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US 600MHz Incentive Auction Forward Auction Rules

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The “Incentive Auction” of 600MHz (UHF) bandwidth is the most ambitious spectrum auction ever proposed. Up to 144 MHz of “beachfront” radio frequencies could be repurposed from terrestrial broadcasting to mobile broadband. The process combines two separate but linked auctions: a **Reverse Auction**, which will identify a set of prices at which broadcasters are prepared to relinquish channels; and a **Forward Auction**, which will determine how much cellular operators are willing to pay to acquire the frequencies. The combined process determines not just the buyers and sellers but also the amount of spectrum to be cleared.

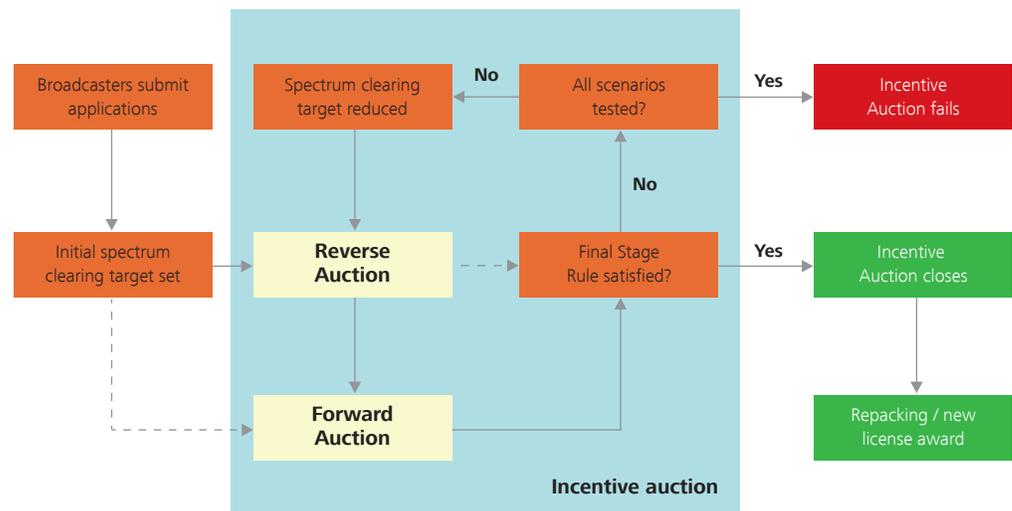
In this paper, **NERA Vice President Richard Marsden** and **NERA Analyst Jonathan Pike** describe the auction rules for the Forward Auction, highlight key innovations in auction design and key rules not yet clarified. In a marked change from past practice, the FCC will use an **ascending clock auction** format for the **Forward Auction**¹. Notable features include the sale of generic lots on a geographic basis; a variable spectrum reservation; and provision for an extended bidding round, in which bidders may offer extra money for specific licences in an attempt to secure a particular clearing target.

The success of the Forward Auction depends on aggregate revenues nationwide; there is no link between the funds raised in individual areas and the clearance of broadcast spectrum in that area.

Overview of the Forward Auction

The Forward Auction takes place over one or more stages, each linked to a target level of revenue for a particular spectrum clearing scenario, based on the outcome of the corresponding stage of the Reverse Auction. In a departure from previous cellular spectrum awards, which used the simultaneous multiple round (SMR) auction format, the FCC has adopted an Ascending Clock Auction format. Under this approach, geographic licenses are grouped together into categories and sold on a generic basis. Aggregate revenues across all categories have to achieve the clearing price in order to support the corresponding clearing scenario and end the Incentive Auction. If revenues are deficient, the auction will move to a new stage with less spectrum available. The overall process is illustrated in Figure 1.

Figure 1. **Overview of the Incentive Auction**



Qualification

The conditions for DE status and associated credits are subject to review by the FCC.

The auction is open to all parties that can meet the standard FCC conditions for participation in spectrum auctions. Businesses that qualify for Designated Entity (DE) status are eligible for bidder credits. Small businesses (annual gross revenues for the preceding three years below \$40 million) will receive a 15% credit; and very small businesses (turnover below \$15 million) will receive a 25% credit.

Available spectrum

The FCC has released these band plans to provide a level of certainty for network engineering analysis.

