

RURAL DIGITAL OPPORTUNITY FUND AUCTION TECHNICAL GUIDE

Bidding Procedures and Bid Processing Algorithms

1 Introduction

This document details the process for bidding and bid processing as a supplement to the procedures proposed in the *Auction 904 Comment Public Notice*.¹

A bid in the Rural Digital Opportunity Fund auction indicates that the bidder agrees to provide service to the required number of locations in the eligible census blocks associated with an area² at the performance tier and latency specified in the bid, in exchange for support, provided that the bid is assigned during bid processing and the support is authorized after post-auction long-form review. The Commission has established weights (“T+L weights”) for each of the performance tier and latency combinations available for bidding in the auction. Bidders will bid for support based on a percentage of the reserve price.³ Before each round, the bidding system will provide bidders with the clock percentage for the round, which will determine the range of percentages at which bidders can place bids during the round. Given the bid’s percentage, the reserve price for the area, and the T+L weight, a bidder will be able to determine the annual support amount corresponding to its bid.⁴

The auction will be conducted in successive rounds of bidding. The clock percentage will be decremented in each successive round. A bidder will submit a bid during a round at the clock percentage or at another percentage between the clock percentage and the prior round’s clock percentage. Once a round concludes, the bidding system processes the bids. The budget is said to clear in the first round in which an estimated aggregate cost of bids at the current round’s clock percentage is less than or equal to the budget. This round is referred to as the clearing round. When processing bids for the clearing round, the bidding system first will determine which bids are assigned—that is, determined to be winning bids—for which areas. It will then use a second-price rule to determine for each assigned area a support payment that is at least as large as the implied support amount corresponding to the bid percentage. The bidding system will also consider whether it is possible to assign any bids at the previous round’s clock percentage within the available budget.

After the clearing round, bidding rounds will continue so long as any area that was bid at the round’s clock percentage has not yet been assigned. Bids at a round’s clock percentage that are not assigned in that round carry forward to the following round.⁵ After each round, the bidding system checks whether

¹ *Comment Sought on Competitive Bidding Procedures and Certain Program Requirements for the Rural Digital Opportunity Fund Auction (Auction 904)*, Public Notice, FCC 20-21 (Mar. 2, 2020) (*Auction 904 Comment Public Notice*).

² The *Auction 904 Comment Public Notice* seeks comment on whether to use census blocks groups or census tracts as the minimum biddable area for the auction. *Id.* at 4-5, paras. 9-11.

³ The approach for calculating per-location reserve prices in eligible areas was determined in *the Rural Digital Opportunity Fund Order. Rural Digital Opportunity Fund; Connect America Fund*, Order, FCC 20-5, at 12-16, paras. 23-28 (Feb. 7, 2020) (*Rural Digital Opportunity Fund Order*).

⁴ A bidder can calculate implied support amounts using the formula in Section 2 or using other resources that will be made available to bidders in educational materials or through the bidding system.

⁵ A bid that carries forward will be considered, or “processed,” for possible assignment during bid processing in the round into which it carries forward, but at the bid percentage at which it was submitted.

any bids for any additional areas can be assigned. A round is deemed to be the final round if the budget has cleared and if all areas that were bid at the round's clock percentage were assigned during the bid processing of the round.

Section 2 shows how the implied support amount is calculated given a percentage, the reserve price for a geographic area, and a performance tier and latency combination. Section 3 describes options for submitting package bids and proxy instructions. Section 4 describes the activity rules and other bidding procedures. Section 5 describes carried-forward bids. Section 6 describes the bid processing. Section 7 describes information that will be provided to the bidders during and after a round. Section 8 provides an example illustrating the overall auction process.

2 Bid Price Point Percentages and Implied Support Amounts

The clock percentage of round 1 is set one decrement lower than the opening percentage.⁶ In round 1, bidders can submit bids at any percentage (with up to two decimal places) that is greater than or equal to the clock percentage of round 1 and less than or equal to the opening percentage. In any later round, bidders can submit bids with any percentage (with up to two decimal places) that is greater than or equal to the round's clock percentage and less than the previous round's clock percentage.

For a given area and a given performance tier and latency combination, the annual support amount corresponding to a price point percentage P is calculated using the following formula:

$$\text{Implied support} = \min \left\{ R, \left(\frac{P - (T + L)}{100} \right) R \right\},$$

where:

- R denotes the area's reserve price;
- T denotes the tier weight; and
- L denotes the latency weight.

We refer to this support amount as the *implied support amount* for the given area and performance tier and latency combination. Implied support amounts are rounded to the nearest cent.

The implied support for an area at a given performance tier and latency combination is equal to the reserve price as long as the price point (the clock percentage or an intermediate percentage) is greater than the T+L weight plus 100.⁷ Once the price point falls below T+L+100, the implied support for the performance tier and latency starts to be reduced from the reserve price. Note that the price point in a bid must be greater than or equal to T+L+1; a bid with a price point less than T+L+1 will not be accepted.⁸

⁶ The opening percentage is set at 100 percent plus an additional percentage equal to the largest T+L weight submitted by any qualified bidder in the auction.

⁷ Whole percentages are expressed as whole numbers, rather than as decimals. For example, a percentage of 75% is written as 75, not .75. A percentage of 50.5 is one-half of one percent larger than 50%.

⁸ See Section 4.1, Bidding Requirements.

Example 1:⁹ Consider an area with a reserve price of \$200.

- For a T+L weight of 0, the implied support at the 140% price point is \$200 (the reserve price), since $\{(140-0)/100\} * 200$ is greater than 200. The implied support at the 75% price point is \$150, since $\{(75-0)/100\} * 200 = 150$, which is less than the reserve price of 200.
- Similarly, for a T+L weight of 50, the implied support at the 140% price point is \$180 and the implied support at the 75% price point is \$50.

A bidder can submit a bid for support for a specific area by specifying a T+L weight and a price point percentage. If that bid is assigned during bid processing and the bidder is authorized to receive support during post-auction application processing, the bidder will then have the obligation to provide service to that area at the specified performance tier and latency in return for support greater than or equal to the support amount implied by the bid percentage (using the implied support formula). Because a second-price rule is used, the support payment to the bidder may be higher than the support amount implied by the bid percentage.

Example 2: Consider a bidder that is bidding to provide service with a T+L weight of 35 for an area with a reserve price of \$200. Suppose that the previous round's clock percentage was 80% and the current round's clock percentage is 75%. If this bidder submits a bid at the 77.5% price point and the bid is assigned during bid processing, the bidder will have the obligation to provide service at the specified performance tier and latency, and will receive a support amount of at least $\left(\frac{77.5-35}{100}\right) \200 , which equals \$85.

Example 3: Consider a bidder that is bidding to provide service with a T+L weight of 75 for an area with a reserve price of \$300. Suppose that the previous round's clock percentage was 130% and the current round's clock percentage is 120%. If this bidder submits a bid at the 128% price point and the bid is assigned during bid processing, the bidder will have the obligation to provide service at the specified performance tier and latency, and will receive a support amount of at least $\left(\frac{128-75}{100}\right) \300 , which equals \$159.

3 Options for Submitting Bids

3.1 Bid for a Package of Areas

In addition to submitting bids for individual areas, a bidder may submit package bids. Package bids may be assigned partially if it is not possible for the system to assign them in full. To submit a package bid, the bidder specifies a price point, a T+L weight, a list of areas, and a minimum scale condition in terms of a percentage that indicates the bidder's lowest acceptable partial assignment.

