

July 26, 1993,<sup>55</sup> and the applicability of competitive bidding to the Basic Exchange Telecommunications Radio Service (BETRS) and the Rural Radio Service.<sup>56</sup>

61. Outside of the two issues mentioned above or where the statute was unclear,<sup>57</sup> no commenter seriously disputed the applicability of auctions to mutually exclusive initial applications in the Public Mobile Services. Neither did any commenter seriously dispute our tentative finding in ¶ 147 of the NPRM that competitive bidding would promote the objectives of Section 309(j). Unless specifically excluded,<sup>58</sup> such applications will be subject to competitive bidding.

62. Multipoint Distribution Service (MDS) and the Multichannel Multipoint Distribution Service (MMDS). In the NPRM, we specifically proposed that future mutually exclusive MDS and MMDS initial applications be subject to competitive bidding, believing that doing so would promote the objectives of Section 309(j).<sup>59</sup> Although we do not address

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<sup>55</sup> See, e.g., comments of John G. Andrikopoulos, et al., Abby Dilley, various partners in The Quick Call Group, John Dudinsky, Jr., M. Kathleen O'Connor, and James F. Stern. As noted, we will address the applicability of competitive bidding to certain cellular radio applications filed prior to July 26, 1993, in a separate order. These applications present unique issues because of the special rule that Congress adopted in Section 6002(e) of the Budget Act that is applicable only to mutually exclusive applications filed prior to that date. The status of the applications at issue in McElroy Electronics v. FCC, 990 F.2d 1351 (D.C. Cir. 1993), will likewise be decided at that time since they present similar issues.

<sup>56</sup> See, e.g., comments of Interdigital. The applicability of competitive bidding to the BETRS and the Rural Radio Service is discussed in subsection F, supra.

<sup>57</sup> See, e.g., comments and reply comments of AllCity Paging.

<sup>58</sup> See, e.g., the discussion at ¶¶ 45-46 excluding the BETRS from competitive bidding on grounds that auctioning licenses in these services would not further the objectives in Section 309(j)(3). In some cases, Public Mobile Service licenses are available to end users as well as common carriers. See, e.g., Section 22.100 (Offshore Radio Service may be licensed to end users) and Section 22.600 (Rural subscriber stations may be licensed to individual users of the service). We defer resolution of the issue of mutually exclusive applications between common carriers and end users to a later date inasmuch as mutual exclusivity in these classes of services is extremely rare; should it occur, we will decide the appropriate course at that time. The 800 MHz air-ground radiotelephone service (although not the 450 MHz air-ground radiotelephone service, which has exclusive frequencies) will be excluded from competitive bidding because those frequencies are shared. See Section 22.31(h) of our Rules.

<sup>59</sup> See NPRM at ¶¶ 147-151. No MDS or MMDS applications are currently being accepted, due to a freeze which the Commission has placed on the filing of such applications. See Public Notice, "MDS/MMDS Applications Filing Freeze," released July 28, 1993.

in this Second Report and Order the applicability of competitive bidding to MDS and MMDS applications which were filed prior to July 26, 1993,<sup>60</sup> we believe that new initial applications for these common carrier services are otherwise eligible for competitive bidding. Very few comments were filed on this subject, but those that addressed it did not oppose competitive bidding. See, e.g., comments of Wireless Cable Association International. No commenter seriously disputed the applicability of competitive bidding to mutually exclusive initial applications in the MDS and MMDS or our tentative finding in ¶ 147 of the NPRM that competitive bidding would promote the objectives of Section 309(j). Therefore, at such time as the Commission accepts additional initial applications for MDS and MMDS licenses, we will resolve any mutual exclusivity between these channels by using competitive bidding. Because it is unclear when the existing freeze on new applications will be lifted, however, we defer promulgation of specific rules until that time.

63. SMR and Exclusive PCP Services. If multiple SMR initial applicants file for the same channels in the same location on the same day and if the Commission's existing procedures do not avoid mutual exclusivity, or if two or more PCP systems in the future file mutually exclusive initial applications, we intend to use competitive bidding to select from among competing applications.<sup>61</sup> Our rules explicitly contemplate and expect that these licensees will provide service to eligible subscribers for compensation.<sup>62</sup> We know from experience that this is the principal use of SMR and exclusive PCP spectrum, and the comments support our determination. See, e.g., comments of GTE and McCaw.

64. We also believe that the use of competitive bidding will speed the development and rapid deployment of SMR service, including those residing in rural areas, with minimal administrative or judicial delays as required by Section 309(j)(3)(A). Because we have confirmed that SMR providers operate in the manner contemplated by Section 309(j)(2)(A),

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<sup>60</sup> See, e.g., comments of MW TV. We will address this issue in a separate order.

<sup>61</sup> In light of our past experiences with the release of new SMR spectrum, we believe that mutual exclusivity is highly likely if we were to release new SMR spectrum at the conclusion of PR Docket Nos. 93-144 and 89-553, the 800 MHz and 900 MHz SMR proceedings. See PR Docket No. 93-144, 8 FCC Rcd 3950 (1993); PR Docket No. 89-553, 8 FCC Rcd 1469 (1993). Due to the uncertainty over the outcome of these proceedings, however, we decline to confirm, as requested by AMTA and Cencall, that the licenses which may be issued as a result of those proceedings will not be the result of "initial" applications. See ¶ 66, infra. If at the conclusion of those proceedings we decide that 800 or 900 MHz SMR applications may fairly be characterized as modification applications, then we will not subject them to competitive bidding. AMTA's argument that the Congressional objective of effective and intensive use of the spectrum is unlikely to be satisfied if the Commission employs auctions to award 900 MHz licenses outside the Designated Filing Areas (the largest 50 markets in the U.S.) is speculative.

