Economists INCORPORATED

Comments on the Design of the Rural Digital Opportunities Fund Phase I Auction

October 21, 2019

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1 Introduction

The FCC proposes to use the same multi-round reverse auction design that it used for the CAF II auction for the Rural Digital Opportunities Fund (RDOF) phase I auction.[2] The CAF II auction was, in many ways, a success, assigning $1.49B in support over ten years to provide fixed broadband and voice services to over 700,000 eligible locations.[3] However, CAF II was only the first application of this auction design for the assignment of funds to provide service to under-served or unserved areas in the United States, and it would be wrong to think that the design is already as good as it can be. After all, the FCC's forward auction designs have evolved to the point of barely resembling the original designs first used over two decades ago. Each point in that evolution took advantage of the data and experience of prior auctions to make efficiency-enhancing refinements. Similarly, the CAF II auction data and experience are available to help consider and examine potential refinements to this reverse auction design.

In this paper, we analyze the CAF II auction to better understand its outcomes and why they occurred. The result of this analysis is a set of proposals that are likely to improve the fairness and efficiency of the RDOF auction.

1. Use CAF II bidding data to update the CAM-driven reserve prices for RDOF in an effort to make more efficient use of the budget
2. Freeze the price clocks for uncontested areas after the budget clears to facilitate package bidding and the revelation of cost synergies
3. Modify the information rule to avoid switching bids that are only intended to gather information on the level of competition and hurt competition discovery
4. Reduce location uncertainty and its negative effects on efficiency and fairness
5. Use the CAF II performance weights to represent consumers' preferences and the proposed high latency weight to avoid paying for areas that do not increase network infrastructure or availability

With these proposals, we focus on working within the existing design to make incremental improvements rather than offering wholesale design changes. However, this is not to say that wholesale design changes should not be considered. To take an example, consider the fact that all areas share a single price clock. So, before the budget clears, bidding only determines which areas will be supported under the budget *given support levels determined by the relative reserve prices*. That is, bidding has no effect on relative support levels. Therefore, allocative efficiency relies on the relative reserve prices set by the FCC before the auction. In this paper, we propose to address that problem within the existing design by more accurately calibrating the relative reserve prices. However, a wholesale design change may be more appropriate. For example, the FCC could do as it does in its forward auctions, giving each

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[2] See *Notice of Proposed Rulemaking*, Rural Digital Opportunity Fund; Connect America Fund, WC Docket Nos. 19-126, 10-90, FCC 19-77 (rel. Aug. 2, 2019) ("RDOF NPRM").
[3] See Connect America Fund Phase II Auction (Auction 903) https://www.fcc.gov/auction/903

area its own price clock, so support only declines in areas with competition.[4] This approach would have the benefit of allowing price discovery to directly drive allocative efficiency instead of relying on relative reserve prices.

The following are terms and concepts that we rely on throughout and that we define here for clarity and convenience:

Inter-CBG Competition: this primarily refers to competition between CBGs for the limited budget, and as such, primarily takes place before the budget clears. However, there is also the potential for inter-CBG competition after the budget clears as support decreases in uncontested CBGs that are part of a package when the uncontested areas do not meet the minimum scale percentage (MSP).

Intra-CBG Competition: this refers to the competition that takes place within contested CBGs after the budget clears.

Dropout Price: the minimum level of support that a bidder will accept for a given CBG or package of CBGs.

Dropout Price Point: the price point (clock percentage) that corresponds to a bidder's dropout price.

2 Use CAF II Bidding Data to Inform Relative Reserve Pricing

One of the most important parameters for an auction of this kind is the relative reserve pricing, i.e., the ratios of the reserve prices for each area.[5] Because all areas share a single price clock that descends uniformly until budget clearing, relative reserve prices determine inter-CBG competition for the budget. In CAF II, the FCC relied exclusively on the CAM estimates to set relative reserve prices and proposes to do the same for RDOF.[6] However, the FCC now has the opportunity to improve its relative reserve pricing for RDOF by integrating CAF II bidding data with the CAM estimates.

2.1 Importance of Relative Reserve Prices in Creating Competition, Price Discovery, and Fairness

Under the CAF II auction design, there is only one price clock. Before the budget clears, support decrements in all areas at the same rate; areas with zero bids and areas with many bids are treated the same in this regard. At the point of budget-clearing, relative prices reflect the relative reserve prices set

[4] With this setup, it would be easy to address concerns about auction failure due to the auction clearing at an aggregate cost above the budget. If the auction were to arrive in such a state, the solution would be to do what the current design does, begin decreasing support in all areas simultaneously until the budget clears.

[5] Here, the term "relative reserve price" refers to a set of numbers, which, when all multiplied by a single positive constant, yield the actual reserve prices.