With such a package bid, the bidder is offering to provide service to any subset of the specified list of areas, each at the support amount implied by the price point of the bid and the performance tier and latency combination that the bidder indicated, as long as the subset is large enough that the sum of the reserve prices for the subset is at least, for example, 70% (or another percentage no greater than the Commission-defined minimum scale percentage cap¹⁰) of the sum of the reserve prices for the whole

⁹ The examples in this document are for illustration only and do not reflect estimates or expectations of auction outcomes.

¹⁰ The *Auction 904 Comment Public Notice* proposes to set the minimum scale percentage cap at 75%. *Id.* at 26, para. 88.

package.¹¹ Because the same T+L weight applies to all areas in a package, it is equivalent to state the minimum scale condition in terms of implied support amounts, that is, for the minimum scale condition to be met the subset needs to be large enough that the total implied support amount for the subset is at least, for example, 70% of the total implied support amount for the whole package.

A bidder can change the minimum scale percentage of a package bid in any round.

Example 4: Consider a bidder that submits a package bid for areas 1, 2, 3, and 4 with a minimum scale percentage of 70%. The reserve prices of areas 1, 2, 3, and 4 are \$120, \$140, \$160, and \$200, respectively. The sum of the reserve prices for the whole package is $\$120 + \$140 + \$160 + \$200 = \$620$. For a subset of the areas in the package to be assigned, the sum of reserve prices for the subset must be at least 70% of \$620, or \$434. If the package bid cannot be assigned in full, the bidder can be assigned areas 2, 3 and 4, because the sum of the reserve prices is $\$140 + \$160 + \$200 = \500 , which is more than 70% of \$620; that is, the subset meets the scale condition. On the other hand, the bidder cannot be assigned only areas 1, 2 and 3, because the sum of the implied support amounts is $\$120 + \$140 + \$160 = \420 , which is less than 70% of \$620; that is, the subset does not meet the scale condition.

3.2 Proxy Instructions

A bidder may submit a proxy instruction to bid for a single area or a package of areas by indicating a price point that is below the current round's clock percentage. Before the budget clears, a proxy instruction is interpreted as a request for the bidding system to bid automatically for that area or that package of areas on behalf of the bidder as long as the percentage in the proxy instruction is less than the previous round's clock percentage. If the percentage in the proxy instruction is less than the current round's clock percentage, the system will submit a bid at the current clock percentage. If the proxy percentage is between the current and the previous round's clock percentages, the system will automatically bid at the proxy percentage. This will be the lowest price point at which the system will submit a bid based on the proxy instruction.

After the budget clears, bidding for some areas may continue in subsequent rounds. Proxy instructions for those areas will continue to apply for bids for individual areas as long as the area is unassigned and the proxy percentage is less than the prior round's clock percentage. In the case of a package bid that was partially assigned to the bidder, the proxy instruction will continue to apply to the unassigned areas in that package bid. That is, the price point percentage specified in the proxy instructions will apply to bids for the unassigned individual remainder areas.¹² In the case of a package bid that was not assigned and no areas in the bid have been assigned to other bidders, the proxy instruction will continue to apply to the entire package bid.

After the budget clears, a proxy instruction will expire in the case of a package bid that was not assigned to the bidder but one or more of the areas in the package bid were assigned to other bidders (to bids with lower T+L weights). In subsequent rounds, the bidder can submit bids or proxy instructions for areas in the package that have not yet been assigned.

A proxy bid (i.e., a bid that is submitted on behalf of the bidder based on a proxy instruction) is treated for purposes of bid processing and the activity rules like any other bid that is submitted by the bidder in the

¹¹ A package bid also will be subject to the rules of carried-forward package bids (see Section 5, Carried-Forward Bids, Section 6.2, Bid Processing for the Clearing Round, and Section 6.3, Bid Processing for Rounds After the Clearing Round).

¹² As described in Section 4.2, once the budget has cleared, remainders of partially assigned packages can only be bid as individual areas.

round. Thus, in the following sections, a bidder's submitted bids in a round refer both to the bids that were submitted by the bidder in the round and to any proxy bids submitted automatically based on the bidder's proxy instructions.

A bidder is not allowed to submit proxy instructions if the implied proxy bids are not consistent with the bidding procedures described in Section 4.

A bidder will be able to revise or cancel its proxy instruction while the proxy instruction is still in effect provided that (1) a bidding round is open, and (2) the area (or the areas in case of a package bid) has not yet been assigned.

Example 5: In round 8, the clock percentage is 90%. The bidder submits a proxy instruction for area 1 with a proxy percentage of 72%. Suppose the bidder does not bid in the following rounds. The following table shows the clock percentages of the following rounds and the proxy bids that will be submitted by the bidding system on behalf of the bidder.

| Round | Clock Percentage | Price Point of Proxy Bid for Area 1 |
|-------|------------------|-------------------------------------|
| 9 | 85% | 85% |
| 10 | 80% | 80% |
| 11 | 75% | 75% |
| 12 | 70% | 72% |
| 13 | 65% | No Proxy Bid |

Example 6: The bidder has submitted a proxy instruction with a proxy percentage of 72% for the package of areas 1, 2, 3, 4, and 5 with a minimum scale percentage of 75% and a T+L weight of 0. In round 8, the clock percentage is 90% and the budget clears in that round. There are no other bids for areas 1, 2, and 3 at the clock percentage with a weight of 0 and thus those three areas are assigned to the bidder (the minimum scale percentage is assumed to be met). Suppose that there are other bids for areas 4 and 5 with weight 0 at the clock percentage. In the following round 9, when the clock percentage is 80%, there is a proxy instruction for area 4 and a separate proxy instruction for area 5, both with a proxy instruction percentage of 72%. If the clock percentage is 70% in round 10, the proxy instruction will continue into round 10 if areas 4 and/or 5 are still unassigned.

Example 7: The budget cleared in a previous round, and the clock percentage in round 10 is 80%. Bidder 1 has submitted a proxy instruction with a proxy percentage of 65% for the package of areas 1, 2, and 3 with a T+L weight of 20. Bidder 2 has submitted a bid for area 2 at a price point of 80% with a T+L weight of 0. Bidder 3 has submitted a bid for area 3 at a price point of 80% with a T+L weight of 20. Then, during the bid processing for round 10, area 2 will be assigned to bidder 2 because it is the bid at the lowest T+L. Suppose that the package bid of bidder 1 does not meet the scale condition. Then, the proxy instruction of bidder 1 for that bid will expire because the package bid was not assigned to the bidder and one of the areas in the package bid was assigned to another bidder. In round 11, bidder 1 can specify new proxy instructions for areas 1 and 3, but cannot submit a new bid or a new proxy instruction for area 2 because that area has already been assigned.

4 Bidding Procedures

A bidder submits its bids for a round while the round is open for bidding.

The price point of a bid can have up to two decimal places. For instance, 80% or 80.52% is allowed, but 80.574% is not allowed. Similarly, the minimum scale percentage associated with a package bid can have up to two decimal places.

A bid is permitted to include any areas available in the auction that have not yet been assigned subject to the requirements of Section 4.1 and the activity rules described in Section 4.2.