<sup>62</sup> See NPRM at ¶ 136 and n. 129; PCP Exclusivity Report and Order, supra.

new section 309(i)(1)(B) does not permit the Commission to utilize lotteries to choose from among mutually exclusive initial SMR applicants, leaving comparative hearings as our sole alternative to resolve such mutual exclusivity. Such hearings are likely to be lengthy, contentious, and complex. Given this prospect, we believe that competitive bidding is likely to be a faster means of delivering service to the public. With respect to promoting the objectives of Section 309(j)(3)(C), we also believe that competitive bidding will recover for the public a portion of the value of SMR and exclusive PCP spectrum made available for commercial use and avoid unjust enrichment for the same reasons explained in conjunction with PCS service.

65. In the NPRM, we requested specific comments on how we should treat mutually exclusive finder's preferences which are currently governed by Section 90.611(d) of our Rules. Under that rule, members of the public may submit to the Commission information that results in the takeback of SMR and other categories of channels. Above, we have determined generally that frequencies allocated to the SMR service should, in the event of mutual exclusivity, be awarded pursuant to competitive bidding. We see no reason to treat mutually exclusive finder's preference requests for SMR frequencies differently from mutually exclusive applications for SMR frequencies. Therefore, we hold that in such event, the licenses should be awarded pursuant to competitive bidding. Accord, reply comments of Southwestern Bell. Conversely, if mutually exclusive finder's preference requests target General Category or non-SMR frequencies, they would not be subject to competitive bidding.

66. Although we believe that SMR services should be subject to competitive bidding, we note that we currently have before us proceedings that propose significant changes to our current 800 and 900 MHz SMR licensing policies. To attempt to promulgate competitive bidding rules governing mutually exclusive SMR licensing in the face of these licensing uncertainties is likely to be difficult, if not impossible.<sup>63</sup> As we move closer to resolving these issues, however, we intend to promulgate rules detailing how competitive bidding would apply in these services.

67. Although we conclude that mutually exclusive 900 MHz PCP applications should be subject to competitive bidding, we recognize that exclusivity in the 900 MHz PCP service

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<sup>63</sup> In PR Docket No. 93-144, for example, we propose a two-step method of licensing proposed wide-area 800 MHz SMRs: in the first step, applicants would negotiate in the hopes of avoiding mutual exclusivity; if they are unable to do so, we propose having lotteries or competitive bidding to resolve the remaining instances of mutual exclusivity. Cencall proposes that if the Commission does auction SMR frequencies that will be licensed as a result of PR Docket Nos. 89-553 and 93-144, the Commission should auction those frequencies one by one and only for individual contested frequencies associated with mutually exclusive applications. See comments of Cencall. This is but one example of the complexities that we would face were we to attempt to promulgate service-specific auction rules for SMRs at this time.

is a very recent phenomenon and it is not clear whether or how frequently mutual exclusivity will arise where first-come, first-served licensing is ongoing. In addition, we believe that alternative measures, such as frequency coordination and private settlement among conflicting applicants, can resolve most, and perhaps all, potential conflicts among PCP applicants. See Section 309(j)(6)(E). Because these efforts may obviate the need for competitive bidding, we leave the promulgation of specific auction rules for this class of service to a time when we can be reasonably certain that they will be needed.

### **III. COMPETITIVE BIDDING DESIGN**

#### **A. Introduction**

68. In this section, we adopt simultaneous multiple round auctions as our primary auction methodology. We believe that, for most licenses that the Commission intends to auction, this method will best meet the Congressional goals that we set forth in Section I. However, our analysis of the record in this proceeding has convinced us that there is no single competitive bidding design that is optimal for all auctionable services. Moreover, Congress has directed us to "design and test multiple alternative methodologies under appropriate circumstances." See Section 309(j)(3). For these reasons, we shall not adopt a single auction design herein. Instead, we will identify a number of auction design options, indicating in general terms the service characteristics for which each option is appropriate. We will issue further Reports and Orders in this docket to adopt auction rules for each auctionable service or class of service. When we announce individual auctions to award licenses in specific services, a Public Notice will include detailed auction procedures. The choice of service specific rules and auction procedures will be governed by the criteria set forth in this Report and Order.

69. This section will discuss the impact of bidding design on our policy objectives, discuss the choice of design criteria to meet those objectives with respect to varying service characteristics, and examine several important bidding procedure issues. As discussed in more detail in subsection B, we have concluded generally that awarding licenses to those parties that value them most highly will foster our policy objectives. Subsection C elaborates on our conclusions regarding auction design: (1) licenses with strong value interdependencies should be auctioned simultaneously; (2) multiple round auctions, by providing bidders with information regarding other bidders' valuations of licenses, yield higher revenues and more efficient allocations of licenses, especially where there is substantial uncertainty as to value; and (3) because they are relatively expensive to implement and time-consuming, simultaneous and/or multiple round auctions become less cost-effective as the value of licenses decreases. Subsection D contains our discussion of preferred auction designs, and subsection E discusses various bidding procedure issues.

## B. Effect of Design on Policy Objectives

70. Awarding Licenses to the Parties that Value Them Most Highly. Our auction design choices are calculated to advance the goals set forth in Section I. Analysis of the record in this proceeding leads us to confirm our tentative view, advanced at ¶ 34 of the Notice, that auction designs that award licenses to the parties that value them most highly will best achieve those goals.<sup>64</sup> Those parties are most likely to deploy new technologies and services rapidly, promote the development of competition for the provision of those and other services (including, but not limited to cellular, SMR, paging, and other wireless services), and thus foster economic growth. We note that this conclusion is subject to the proviso that certain safeguards to prevent undue market concentration, spectrum warehousing, and to promote economic opportunity may be needed. In general, however, the market value assigned to licenses via the auction process can be expected to reflect the benefits to both consumers and producers, now and in the future.