[6] Note that the method used to set reserve prices in the CAF II auction was the difference between the CAM estimated cost and the high cost benchmark of $52.50.

by the FCC before the auction began.[7] As relative prices do not adjust in response to bidding, price discovery before the budget is extremely limited and has very little effect on allocative efficiency. So, without meaningful price discovery before the budget clearing, the burden of making efficient use of the budget falls on the relative reserve prices.

A simple example illustrates why the resulting inefficiency increases as relative reserve prices deviate more from relative dropout prices. Assume the budget is $110. Suppose there are only two areas, A and B, and each has a reserve price of $100. So, the relative reserve price ratio is 1:1, and the aggregate cost at the start of the auction is $200. Suppose the minimum dropout price is $60 in area A and $40 in area B, a ratio of 3:2. Given the CAF II rules, the single price clock decrements until 60, when area A is dropped because support falls to its dropout price of $60. At that point, the aggregate cost goes from $120 to $60, and the budget clears. Area B may be assigned at any price between $40 and $60, depending on competition. So, with this mechanism, we may or may not get price discovery after the budget clears. But what is certain is the fact that the auction mechanism has no ability to discover the relative dropout prices before the budget clears, and hence no ability to transfer the $20 difference between the clearing price and area B's dropout price to help support area A. Therefore, it only manages to fund half of the areas and spend about 36-55% of the budget. On the contrary, if the relative reserve prices had reflected the dropout price ratio of 3:2, say $150 and $100 for A and B respectively, then the budget would have cleared at $110, when prices were $66 and $44. All areas would be supported under the budget. Furthermore, inter-CBG competition would drive support lower in area B, to $44 instead of $60 under the other reserve prices. So, conditional on supporting an area, the new reserve prices also yield lower prices for that area, another efficiency gain. And if intra-CBG competition were to continue in both areas after the budget cleared, the total auction spend could be as low as $100.[8]

There are two possible ways forward. The first is a total redesign of the auction to allow for price discovery before the budget clears, for example, by giving each area its own independent bid-driven price clock. The alternative (and the focus of this piece) is to do a better job of calibrating the relative reserve prices before the auction starts, adjusting them upwards for areas that are likely to have higher dropout prices and downwards for areas that are likely to have lower dropout prices. The goal of these adjustments is to have more areas in play when the budget clears, which, in a sense, is a way of using inter-CBG competition and estimated dropout price ratios to make up for the lack of relative price discovery. With more areas in play when the budget clears, the available budget would be used more efficiently to bring broadband to more locations without sacrificing speed or paying more support for areas that already received it. Adjusting relative reserve prices in this way would also make the RDOF

[7] Note that this is in strict contrast to analogous FCC forward auctions with a budget clearing rule (e.g. Auction 1002, Auction 103). In those auctions, each service area had its own price clock that only incremented with excess demand, so the relative prices at budget clearing were not fixed at levels determined by the FCC.
[8] Pushing the relative reserve prices further from the dropout price ratios creates more inefficiency. For example, suppose we set the ratios to the inverse, so that area A is $100 and area B is $150. Then when A reaches its dropout price of $60, area B is $90. At this price, the budget clears. Area B could potentially receive more than two times its dropout price, while area A goes unfunded.

program fairer by leveling the likelihood that each area gets broadband service, rather than favoring areas where the CAM overestimates the cost of deployment, as the proposed design does.

2.2 Using CAF II Bidding Data to Inform Relative Reserve Pricing

Fortunately, for the RDOF auction, the FCC can improve on the reserve pricing methodology it used for the CAF II auction, because the FCC now has more information than it had for the CAF II auction. That additional information is the CAF II bidding data itself, which can help to improve the calibration of the relative reserve prices.

To make the necessary adjustments, we follow the intuition developed in the simple example above. In that example, adjusting the relative reserve prices of areas A and B to the dropout price ratio put the areas on equal footing in competition for the budget. Unfortunately, the dropout price ratios for the RDOF areas are unknown (hence the need for an auction). So, for the purpose of setting the relative reserve prices, they must be estimated. CAF II relied entirely on the CAM estimates. However, one should not expect the CAM estimates to be so accurate for RDOF that they could not be improved using the CAF II bidding data. Indeed, in CAF II, when the CAM model was arguably more up-to-date, the auction cleared at an aggregate cost of just $149M. Approximately 25% of the budget went unused, and 27% of the locations were unassigned, indicating that adjustments to the relative reserve prices could have resulted in more locations funded under the budget.[9]

In estimating the dropout price ratios, the lowest CAF II bid on an area, in terms of price point, serves as a reasonable proxy for how the actual cost of providing service in that area compares to the reserve price set by the FCC. That is, areas that were dropped at high price points or that never received a bid at all are most likely the areas where the reserve price was low relative to the costs of providing service. Areas that received bids at low price points are most likely the areas where the reserve price was high relative to the costs of providing service.