4.1 Bidding Requirements

The following bidding requirements apply:

- i. The bidder's total implied support at the round's clock percentage must be less than or equal to a certain percentage¹³ of the budget;¹⁴
- ii. If a bidder submits multiple bids within a round, each area can be in only one bid, including package bids;
- iii. All the areas in a package bid must be in the same state;
- iv. All the areas in a package bid must be bid at the same performance tier and latency combination;
- v. A bidder can only bid on areas that are in states that the bidder selected on its application and for which it qualified;
- vi. A bidder can only bid for a performance tier and latency combination that it selected on its application for a given state and for which it qualified;
- vii. If a bidder submitted a bid for an area in an earlier round, and that bid was processed by the bidding system (that is, the bidder did not change the bid later in the round), then in the current round the bidder can only submit a bid for this area with the same performance tier and latency combination as in the earlier round;
- viii. The price point in a bid must be greater than or equal to $T+L+1$, where T is the tier weight and L is the latency weight. In other words, the implied support amount must be at least one percent of the area's reserve price to be acceptable. If all price points associated with a round are less than $T+L+1$, bids for that performance tier and latency are no longer accepted; and
- ix. The minimum scale percentage indicated for a package must not exceed the Commission-specified minimum scale percentage cap (which is proposed to be 75%).

The bidding system will not accept bids that violate one or more of requirements i-ix listed above.

Example 8: If $T+L=0$, a bid for that performance tier and latency will be accepted only if the price point is greater than or equal to 1%. As another example, if $T+L=90$, a bid for that performance tier and latency will be accepted only if the price point is greater than or equal to 91%.

¹³ The *Auction 904 Comment Public Notice* has proposed to set this percentage at 100%. *Id.* at 25, para. 83.

¹⁴ This includes any proxy bids that were submitted on behalf of the bidder based on its proxy instructions.

4.2 Activity Rules

A bidder's *activity* in a round equals the sum of the implied support amounts across all of the bidder's bids submitted in the round.¹⁵

Example 9: The clock percentage in a round is 70% and the clock percentage in the previous round was 80%. Areas 1 and 2 have reserve prices of \$200 and \$100, respectively. A bidder submits a bid for area 1 at the 78% price point and a bid for area 2 at the 70% price point. Both bids specify a performance T+L weight of 0. Thus, the implied support amounts of these bids are \$156 and \$70, respectively. Then, the bidder's activity in the round equals $\$156 + \$70 = \$226$.

Activity rules limit a bidder's activity in a round based on its bidding in the prior round, as follows:

If the budget has not yet cleared:

- A bidder's activity cannot exceed its activity from the previous round; and
- The bidder's activity from areas that the bidder did not bid on at the previous round's clock percentage cannot exceed the maximum switching percentage for the round (proposed to be 20% in round 2 and 10% in other rounds) multiplied by the bidder's total implied support at the previous round's clock percentage.¹⁶

Beginning in the first round after the clearing round:

- No switching is allowed. A bidder can only bid for an area that it bid for at the previous round's clock percentage and if the area has not yet been assigned.
- A bidder can only bid for a package if it is the same as or a subset of a package for which it bid at the previous round's clock percentage and if the package does not contain any areas that have already been assigned. That is, subdividing packages is permitted, but adding to or combining packages is not; and
- Remainders of partially assigned packages can only be bid as individual areas.

Once the budget has cleared and no switching is allowed, the bidder's activity in a round is guaranteed to satisfy the activity rule because the bidder cannot bid for more areas than it bid for in the previous round, and the percentage at which implied support is calculated is decreasing.

Before the budget clears, the activity rules limit overall activity (for all areas and all performance tiers and latencies). In addition, the maximum switching requirement limits a bidder's ability to bid for areas for which it did not bid at the previous round's clock percentage. As a result, a bidder's overall activity in the current round may be limited if the bidder did not bid for a sufficient number of areas at the previous round's clock percentage. For instance, if the bidder did not submit any bids at the previous round's clock percentage, the bidder will not be able to submit any bids in the current round.

Example 10: Suppose that the clock percentage of round 12 is 75%. Consider a bidder who submits the following bids in round 12:

¹⁵ This includes any proxy bids that were submitted on behalf of the bidder based on its proxy instructions.

¹⁶ The *Auction 904 Comment Public Notice* proposes to give OEA the discretion to change the maximum switching percentage during the auction. *Id.* at 27, para. 94. Any change to the maximum switching percentage will be announced in advance.

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- A package bid for areas 1, 2, 3 and 4 at the clock percentage (i.e., a price point of 75%) with a T+L weight of 0 and with a minimum scale percentage of 75%; and
- A bid for area 5 at a price point of 78% with a T+L weight of 20.

The following table shows for each of these five areas the area’s reserve price and the T+L weight that the bidder selected for the area. The last two columns of the table show the price point at which the area is bid and the implied support for the area at that price point.

| Area | Reserve Price | T+L Weight | Bid Percentage | Implied Support |
|------|---------------|------------|----------------|-----------------|
| 1 | \$120 | 0 | 75% | \$90 |
| 2 | \$140 | 0 | 75% | \$105 |
| 3 | \$160 | 0 | 75% | \$120 |
| 4 | \$200 | 0 | 75% | \$150 |
| 5 | \$100 | 20 | 78% | \$58 |

The bidder’s activity for round 12 is $\$90 + \$105 + \$120 + \$150 + \$58 = \523 , whereas its total implied support at the clock percentage is $\$90 + \$105 + \$120 + \$150 = \$465$.

Suppose that the budget has not yet cleared by round 12, the clock percentage of round 13 is 70%, and the maximum switching percentage is 10%. Then, the bidder’s activity in round 13 can be at most \$523 and its implied support from areas other than 1, 2, 3, and 4 can be at most 10% of \$465, that is, \$46.50.

For instance, the bidder can submit the following bids in round 13:

- A package bid for areas 1, 2, 3, and 4 with a T+L weight of 0 at the clock percentage (i.e., a price point of 70%) and a minimum scale percentage of 75%; and
- A bid for area 6 with a reserve price of \$80 with a T+L weight of 20 at the clock percentage (i.e., a price point of 70%).

The following table shows the implied support for each area in these bids:

| Area | Reserve Price | T+L Weight | Bid Percentage | Implied Support |
|------|---------------|------------|----------------|-----------------|
| 1 | \$120 | 0 | 70% | \$84 |
| 2 | \$140 | 0 | 70% | \$98 |
| 3 | \$160 | 0 | 70% | \$112 |
| 4 | \$200 | 0 | 70% | \$140 |
| 6 | \$80 | 20 | 70% | \$40 |

These bids are allowed because the following conditions are satisfied:

- (1) The activity is \$474, which is less than the bidder’s activity in the previous round (i.e., \$523); and
- (2) The activity from areas on which the bidder did not bid at the previous round’s clock percentage (i.e., area 6) is \$40, which is less than \$46.50.

Suppose that the bidder did not bid on area 6 in a previous round and that, on its application, the bidder selected multiple performance tier and latency combinations for the state that includes area 6. In this example, the bidder would not be able to submit a bid for area 6 with a T+L weight of 0 (instead of 20) because in that case the activity from area 6 would be \$56, which is greater than \$46.50.

5 Carried-Forward Bids

If the budget has not cleared after a round, every bid at the round's clock percentage carries forward to the next round at the same percentage and, if the next round is the clearing round, the bids will be considered during bid processing.

