

THE CAF AUCTION: DESIGN PROPOSAL

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I. Qualifications and Assignment

1. My name is Paul Milgrom. I am a professor in the Department of Economics at Stanford University and professor, by courtesy, at the Stanford Graduate School of Business. I am a member of both the National Academy of Sciences and the American Academy of Arts and Sciences and a winner of the Nemmers Prize in Economics. I have published around 90 peer-reviewed articles in many areas of economics, including auction theory, market design, incentive theory, industrial economics, economic history, economics of manufacturing, economics of organizations, and game theory. My articles have been reprinted 55 times in books and collections of leading articles. My book, *Putting Auction Theory to Work*, published by Cambridge University Press in 2004, has received lavish praise from Nobel-winning economists as well as leading practitioners. I also published a book with John Roberts titled *Economics, Organization and Management*. I was one of the inventors of the simultaneous multiple round auction design, which was adopted by the Federal Communications Commission in 1994 as its principal method for auctioning radio spectrum. This design has been copied and adapted worldwide for auctions of hundreds of billions of dollars' worth of radio spectrum, electricity, natural gas, and other assets. I have advised regulators in the U.S., U.K., Canada, Australia, Germany, and Mexico on the implementation and improvement of spectrum auction design, including advice about the new combinatorial auction designs. In 2009, I was engaged to advise the U.S. Treasury on auctions of warrants received as part of its TARP program providing funding for troubled banks. I have also advised Google, Yahoo and Microsoft on auction-design issues, and have advised or led teams of consultants to advise bidders in several major auctions.

2. My name is Assaf Eilat. I am a Senior Economist at Compass Lexecon. I specialize in the economics of industrial organization, antitrust, competition, and auctions. I have conducted theoretical and empirical research on various competition topics and earned a Ph.D. in Economics from Stanford University. At Compass Lexecon,

I evaluated the competitive effects of proposed mergers in the USA and in Europe. I have also consulted clients on a wide variety of matters including various regulatory issues, settlement discussions, damages, auction-related issues, and claims of price fixing, collusion, and exclusionary conduct.

3. We have been engaged by counsel for ViaSat, Inc. (“ViaSat”) to evaluate, from an economic perspective, the proposed use of auctions to provide support from the Connect America Fund (“CAF”). Specifically, the Federal Communications Commission (“FCC”) has proposed to conduct a procurement auction to select providers to deploy broadband in areas that currently do not have broadband access. The FCC has proposed to prevent satellite providers from participating in the auction in order to ensure that they focus their capacity on areas that are very expensive to serve terrestrially. We have been asked by ViaSat to evaluate the FCC’s concern regarding satellite providers’ participation in the auction and to propose an auction design that would allow the FCC to select the lowest-cost broadband provider to serve each of the areas covered by the auction.

II. Introduction and Overview

4. The FCC has identified a “Broadband Gap” – at least 7 million households that currently do not have 4/1 Mbps broadband access and are unlikely to get such access without some form of subsidy (“unserved households”). Of the unserved households, the FCC determined that hundreds of thousands of households (if not many more) would be extremely hard to serve terrestrially and can only reasonably be served by satellite (“most expensive households”).

5. The FCC has considered conducting a procurement auction to select providers to deploy broadband in these areas. The FCC has issued a Notice of Proposed Rulemaking (“NPRM”), which proposes to create the CAF, aimed at making affordable broadband services available to all unserved Americans. The NPRM discusses holding the first CAF auction in 2012, and seeks comment on “using a competitive bidding mechanism to

award funding to one provider per geographic area in all areas designated to receive CAF support”.