So, the first step is to determine the lowest bids in terms of price points for each area and to convert them to implied support in terms of dollars per location, *assuming Tier + Latency (T+L) weights are zero*.[10] Next, fit that dropout price proxy as a function of the economic drivers of cost, like region, distance to urban center, location density, topography, etc.[11] Then, use that fitted model of relative

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[9] CAF II assigned $148,832,986 of the total budget of $198,000,000 to 713,176 out of 974,223 eligible locations in 16,950 out of 30,033 CBGs. See https://www.fcc.gov/auction/903

[10] Note that this methodology takes the performance and latency weights as exogenous and valid. We comment elsewhere in this document that the CAF II performance weights are appropriate for RDOF. We also comment that the FCC's proposal of 40 for the high latency weight could be more efficient for RDOF. To use the new high latency weight for this calculation, convert all high latency CAF II bids to the price point implied by the new weight for the same level of support.

[11] Compared to the CAM model, this would be a reduced-form model. Whereas the CAM based its estimates on a complicated set of engineering and other assumptions to make high-fidelity cost calculations, this approach exploits the benefit of bidding data to represent cost as a statistical function of known drivers of cost. However, many of the same variables driving the CAM estimates could be used here. See *Alternative Connect America Cost Model Overview,* April 1, 2015, https://transition.fcc.gov/wcb/ACAM040115.pdf

reserve prices for CAF II to make relative reserve price predictions for RDOF areas. Finally, set the scale of the reserve prices by scaling the new model predicted relative reserve prices such that the sum equals the sum of reserve prices produced by applying the CAM to the RDOF areas. If necessary, the FCC can also impose a pre-determined maximum reserve price that none of the newly calibrated reserve prices may exceed.

We have conducted a version of this analysis on the CAF II bidding data to examine the resulting reserve prices calibrated by the lowest bid in terms of price point. We took the lowest bid in terms of price point in each CBG and calculated the implied support assuming T+L weight equal to zero.[12] Then we rescaled these numbers so that the sum was equal to the sum of the actual reserve prices. Table 1 summarizes the adjustments made to CAF II reserve pricing using this method. CBGs are categorized according to whether their reserve price would be increased or decreased. The majority of CBGs would receive an increase (25,613), indicating that the inefficient use of the budget was driven by significant CAM overestimates for a minority of CBGs (4,420). Furthermore, these were, on average, the CBGs with the highest reserve prices, on both a per location ($881) and per CBG ($44,869) basis. In a theoretical counterfactual auction with the adjusted reserve prices where each of the actual lowest bids was submitted as a proxy bid, virtually all locations would be covered using virtually all of the budget.

Table 1: Summary of Adjustments to CAF II Reserve Pricing by Lowest Bid Received

Adjustment Category	CBGs	Locations	Change in Reserve	Change in Reserve per Location	Change in Reserve per CBG	CAF II Reserve per Location	CAF II Reserve per CBG
Increase	25,613	706,768	$65,954,916	$93	$2,575	$696	$16,073
Decrease	4,420	267,455	-$65,954,916	-$247	-$14,922	$881	$44,869
Total	**30,033**	**974,223**	**$0**				

3 Freeze Price Clocks for Uncontested Areas after the Budget Clears

In CAF II, strict adherence to the use of a single price clock resulted in continued price decreases after the budget cleared for some CBGs that only had a single bidder. This occurred for a CBG that was bid as part of a package that could not be assigned due to competition in the package's other CBGs such that the minimum scale percentage (MSP) could not be satisfied. This type of continued price decrease results from inter-CBG competition imposed by the auction design, as the CBG itself is uncontested.

Though this rule could further decrease the amount of support required for some uncontested CBGs, thereby shifting surplus from bidders to the FCC, the desire for additional cost savings in uncontested areas must be weighed against potential negative effects on efficiency. It is inconsistent with the

[12] We omit 10 CBGs from this analysis because they either never received a bid (5 CBGs: MP-100-9501001; MP-100-9501002; MP-110-0001001; MP-120-9502001; MP-120-9502002) or because the lowest bid they received was deemed "insincere" because it was at the reserve price (5 CBGs: MA-003-9343002; MA-011-0406001; VA-015-0706002; VA-015-0706003; VA-023-0401002)

second-price rule that otherwise determines assigned support and can have perverse effects on the incentive to bid truthfully, thereby harming allocative efficiency. Other negative effects include reducing incentives for efficiency-enhancing package bidding and disadvantaging package bidders by increasing the price effects of intra-CBG competition. It is up to the FCC to determine whether these negative efficiency effects outweigh the additional cost savings. If so, the FCC can improve the auction by freezing uncontested clocks after the budget clears. The only bidders that may oppose this change are those non-package bidders that seek to preserve an unfair and inefficient advantage.