71. The conclusion that licenses generally should be awarded to those who value them most highly received substantial support in the comments, particularly by the academic commenters. As stated by Professor Milgrom:

Since a bidder's abilities to introduce valuable new services and to deploy them quickly, intensively, and efficiently increase the value of a license to a bidder, an auction design that awards licenses to those bidders with the highest willingness to pay tends to promote the development and rapid deployment of new services in each area and the efficient and intensive use of the spectrum.<sup>65</sup>

72. The Association for Independent Designated Entities (AIDE), however, disagrees with our presumption that licenses should be awarded to those who value them most highly.<sup>66</sup> It also argues that the Commission cannot lawfully design its competitive bidding system to

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<sup>64</sup> To the extent that the initial auction does not award licenses to those who value them most highly, after-market transactions will perform this function to some degree, but not without delays and additional transaction costs.

<sup>65</sup> Comments of PacBell, Attachment by Paul R. Milgrom and Robert B. Wilson at 7. Professors Harris and Katz agree: "Because its overall supply is limited, it is important to allocate spectrum to those license holders who will use it to generate the greatest social benefits. The overall presumption should be that those who are willing to pay the most for the spectrum are the ones who will put it to the most valuable use." Harris and Katz concur with us that safeguards against undue market power and measures to ensure appropriate participation of designated entities may be needed. See comments of NYNEX, Attachment by Robert G. Harris and Michael L. Katz: "A Public Interest Assessment of Spectrum Auctions for Wireless Telecommunications Services" at 1-2.

<sup>66</sup> Comments of AIDE at 4-5.

maximize auction revenue, citing §§ 309(j)(7)(A) and (B) of the Act, but should base its decisions in this proceeding upon traditional public interest factors and the specific statutory objectives of competitive bidding. Likewise, PageMart argues that Congress has affirmatively directed the Commission to encourage a diverse and competitive marketplace even if the so-called allocative efficiency of the market is "somewhat" disturbed as a result.<sup>67</sup> PageMart further argues that auction schemes that focus on efficiency alone must be rejected.

73. We disagree with AIDE's implicit assumption that our purpose is to maximize auction revenue. While Congress has charged us to recover a portion of the value of the public spectrum made available via competitive bidding, this does not amount to maximizing revenue, nor is it our sole objective. To the contrary, our goals are to encourage the rapid deployment of service, efficient use of the spectrum, and the other goals enumerated in Section I. Pursuing these objectives is in full accordance with the statutory purpose of auctions as set forth in § 309(j)(3). And, we have concluded, based on our analysis of the record, that we can best achieve these objectives by generally awarding licenses to the parties that value them most highly. Moreover, this approach is permitted by § 309(j)(7)(C), which provides that §§ 309(j)(7)(A) and (B) do not prevent the Commission from considering "consumer demand," such as by assigning licenses to those who would provide services most highly valued by the public.

74. In addition, contrary to PageMart's contention, the development of a diverse and competitive marketplace is only one of the several goals that the Congress required the Commission to consider in designing systems of competitive bidding. That objective must be balanced with other objectives of the Act, such as § 309(j)(3)(D)'s requirement that we promote efficient and intensive use of the spectrum.

75. While we believe that the overall presumption should be that those who are willing to pay the most for a spectrum license should receive it, we have established an extensive menu of programs to ensure that the entities designated by Congress have an equitable opportunity to participate in the competitive bidding process. Because of concerns over competition, we have also created safeguards to prevent undue market concentration, such as placing limits on the amount of broadband PCS spectrum that cellular carriers may acquire and similarly limiting the amount of narrowband PCS spectrum that a single entity can acquire.<sup>68</sup> Given these and other steps we have taken, we cannot agree with the proposition that our proposed auction designs promote efficiency to the exclusion or subordination of all other goals.

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<sup>67</sup> Reply comments of PageMart at 4.

<sup>68</sup> See, e.g., Second Report and Order in GEN Docket No. 90-314, 8 FCC Rcd 7700 (1993), recon. pending; First Report and Order in GEN Docket No. 90-314, 8 FCC Rcd 7162 (1993), recon. FCC No. 94-30, released March 4, 1994.

76. Facilitating Efficient Aggregation. In designing auctions to best meet all our goals, we must take into account the value interdependency among many of the licenses that we propose to auction. As discussed in more detail below, when licenses are highly value-interdependent, *i.e.*, when the value of a license to a bidder depends on the other licenses that the bidder acquires, it is particularly important that we implement auction designs that facilitate efficient (but not anticompetitive) aggregation of such licenses.

77. Awarding Licenses Rapidly. It is also important to award licenses to the appropriate parties rapidly, since the sooner the licenses are awarded to the parties that value them most, the sooner new service is likely to be available, and the sooner consumers will benefit from competition among new suppliers and between new suppliers and incumbent firms. We therefore seek to employ bidding procedures that can be implemented efficiently and within a reasonable time period.

78. Avoiding Excessive Implementation Costs and Complexity. Finally, in selecting auction methods the Commission must take into account the costs of implementation both for the Commission and potential bidders. We therefore intend to select bidding procedures that are not overly complex relative to the task that they are meant to accomplish and which ensure that the full range of qualified bidders have access to the process.

### **C. Alternative Competitive Bidding Designs**

79. There are several auction design elements which, in combination, produce many different auction types. The two most important design elements are: 1) the number of auction rounds (single or multiple); and 2) the order in which licenses are auctioned (sequentially or simultaneously). These two elements can be combined to create four basic auction designs: sequential single round, simultaneous single round, sequential multiple round, and simultaneous multiple round. A third element of auction design is whether to permit all or nothing bids for combinations of licenses, *i.e.*, combinatorial bidding. Before addressing which of these auction designs will be our preferred design, it is useful to discuss the basic design elements and describe their advantages and disadvantages.

