidding at its limit for the “regular” licenses in that area. Such a change would give some flexibility for bidders to move demand for no limit licenses across areas to respond to relative price changes.

**Reducing Clearing Targets.** A small difficulty may arise if the FCC is forced to reduce the target number of licenses. The reason is that the spectrum aggregation limits in an area may depend on the number of licenses available in that area and as the supply tightens, the limits may tighten as well. If that happens, it is possible that when the supply of licenses is reduced, total demand is reduced by even more. So, somewhat paradoxically, even though supply is reduced, an area may switch from market clearing to excess supply. There are several possible ways to deal with this problem. One possibility is to restart the auction at the last anchor (price and demand, now possibly restricted by the new limits) and, if necessary, follow the rules in point 3 above: *i.e.*, continue the regular rounds of the forward

auction until there is no excess demand in the auction and relax the limits in any area with excess supply if the target is not met. Note that since during the regular rounds bidders are allowed to substitute demand between areas, even if a given area has excess supply at some point, new demand can remove it. There may be other alternatives that may ameliorate the problem, but also may lead to some strategic bidding.

**Bidding eligibility.** As discussed in point 5b, when limits are relaxed for the first time in a given area, any bidder currently at its limit is eligible to bid for the “no limit” license. There are two possible outcomes of this first relaxation: either no bidders win the “no limit” license (point 5.d.i) or one bidder does (point 5.d.ii). In the latter case there may be additional relaxations of the limit in this area.

The rules need to specify for each bidder how many of the “no limit” licenses that bidder is eligible to bid for when there are additional relaxations. The only constraint we proposed above is that to be eligible to bid for any of the “no limit” licenses, a bidder has to be currently bidding at its limit for the “regular” licenses. But the FCC can incorporate additional measures to refine the rule.

For example, when a second “no limit” license is made available, the rules could specify that only the bidder that was bidding the *highest* for the first “no limit” license is eligible to bid for two “no limit” licenses and all the other bidders can bid only for one. Alternatively, a bidder might be eligible to bid for two “no limit” licenses up to the price it was bidding for one “no limit license” when only one was available and once that price is reached, that bidder eligibility would drop to one license. These alternative eligibility rules would promote more aggressive bidding at the first relaxation of the limits (but could reduce competition in the subsequent relaxations). As with many of the rules discussed here, implementation of these measures would occur in bidding software itself and would not require the bidders to calculate the information.