6. With regards to satellite broadband, the NPRM notes that satellite broadband is the most cost-effective technology to cover the most expensive households.¹ It proceeds to propose that satellite broadband providers will be excluded from directly participating in the first phase – and possibly in subsequent phases – of the CAF auction.²

7. The proposal to exclude satellite providers from the first phase of the auction seeks to ensure that satellite broadband will be deployed in the most expensive areas, i.e., in areas that are prohibitively expensive to serve terrestrially. The FCC’s concern is that if satellite providers are allowed to participate in the auction, they might bid for areas that are cheap to serve terrestrially; consequently, they will have no capacity left to serve the most expensive households.³ According to the NPRM, excluding satellite providers from the auction will solve this issue because bidders will subcontract satellite providers to fill in the most expensive households.⁴

8. Based on our research and analyses, we have reached the following conclusions:

- i. All broadband providers, including satellite broadband providers, should be allowed to participate directly in the CAF auction and to compete for

¹ NPRM at ¶ 133.

² NPRM at ¶ 272. As for subsequent phases, the NPRM proposes several potential approaches regarding satellite providers’ roles. One option is to exclude satellite operators from the bidding and allow them to contract with winning bidders, as proposed for the first phase of the CAF. A second option is to allow satellite providers to bid in the form of a per-housing-unit price for a maximum number of housing units within geographic areas. Finally, the NPRM also considers allowing satellite providers to bid in the CAF auction and compete with other providers. NPRM at ¶ 424-7.

³ NPRM at ¶ 272.

⁴ NPRM at ¶ 282.

all areas. In a properly competitive procurement auction, broadband providers are expected to focus on areas in which they enjoy the greatest competitive advantage. Bids submitted by satellite providers are expected to reflect scale economies and other efficiencies as well as satellite providers' ability to expand capacity in response to high demand. To the extent that the FCC is concerned about competitive advantages or misallocation of broadband capacity, we believe that such concerns can be addressed by designing the CAF auction properly.

- ii. Moreover, it is unclear why the alternative mechanism proposed by the FCC – that is, negotiations between satellite providers and bidders to fill in gaps in the bidders' coverage – would alleviate concerns about the efficient deployment of satellite capacity. We see no reason to believe that such negotiations would lead to a more efficient outcome than an auction – indeed, they add an unnecessary layer to the resource allocation process that more likely would lead to *less* efficient outcomes. Similarly, a cost-model approach that would attempt to guess providers' costs at some future date based on limited information, staff judgment and political pressure is not likely to promote efficient outcomes. In contrast, an auction is a market mechanism that accounts for variations in cost structures across different bidders and technologies. These differences would be reflected directly in competing bids and would be grounded in the service providers' own estimates of their anticipated costs.
- iii. We propose an auction design that allows bidders the flexibility to bid for various combinations of service areas while taking into account their specific network structures. At the same time, the auction is simple enough to allow the FCC to blend services offered by providers with diverse networks, capabilities, and costs.

- iv. In our proposed design, bidders compete for service areas or combinations of service areas. Each bid includes four elements: a list of service areas; a list of prices, one for each service area; a fixed cost to be paid if any of the areas on the list is selected; and a capacity constraint. The bid expresses an offer to serve any subset of the service areas on the list, consistent with the capacity constraint, for a payment equal to the sum of the fixed cost plus the prices of the service areas selected.
- v. Because each bid expresses an offer to serve any subset of areas included in the list, the proposed form of bids compactly expresses offer prices for many packages with just a few bids. This, in turn, allows the FCC the flexibility to select from each bid the subset of areas that can be served most efficiently by the provider.
- vi. The two elements that most distinguish our proposed bids are the fixed cost and capacity elements. In economic terms, the fixed cost variable in our bidding proposal gives bidders a way to describe scale economies and *complementarity* by allowing them to incorporate in the bid costs that are shared by multiple areas. The capacity variable allows bidders to describe a relationship of *substitution* in supply by allowing bidders the flexibility to offer service in alternative service areas.
- vii. Our proposed auction design can be varied in a number of different ways. The FCC could use *scoring* to account for differences in coverage, quality, and other factors. For example, the auction could be extended to account for coverage by penalizing bids that do not cover all the households in the collection of service areas covered by the bid. We also discuss how reserve prices can be used to restrict competitive advantages and to discourage bidders from leaving gaps in coverage.