An Initial Spectrum Clearing Target will be determined by the FCC based on offers by broadcasters to move or relinquish frequencies at the opening prices in the Reverse Auction. This, in turn, determines the amount of spectrum that that will be offered in the first stage of the Forward Auction.

One unusual feature in band plans greater than 30+30 MHz is the need for a carve-out in the lower duplex band to protect radio astronomy in channel 37.

There are eleven distinct scenarios for spectrum to be cleared in the Reverse Auction, ranging from a maximum of 60+60 MHz down to 10+10 MHz. As illustrated in Figure 2, each scenario has a specific cellular band plan associated with it, ranging from a maximum of 12 paired licenses to a minimum of 2 paired licenses, each license consisting of 5+5 MHz of spectrum (downlink + uplink).

The first scenario to be tested in the auction will be the Initial Spectrum Clearing Target. The Reverse Auction will set a revenue target for that scenario. If bidders in the Forward Auction do not collectively offer enough money to meet the revenue target, then the process will be repeated for successive smaller scenarios until a solution is found or the auction fails. The FCC has discretion to skip some scenarios.

Figure 2. Spectrum clearing scenarios and associated UHF band plans

Scenario #	MHz cleared	MHz sold	21 6MHz Broadcast channels	B New 5+5 MHz Cellular blocks	37 Radio Astronomy (protected)	7 Other cleared (MHz)
0	0	0	21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36		37	38 39 40 41 42 43 44 45 46 47 48 49 50 51
2	42	10+10	21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36		37	38 39 40 41 42 43 44 11 A B 11 A B
3	48	15+15	21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36		37	38 39 40 41 42 43 7 A B C 11 A B C
4	60	20+20	21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36		37	38 39 40 41 9 A B C D 11 A B C D
5	72	25+25	21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36		37	38 39 11 A B C D E 11 A B C D E
6	78	30+30	21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36		37	38 7 A B C D E F 11 A B C D E F
7	84	35+35	21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36		37	3 A B C D E F G 11 A B C D E F G
8	108	40+40	21 22 23 24 25 26 27 28 29 30 31 32 11 A B 3		37	3 C D E F G H 11 A B C D E F G H
9	114	45+45	21 22 23 24 25 26 27 28 29 30 31 7 A B C D 3		37	3 E F G H I 11 A B C D E F G H I
10	126	50+50	21 22 23 24 25 26 27 28 29 9 A B C D E F 3		37	3 G H I J 11 A B C D E F G H I J
11	138	55+55	21 22 23 24 25 26 27 11 A B C D E F G H 3		37	3 I J K 11 A B C D E F G H I J K
12	144	60+60	21 22 23 24 25 26 7 A B C D E F G H I J 3		37	3 K L 11 A B C D E F G H I J K L

Geographic license structure

PEAs are a hybrid of the Economic Area (EA) and local area (RSA / MSA) licensing regimes. Some PEAs may yet be merged to reduce the number of categories.

The available spectrum will be divided into up to 416 geographic areas, based on the new Partial Economic Area (PEA) licensing regime. Within each PEA, licenses will be grouped into one or more categories, each containing a number of equivalent ‘generic’ 5+5 MHz licences. A bidder that wins one or more generic licences in a category will presumably be guaranteed to receive a corresponding range of specific contiguous frequencies in the Assignment Round, which takes place after the Forward Auction if the “Final Stage Rule” is satisfied.

The same band plan will be used nationwide, regardless of the amount of broadcast stations cleared in each area. However, it is possible that the number of licences available could be reduced in some PEAs. This could happen either because there are a few regions where an insufficient number of broadcasters offer to relinquish spectrum to support the Initial Spectrum Clearing Target, or due to the need to protect broadcasters in Canada and Mexico.

Using generic licences greatly simplifies bidding. Ideally, the FCC would prefer just one category of generic lots per region but this is only feasible if it can be shown that all lots have reasonably similar value.

In practice, only AT&T and Verizon will be ineligible to bid for reserved spectrum, as they are the only companies with sufficiently large low frequency holdings.

The unusual complexity of the reservation rules appears to be driven by the FCC’s need to ensure that a clearing scenario does not fail owing to lack of demand.