Once the budget has cleared, a bid for a single area at the clock percentage carries forward to the next round at the same percentage if the area has not been assigned. If a bidder's package bid at the clock percentage was partially assigned to the bidder and some areas in the package did not get assigned to any bidder, then a separate bid for each unassigned area in the bid carries forward to the next round. If a package bid at the clock percentage did not meet the scale condition, then a bid for the entire package carries forward to the next round, even if some of those areas have already been assigned (to another bidder that bid at a lower T+L weight).

By definition, all carried-forward bids will be at the previous round's clock percentage. A bidder with a carried-forward bid may also choose to bid at a lower price point for the area or areas in the bid that have not yet been assigned. Because a bidder can only specify price points that are less than the previous round's clock percentage, all bids that are submitted in a round must be at price points that are less than the price points of carried-forward bids.

Example 11: The budget cleared in a previous round, and the clock percentage in round 10 is 85%. Bidder 1 submits a package bid for areas 1, 2, 3, 4, and 5 at a price point of 85% with a T+L weight of 20. Bidder 2 submits a bid for area 3 at a price point of 85% with a T+L weight of 0. Bidder 3 submits bids for areas 4 and 5 at a price point of 85% with a T+L weight of 20. Then, during the bid processing for round 10, area 3 will be assigned to bidder 2. If the package bid of bidder 1 meets the scale condition and areas 1 and 2 are assigned to bidder 1, then the following two bids carry forward to round 11 for bidder 1: a bid for area 4 at a price point of 85%, and a bid for area 5 at a price point of 85%. If the package bid of bidder 1 did not meet the scale condition, then the package bid for areas 1, 2, 3, 4, and 5 at a price point of 85% carries forward to round 11. Bidder 3's bids for areas 4 and 5 also carry forward. Note that in round 11, bidders can only specify price points that are less than 85% and they cannot bid for areas that have already been assigned.

6 Bid Processing

6.1 Bid Processing for Rounds Before the Clearing Round Has Been Determined

In the early rounds of the auction, before the budget has cleared, bid processing consists of calculating the aggregate cost at the clock percentage and checking whether the budget has cleared. The budget clears in the round when the aggregate cost at the clock percentage is less than or equal to the budget. The aggregate cost at the clock percentage is calculated as described below.

Aggregate cost at clock percentage. The aggregate cost at the round's clock percentage is the sum of the support amounts implied by all bids submitted in the round at the clock percentage, summing over all areas that are part of at least one bid at the clock percentage and counting each area with a bid only once. The bidding system calculates the most expensive scenario based on the following: If an area is included in bids of two or more bidders at the clock percentage, then the most expensive of the performance tier

and latency combinations that are bid for that area at the clock percentage is included in the calculation, i.e., the calculation includes the implied support of the bid with the lowest T+L weight.

Example 12: Suppose that the round's clock percentage is 75%. Consider an area with a reserve price of \$200 and assume that two bidders bid for that area at the clock percentage. For one bid, the T+L weight is 0, so the implied support is \$150. For the other bid, the T+L weight is 20, so the implied support is \$110. Then the amount of \$150 will be used when calculating the aggregate cost at the round's clock percentage.

If it is determined that the budget clears in the round, bid processing proceeds as described in Section 6.2 below.

6.2 Bid Processing for the Clearing Round

If bid processing after a round indicates that the budget has cleared in the round (i.e., the round being processed is the clearing round), the bidding system:

1. first determines which areas in bids submitted in the round are assigned to each bidder (assignment determination for bids submitted in the round);
2. then calculates the *clearing price point* as the highest price point not exceeding the clock percentage of the previous round at which the aggregate cost, adjusted for the assigned areas and the second-price rule, is less than or equal to the budget (clearing price point determination);
3. determines the payment for each assigned area using a second-price rule (support payment determination for assigned areas in bids submitted in the round); and
4. finally, if the clearing price point is equal to the previous round's clock percentage, the bidding system processes the carried-forward bids from the previous round to determine whether some of those bids can be assigned (assignment and support payment determination for carried-forward bids).

These four steps are described below.

1. Assignment determination for bids submitted in the round. The bidding system processes the bids from the round in ascending order of price point. Bids at the same price point are processed in ascending order of T+L weight, and pseudo-random numbers will be used to break ties.¹⁷ An area in a bid is *available to be assigned at a given T+L weight* if the area has not previously been assigned and if no other bidder bid for it at the round's clock percentage at the same or at a lower T+L weight. The areas that are available to be assigned at the bid's T+L weight are assigned if (1) the aggregate cost at the price point of the bid (taking into account the bids at the round's clock percentage and the areas that have already been assigned), plus the cost of the areas in the bid that are available to be assigned at the bid's T+L weight, is less than or equal to the budget, and (2), for a package bid, the areas in the bid that are available to be assigned at the bid's T+L weight are sufficient to meet the minimum scale percentage. Otherwise, the bidder is not assigned any of the areas in the bid. Even if the system determines that it cannot assign a bid because it would exceed the budget, the system continues to process any bids from this round at higher price points.

¹⁷ The bidding system will assign a pseudo-random number to each bid. Among bids at the same price point and the same T+L weight (including both package bids and bids for individual areas), the bid with the highest pseudo-random number will be processed first.

Specifically, the bidding system calculates the *aggregate cost at a given price point*¹⁸ P as the sum of:

- (i) For all areas that were bid at the clock percentage and have not yet been assigned, the support amounts implied by the clock percentage, counting each area once and using the most expensive scenario; i.e., if an area is part of bids by two or more bidders at the clock percentage and has not yet been assigned, then the most expensive (lowest weighted) of the performance tier and latency combinations that are bid for that area at the clock percentage is included in the calculation;
- (ii) For all areas that have already been assigned and that received no other bids (except from the bidder to which they were assigned) at less than P , the support amounts implied by P ; and
- (iii) For all areas that have already been assigned which received other bids at less than P , the support amount implied by the greater of the price point bid by the bidder to whom the area is assigned and the lowest price point at which any other bidder bid for the area.

As the bidding system considers the bids in ascending price point order to determine whether the budget is sufficient to support another assigned bid, it uses an estimate of the maximum possible cost of assigning support for the areas bid at the round's clock percentage that may carry forward to the next round (using (i) above). For areas that were assigned at lower price points, it estimates their cost using the current price point ((ii) above) unless it has already determined that the support for the bid would be capped by another bidder's bid price point (as considered in (iii)). As the currently considered price point P increases, the aggregate cost at P increases. See Example 15 and Section 8 for examples of how the aggregate cost at a price point is calculated.

2. Clearing price point determination. When the assignment determination process for bids submitted in the round concludes, the bidding system has determined which of the bids submitted in the clearing round have been assigned. The bidding system then calculates the *clearing price point* as the highest price point (that is a multiple of 0.01%) that is less than or equal to the previous round's clock percentage and at which the aggregate cost is less than or equal to the budget. The clearing price point will always be greater than or equal to the price point of any bid assigned in the round.¹⁹ See Example 15 and Section 8 for an example of how the clearing price point is calculated.

3. Support payment determination for assigned areas in bids submitted in the round. For areas assigned to a bidder in the round that received no other bids at less than the clearing price point, the support payment is the amount implied by the clearing price point. However, for areas that also received bids from other bidders at less than the clearing price point, the support payment is the amount implied by the greater of (1) the price point bid by the bidder to whom the area is assigned and (2) the lowest price point at which any other bidder bid for the area.²⁰ That is, support payments will be calculated using a second-price rule. See Examples 16 and 17 and Section 8 for examples of how the support payment is determined.