III. Proposed Auction Design

9. The conclusion that satellite providers should be eligible to participate in the CAF auction does not depend on the specific auction design chosen by the FCC. Nevertheless, a good auction design is essential to enable all competitors to compete fairly and to promote the most efficient, lowest cost provision of services to the targeted households. Below, we discuss one auction design that achieves the NPRM's objectives while allowing all potential bidders to participate in the auction directly.

A. Service Areas

10. Consistent with the proposal in the NPRM, service areas to be assigned in the auction are census blocks or census blocks groups.⁵ This selection permits very many possible combinations of blocks for bidding and poses the challenge of creating an auction that, on one hand, makes bidding easy and, on the other hand, allows diverse bidders to vary their package bids in ways that reflect their network capabilities and cost structures. The design we suggest below is tailored to do these things.

11. In a properly structured market solution, there is no need to limit bidding in order to reserve the capacity of satellite providers for the highest cost areas. If, despite our analysis, the FCC is concerned about reserving satellite capacity for the highest cost areas, then its first CAF auction should include service for those areas. The timing of procurement matters, because auctions that depend on future budget appropriations are inherently uncertain and do not encourage any kind of service provider to retain capacity.

⁵ NPRM at ¶ 293.

B. Service Requirements

12. Area winners are required to cover all households within the area. The minimum speed to be provided, and possibly the maximum price to be charged to households, will be specified prior to the auction.

13. Additional dimensions of quality should only be included to the extent they can be measured and valued objectively. Another possible variation is to define (at least in some service areas) coverage requirements that are less than 100% of the households in the service areas. These issues are discussed in more detail below.

14. The coverage requirement within each area may be less than 100% of households, as described in more detail below. Coverage, speed, and price requirements may potentially vary by area or by technology.

C. The Bidding Process

15. The bidding process described below is available for testing in commercial software.

16. A *bid* consists of four parts, as follows:

- i. A list of service areas.
- ii. A list of prices, one for each service area in list *i*.
- iii. A fixed cost that represents a payment to be made in addition to the individual service area prices if any of the service areas in the group is selected.
- iv. A capacity limit, so that the bid is applied only to the extent that the population to be served does not exceed this limit, taking into account the expected subscriber “take rate.”

17. Each bid is understood to express a collection of service offers. For any subset of the service areas in list *i* consistent with capacity limit *iv*, the bid expresses an offer to provide service to all the households for a price equal to the sum of the service area prices from list *ii* plus the fixed cost *iii*.

18. For example, suppose that there are 2,000 households in each service area. Suppose that a bidder submits the following bid: (i) Service areas: A, B, C; (ii) Prices for A, B, C: \$10, \$7, \$5, respectively; (iii) Fixed cost: \$15; (iv) Capacity limit: 5,000 households. The FCC can choose to award any subset of the service areas A, B, and C to the bidder. A possible outcome of the auction is that the bidder wins areas A and B and receives a payment of $\$15 + \$10 + \$7 = \32 : the fixed cost plus the prices for areas A and B.

19. Each bidder in the auction may submit multiple bids and may express a limit on the number of its bids that can be accepted. To reduce the complexity of the process, there may also be other limits on the bids. For example, a bidder may be limited in the number of total bids, or in the number of bids that can include any particular census block.

D. Selection of Winning Bids

20. Having received all the bids, the FCC determines the combination of bids that covers unserved households at the lowest cost. This is a combinatorial optimization problem, which can be solved by standard optimization software.

21. If the FCC's budget is insufficient to cover all the unserved households, then the FCC may choose – based on the bids – which households to cover in the auction. For example:

- i. The FCC may select the combination of bids that serves the greatest number of households for a total cost not exceeding its budget limit.

- ii. Alternatively, for the first procurement auction, the FCC may choose to prioritize procuring service to households that are more expensive to serve, while postponing the procurement for “cheaper” households for a later auction. One reason to do this is to ensure that the most expensive households, which are less likely to be served absent a subsidy, will be covered by the CAF.