3.1 Efficiency Costs of Discouraging Package Bidding

Package bidding allows bidders to find combinations of CBGs that together make the most efficient use of their current and future networks. It is precisely through these network/scale economies that the CAF II and RDOF auctions are meant to bring broadband to more locations at lower average cost. Unfortunately, the current rules allowing prices to decrease in uncontested areas even after the budget clears actively discourage package bidding. After the budget clears, the CAF II rules stipulate that as long as a package does not meet the MSP, prices will continue to decrease for *all* CBGs in the package, even the ones that are uncontested. The maximum MSP was 75%, and in the context of the rules in question, this means that competition on as little as 25% of a package would have a 4x price effect on the package as a whole. Meanwhile, package bidders must compete on contested CBGs against non-package bidders that experience no multiplier on that competition. This presents an obvious and significant disadvantage for package bidding.

Bidders can respond to the disincentive in multiple ways, none of which is good for auction efficiency. First, knowing that the budget could clear at any time, bidders may avoid package bidding in the first place. With rounds defined by base clock percentage decrements of 10, placing a bid for a package at the base clock percentage could jeopardize up to 10 percentage points of support on uncontested areas before the package bidder has the chance to react. This forces bidders to bid according to the costs of serving each CBG independently, which, in the absence of network/scale economies, are higher than the average costs for the package. Both inter and intra-CBG competition suffer. Fewer CBGs can be supported under the budget, and bidders compete less aggressively after the budget clears.

Bidders may also respond to the disincentive by splitting a package bid into independent bids after the budget clears. This is done in an effort to lock in prices in uncontested areas. However, in doing this, the dropout prices for the pieces of the split package are likely to increase because smaller packages have smaller synergies. So, a bidder that splits its package after the budget clears may be at risk of being assigned a partial package at support levels below that partial package's dropout price. This not only harms auction competition but also raises the potential for default on deployment obligations. In CAF II, out of 4,523 CBGs in contested, unassigned packages after the budget cleared, 3,419 CBGs were split in this way, approximately 75%. This yielded 851 assigned CBGs in the first round the packages were split.[13]

[13] This is the set of CBGs in unassigned packages, where a portion was contested.

Finally, bidders may respond by dropping some or all of the CBGs in a contested package after the budget clears. The efficiency costs here are similar to those above. There is an obvious negative impact on auction competition, either through the loss of a potential winning bidder (i.e., the lowest cost bidder) or the loss of a second-price bidder with the ability to price the winner.

3.2 Freezing Price Clocks for Uncontested Areas after the Budget Clears

Fortunately, there is a straightforward way to fix the disincentive to package bidding and its associated efficiency costs. The FCC can simply rule that after the budget clears, a CBG's price will only decrease when it receives two or more bids. This is the same type of rule the FCC uses in all of its forward clock auctions. It introduces no special computational complexity into bid processing. Nor does it present an opportunity for inefficient gaming behavior.

There is one detail of this change for the FCC to decide. In calculating the proportion of a package that is contested versus uncontested for purposes of applying the MSP, the FCC can use either each CBG's current support or its reserve price. The benefit of using the reserve price is that it makes the proportions stable and therefore predictable from the perspective of bidders. Furthermore, using current support when prices in contested areas are declining and prices in uncontested areas are stable will result in an increasing likelihood of partial package assignments round over round. This should not be a goal of the auction, and it should not be a consideration requiring bidding attention. So, basing the proportions on reserve prices is the appropriate decision.

4 Modify the Information Rule to Avoid Information-Gathering Switches

The proposed partial information rule gives bidders an opportunity and an incentive to make switches merely to gather information about the number of other bidders competing for a CBG. This type of switching frustrates the process of competitive discovery, as it dilutes the correspondence between market information and sincere competition, making it harder for bidders to adjust their target areas in response to market information. In this section, we propose changing the information rule to take away the incentive for information-gathering switches.

The section proceeds as follows. We first describe the mechanics of how the partial information rule incentivizes information-gathering switches. We then present evidence from CAF II bidding data showing that bidders engaged in information-gathering switches during the CAF II auction, which suggests they are likely to do so again in RDOF. Finally, we propose changing the information rule to provide the exact number of bids in each CBG in each round and argue that this will not create inefficient gaming opportunities.