If the clearing price point is less than the previous round's clock percentage, then the bid processing for the clearing round concludes. Otherwise (i.e., if the clearing price point is equal to the previous round's

¹⁸ The concept of aggregate cost at a price point takes into account the areas that have been assigned and the fact that a second-price rule is used.

¹⁹ There may be unassigned bids at price points below the clearing price point (e.g., a bid that, if assigned, would have exceeded the budget or a package bid that did not meet the scale condition).

²⁰ The support amount is always based on the performance tier and latency combination of the assigned bid.

clock percentage), the bidding system processes the bids that carried forward from the previous round as described below.

4. Assignment and support payment determination for carried-forward bids. All carried-forward bids are at the previous round's clock percentage—the price point at which the bids were submitted. The bidding system will process the carried-forward bids in ascending order of T+L weight, using pseudo-random numbers to break ties. The support payment for any area assigned in this step is calculated using the previous round's clock percentage (which is also the clearing price point and the price point of any carried-forward bid).

The areas in a carried-forward bid that are available to be assigned at the bid's T+L weight are assigned if (1) the aggregate cost at the price point of the bid (taking into account the bids at the round's clock percentage and the areas that have already been assigned), plus the cost of the areas in the bid that are available to be assigned at the bid's T+L weight, is less than or equal to the budget, and (2), for a package bid, the implied support of the areas that are available to be assigned at the bid's T+L weight plus the support payment²¹ for any areas in the bid that have already been assigned to this bidder is greater than or equal to the minimum scale percentage for the bid times the sum of the implied support amounts for all areas in the bid at the previous round's clock percentage. In other words, when considering a carried-forward bid that is a package bid, the bidding system checks whether the minimum scale condition is met, taking into account that bids for one or more areas in the package bid may have already been assigned to the bidder at lower price points in the round. The bidding system will include the support payments for any such areas when determining whether the minimum scale condition is met.

Example 13: In the clearing round, there are two bids for a given area. Both of these bids are single area bids at the clock percentage. If the two bids have different T+L weights, then this area will be assigned to the bidder that submitted the bid with the lower T+L weight. If the two bids have the same T+L weight, then this area will not be assigned in the clearing round and both bids will carry forward to the following round.

Example 14: In the clearing round, the clock percentage is 90% and bidders have submitted the following bids:

- Bidder 1 submitted a bid for area 1 at 90% at a T+L weight of 0
- Bidder 2 submitted a package bid for areas 1, 2, and 3 at 90% at a T+L weight of 0
- Bidder 3 submitted a package bid for areas 3, 4, and 5 at 90% at a T+L weight of 20
- Bidder 4 submitted a bid for area 4 at 92% at a T+L weight of 0

Area 1 is not available to be assigned at any weight, because there are two bids for that area at the round's clock percentage with a weight of 0. Thus, the bid of bidder 1 is not assigned. Suppose that areas 2 and 3 are not sufficient to meet the minimum scale condition for the package bid of bidder 2, so the bid of bidder 2 is not assigned.

The bid of bidder 3 is considered next. Area 3 is not available to be assigned at this bid's T+L weight, because there is a bid for area 3 at a lower weight. Suppose that because of this, the bid of bidder 3 does not meet the minimum scale condition and thus is not assigned.

The bid of bidder 4 is considered next. Area 4 is available to be assigned at this bid's T+L weight and therefore is assigned to bidder 4 as long as there is sufficient budget.

²¹ This is the second-price payment that was determined when the submitted bids were processed.

Example 15: The budget is \$250. Areas 1, 2, 3, 4, 5, and 6 each have a reserve price of \$100. Each bid in this example has a T+L weight of 0 for all items in the bid. In round 7, the clock percentage was 85%. In round 8, the clock percentage was 80%. The following table shows the bids that were submitted in round 8.

| Bids of Bidder 1 (T+L weight = 0) | Bid of Bidder 2 (T+L weight = 0) |
|--------------------------------------|---|
| 1 at 80% 2 at 80% 3 at 82% | {4, 5, 6} at 81% with a minimum scale percentage of 50% |

The budget clears in this round because the aggregate cost of bids submitted at the clock percentage is \$160, which is less than \$250. The bidding system processes the bids as follows:

- The bids at the clock percentage (80%) are considered first. Areas 1 and 2 are assigned to bidder 1, because there are no other bids for those areas at the clock percentage.
- The bidding system then considers the package bid of bidder 2 at a price point of 81%. All areas in this bid are available to be assigned at a T+L weight of 0, but the bid is not assigned due to insufficient budget. Specifically, the aggregate cost at the price point of the bid (81%) for the areas (1 and 2) that have already been assigned is \$162. The cost of the areas in the bid that are available to be assigned at a T+L weight of 0 is \$243. The sum of these two quantities is \$405 which exceeds the budget.
- The bidding system then considers the bid of bidder 1 for area 3 at a price point of 82%. The aggregate cost at the price point of the bid (82%) considering the areas (1 and 2) that have already been assigned is \$164. The cost of the bid for area 3 (at 82%) is \$82. The sum of these two quantities is \$246 which does not exceed the budget. Thus, bidder 1 is assigned area 3.

Assignment determination concludes because all bids have been processed. It has been determined that areas 1, 2, and 3 will be assigned to bidder 1. The clearing price point will determine the support amount for each of these bids because bidder 1 was the only bidder for each of these areas. Therefore, the aggregate cost at any price point P is given by $3 * P$, since the aggregate cost of the three areas, each with reserve price of \$100 and a T+L weight of 0, is $3 * \{(P-0)/100\} * 100 = 3 * P$. The aggregate cost at the clearing price point must be less than or equal to the budget of \$250, and P must be greater than or equal to 82% and less than or equal to 85%. The bidding system then calculates the clearing price point as the highest price point (that is a multiple of 0.01%) that is less than or equal to 85% at which $3 * P \leq 250$. Thus, the clearing price point is equal to 83.33%.

Example 16: In round 6, the clock percentage was 110% and the following bids were submitted:

- Bidder 1 submitted a bid for area 1 at 110%
- Bidder 2 submitted a bid for area 2 at 110%
- Bidder 3 submitted a bid for area 3 at 114%
- Bidder 4 submitted a package bid for areas 2, 3, 4, and 5 at a price point of 116% with a minimum scale percentage of 75%.

Suppose that the budget clears in this round and that the clearing price point is 117%. Suppose that the bids of bidders 1, 2, and 3 are assigned. Further, suppose that the package bid of bidder 4 does not meet the scale condition, and thus bidder 4 is not assigned any areas. Then:

- Bidder 1 is assigned area 1 and the support payment is the amount implied by 117% (i.e., the clearing price point) and the T+L weight in the bid of bidder 1.

- Bidder 2 is assigned area 2 and the support payment is the amount implied by 116% (i.e., the bid percentage of bidder 4's bid that included area 2) and the T+L weight in the bid of bidder 2.
- Bidder 3 is assigned area 3 and the support payment is the amount implied by 116% (i.e., the bid percentage of bidder 4's bid that included area 3) and the T+L weight in the bid of bidder 3.