E. Pricing

22. The price paid to each winning bidder in the auction is most simply set equal to the amount of its winning bid. Other alternatives are possible: so-called *core-selecting* auctions provide less scope for strategizing and better incentives for bidders to align their bids with their actual costs. We do not recommend such a rule, because we judge it unwise to add another layer of complexity to an already complicated procurement problem.

F. Discussion

23. The proposed form of bids has several quite important advantages for a combinatorial procurement auction.

24. First, the proposed bidding rules allow and *require* service providers to express price offers for *every subset* of the collection of areas that they propose to serve. This stands in sharp contrast with a system that requires bidders to specify large numbers of packages with separate prices for each package to be served. This simplification is useful, because it makes bidding less costly and error prone. But the particular structure is even more important than that, on account of the next two points.

25. Second, because subsets are always included, service providers who bid on overlapping groups of service can *always* be combined to cover the union of the areas for which bids are offered. With bidding formats that do not require bids on subsets of packages, it may be impossible to fit together bids on a collection of intersecting

packages to provide coverage to the union – the complete set of households to which coverage could be offered.

26. Third, because the proposed form of bids compactly expresses offer prices for many packages with just a few bids, it is feasible to find the cost-minimizing combination even from a very large number of price offers. This property is not only valuable: it is necessary for a single auction to procure services for more than a handful of areas.

27. Fourth, the proposed bids provide are a familiar representation of costs for business analysts. For example, the costs associated with installing a switch or backhaul equipment or with dedicating a satellite spot beam are commonly described in the business as fixed costs. Each of these costs provides capacity only up to some limit, so it is natural for bidders to wish to predicate their offers on that limit. The proposed bids allow them to do just that.

28. Fifth, because the proposed bids can represent the cost structure of many different kinds of technologies, and because bids cover subsets of each provider's service proposal, the auction allows a realistic way for the FCC to blend services offered by providers with diverse networks, capabilities, and costs to provide coverage to the widest possible set of consumers.

29. The two elements that most distinguish our proposed bids are the fixed cost and capacity elements. Without these, the auction would become just a collection of sealed bid procurements for each area separately. Indeed, if bidders were to omit the fixed cost and capacity elements from their bids, then the auction would operate in just the same way as a set of independent sealed-bid auctions.

30. In economic terms, the fixed cost variables in our bidding proposal give bidders a way to describe scale economies and *complementarity*, while the capacity variable allows bidders to describe a relationship of *substitution* in supply. Given the importance of these elements, it is useful to describe them separately.

31. Within our auction proposal, the purpose of the fixed cost variable is to allow bidders to describe scale economies. Suppose, for example, that a service provider must make a \$30 investment to cover areas D and E; after making this investment, the marginal cost of serving each area is \$1. Without the ability to report its fixed cost separately, the provider would have to somehow incorporate the cost complementarity in the separate bids for areas D and E. But this would be imprecise given that the provider cannot know when it is bidding which areas it will win. Indeed, the provider may bid high in both areas to ensure that its fixed costs are covered even in the event that it only wins one of these areas. The result may be that the service provider's bids lose even if it could provide service to the two areas together at much lower cost than the winning bidder. The fixed cost variable allows each bidder to describe any complementarities in its cost structure more accurately.

32. The purpose of the capacity variable is to allow bidders the flexibility of offering service in alternative areas (or in alternative combinations of areas) – a situation that in economic terms means that service in different areas behaves as substitutes in supply. For example, suppose that a provider can cover areas F or G but not both. Without the ability to report its capacity constraint, the provider would have to bid for either F or G. The capacity variable allows the bidder to offer service in both areas; the FCC enjoys the flexibility to decide in which of these areas the provider's capacity can be most efficiently used.