4.1 Partial Information Rule Incentivizes Information-Gathering Switches

As in the CAF II auction, the FCC proposes to report the number of bidders in each service area as zero bidders, one bidder, or more than one bidder. That means a participant bidding in each area will only know if there are zero other bidders, or one or more other bidders. However, by switching out of the area and observing the new aggregate bids number, the bidder could learn whether there is only one other bidder or more than one other bidder. Consider the following example:

- In the first round, Alpha Telecom bids to offer service in CBG A. At the end of the round, the auction system reports that there are more than one total bidders in CBG A.
- In the second round, Alpha does not bid for CBG A. Assuming other bidders hold constant, then if the aggregate number of bidders is one, they know only one other bidder was competing with them. If it's more than one, they know two or more other bidders competed.
- In the third round, assuming the budget has not cleared and Alpha has available switching power, Alpha can decide whether to go back into CBG A or not, given their enhanced view of competition.

One could argue that anyone engaging in this strategy is taking a risk by switching away from their desired areas and risks being assigned in the round they choose to switch away. However, if the aggregate cost is sufficiently above the budget, that risk is low. Furthermore, a large enough bidder could be active on a position that exceeds the budget on its own, so that bidder can be certain the budget will not clear while engaging in this strategy.

Note that a bidder need not switch away and back ("switchback") to an area to engage in this strategy; they could alternatively avoid bidding in an area to gather more information and add it in a later round ("new add"). Furthermore, though the example above describes a scenario where a bidder switches away in reaction to aggregate bids of more than one, that scenario is not necessary to engage in this strategy. The information rule is such that one gets more information about an area if they *are not* bidding in it, so while a bidder may expect to get more information when they switch away from an area that has more than one bidder, any round not bidding in an area yields more information about competition in expectation.[14]

4.2 Bidders Switched to Gather Information in CAF II

In analyzing information-gathering bids, we classified these potential bids into two categories:

- **Switchbacks**: a bidder bids for an area, drops it, and then bids it again
- **New adds**: a bid for an area that was never bid in a prior round (not including round 1).

Below is a table summarizing switchbacks:

[14] As an example, suppose Alpha telecom switches away from an area where there was only one bidder (i.e. just Alpha). In the round they switch away, they see that there is still one bidder, meaning that one new bidder switched in. If Alpha had not switched away, they would see that there is more than one bidder, meaning that one or more new bidders could have switched in. Thus, they have more info by switching away, since they know for sure that only one new bidder switched in.

Table 2 Switchback Summary by Bidder

Bidder	Support[15]	CBGs	Locations	Support % (2+ bids)	CBGs % (2+ bids)	Locations% (2+ bids)
Flat Wireless, LLC	$2,133,539	16	2,614	18%	19%	34%
Wisper ISP, Inc	$19,870,979	953	32,918	77%	45%	66%
ArisWave Consortium	$1,222,468	56	4,411	26%	38%	43%
Consortium 903	$126,332	1	359	0%	0%	0%
Viasat, Inc.	$79,113,988	16,257	603,600	80%	76%	88%
Windstream Services, LLC	$19,857	5	26	100%	100%	100%
Benton Ridge Telephone Company	$50,255	20	86	100%	100%	100%
Computer 5 Inc. d/b/a LocalTel Communications	$13,776	2	28	100%	100%	100%
Townes Wireless, Inc.	$113,923	37	160	0%	0%	0%
Evertek Enterprises, Inc.	$43	1	1	100%	100%	100%
Hawaiian Telcom, Inc.	$132,642	12	233	100%	100%	100%
AMG Technology Investment Group LLC	$195,661	13	377	47%	46%	25%
LTD Broadband LLC	$612,350	174	5,265	100%	100%	100%
Totals:	$103,605,813	17,547	650,078	77%	75%	86%

The table above classifies switchbacks by bidder. The columns on the left show the statistics for all switchbacks, while the three columns on the right show the percentages where the drop occurred plausibly in reaction to there being more than one bidder.[16] 75% of switchbacks overall (on a CBG basis) occurred with more than one bidder during the drop. For six bidders, 100% of their switchbacks had more than one bidder while executing the drop. Furthermore, when analyzing switchbacks on a per bidder, per round basis, in 20 out of the 41 instances, switchbacks were 100% in areas that had more than one bidder during the drop. In particular, Viasat, the bidder who executed 93% of total switchbacks on a location basis, executed switchbacks in 9 rounds. In 7 out of those 9 rounds, more than 90% of switchbacks had more than one bidder during the drop. The above statistics would be insignificant if CBGs were similarly contested in all areas as in areas where bidders executed switchbacks. For

[15] Support is measured as the implied support of the switchback bid.
[16] That is, the aggregate number of bids was reported as “2+” for the round prior to when the drop occurred.

comparison, only 45.7% of all CBGs were contested in rounds before the clearing round, suggesting that the execution of switchbacks was correlated with contested areas.[17]

New adds accounted for 917,122 locations of bidding activity.[18] Recall that bidders could plausibly engage in an information-gathering strategy without responding to bidding activity of more than one bidder. Indeed, there are other reasons why bidders may have executed switchbacks or new adds. However, the analysis of bidding behavior strongly suggests that bidders switched for information-gathering purposes to a large degree.