To minimize value differences between specific frequency lots, the FCC will mandate interoperability across the whole band. In principle, this could mean that there will be just one category of license per PEA, an approach that would simplify the bidding process. However, this may cause problems for bidders if there are significant value differences across frequency blocks, for example owing to impairments on use owing to cross-border interference. Operators may also have technical concerns associated with the complex band plans required for larger releases of spectrum, which will require phones to support up to three “carriers” and variation in the duplex gaps between the uplink and downlink bands necessary to protect radio astronomy in channel 37.

Spectrum reservation

In a departure from recent auctions of US cellular spectrum, the FCC has proposed restrictions on the spectrum that operators can acquire in the auction. Up to 30 MHz will be reserved in each PEA for “reserve-eligible bidders” who currently have less than 45 MHz of sub-1 GHz spectrum in that PEA. The maximum amount of reserved spectrum depends on the spectrum available in each stage, as illustrated in Figure 3.

Figure 3: **How reserved spectrum varies with the clearing scenario**

Clearing scenario #	12	11	10	9	8	7	6	5	4	3	2
Spectrum Available (MHz)	120	110	100	90	80	70	60	50	40	30	20
Maximum Unreserved Spectrum	90	80	70	60	50	40	40	40	30	20	10
Maximum Reserved Spectrum	30*	30*	30*	30*	30*	30*	20	10	10	10	10

*May be reduced to 20 MHz if only one reserve-eligible bidder is still bidding at the price point when the reserve applies.

Even within a stage, the amount of reserved spectrum may vary depending on aggregate prices and the level of demand from reserve-eligible bidders. Spectrum will only be reserved from a point, called the “spectrum reserve trigger”, where gross revenue across all PEAs is sufficient to ensure the clearing scenario can be met. If, at this point, demand in a region from reserve-eligible bidders is below the maximum, then the reserve for that region will be reduced accordingly. Furthermore, for scenarios where a 30 MHz reservation applies, this will be reduced to 20MHz if only one reserve-eligible bidder remains.

If prices progress at a different pace across PEAs, reserve-eligible bidders may be eliminated from some PEAs but become protected elsewhere when the trigger point is reached. This may encourage regional bidders to bid out of area.

These rules complicate the otherwise simple approach to price increments in an ascending clock auction. Within each PEA category, the same price increments will apply to all lots up to the point where the “spectrum reserve trigger” is achieved. Beyond this point, prices for any reserved spectrum will be frozen as soon as demand from reserve-eligible bidders falls below maximum reserve spectrum for that stage. Meanwhile, the price of unreserved spectrum in the same PEA will continue to rise as long as overall demand exceeds supply. This implies that a reserve-eligible bidder could find itself with de facto winning bids on reserved spectrum but still be competing for additional unreserved spectrum in the same area.

Opening bids and eligibility points

The relative level of opening bids and eligibility points across regions could have a big impact on outcome, as it may affect which PEAs clear first and whether they do so before or after the reserve price trigger is met.

As in previous spectrum auctions, the FCC is expected to announce opening bid levels and eligibility points for each licence. All licenses within a category will have the same price and eligibility weighting. Historically, the FCC has set both opening bids and eligibility proportional to the population in the license area. However, the FCC’s consultants have raised the possibility of variations to this approach, for example weighting prices and eligibility towards major cities based on an econometric analysis of past auction results.

As with previous auctions, we expect each bidder will start the auction with a number of eligibility points determined by their initial deposit. This in turn will presumably be based on an application that specifies demand for a number of licenses in specific PEAs. Each bidder’s activity in the auction will be constrained by their initial eligibility, as described below.