IV. Variations on the Proposed Auction Design

A. Scoring and Other Adjustments

33. The FCC could decide that it is useful for the auction to account for differences in coverage, objective quality measures, and other non-subjective factors, that is, to *score* the bids. For example, a bid could be extended to include elements such as the *quality index* of the service and the *percentage of households* to be served in the collection of

service areas covered by the bid. These factors can be incorporated in evaluating the bids by multiplying the price offers by an amount that disadvantages them if the percentage of households served is less than 100% or if the quality of service is less than some measurable standard (e.g., 4/1 Mbps).

34. One example of multiplicative bid adjustments to account for coverage and other differences can be found in the upcoming 4G spectrum auction for France. This auction will allocate frequencies in the 800 MHz and 2.6 GHz bands for use in mobile data services. For the 2.6 GHz spectrum, sealed bids will be evaluated based on the price offered, multiplied by a factor that depends jointly on whether the provider allows MVNO access and on the bandwidth of the spectrum acquired. For the 800 MHz spectrum, the sealed bids will be evaluated based on the price offered, multiplied by a factor for allowing MVNO access and multiplied again by a second factor that accounts for whether the service provider commits to cover 95% of the French population within a specified period. (All winning bidders are held to a 90% coverage obligation.)

35. A similar handicapping scheme would work well for the coverage requirement of the CAF procurement auction. It might also work for the quality differences, if a reasonably objective good quality index can be identified. If no such index can be identified, then the FCC should instead set a minimum quality standard.

36. Coverage adjustment. Although the FCC's purpose is to provide near-universal access to broadband services, achieving 100% in some areas may be prohibitively costly. That should not stand in the way of partial coverage for the area: the FCC should allow bidders to submit bids that do not cover every single household in a service area. A good way to handicap bids that provide partial coverage in the determination of winning bids is to adjust the objective function, multiplying the cost of a bid that covers α of the households by the factor $1/\alpha^2$. For example, a bid to serve 90% of the households in service area A for a subsidy of \$10 would be equivalent to a bid to serve all households in service area A for a subsidy of $\$10/0.9^2 = \12.3 .

37. Quality adjustment. Quality adjustments can potentially be incorporated in the bids as well, to the extent they are objective and based on readily measurable criteria. Suppose that there exists a quality index that takes values between 0 and 1 (with 1 representing the highest quality). Then a bid with service quality β can be multiplied by a factor such as $1/\beta$ to reflect differences in quality. Such an adjustment can also be combined with the coverage adjustment proposed above. For example, a bid that covers a fraction $\alpha=0.9$ of the households with service with a quality multiplier of $\beta=0.8$ for a subsidy of \$10 would be equivalent to a bid that covers all the households in the service area with service with quality 1 for a subsidy of $\$10/(0.9^2*0.8) = \15.4 .

38. Additional constraints. There could be additional constraints besides overall capacity included in the bids without adding significant complexity to the auction. See Milgrom (2009).⁶

B. Reserve Prices

39. If the FCC has a tight budget constraint, one might argue that reserve prices are unnecessary: as explained above, competition across service areas for government funding may hold down the bid prices.

40. Under some circumstances – for example, if the fund is sufficient to cover all service areas – competition across service areas may not be sufficient to discipline bid prices. In this case, reserve prices can address concerns regarding various providers' ability to extract high subsidies in areas in which they enjoy substantial competitive advantages.

41. Various mechanisms can be used to set reserve prices:

⁶ Milgrom, Paul (2009). "Assignment Messages and Exchanges." *AEJ Micro* 1(2): 95-113.

- i. Reserve prices can be tied to the bids in other service areas. For example, the maximum subsidy in any area can be capped at a certain percentage above the average bid in other (or in similar) service areas.
- ii. Reserve prices can be tied to other bids submitted by the same provider. For example, a provider may not be allowed to submit in any area bid components (fixed costs or service area prices) that are more than a certain percentage above the provider's average bid in other (or in similar) service areas.
- iii. Reserve prices can be tied to some cost measure of providing broadband services. For example, the maximum subsidy in any area can be capped at a certain percentage above the nationwide average cost of providing a broadband service.
- iv. Reserve prices can be tied to some percentile of terrestrial bid prices. For example, a non-terrestrial broadband provider can be required to submit bids that are lower than the 60th-percentile terrestrial bid in the auction. Providers that bid above this level would get an opportunity to reduce the components of their bids to reach that level.