#### **1. Multiple v. Single Round Bidding**

80. Auctions may have either a single round or multiple rounds. Single round auctions are often referred to as sealed bid auctions (*see* NPRM at ¶ 40). In a single round auction, a single bid is submitted and the license awarded to the high bidder. In multiple round auctions, bidders have the opportunity to top the high bids from the previous round. Typically such auctions end when no bidders are willing to top the bids from the previous round. A common form of a multiple round auction is the oral auction, also known as an

open outcry or English auction (see NPRM at ¶ 37) in which bids are submitted orally in an auction hall.<sup>69</sup>

81. Alternative Multiple Round Bidding Designs. Multiple round auctions may differ in both the interval between bidding rounds and the method of bid submission. In a traditional open outcry auction, bids are made continuously, one after another, and items often sell within minutes. In other multiple round auctions, there are discrete intervals between the periods during which bids are submitted.<sup>70</sup> With discrete rounds, the Commission can control the pace at which the auction proceeds. The method of bid submission depends in part on whether the auction rounds are continuous or discrete. In continuous auctions, bids may be submitted orally, by telephone, or computer. Telephone bidding is currently used for auctioning financial instruments and the current high bids for these assets are made available to bidders on specially designed computer bulletin boards. If there are discrete bidding rounds bids could also be submitted on paper or computer disks.

82. Advantages of Multiple Round Bidding. The principal advantage of a multiple round auction is the information that it provides bidders regarding the value other bidders place on licenses. This information increases the likelihood that licenses are assigned to bidders that value them most highly and will generally yield more revenue in auctions where there is much uncertainty about common factors that affect the value of a license to all bidders (common value auctions).<sup>71</sup> In a single round auction, bidders must guess about the value that other bidders place on a license in trying to submit a single bid that just exceeds the next highest bid. Thus the party who values the license most highly may not submit the highest bid. In a multiple round auction, bidders need not guess about the value the second highest bidder places on the license because bidders have the opportunity to raise their bids if they are willing to pay more than the current high bidder. Multiple round bidding is also more likely than single round bidding to be perceived as open and fair. No bidder can argue that it did not have the opportunity to obtain a license if it was willing to pay enough.

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<sup>69</sup> Many commenters favored the use of oral auctions exclusively. See, e.g., comments of McCaw, Quentin L. Breen, and U.S. Intelco Networks. Commenters favoring this method praise its openness, ease of administration, familiarity, and high degree of information dissemination. See also comments of BellSouth. Professor R. Mark Isaac, commenting on behalf of CTIA, asserted that auction theory predicts that oral sequential auctions for single units will be efficient, approximately demand revealing, and generate the same revenue as the other methods.

<sup>70</sup> An example of such a procedure is the recently completed bidding for control of Paramount Communications, which was conducted in intervals over a five month period.

<sup>71</sup> In a pure common value auction, the item up for auction has the same value to everyone, but bidders' valuations at the time of the auction differ because they have different estimates of that underlying true value.

83. Auction theory shows that multiple round bidding tends to increase revenue in common value auctions by reducing the incentive of bidders to shade down bids to avoid the winner's curse -- the tendency for the winner to be the bidder who most overestimates the value of the item for sale.<sup>72</sup> Common value aspects of spectrum licenses arise from common technological possibilities, common demand for the services, and the presence of a common aftermarket. Multiple round bidding provides information about other bidders' estimates of common values, allowing all bidders to improve their estimates of these common values. With better information, sophisticated bidders will have less incentive to bid cautiously so as to avoid falling victim to the winner's curse.

84. Several commenters stress the importance of providing bidders with information in common value auctions via multiple round bidding.<sup>73</sup> For example, Professor McAfee states that "ascending bid auctions tend to produce more efficient outcomes and higher average prices" than first-price, single round sealed bid auctions, and, after noting sources of bidder uncertainty about the value of PCS licenses, asserts that "the auction should be designed to provide bidders with as much information as possible, which means providing information about other bidders' estimates of the licenses' value in the process of running the auction."<sup>74</sup> Multiple round bidding will maximize the provision of such information.

85. Advantages of Single Round Bidding. On the other hand, multiple round bidding does involve some increased administrative cost. Therefore, a single round (i.e., sealed bid) procedure may be an appropriate option for relatively low value licenses in which the costs of implementing a multiple round auction may outweigh the benefits. A single round of bidding may also be appropriate in certain auctions where eligibility requirements limit participation to

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<sup>72</sup> John McMillan, *Games, Strategies and Managers*, (New York: Oxford University Press), at 142-143. When bidders are risk averse there is another effect on revenue opposite to that of the winner's curse -- risk aversion tends to raise bids more in single round bidding than multiple round bidding. John Riley and William Samuelson. "Optimal Auctions," *American Economic Review*. Vol. 71, No. 3 (June 1981)

<sup>73</sup> Only when there are common value elements can bidders improve estimates of their own value of an item based on observing bids of others on that item.

<sup>74</sup> Comments of PacTel Attachment by R. Preston McAfee: "Auction Design for Personal Communications Services" at 4-5. See also comments of Bell Atlantic, Attachment by Barry J. Nalebuff and Jeremy I. Bulow: "Designing the PCS Auction" at 12, 20-21, and comments of NYNEX, Attachment by Robert G. Harris and Michael L. Katz at 7-9. For a more detailed discussion of common value models, see comments of NTIA, staff paper by Mark Bykowsky and Robert Cull: "Issues in Implementing a Personal Communications Services Auction" at 20-28.

very few bidders.<sup>75</sup> With a small number of bidders, bidding cartels are easier to organize and may reduce auction revenue below fair market value (although not necessarily result in any efficiency loss). Using a single sealed bid could reduce the likelihood of such collusive behavior since it provides colluding bidders a greater incentive to defect. With a single sealed bid, retaliation must come in later auctions, if any, while with multiple round bidding, retaliation against a cartel defector can come immediately. In opting for single round over multiple round bidding, the Commission must weigh the benefits of deterring collusion and lower administrative expenses against the costs of a lower likelihood of awarding licenses to the bidders who value them most highly and the loss in revenue associated with a stronger winner's curse.