Bidder association

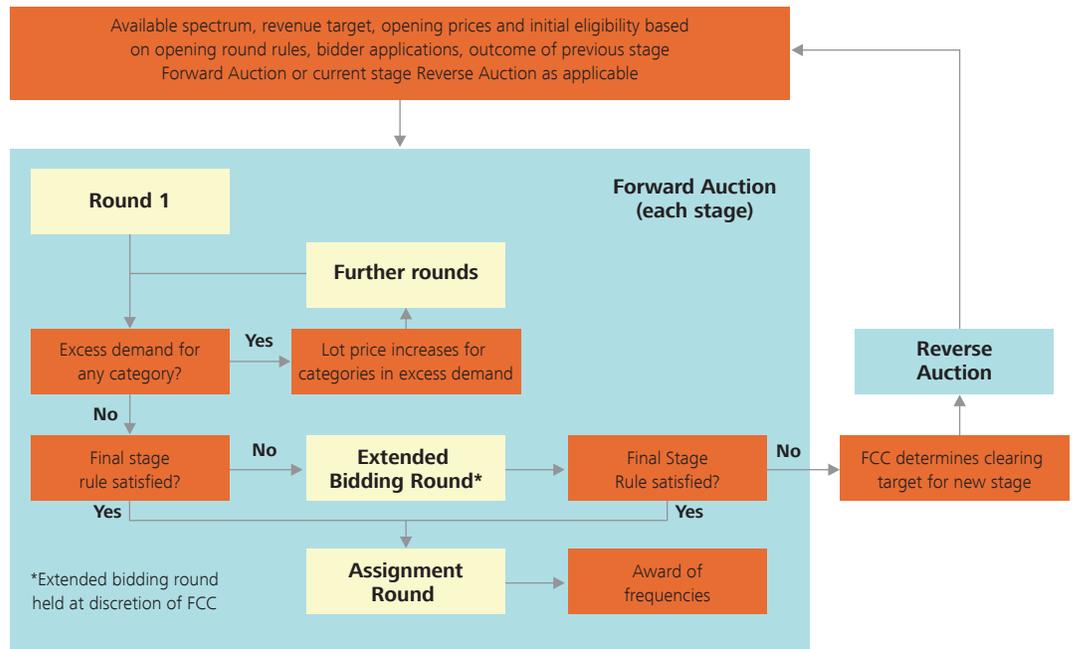
It is unclear how these rules will be enforced given that clock auctions typically allow bidders to switch freely between regions.

After the application deadline, bidders competing in the same geographic area will not be allowed to communicate with each other about the auction. However, this restriction does not apply to participants not bidding in the same geographic areas. The FCC has not specified how it will enforce the rule that bidders that have communicated cannot bid in the same area.

The bidding process

The bidding process will use an ascending clock auction format, and takes place over one or more stages (one for each clearing scenario as required). The process is illustrated in Figure 4.

Figure 4. **Overview of the bidding process for the Forward Auction**



The FCC’s Report and Order, published in June 2014, provides little new information about the bidding process, but based on material published by the FCC’s consultants, our understanding is that the auction will likely proceed as follows:

- **First round:** Each bidder specifies the number of licenses it wishes to acquire in each category (PEA) at the opening prices. A bidder may be active in multiple PEAs, but each bid is independent. Bidding for all categories will be conducted simultaneously.
- **Subsequent rounds:** Prices for categories where aggregate demand exceeded supply in the previous round will be increased by a price increment. Price increments will be determined by the FCC and the percentage increase may vary across categories. Each bidder that was active in the previous round will have the opportunity to place new bids at current round prices.
- **Activity rules:** The scope for bidders to make new bids and switch between categories will be constrained by activity rules, based on an eligibility point regime. Each bidder’s current eligibility will be based on their activity in the previous round (or based on their application in round 1). Each bidder’s activity is equal to the sum of eligibility points associated with the licenses that they were active on in the previous round. As a general rule, bidders can only maintain or reduce their aggregate level of activity; they cannot increase it.

Observe that the prices of all licenses in a category rise if there is excess demand. This is true regardless of the level of excess demand (although the FCC has discretion to use lower % bid increments for lower levels of excess demand).

The option to retain bids is necessary to protect the auction from sudden drops in revenue. However, it may expose bidders to aggregation risk. In the absence of any provision for package bidding, a bidder attempting to drop demand in or switch away from a PEA could find itself with partially retained demand. This risk is similar to an SMR auction, when bidders may become stranded on an unwanted subset of their demand.

- **Retained bids.** There are no standing high bids in a clock auction. Bidders are typically free to switch demand from one category to another, and to reduce or increase their demand in any category, provided they have sufficient eligibility. However, we anticipate that there will be rules enabling the Auctioneer to retain bids at the individual lot level (and if necessary deny switches between PEAs) in case this would otherwise result in deficient demand and lower auction revenues. Also, bids from reserve-eligible bidders may be retained and their price frozen under the conditions described above.
- **Intra-round bidding:** When a bidder drops demand in a region, it is obliged to specify a price point for each unit of demand dropped. This applies even if the bidder is not dropping eligibility and intends to use the points to switch to another PEA. The default price point is the previous round price, but the bidder may alternatively submit an “intra-round bid” for each unit of demand. An intra-round bid must be at a price that is greater than the previous round price and less than the current round price.
- **Final round:** Normal bidding ends when there is a round in which there is no excess demand for any category, but the auction stage could be prolonged if the Final Stage Rule is not met.
- **Extended bidding round:** The Final Stage Rule is satisfied if the aggregate proceeds from the Forward Auction meet the revenue requirements for that stage. If the rule is met, bidding will stop and the auction will proceed to the Assignment Round. However, if the rule is not met, the FCC may initiate an extended bidding round, in which bidders will have the opportunity to increase their bids.