42. The FCC may require cost justification for parties seeking support above the reserve price.

C. Preventing Gaps in Coverage

43. One potential concern is that bidders may leave unserved "islands" when submitting a bid for a package of service areas. The FCC can prevent this from happening by using a system of reserve prices. For this purpose, it is easiest to think of reserve prices as bids placed by an auctioneer: the FCC effectively makes its own "bids" for contiguous areas. By setting these bids at relatively high levels, the FCC penalizes solutions that leave behind islands or small groups of unserved areas because these

unserved areas are treated as if they are to be served by the government at the high bid level. This encourages the bidders to provide coverage in these areas.

V. All Broadband Providers Should Be Eligible to Bid for All Households

A. Potential Concerns about the Participation of Satellite Broadband Providers in the CAF Auction

44. The NPRM proposal to exclude satellite broadband providers from participating in the first phase – and possibly in subsequent phases – of the CAF auction appears to be driven by three concerns (each of which can be addressed through a proper auction structure, as outlined above):

- i. Allocation: The FCC appears concerned that satellite providers would focus their capacity on households that are not the most expensive to serve terrestrially.
- ii. Capacity: The FCC appears concerned that satellite providers' capacity is limited and should therefore not be used in areas that are cheap to serve terrestrially.
- iii. Competitive Advantages: The FCC appears to believe that while satellite providers have substantial cost advantages in serving certain service areas, they might not pass these advantages on to the public in the form of lower bids due to the state of competition.

45. The NPRM does not provide much detail or support on why excluding satellite providers from the auction would lead to a better auction outcome. The FCC appears to assume that if satellite providers are not allowed to participate in the CAF auction, they still would provide capacity where needed pursuant to negotiated resale arrangements between satellite providers and terrestrial bidders. However, it is unclear whether satellite

providers would have a business case to build-out capacity to support this limited wholesaler role given the significant economies of scale that affect satellite infrastructure. Moreover, the NPRM does not explain how such negotiations would operate and why this mechanism addresses concerns about the deployment of satellite capacity. There is no reason to believe that negotiations between satellite providers and bidders would lead to a more efficient solution compared to an auction. Indeed, there is every reason to believe that such negotiations would lead to *less* efficient outcomes, adding a second layer in which bargainers must reach agreements about how to share the gains from cooperation, even when the gains themselves are obvious.

46. We disagree with the proposal to exclude satellite providers from participating in the CAF auction. The implication of this proposal is that the FCC will decide for the market where – and how much – to deploy satellite broadband. But the whole point of the CAF auction is to determine the least costly way of providing coverage in each area. The auction should be designed to efficiently assign all bidders, including satellite providers, to areas that they can serve at the lowest cost.

47. Below, we explain why allowing satellite providers to bid in a well-designed auction would address each of the FCC’s concerns regarding the efficient deployment of satellite broadband.

B. Allocation

48. The best way to deploy satellite providers’ capacity efficiently is to allow satellite providers to bid directly in the auction. As bidders, satellite broadband providers have an incentive to bid where they have the biggest competitive advantage. In turn, satellite providers are likely to win areas that are costly to serve by other technologies.

49. The FCC’s concern that satellite providers will devote their capacity to areas that can be served cheaply terrestrially is unwarranted. In a properly competitive procurement auction, there would be no incentive for satellite providers to devote capacity to areas that

others can also serve cheaply instead of focusing on areas in which satellite providers have a greater competitive advantage.

C. Capacity

50. The NPRM assumes that satellite providers' capacity is limited and concludes that this capacity should not be wasted on areas that are easy to serve terrestrially.

51. We understand that, contrary to this assumption, satellite capacity can be increased substantially and timely. Specifically, we understand that it takes satellite providers roughly the same time to expand their capacity as other broadband providers.⁷ Bidding in the auction will allow satellite providers to submit bids that reflect their abilities to expand capacity in response to high demand.