4.3 Modifying the Information Rule to Avoid Information-Gathering Switches

As mentioned above, information-gathering switches represent insincere bids, the presence of which makes it harder for all bidders to understand competition and to make efficiency-enhancing adjustments. The most straightforward remedy to this inefficiency is to merely change the information rule to take away the incentive for information-gathering switches. Here, the FCC has two options: i) to provide full information about the number of bids in each CBG after each round, or ii) to provide no information about the number of bids in each CBG after each round. Option i) is preferred as it still allows bidders to make efficiency-enhancing adjustments to their target areas in response to market information.

As a rule of thumb in auction design, it is often best to limit information when that information could be used for inefficient gaming. This is the logic driving anonymous bidding and other limited information rules used in forward auctions in the US and around the world. One specific concern is that bidders could use market information to park demand in unwanted areas, driving prices up in those areas and keeping them low in wanted areas. However, even in those forward auctions, it is common practice to report full aggregate bidding information by market. In the reverse auction design employed here, limiting this information actually creates inefficient gaming in the form of information-gathering switches. Furthermore, it is unclear what kind of inefficiency the partial information rule is intended to avoid. There is no sense in which a bidder could gain an advantage by parking in unwanted areas in this reverse auction design. As there is only a single price clock, bidding unwanted areas would not have a desirable price effect. The only thing it might do is encourage more competition on wanted areas by making it appear there is less competition.

Collusive bidding is also not a real concern here. There are so many products and bidders and so few auction rounds that it would be nearly impossible for bidders to coordinate on who gets to bid on which CBGs using only the incremental bidding information we propose. The limit on switching provides a further check on the strength of market signals and the speed of coordination. Also note that there is no immediate advantage to dividing up markets before the budget clears because inter-CBG competition for the budget will be largely unaffected, and prices will continue to decline until the budget clears.

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[17] In rounds 1 – 11, there were 330,363 reported CBG-round stats (30,033 total CBGs x 11 rounds before clearing). Out of those, 151,097 were contested (2+ bids), 168,913 had 1 bidder, and 10,353 were uncontested (no bidders). Table 3 in Section 0 breaks this down by round.

[18] 25,828 CBGs, $225,821,806 of implied support

Then, after the budget clears, because there is no switching allowed, there can be no give and take. There is also the incentive to “cheat” on the collusive outcome by pretending to give up a set of areas to a rival and then bidding them back right before the budget clears, which further dilutes the potential for collusion. For these reasons, the proposed marginal increase in market information does not pose a legitimate risk of collusive bidding behavior.

We encourage the FCC to consider providing full information about the number of bidders in each area at the end of each round. This is only an incremental change from the CAF II partial information rule. It is consistent with common auction practices around the world. It will remedy a documented incentive for inefficient gaming, information-gathering switches. And this reverse auction design is unique in its insusceptibility to using the additional information for inefficient gaming.

5 Reduce Location Uncertainty and its Negative Effects

For the CAF II auction, the FCC used the CAM to estimate the number of locations in each CBG. There were disparities between the CAM location estimates and the actual number of existing locations. In response, the Commission granted flexibility in meeting deployment obligations, including:[19]

- serving as little as 95 percent of the locations determined by the CAM on a statewide basis and returning an amount of support proportional to unserved locations and
- applying for a waiver of the deployment obligations

The Commission expects that individual bidders will carry out enough due diligence with respect to location counts in their areas of interest that these flexibility measures will be sufficient.[20]

The chief concern with this approach is that it has a differential impact on bidders. Large bidders have a greater ability to insure against the risk of location shortfalls by bidding for many areas within the same state. This reduces the variance of the real locations as a percentage of the CAM location estimate, i.e., it reduces meaningful location uncertainty. The smaller the bidder, the less they are able to take advantage of the flexibility to cover at least 95 percent of locations statewide. Bidders also differ in their ability to conduct due diligence with regard to location counts. Large bidders are likely to have access to large datasets and mapping technology, and very small bidders may have firsthand knowledge of the markets and locations in question. However, medium bidders are unlikely to have either and will have a harder time conducting due diligence as a result. These differential impacts make some bidders less likely to win assignments even when they would be the low-cost provider, which results in efficiency loss.

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[19] See 47 CFR § 54.320.