Example 17: In this example, the setup is as in the Example 16 except that the bid percentage of bidder 4 is lower than the bid percentage of bidder 3. In this case, the support amount of bidder 3 is determined by the bid percentage of bidder 3, not of bidder 4.

Specifically, suppose that in round 6, the clock percentage was 110% and the following bids were submitted:

- Bidder 1 submitted a bid for area 1 at 110%
- Bidder 2 submitted a bid for area 2 at 110%
- Bidder 3 submitted a bid for area 3 at 114%
- Bidder 4 submitted a package bid for areas 2, 3, 4, and 5 at a price point of 112% with a minimum scale percentage of 75%.

Suppose that the budget clears in this round and that the clearing price point is 118%. Suppose that the bids of bidders 1, 2, and 3 are assigned. Further, suppose that the package bid of bidder 4 does not meet the scale condition, and thus bidder 4 is not assigned any areas. Then:

- Bidder 1 is assigned area 1 and the support payment is the amount implied by 118% (i.e., the clearing price point) and the T+L weight in its bid.
- Bidder 2 is assigned area 2 and the support payment is the amount implied by 112% (i.e., the bid percentage of bidder 4) and the T+L weight in its bid.
- Bidder 3 is assigned area 3 and the support payment is the amount implied by 114% (i.e., the bid percentage of bidder 3) and the T+L weight in its bid.

6.3 Bid Processing for Rounds After the Clearing Round

For rounds after the clearing round, bid processing consists of checking whether any additional areas can be assigned in the current round and identifying the appropriate support amounts for any such areas. In addition to processing the bids submitted in the round, the bidding system will process bids that carry forward from the previous round (see Section 5). The bidding system processes all the bids (the bids submitted in the round and the bids that carried forward from the previous round), in order of ascending T+L weight, and then in order of ascending price point. In particular:

Assignment determination. The bidding system processes all the bids (submitted in the round or carried forward from the previous round) in ascending order of T+L weight. Bids at the same T+L weight are processed in ascending order of price point,²² and ties are then broken with pseudo-random numbers.²³ As in Section 6.2, an area in a bid is *available to be assigned at a given T+L weight* if the area has not previously been assigned and if no other bidder bid for it at the round's clock percentage at the same or at a lower T+L weight.

²² Note that this processing order is different than that used in the clearing round, where bids are considered first in order of ascending price point and then in ascending order of T+L weight.

²³ The system will generate a pseudo-random number for each bid submitted in the round and for each carried-forward bid. The pseudo-random number associated with a carried-forward bid will be different than the pseudo-random number of the corresponding bid in the previous round.

If the bid contains a single area (i.e., is not a package bid) and the area is available to be assigned at the bid's T+L weight, then the area is assigned to the bidder. In the case of a package bid that was submitted in the round, the areas in the package bid that are available to be assigned at the bid's T+L weight are assigned if they are sufficient to meet the minimum scale percentage.

When considering a carried-forward bid that is a package bid, the bidding system checks whether the minimum scale condition is met, taking into account that bids for one or more areas in the package bid may already have been assigned to the same bidder at lower price points in the round. The bidding system will include the support payments for any such areas when determining whether the minimum scale condition is met. Specifically, the system checks whether the implied support of the areas that are available to be assigned at the bid's T+L weight plus the support payment²⁴ for any areas in the bid that have already been assigned is greater than or equal to the minimum scale percentage for the bid times the sum of the implied support amounts for all areas in the bid at the previous round's clock percentage. If this condition is satisfied, then the areas in the carried-forward bid that are available to be assigned at the bid's T+L weight are assigned.

Support payment determination for assigned areas in bids submitted in the round. For areas that are assigned to a bidder in the round and which received no other bids in the round at the same or lower T+L weight, the support payment is the amount implied by the previous round's clock percentage. For areas that are assigned and received bids from other bidders in the round at the same or lower T+L weight, the support payment is the amount implied by the greater of the price point bid by the bidder to whom the area is assigned and the lowest price point at which any other bidder bid for the area at the same or lower T+L weight.

Support payment determination for carried-forward bids. All carried-forward bids are at the previous round's clock percentage—the price point at which the bids were submitted. Therefore, for each area that was assigned at the time that a carried-forward bid was processed, the support payment is calculated using the previous round's clock percentage.

The bidding system also checks whether any areas that were bid at the current round's clock percentage remain unassigned. If there are any such areas, the auction proceeds to a new round.

Example 18: In round 7, the clock percentage was 100%, and the bidder submitted a package bid for areas 1, 2, 3, 4, and 5, each with a reserve price of \$100, at the clock percentage with a T+L weight of 0 and a minimum scale percentage of 75%. The budget cleared in round 7, but that bid did not meet the scale condition (because other bids, also at the clock percentage and with a T+L weight of 0, were submitted for at least some of the areas in the package) and thus carried forward to round 8. In round 8, the clock percentage was 95% and the bidder submitted a bid for area 1 and a separate bid for area 2, both at 95%. The bidder did not submit any bids for areas 3, 4, and 5 in round 8. During bid processing of round 8, the bidding system determined that the bidder is assigned areas 1 and 2, each with a support amount of \$98 because the lowest bid on those areas with a T+L weight of 0 by another bidder was at 98%. Suppose that at the time that the carried-forward bid is processed, only areas 3 and 4 are available to be assigned at a T+L weight of 0. Areas 1 and 2 have already been assigned to the bidder. Area 5 has either been assigned to another bidder or it received one or more bids at the round's clock percentage at a T+L weight of 0; in either case, it is not available to be assigned at a T+L weight of 0.

To check whether the carried-forward package bid meets the scale condition, the support amounts, as assigned, are compared to the implied support for the package, as bid, as in the following table:

²⁴ This is the second-price payment that was determined when the submitted bids were processed.

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| Area | Reserve Price | T+L Weight | Implied Support at 100% | Amount Used to Check if Carried-Forward Package Bid Meets Scale Condition |
|------|---------------|------------|-------------------------|---|
| 1 | \$100 | 0 | \$100 | \$98 |
| 2 | \$100 | 0 | \$100 | \$98 |
| 3 | \$100 | 0 | \$100 | \$100 |
| 4 | \$100 | 0 | \$100 | \$100 |
| 5 | \$100 | 0 | \$100 | None (Area not available to be assigned) |

In this example, the carried-forward package bid meets the scale condition because:

$$\$98 + \$98 + \$100 + \$100 \geq (75\%) * (\$100 + \$100 + \$100 + \$100 + \$100)$$

or equivalently:

$$\$396 \geq \$375$$

6.4 Identification of Winning Bids for Post-Auction Purposes

After the bidding concludes, the winning bids and the support amounts for each of those bids in dollars will be announced to the public by public notice. In general, any bid as assigned will be listed in the public notice and will constitute a separate winning bid for post-auction purposes. However, if an assigned bid is needed to meet the minimum scale condition for an assigned carried-forward package bid, it will not be considered a separate winning bid (see Sections 6.2 and 6.3).²⁵ Instead, any areas in such bids will be included in the package bid, which will be a winning bid.

Specifically:

- If the implied support of the areas in the carried-forward package bid that are available to be assigned at the bid’s T+L weight is greater than or equal to the minimum scale percentage for the bid times the sum of the implied support amounts for all areas in the bid at the previous round’s clock percentage, then the areas that are available to be assigned in the carried-forward bid constitute a single winning bid. Any areas in the carried forward bid that were assigned to the bidder at lower price points in the round constitute one or more separate winning bids.
- Otherwise, if any bids assigned at lower price points in the round are needed to meet the minimum scale condition, all areas in the carried-forward package bid that are assigned to the bidder in the round will constitute one winning bid.