## **2. Sequential v. Simultaneous Bidding**

86. Licenses may be auctioned either sequentially or simultaneously. In a pure sequential auction, licenses are auctioned one at a time. That is, bidding ends on one item before bids are accepted for another item, as is typically the case in an open outcry auction. In a pure simultaneous auction, all licenses are put up for auction at the same time. That is, bidding is open on all licenses at once until no more bids are received on any license. There are intermediate designs between pure sequential and pure simultaneous auctions. Related licenses may be placed into groups and all licenses within the group auctioned simultaneously, but the groups can be auctioned one after another, *i.e.*, sequentially. In this case, a choice must be made as to how to group licenses and the sequence in which groups will be auctioned.

87. Simultaneous Bidding for Homogeneous Licenses. An important special type of simultaneous bidding, which we will refer to as a single combined auction (which could incorporate either one or multiple rounds of bidding),<sup>76</sup> may be useful when auctioning multiple homogeneous licenses.<sup>77</sup> Under this approach, the Commission would combine

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<sup>75</sup> A minority of commenters strongly support sealed single round bidding. They argue that it is less subject to manipulation than oral bidding and is easier to implement than oral bidding. See comments of Richard S. Myers. Others support using sealed bids only in limited circumstances, as when there are only two or three bidders. See comments of AT&T, Cellular Communications, Inc. and Calcell Wireless.

<sup>76</sup> This is a special case of a simultaneous auction because bids are accepted on multiple (identical) items at the same time.

<sup>77</sup> Two or more licenses are perfectly homogeneous if they are perfect substitutes, *i.e.*, if bidders are indifferent about which one they acquire. Licenses in the same spectrum band, with the same amount of spectrum, and in the same geographic license area may, however, not be perfectly homogeneous for two reasons. First, there may be differences in the amount and location (geographic and frequency) of spectrum occupied by incumbent users, as in the case of broadband PCS licenses. Second, a bidder seeking to operate in more than one

bidding for two or more homogeneous licenses.<sup>78</sup> Licenses would be awarded to the highest bidders until the available licenses are exhausted, e.g., four virtually identical licenses would be awarded to the four highest bids. Single combined auctions could also be used for licenses that are close, but not perfect, substitutes. Small differences among licenses could be accounted for by allowing winning bidders to choose among the licenses in descending order of their bids, i.e., the party with the highest winning bid would pick first. Single combined auctions are used by the U.S. Department of the Treasury to sell (perfectly homogeneous) U.S. securities (see NPRM at ¶ 43). In such Treasury auctions the sales price is generally the bid price. However, Treasury has recently experimented with single-price auctions in which all successful bidders pay the same price -- the highest losing bid.

88. Comments. Many of the comments and papers written by academic auction theorists strongly favored the use of simultaneous multiple round bidding.<sup>79</sup> Those favoring simultaneous multiple round bidding argue that it permits bidders to receive greater information during the bidding process and allows bidders back up strategies that take account of the value of interdependencies among licenses. Other academic papers, however, while incorporating a certain degree of simultaneity in their auction design, favored greater reliance on sequential bidding.<sup>80</sup>

89. Advantages of Simultaneous Multiple Round Bidding. Simultaneous multiple round bidding has a number of important advantages over sequential auctions for awarding interdependent licenses. First, they are more likely to award interdependent licenses efficiently -- to those who value them the most and aggregated in the way that is most valuable. This increased efficiency derives from the information about the value of interdependent licenses provided to bidders during the bidding process and the opportunity to use that information because all such licenses are available until the close of the auction.

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license area may prefer that all the spectrum be on the same channel. Acquiring spectrum on the same channel tends to simplify coordination of interference at boundaries, thus lowering the cost of providing service.

<sup>78</sup> This approach was proposed by Bell Atlantic, see comments of Bell Atlantic Personal Communications Inc., Attachment by Barry Nalebuff and Jeremy Bulow at 4-5. It can be used in conjunction with any auction type.

<sup>79</sup> See comments of PacTel, Attachment by R. Preston McAfee; comments of PacBell, Attachment by Paul R. Milgrom and Robert B. Wilson; and comments of NYNEX, Attachment by Robert G. Harris and Michael L. Katz.

<sup>80</sup> See comments of Bell Atlantic, Attachment by Professors Barry Nalebuff and Jeremy Bulow; and comments of TDS, Attachment by Professor Robert J. Weber: "A Proposed Auction Methodology for PCS Licenses." Some of the academicians modified their original proposals in response to the comments of others. See reply comments of Bell Atlantic and of PacBell.

Second, simultaneous multiple round auctions are likely to raise more revenue than sequential auctions because they mitigate the effect of the winner's curse. Third, they avoid the need to choose the sequence of bidding.<sup>81</sup>

90. The magnitude of the advantages of simultaneous multiple round bidding depends on the degree of interdependence among licenses. Licenses may be interdependent either because they are substitutes or because they are complements. With substitutes, the lower the price of one license, the less a bidder would be willing to pay for another. Perfect substitutes are highly interdependent because the price of one puts an absolute cap on the amount a bidder is willing to pay for the other. If, for example, licenses A and B are perfect substitutes and a bidder knew that license A could be purchased for \$100, that bidder would be willing to pay no more than \$100 for license B.