52. Because of scale effects, even if the capacity of satellite broadband providers is assumed to be fixed, allowing them to bid for all unserved households may *increase* the likelihood that they also provide service to the most expensive households. Satellite providers incur high fixed costs to provide service within a geographic area and must spread these costs over a sufficient number of subscribers in the area, rather than serving just a handful of the highest cost households. Allowing satellite providers to reach additional households may create the scale effects required to justify serving the expensive households that might not be served otherwise. Again, a well-designed auction should allow satellite providers to submit bids that take these considerations into account.

⁷ Dr. Charles L. Jackson, *Satellite Service Can Help to Effectively Close the Broadband Gap* (Apr. 18, 2011).

D. Competitive Advantages

53. The FCC may be concerned that satellite providers, who enjoy significant cost advantages in certain areas, will use their competitive advantage to demand high subsidies to serve these areas.

54. Even in areas that are very expensive to serve terrestrially, satellite providers face competition from a number of sources. First, multiple satellite providers are expected to compete head-to-head in high-cost areas. Second, entities could negotiate resale agreements with satellite providers before an auction, and then compete against each other. Particularly in areas where new capacity is to be added, competition at the capacity supply stage could be intense. Third, wireless networks are constantly expanding, increasingly allowing wireless providers to compete with satellite providers. Fourth, even in areas without existing terrestrial capacity for broadband service, terrestrial providers would exert competitive pressure by establishing a “ceiling” that satellite providers and other bidders could not exceed as a practical matter. Stated somewhat differently, even in areas in which *only* satellite providers bid, the amount of support provided through the CAF still would be less than the amount required to support terrestrial broadband service – which would be the only viable option if satellite providers were *not* allowed to participate.

55. Concerns about market power are not unique to satellite providers. Indeed, other broadband providers may also enjoy significant cost advantages in certain areas because of factors such as incumbency advantages and scale effects. Such providers may have an incentive to bid above their costs. Concerns about market power should therefore be addressed by building in the auction protective mechanisms that apply to all bidders.

56. To the extent that specific concerns about the market power of satellite providers remain, such concerns can be addressed by designing the auction appropriately. As discussed in Section III, reserve prices can be used to limit the subsidies in high-cost areas. The FCC can also lower its coverage requirements in high-cost areas; this would

mitigate the competitive advantage enjoyed by satellite providers in these areas because other bidders would not be required to serve the highest-cost households to win the service areas.

E. The FCC Should Not Conduct a Separate Auction for the Most Expensive Households

57. We understand that one potential proposal is to conduct a separate auction for the most expensive households. Under this proposal satellite providers would bid for the most expensive households, but would presumably be prevented from bidding for other unserved households.

58. Conducting a separate auction for the most expensive households would require the FCC to identify ex-ante the households for which satellite providers enjoy the most substantial cost advantages over their competitors. Given the complex cost structures of various broadband providers as well as the private information that they possess about their operations, such a process would inevitably be imprecise.

59. The bidding process is a more efficient way to gather accurate information on broadband providers' costs of serving various areas. As described in more detail below, the auction can be designed to help the FCC learn about each provider's costs of serving each area and use this information to select the households to be covered by the fund. If the FCC is concerned about reserving satellite capacity for the most expensive households, then its first CAF auction should include service for those households.

VI. Conclusion

60. In this report we argue that the best mechanism to assign satellite broadband capacity is a well-designed procurement auction that encourages satellite providers to bid directly for areas that they can serve at the lowest cost.

61. In our proposed auction design each bid expresses an offer to serve any subset of service areas included in the bid. Bids incorporate fixed costs and capacity constraints to allow bidders to account for complementarity and for substitution in supply.

62. The auction design provides the FCC with a realistic way to tailor the coverage offered by various broadband providers with diverse networks efficiently so that broadband services can be enjoyed by unserved households at the lowest cost.