Example 19: In round 9, the clock percentage was 90% and the bidder submitted the following bids:

- A bid for area 1 at 90%
- A package bid for areas 2, 3, 4, and 5 at 92% with a scale percentage of 60%

Suppose that the bidder is assigned areas 1, 2, 3, and 4 in this round. Then, the bidder will have the following two winning bids from this round: {1} and {2, 3, 4}.

Example 20: Consider Example 18 where the scale percentage of the carried-forward bid is 75%. The carried-forward package bid meets the scale condition because:

$$\$98 + \$98 + \$100 + \$100 \geq (75\%) * (\$100 + \$100 + \$100 + \$100 + \$100)$$

²⁵ This situation is illustrated in Example 17 and in examples below.

However, without including the payments for areas 1 and 2 (which have already been assigned to the bidder) the carried-forward package bid does not meet the scale condition because:

$$\$100 + \$100 < (75\%) * (\$100 + \$100 + \$100 + \$100 + \$100)$$

Thus, all areas in the carried-forward bid that are assigned to the bidder in the round will constitute a single winning bid, namely {1, 2, 3, 4}.

Example 21: Now consider a variation of Example 18 (and Example 20) where the scale percentage of the carried-forward bid is 40%. Then, the carried-forward package bid meets the scale condition even without including the payments for areas 1 and 2 (which have already been assigned to the bidder) because:

$$\$100 + \$100 \geq (40\%) * (\$100 + \$100 + \$100 + \$100 + \$100)$$

In this case, the bidder will have the following three winning bids from this round: {1}, {2}, and {3, 4}.

7 Information Available to Bidders

7.1 Bidding Information Available During a Round

During a round, a bidder will be provided the following information about its bidding:

- **Implied support for bids submitted in the round.** Equal to the sum of the implied support amounts across all the bidder's submitted bids in the round.²⁶
- **Implied support across bids at the clock percentage.** Equal to the sum of implied support amounts across all the bidder's bids in the round submitted at the round's clock percentage.
- **Number of areas in bids (submitted in the round).** The number of areas across all of the bidder's submitted bids in the round.
- **Number of areas in bids at the clock percentage.** The number of areas across all the bidder's submitted bids in the round at the round's clock percentage.

A bidder will also be provided information about its carried-forward bids and its proxy instructions. Note that carried-forward bids are not included in the calculations above.

During rounds up to and including the clearing round, a bidder will be provided the following information that relates to the activity rules:

- **Maximum activity.** The maximum activity that the bidder is allowed to submit in the round, which according to the activity rules, is equal to the bidder's activity in the previous round.
- **Maximum activity in new areas.** The maximum activity that the bidder is allowed to submit in the round for areas for which it did not bid at the previous round's clock percentage. According to the activity rule, this is equal to the maximum switching percentage times the bidder's total implied support at the previous round's clock percentage.

²⁶ This includes any bids generated in the round on behalf of the bidder based on any proxy instructions still in effect.

During rounds after the clearing round, a bidder will be provided the following information about the bids it has been assigned:

- **Assigned support.** The annual support across all areas that have already been assigned to the bidder. As described in Sections 6.2 and 6.3, the annual support for an assigned area is based on a second-price calculation and will be greater than or equal to the implied support at the bid percentage.
- **Provisionally winning bids.** The implied support at the bid percentage across all areas that have been assigned to the bidder. This amount will generally be smaller than the bidder's assigned support.

7.2 Round Results

This section describes the information that is provided to bidders on the results of bid processing for a round.

For rounds before the clearing round, each bidder is informed of:

- The aggregate cost at the round's clock percentage, which provides an indication of how near the budget is to clearing; and
- For each area, whether the number of bids at the round's clock percentage was 0, 1, or greater than 1.

For the clearing round and any subsequent rounds, each bidder is informed of:

- The areas it was assigned in the round (if any) and the associated support amounts;
- For each area, whether the area has been assigned;
- For each area that has not been assigned, whether the number of bids at the round's clock percentage was 0, 1, or greater than 1.

Before the next round begins, all bidders are informed of the new round's clock percentage.

8 Illustrative Example

We illustrate the mechanics of the bid processing with a simple example. The setup and outcome are intended to be illustrative, rather than realistic or typical.

The budget is \$6,800. The maximum switching percentage is 20% for round 2 and 10% for later rounds.

There are 5 areas. The following table provides the reserve price for each area.

| Area | Reserve Price |
|------|---------------|
| 1 | \$2,000 |
| 2 | \$2,000 |
| 3 | \$1,000 |
| 4 | \$2,000 |
| 5 | \$1,000 |

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There are 3 bidders. Bidders 1 and 2 (B1 and B2) always submit bids with T+L weight of 0. Bidder 3 (B3) always submits bids with T+L weight of 20. The opening percentage is set at 120%.

The following table provides the clock percentage, the bids of each bidder, the aggregate cost at the clock percentage and the assignments (if any) for each round. For a given bidder and a given round, each row represents a separate bid. The areas in a package bid are included in brackets. All package bids have a scale percentage of 50%. A round-by-round explanation follows the table.

| Round (Clock) | Bids of B1 (weight = 0) | Bid of B2 (weight = 0) | Bids of B3 (weight = 20) | Cost at Clock % | Assignments and Support Amounts |
|----------------------------------|------------------------------|------------------------|--------------------------------|-----------------|--|
| 1 (110%) | {1, 2, 3, 4} at 110% | 3 at 110% | 1 at 110% {2, 3, 4} at 110% | \$7,000 | |
| 2 (100%) | {1, 2, 3, 4} at 100% | 3 at 100% | {2, 3, 4, 5} at 100% | \$7,800 | |
| 3 (90%) <i>clearing round</i> | {1, 2, 3} at 90% 4 at 98% | 3 at 90% | {2, 3, 4, 5} at 90% | \$6,600 | B1 is assigned: \$1,880 for 1 \$1,800 for 2 B3 is assigned: \$1,480 for 4 \$740 for 5 |
| 4 (80%) <i>final round</i> | 3 at 85% | 3 at 82% | 3 at 80% | | B2 is assigned: \$850 for 3 |

Round 1

The clock percentage is 110%. Bidder 1 submits a package bid for areas 1, 2, 3, and 4 at the clock percentage. Bidder 2 submits a bid for area 3 at the clock percentage. Bidder 3 submits a bid for area 1 and a package bid for areas 2, 3, and 4; both bids are at the clock percentage.

The following table illustrates how the aggregate cost at the round's clock percentage is calculated. The three middle columns list the implied support amounts based on the bids of each bidder submitted at the clock percentage. The aggregate cost is calculated by taking the maximum of these implied support amounts for each area and then summing over all areas.

| Area | Implied Support at 110% for B1 | Implied Support at 110% for B2 | Implied Support at 110% for B3 | Maximum |
|--|--------------------------------|--------------------------------|--------------------------------|---------|
| 1 | \$2,000 | | \$1,800 | \$2,000 |
| 2 | \$2,000 | | \$1,800 | \$2,000 |
| 3 | \$1,000 | \$1,000 | \$900 | \$1,000 |
| 4 | \$2,000 | | \$1,800 | \$2,000 |
| 5 | | | | \$0 |
| Aggregate Cost at 110% (Round 1 Clock %) | | | | \$7,000 |

Since the aggregate cost at the clock percentage exceeds the budget, the budget does not clear in this round.