91. With complementary licenses, on the other hand, the lower the price of one, the more a bidder would be willing to pay for another. One way to think about complementary licenses is that they are worth more as part of a package than individually. For example, bidders are likely to be willing to pay more for two geographically contiguous PCS licenses than two equivalent non-contiguous licenses, and a single bidder may be willing to pay more for two licenses than would two separate bidders. Commenters have identified several sources of such interdependence among PCS licenses. First, common ownership of licenses in adjacent areas facilitates roaming by users. Professor Daniel Vincent argued that consumer demand for a service that will allow them to use their handset across regions is the main source of interdependence.<sup>82</sup> NTIA agreed, noting that the value of roaming has already been clearly demonstrated in the cellular industry.<sup>83</sup> Second, ownership of multiple licenses both across geographic areas and within a given area provides economies of scale arising largely from spreading of fixed costs over more units of output.<sup>84</sup> Marketing, system engineering,

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<sup>81</sup> The analysis of simultaneous single round bidding for interdependent licenses is very different from that of simultaneous multiple round bidding. Although a single round of sealed bids for all licenses would be fast and administratively simple, it is the least likely method to achieve our other auction objectives for two reasons. First, such an auction generates no information about license values until after the auction closes, when the information cannot be used by bidders. This factor tends to decrease bid levels and to reduce the efficiency of the license assignment. Second, the method provides bidders no opportunity to pursue back-up strategies, except in the after-market, where transactions costs may be high.

<sup>82</sup> Ex parte presentation, February 17, 1994 at 2.

<sup>83</sup> Comments of NTIA, Bykowsky-Cull staff paper at 15-16.

<sup>84</sup> See ex parte comments of Professor Paul R. Milgrom, February 14, 1994, at 9. Many of the academic commenters specifically mentioned the potential benefit of aggregating licenses within a given geographic area. See, e.g., comments of NTIA, Bykowsky-Cull staff paper at 16.

switching and standard setting are examples of activities with important elements of such fixed costs. Third, common ownership of geographically adjacent licenses on the same spectrum block reduces problems of controlling interference at license boundaries.<sup>85</sup> There may be additional economies of scope from common ownership of contiguous licenses, whether or not they are on the same spectrum block.

92. The greater efficiency of simultaneous multiple round auctions in awarding interdependent licenses follows in part from the fact that they reduce the need for bidders to guess about outcomes in later auction rounds. With sequential auctions bidders in initial rounds must guess about prices in later rounds. A bidder may pay too much for a license in an early round on the mistaken expectation of a low price for a complementary license (or a high price for a substitute license) in a later round. Alternatively, a bidder may bid too little for a license in an early round in the hope that a close substitute will sell for less in a later round. Either situation could result in award of licenses to those who do not value them the most, but we will illustrate the potential for inefficiency only for the latter case. Suppose that there are two licenses that are close substitutes, for example the A and B PCS licenses in the same region. If the two parties that value these licenses most highly hold back on bidding when the first license is offered in a sequential auction, the first license would be awarded to the bidder with the third highest valuation. In contrast, with simultaneous auctions, the two bidders with the highest valuations would generally win the two licenses. A simultaneous auction also allows bidders to pursue backup strategies. With sequential auctions, a bidder may learn too late that, given the licenses it has won and those it failed to win, it is now willing to pay more than the high bids for licenses that were awarded in earlier rounds.

93. By providing more information to bidders about the value of interdependent licenses, simultaneous auctions are also likely to raise more revenues by alleviating the winner's curse. With sequential auctions bidders are likely to be especially cautious in their bidding on initial licenses. If the largest PCS regions were to be put up for bid first in a sequential auction, the revenue loss could be significant.

94. Finally, simultaneous auctions reduce the need to choose the sequence in which licenses within a service are auctioned. With pure simultaneous auctions, no choice of sequence would be necessary since all available licenses within a service would be auctioned at the same time. In the case of a sequence of simultaneous auctions, the Commission would need to choose which licenses to auction together and the sequence in which such groups would be auctioned. Within each group, however, no choice of auction order would be necessary. In contrast, with a pure sequential auction, the Commission must decide on the order in which to auction every individual license. Different bidders are likely to want licenses auctioned in different sequences to favor their particular business plans, and there is no agreement among the commenters on the appropriate sequence.

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<sup>85</sup> See ex parte comments of Professor Paul R. Milgrom, February 14, 1994, at 9.

95. Disadvantages of Simultaneous Multiple Round Bidding. On the other hand, simultaneous multiple round auctions may have some disadvantages. First, as recognized in the Notice, such auctions have only limited precedent for use and could be more difficult to implement. Second, they may appear more complex to bidders because of the number of licenses that must be monitored during the bidding process. Third, a bidder interested in only one or a few licenses would need to participate over a longer period of time in a simultaneous auction than in sequential auctions. Fourth, with all licenses being auctioned simultaneously, bidders cannot be absolutely certain which licenses they have won until the end of the auction. In sequential auctions bidders know which licenses they have won in early rounds before having to bid in later rounds.

96. These difficulties are emphasized by those academic commenters who favor primary use of sequential bidding.<sup>86</sup> With regard to the problem of added complexity, Nalebuff and Bulow, for example, argue that simultaneous auctions present too many decisions to be made at once.<sup>87</sup> However, we believe that by providing adequate time for bidding, e.g., one round per day, each bidder will have ample time to analyze their options for the subset of licenses in which it is interested. Indeed, for those bidders interested in only a few licenses, a simultaneous auction would have the advantage of providing far more time per license to make bidding decisions than in sequential auctions. Moreover, most of the time, a bidder in a simultaneous auction merely needs to make incremental decisions -- whether to raise its bids on the properties on which it is already bidding. Only occasionally might a bidder have to make a major decision -- whether to switch to a backup strategy and bid for a different group of licenses. Indeed, the strategic decisions in a simultaneous auction may be less complex than in sequential auctions, where a bidder must decide in early auctions how much it is willing to pay for a license without knowing what it will have to pay in later auctions for other licenses that are important to its aggregation strategy.