[20] See Connect America Fund; ETC Annual Reports and Certifications; Rural Broadband Experiments; Connect America Fund Phase II Auction, WC Docket Nos. 10-90, 14-58, 14-259, AU Docket No. 17-182, *Order on Reconsideration*, FCC 18-5 (rel. Jan. 31, 2018) par. 35

Even without a differential impact on bidders, the general uncertainty about location counts will lead to inefficient outcomes. To account for the risk of location shortfalls and their associated costs, bidders have two main options i) price in the risk by bidding less aggressively or ii) pay to remove the risk before the auction through due diligence. Under the first option, the price of the risk gets passed onto the public through a less efficient use of the auction budget, i.e., higher support levels per assigned location. Under the second option, the cost of due diligence becomes a cost of CAF II participation and is still passed onto the public. However, this is only part of the cost. Because bidders are performing due diligence for the same areas without the ability or incentive to share information, the costs are redundant and exist even for some areas that never end up being assigned.

As the market designer, the FCC is in a unique position to solve this information problem. As long as it is not substantially more costly for the FCC to provide more accurate location information than it would be for individual bidders to determine on their own, doing so would reduce all of the inefficiencies described above.

6 The CAF II Performance and Latency Weights

The FCC proposes to change the performance and latency weights from what it used in CAF II. There is no evidence that the proposed weights better represent consumers' preferences, and there is no way to predict the impact of such a change on auction outcomes. For the performance weights, this amounts to a lack of a good reason to make any changes at all. That is, the FCC should continue to use the same performance weights it used in CAF II. However, there may be a good reason to increase the high latency weight to 40, as the FCC has proposed. Doing so could have a positive effect on overall efficiency if it diverts the budget away from areas that would not experience increases in overall broadband availability.

6.1 Maintain the CAF II Performance Weights

For the RDOF auction, the FCC has proposed to get rid of the Minimum performance tier from CAF II and to recalibrate the remaining performance tier weights to keep the spread between the highest and lowest tiers at 90 points to match the spread between the highest and lowest tiers in CAF II.[21] We are unaware of any economic motivation for maintaining the same spread between the highest and lowest tiers when the lowest tier has changed from Minimum to Baseline. Instead, the weights should be calibrated based on the differences between weights for *specific* performance tiers. For example, in CAF II the difference between Gigabit and Above Baseline (both low latency) was 15, reflecting a value for Above Baseline that was 15 percentage points of the reserve price less than the value for Gigabit. These differences should not be calibrated to supply-side factors like the costs of providing service or to maximize participation (however so defined), as some commenters have argued.[22] Because the FCC

[21] RDOF NPRM par. 25

[22] See *Comments of ACA Connects – America's Communication Association on the Notice of Proposed Rulemaking,* Rural Digital Opportunity Fund, Connect America Fund, WC Docket Nos 19-126, 10-90. September 20, 2019. p. 6: "But the Commission provides no evidence in the NPRM or elsewhere that this spread will make bidding more

represents rural consumers in this auction, the weight differences should reflect differences in rural consumers' willingness to pay for higher speed and more locations.

We defer to the FCC as to how rural consumers should make trade-offs between cost and speed. However, we note that it is unlikely that these preferences would have changed so drastically since CAF II. For example, the new proposal would increase the weight on Above Baseline to 25 points, reflecting a nearly 12% decline in the value of Above Baseline relative to Gigabit at the reserve price. Similarly, the proposed weight for Baseline would increase from 45 to 50, a reduction of 9% relative to Gigabit at the reserve price, which also reflects a small *increase* in the relative value of Baseline compared to Above Baseline. Presumably, the FCC put great consideration into the CAF II weights. So, with no reason other than to maintain a 90-point spread, it should not change them for RDOF.

Moreover, the CAF II weights are the only weights that have been tested and found to achieve a desirable outcome for the FCC. It is impossible to know how changing the weights could impact auction competition and efficiency. Attempts to use CAF II bidding data to predict outcomes under the proposed weights are unreliable for many reasons.[23] So, it would be needlessly risky to make drastic changes to the weights, particularly without knowledge that the new weights would better represent consumers' preferences for speed and locations.

6.2 Increasing the High Latency Weight Could Improve Efficiency

As the only high-latency bidder, Viasat won 190,595 locations for only $12.2M. Compared to the rest of the auction participants, which won 522,581 locations for $136.9M, this seems like a good deal for rural America. However, upon deeper inspection, questions arise. Viasat's winning bids totaled only $5.4M, which resulted in the $12.2M in support through the second price rule. That is, for Baseline/high latency, they expressed a willingness to accept only $28.66 per location on average across their winning bids. For comparison, winning bids for Baseline/low latency averaged $122.09 per location. Viasat also submitted 3,910 (47%) of its winning bids at the absolute lowest price point allowed for Baseline/high latency bidders, 71. At this level, implied support is only one percent of the reserve. Its highest winning bid was for only 8.35% of the reserve price, and its winning bids totaled only 3.72% of the reserve prices in those areas.