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Round 2

The clock percentage is 100%. Bidder 1 submits a package bid for areas 1, 2, 3, and 4 at the clock percentage. Bidder 2 submits a bid for area 3 at the clock percentage. Bidder 3 submits a package bid for areas 2, 3, 4, and 5 at the clock percentage. Bidder 3 is allowed to bid on area 5, because its activity from area 5 is \$800 which is less than 20% (the maximum switching percentage for the round) times the bidder's total implied support at the previous round's clock percentage ($\$6,300 = \$1,800 + \$1,800 + \$900 + \$1,800$).

The following table illustrates how the aggregate cost at the round's clock percentage is calculated.

| Area | Implied Support at 100% for B1 | Implied Support at 100% for B2 | Implied Support at 100% for B3 | Maximum |
|--|--------------------------------|--------------------------------|--------------------------------|---------|
| 1 | \$2,000 | | | \$2,000 |
| 2 | \$2,000 | | \$1,600 | \$2,000 |
| 3 | \$1,000 | \$1,000 | \$800 | \$1,000 |
| 4 | \$2,000 | | \$1,600 | \$2,000 |
| 5 | | | \$800 | \$800 |
| Aggregate Cost at 100% (Round 2 Clock %) | | | | \$7,800 |

The aggregate cost at the clock percentage is \$7,800, which exceeds the budget (\$6,800). Thus, the budget does not clear in this round.

Round 3

The clock percentage is 90%. Bidder 1 submits a package bid for areas 1, 2 and 3 at the clock percentage, and a bid for area 4 at 98%. Bidder 2 submits a bid for area 3 at the clock percentage. Bidder 3 submits a package bid for areas 2, 3, 4, and 5 at the clock percentage.

The following table illustrates how the aggregate cost at the round's clock percentage is calculated.

| Area | Implied Support at 90% for B1 | Implied Support at 90% for B2 | Implied Support at 90% for B3 | Maximum |
|---|-------------------------------|-------------------------------|-------------------------------|---------|
| 1 | \$1,800 | | | \$1,800 |
| 2 | \$1,800 | | \$1,400 | \$1,800 |
| 3 | \$900 | \$900 | \$700 | \$900 |
| 4 | | | \$1,400 | \$1,400 |
| 5 | | | \$700 | \$700 |
| Aggregate Cost at 90% (Round 3 Clock %) | | | | \$6,600 |

The aggregate cost at the clock percentage is \$6,600, which is less than the budget (\$6,800). Thus, the budget clears in this round. In other words, round 3 is the clearing round.

Assignment determination for bids submitted in the round. Bids are processed in ascending order of price point, and bids at the same price point are processed in ascending order of T+L weight (using pseudo-random numbers to break ties). Thus, the bids of bidder 1 and bidder 2 at the clock percentage are considered first. Suppose that, based on the pseudo-random numbers, the bid of bidder 1 is considered first:

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- Bidder 1 bid for the package of areas 1, 2 and 3 with a scale percentage of 50% and a T+L weight of 0. Area 3 is not available to be assigned at a T+L weight of 0, because bidder 2 also bid for that area at the clock percentage at a weight of 0. Areas 1 and 2 are available to be assigned at a T+L weight of 0, because there was no other bid for those areas at the clock percentage with a T+L weight of 0. The package bid of bidder 1 without area 3 meets the scale percentage, and thus areas 1 and 2 are assigned to bidder 1.
- The bid of bidder 2 for area 3 is considered next. Area 3 is not available to be assigned at a T+L weight of 0, so the bid of bidder 2 is not assigned.
- The bid of bidder 3 is considered next. Bidder 3 bid for the package of areas 2, 3, 4, and 5 with a scale percentage of 50% and a T+L weight of 20. Area 2 is not available to be assigned at a T+L weight of 20, because it has already been assigned to bidder 1. Area 3 is not available to be assigned at a weight of 20, because there are bids for this area at the clock percentage with a T+L weight of 0. Areas 4 and 5 are available to be assigned at a T+L weight of 20. These two areas are sufficient to meet the scale percentage, and thus areas 4 and 5 are assigned to bidder 3.
- The bid of bidder 1 for area 4 is considered next. Area 4 cannot be assigned to bidder 1 because that area has already been assigned to bidder 3.

Clearing price point determination. The clearing price point is the highest price point (that is a multiple of 0.01%) between 90% and 100% at which the aggregate cost is less than or equal to the budget. The aggregate cost at a price point P between 90 and 100 is the sum of the terms shown in the third column of the table below:

| Area | Status | Implied Support at Price Point P ²⁷ | Notes |
|------|------------------|---|--|
| 1 | Assigned to B1 | $\left(\frac{P}{100}\right) (\$2,000)$ | This is the implied support at P for a T+L weight of 0 |
| 2 | Assigned to B1 | \$1,800 | This is the implied support at 90% (the bid percentage of B3) for a T+L weight of 0 |
| 3 | Not yet assigned | \$900 | This is the implied support at the clock percentage (90%) for a T+L weight of 0 (the most expensive scenario) |
| 4 | Assigned to B3 | $\left(\frac{\min\{P, 98\} - 20}{100}\right) (\$2,000)$ | If $P \leq 98$, the implied support is calculated at P for a T+L weight of 20 If $P > 98$, the implied support is calculated at 98% (the bid percentage of B1) for a T+L weight of 20 |
| 5 | Assigned to B3 | $\left(\frac{P - 20}{100}\right) (\$1,000)$ | This is the implied support at P for a T+L weight of 20 |

The highest price point that is a multiple of 0.01% such that the aggregate cost is less than or equal to the budget is 94%. Areas 1, 2, 4, and 5 are assigned in the round. The support payments are determined from the third column in the table above, substituting 94 for P.

²⁷ The implied support for a bid takes into account the reserve price for the area and the tier and latency combination of the bid using the formula in Section 2.

Since the clearing price point is smaller than the previous round's clock percentage, the bidding system will not process the bids that carried forward from the previous round.

The auction proceeds with a new round, because area 3 was bid at the clock percentage and has not yet been assigned.

Round 4

The clock percentage is 80%. Each bidder can only bid on area 3 in this round, because that is the only area that the bidder bid on at the previous round's clock percentage and that has not yet been assigned. Bids for area 3 for each bidder carry forward to round 4 at 90%, the previous round's clock percentage. Bidder 1 submits a bid for area 3 at 85%, bidder 2 submits a bid for area 3 at 82%, and bidder 3 submits a bid for area 3 at 80%. These bids are considered by the bidding system in addition to the carried forward bids.

The bids are processed in ascending order of T+L weight and then in ascending order of price point. Thus, the bid of bidder 2 is processed first. Area 3 is available to be assigned at a T+L weight of 0 because it has not yet been assigned and there is no bid for area 3 at the round's clock percentage with a T+L weight of 0. Thus, area 3 is assigned to bidder 2. The support payment is determined by the 85% price point, which is the lowest price point at which another bidder (bidder 1) bid for the area at a T+L weight of 0.

Round 4 is the final round because all areas that were bid at the round's clock percentage were assigned during the bid processing of the round.