97. With regard to a bidder's lack of certainty about which licenses it has won until the end of a simultaneous auction, those advocating sequential auctions claim that the "quality" of information released by sequential auctions is higher because actual prices of

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<sup>86</sup> Even the academics who generally favor sequential auctions advocate incorporating a limited degree of simultaneity into their preferred auction designs. For example, Nalebuff and Bulow would "allow some simultaneity into the process by combining the bidding across the two 30 MHz licenses within an MTA, the three 10 MHz licenses within a BTA, and running the two designated license auctions simultaneous with the auction for the other three BTA license." Reply comments of Bell Atlantic, Attachment by Barry J. Nalebuff and Jeremy I. Bulow at 26. Moreover, Nalebuff and Bulow note that "reasonable people could hold different opinions" regarding the utility of simultaneous auctions. *Id.* at 10-11.

<sup>87</sup> *Id.* at 11.

licenses auctioned earlier are available to bidders in later auctions.<sup>88</sup> That is, advocates of sequential auctions appear to be claiming that only the final, equilibrium price of a license provides useful information about valuation. However, we have concluded that, with appropriate activity and stopping rules (see discussion infra), simultaneous auctions provide bidders with significant useful valuation data at a time when they can use it.<sup>89</sup> In contrast, bidders in the early sessions of a sequential auction have little or no information about prices of licenses to be auctioned later. In later auctions, while they do have good information about prices from the earlier auctions, they are unable to go back and change their bids in earlier auctions, based on what happens in later auctions.

### 3. Combinatorial Bidding

98. Combinatorial bid techniques permit bidding for multiple licenses as all or nothing packages. It could be implemented with either simultaneous or sequential auction designs. If a package bid were to exceed the sum of the highest bids for the licenses that comprise the package (individually or in smaller packages), then the package bid wins. The range of packages for which bids are permitted could be defined by the Commission (e.g., all PCS licenses in band A) or bidders could be allowed to choose their own packages.<sup>90</sup> NTIA is the primary proponent allowing bids on any combination of licenses, i.e., full combinatorial bidding.<sup>91</sup>

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<sup>88</sup> See, e.g., reply comments of Bell Atlantic, Attachment by Nalebuff and Bulow at 13 ("Although there is a lot of information, it can still be hard to interpret. Until the auction is over, nothing has been determined.") See also Letter from Robert Weber to Professor John McMillan, Jan. 9, 1994 (Simultaneous auctions "bring relatively little meaningful information into the public domain until near the very end," whereas appropriately structured sequential auctions "will bring the most important information into the public domain early").

<sup>89</sup> See ex parte submission of Paul R. Milgrom, Feb. 14, 1994, at 12-14. See also reply comments of PacTel, Attachment by R. Preston McAfee at 1-2, 7-8.

<sup>90</sup> The NPRM proposed a nationwide combinatorial bid for broadband PCS licenses. See ¶¶ 57-60 and 120 of the NPRM. This proposal was criticized by commenters as inequitable as well as economically inefficient. See, e.g., comments of NTIA, Bykowsky-Cell staff paper at 48-49 (combinatorial bidding limited to a single package would result in some PCS licenses being assigned to bidders that do not value them most highly); comment of PacBell, Attachment by Milgrom and Wilson at 8-13 (proposal would create free rider problems among bidders for individual licenses); comments of Arch Communications at 9 (FCC's proposal too complex).

<sup>91</sup> NTIA argues that where licenses exhibit high degrees of interdependency, full combinatorial simultaneous multiple round bidding is likely to produce more efficient license assignments and more revenues than other auction forms. See comments NTIA, Bykowsky-Cull staff paper, and Letter from Larry Irving, Assistant Secretary for Communications and

99. Advantages of Combinatorial Bidding. Combinatorial bidding may promote efficient aggregation of licenses that are worth more as a package than individually. It may also simplify bidding strategy since bidders can avoid the problem of determining how to allocate the added value of a package among individual bids. Without combinatorial bidding bidders risk paying too much for part of a desired package while losing the rest of the package to other bidders. The magnitude of this exposure depends on the specifics of the auction design and the value bidders put on various packages of licenses. This exposure is greater in a sequential auction than a simultaneous auction because bidders have less information about the likely prices of complementary licenses. It is also greater the more severe the consequences of bid withdrawal. Exposure risk is greatest when the value of a package is severely diminished by the absence of a single part. Finally, the risk of exposure is greater when bidders do not agree on how licenses should be combined. When bidders generally want the same packages of licenses, if a firm is outbid on part of a package it is likely to be outbid on the entire package, and thus not likely to be stuck holding a piece of a package that is of little value without the rest of the package.

100. There is also some limited experimental support for the use of combinatorial bidding. Laboratory experiments conducted at Caltech found that full combinatorial bidding as proposed by NTIA resulted in more efficient outcomes than any of the individual bidding alternatives tested including various sequential and simultaneous auction forms. The Caltech experiments also found that full combinatorial bidding also generally raised more revenue than the simultaneous independent auction form tested.<sup>92</sup>

101. Disadvantages of Combinatorial Bidding. On the other hand, a simultaneous auction design offers the possibility of efficient license aggregation without combinatorial bidding and combinatorial bidding appears to bias auction results in favor of the combination bid. This is due to the "free rider" problem. Bidders for individual licenses (or smaller packages) may be reluctant to raise their own bids in order to beat a combinatorial bid for a larger package because they hope that other bidders for other parts of the larger package will raise their bids. Since all individual bidders can be expected to reason this way, it is likely to be difficult to put together a coalition of bidders to raise their bids enough to beat a combinatorial bid for a larger package.<sup>93</sup>

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Information, NTIA, to Reed Hundt, Chairman, Federal Communications Commission, ex parte submission in PP Docket No. 93-253, February 28, 1994.