In light of how little support Viasat was willing to receive for so many of its areas, it is unclear whether it needed the support at all. What appears to be a very efficient outcome could, in fact, be the opposite if the CAF II auction paid to support areas that do not increase broadband availability. If so, the support amounts used in these areas could have been used to support areas that did not receive any support at all but needed it. As such, increasing the high latency weight to 40 could have a positive effect on overall efficiency if it targets spending that produces new broadband infrastructure and availability.

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technology-neutral than alternative weighting methodologies or that this spread will maximize RDOF auction participation by service providers across all performance tiers."

[23] Strong assumptions must be made about counterfactual bidding behavior. For example, we do not know the winning bidder's dropout price for many of the assigned CBGs.

Finally, in its comments, Viasat argues against the claim that satellite services should not be eligible to receive support "because this coverage is in a certain sense already 'available' to any U.S. location."[24] It argues that "even though a satellite provider may be able to provide service to any U.S. location on a short time frame, this is only possible by diverting some of its limited orbital capacity from more profitable uses."[25] However, this opportunity cost exists only if i) capacity is constrained *and* ii) there are more profitable uses *and* iii) new customers actually sign up. Without all three conditions being met, Viasat's CAF II support could be free money with little public benefit. The degree to which new customers sign up for its service is largely under the control of Viasat itself through its marketing decisions. So, even under the questionable assertion that the first two conditions were met, Viasat would still have the ability to limit the number of new subscribers by reducing marketing efforts. Therefore, the argument that the "short-run public benefit of subsidizing satellite coverage of underserved areas is that it induces the providers to shift their capacity from uses that are privately profitable … to uses with greater public benefits" may be untrue.[26] There may be no need to shift capacity because capacity is not sufficiently constrained, and even if it is, there is no inducement to do so because satellite providers need not make any real effort to gain new customers where they win auction support. This means Viasat could accept any amount of auction support because they would never be truly committed to any variable costs, even if opportunity costs really did exist.[27]

7 Conclusion

The FCC has an opportunity to improve outcomes for the RDOF program by considering changes to the proposed auction design. In this paper, we have examined modifications to key features of the design, including the reserve prices, performance and latency weights, the information rule, and the price increment rules. While these would be relatively incremental modifications to the proposed design, they would likely result in material improvements in allocative efficiency and fairness.

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[24] See *Comments of Viasat, Inc.* Rural Digital Opportunity Fund, Connect America Fund: WC Docket Nos. 19-126, 10-90, September 20, 2019 (Viasat RDOF comments), Exhibit A, p. 6
[25] Viasat RDOF comments, Exhibit A, p. 6
[26] Viasat RDOF comments, Exhibit A, p. 7
[27] There is an administrative cost associated with winning support, but at least after a threshold level of support is won, this is largely a fixed cost.

Appendix A: Switch Analysis

Table 3 Competition Evaluation Pre-clearing Rounds

Round	Bids for Item	Reserve Price Sum	CBG Count	Location Count	CBG Count %
1	0	$ 11,342,446	1,209	18,323	4%
	1	$ 157,825,733	12,355	281,887	41%
	2+	$ 440,840,324	16,469	674,013	55%
2	0	$ 1,797,553	516	3,350	2%
	1	$ 183,760,713	15,389	332,595	51%
	2+	$ 424,450,237	14,128	638,278	47%
3	0	$ 1,166,712	296	1,869	1%
	1	$ 179,550,937	15,417	327,595	51%
	2+	$ 429,290,854	14,320	644,759	48%
4	0	$ 1,161,235	227	1,516	1%
	1	$ 201,714,773	15,960	370,671	53%
	2+	$ 407,132,495	13,846	602,036	46%
5	0	$ 1,161,235	227	1,516	1%
	1	$ 201,478,475	15,962	370,455	53%
	2+	$ 407,368,793	13,844	602,252	46%
6	0	$ 185,839	5	106	0%
	1	$ 202,502,736	16,181	371,267	54%
	2+	$ 407,319,928	13,847	602,850	46%
7	0	$ 185,839	5	106	0%
	1	$ 202,707,163	16,176	370,720	54%
	2+	$ 407,115,501	13,852	603,397	46%
8	0	$ 5,169,219	336	8,111	1%
	1	$ 235,432,587	17,697	436,538	59%
	2+	$ 369,406,697	12,000	529,574	40%
9	0	$ 2,727,939	296	5,815	1%
	1	$ 233,360,255	17,006	429,628	57%
	2+	$ 373,920,309	12,731	538,780	42%
10	0	$ 11,852,325	3,014	46,956	10%
	1	$ 225,339,430	13,225	392,673	44%
	2+	$ 372,816,748	13,794	534,594	46%
11	0	$ 28,666,392	4,222	101,602	14%
	1	$ 203,119,203	13,545	374,381	45%
	2+	$ 378,222,908	12,266	498,240	41%

The table above classifies competition by round in each CBG prior to the clearing round.