With the switch from an SMR auction to clock auction format, a number of other changes to the auction process can be anticipated:

The use of intra-round bidding and retained bids will protect the auction from sudden drops in demand that could otherwise undermine the process.

- **Pace of the auction:** The auction is likely to proceed rapidly, as prices for all lots in each category with excess demand will increase each round, as compared to an SMR auction where only individual lots increase in price.
- **Round duration:** Individual auction rounds may be longer than usual, so as to allow bidders time to bid on hundreds of categories simultaneously.
- **Round extensions:** Waivers may be replaced with “extension rights”, giving bidders a limited number of rights to extend the duration of the round in case they need more time to submit their bids.
- **Information for bidders:** The FCC is expected to limit information provided to bidders each round about other bids. We expect bidders to receive price data and information about aggregate demand by category, and possibly some information about the spectrum reserve trigger and the number of retained bids.

The Assignment Round is necessary because licenses in the main stage of the Forward Auction are awarded on a generic basis. It is a new procedure in the United States but has been widely used in other countries.

Any guarantee of contiguous spectrum is likely to apply only within PEAs not across adjacent regions. This may raise concerns for bidders seeking to aggregate large regional footprints.

It is ambiguous what use if any the FCC will make of extended bid round offers in case the auction goes to a new stage.

Assignment Round

Once the Incentive Auction concludes, an Assignment Round will take place to determine the specific frequencies in each PEA that each winning bidder will be issued. The Assignment Round provides an opportunity for bidders to express any preferences they may have for specific frequency positions within each PEA.

Little information has been given on how the Assignment Round will be run. It is likely that bid options will be constrained to ensure that bidders that won multiple lots in the same area receive contiguous spectrum, although this may not always be possible if spectrum within a PEA was sold in more than one category. Only outcomes in which all winning bidders receive frequencies that correspond to their winning bids will be permitted.

In other countries where assignment rounds have been used, such as Australia, Canada and the UK, the typical approach is to conduct a single round sealed bid, one for each category or group of related categories. A “second price” rule is widely used, in which the price paid is based on the opportunity cost of denying preferred frequencies to other bidders. It is expected that the FCC will propose a format and pricing rule in the Procedures PN.

What happens if there is a new bidding stage?

In the event that the Forward Auction fails to realize sufficient revenues to support a particular clearing scenario, the auction will move to a new stage with reduced spectrum available. The Forward Auction will resume once the new stage of the Reverse Auction has been completed. Our understanding is that bidding will resume at prices from the end of the last clock round (but not the extended round if there was one). As the number of lots in each PEA will be reduced, categories where demand previously equalled supply will now have excess demand, so price increments will resume.

Payments by winning bidders

Each winning bidder must make a payment equal to the sum of their winning bids for individual licenses in the Forward Auction and any additional payments due for successful bids in the Assignment Round.

Notes

¹ Based on a review of the Incentive Auction Report and Order, GN Docket No. 12-268, June 2, 2014, and other documents published on the FCC website (www.fcc.gov).

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- Experience with designing and implementing all major auction formats, including sealed bid, SMR, clock and package bid auctions
- Valuation of 4G spectrum portfolios
- Online bidding software for running or simulating auctions
- Visualization tools for tracking bids, monitoring payment exposure and identifying optimal bids

About the Authors

Richard Marsden, a Vice President based in New York City, leads NERA's spectrum policy and auction advisory work. Over the last 15 years, he has advised bidders or governments in more than 45 spectrum auctions in the Americas, Asia, Africa and Europe. He was a key member of the design team that pioneered the use of package auctions, including the CCA, for the UK, Dutch and Danish spectrum regulators. Recently, he has focused on developing and executing bid strategies for bidders in 4G spectrum auctions.

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