<sup>92</sup> Ex parte submission of NTIA, February 28, 1994.

<sup>93</sup> The stand-by queue in the Banks-Ledyard-Porter AUSM mechanism proposed by NTIA mitigates the problem of bidders for individual licenses or smaller packages coordinating bids against bidders for larger packages. J. S. Banks, J. O. Ledyard, and D. P. Porter, "Allocating Uncertain and Unresponsive Resources: An Experimental Approach," *Rand Journal of Economics* 20, 1989: 1-22. According to NTIA, the stand-by queue "allows parties seeking individual licenses to coordinate their bids in order to beat the currently prevailing bid

102. Combinatorial bidding would also add one more layer of complexity to implementing an auction. Implementation problems are especially difficult if parties are permitted to bid for any combination of licenses as proposed by NTIA. First, there are a huge number of such possible combinations. For example, Professor Weber calculated that if there were five licenses available in each of six geographic areas there would be over one billion possible packages of licenses.<sup>94</sup> Second, full combinatorial bidding would require computer software that has not yet been fully developed for use on a large scale and would risk computer or other administrative failure. Third, full combinatorial bidding is non-transparent, that is, it would be difficult for bidders to determine in advance what constitutes a high bid. This could lead losing bidders to challenge the procedure in court.

103. Limiting combinations to a small number would reduce complexity but require a determination of the most valuable packages prior to the auction. There is no simple way to make such a determination, and if there is a wide diversity of desired license groupings, offering only a limited set will not accommodate all preferences and may not enhance efficiency.

104. We also note that some of the conditions under which the advantages of combinatorial bidding are apt to be the greatest are not likely to be present for most FCC auctions. First, while certain licenses are likely to be worth more as part of packages, there is no evidence of an extreme discontinuity in value if one or more licenses in the package are not acquired. Certainly there is no reason to believe that the entire benefit of aggregation is lost if a single license is not included in the package. Second, both the existence of an after-market and the proposed bid withdrawal penalty (*see infra*) limit the risk associated with failing to acquire all the licenses in a desired package. Whether a bid is withdrawn or a license acquired and resold in the after-market, the cost is likely to be limited to about one bid increment.

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for a combination of licenses. The stand-by queue displays the amount that other bidders are willing to pay for the licenses that are part of a combination bid. A bidder can determine from the sum of these amounts how much to raise his or her own bid in order to surpass the current winning bid." *Ex parte* submission of NTIA, February 28, 1994, at 4, n. 6. Although the stand-by queue facilitates coordination it does not eliminate the free rider problem. Moreover, as the information in the stand-by queue grows with the number of bidders and licenses, bidders will have increasing difficulty efficiently combining contingent bids in the queue. Finally, there is the danger that some bidders for large combinations of licenses may strategically flood the queue with numerous contingent bids in order to prevent it from functioning.

<sup>94</sup> Robert J. Weber, "A Proposed Auction Methodology for the Allocation of PCS Licenses: Simultaneous Ascending-Bid Auctions," September 4, 1993, at 6.

105. Although the Caltech experiments suggest empirical advantages of full combinatorial bidding it is difficult to assess their significance. First, the results are sensitive to the assumptions about benefits of aggregation, and we can not know the extent to which these assumptions reflect reality until after the auctions. However, it appears that the experimenters generally assumed an unrealistically large premium from acquiring an entire package.<sup>95</sup> Second, the experiments were conducted on a small scale. The complexity of running and participating in a full combinatorial auction may be manageable with 10 bidders and 54 licenses, but it may not be with hundreds of licenses and bidders.

#### **D. Preferred Competitive Bidding Designs**

##### **1. Primary Method: Simultaneous Multiple Round Bidding**

106. After carefully considering all of the comments presented in this proceeding, we conclude that in most circumstances the best method to advance the goals for competitive bidding expressed in Section I, *supra*, is a sequence of simultaneous multiple round auctions. Compared with other bidding mechanisms, simultaneous multiple round bidding for interdependent licenses generates the most information about license values during the course of the auction and provides bidders with the most flexibility to pursue back-up strategies. Thus, it is most likely to award interdependent licenses to the bidders who value them most highly. It will also facilitate efficient aggregation across spectrum bands and geographic areas, thereby resulting in vigorous competition among several strong competitors who will be able to introduce rapidly a wide variety of services that will be highly valued by end users. Because of the superior information and flexibility it provides, this method is also likely to yield more revenue than other auction designs. Thus, we find that the use of simultaneous multiple round auctions will generally be preferred.

107. However, the Commission must balance the informational and bidding flexibility advantages of simultaneous multiple round auctions with the greater cost and complexity of running such auctions. For example, it is not our intention to put all PCS licenses up for bid at the same time, even though there is likely to be some degree of interdependence. Such a large simultaneous auction would most likely be unmanageable. As a result, we expect to have a sequence of simultaneous auctions. Licenses that are highly interdependent will be grouped together and auctioned simultaneously.

108. We do not now plan to use combinatorial bidding in the simultaneous multiple round auction context. We reach this conclusion because (1) the simultaneous multiple round

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<sup>95</sup> See *ex parte* submission of NTIA, February 28, 1994, Attached staff paper by Mark Bykowsky and Robert Cull. See also *ex parte* submission of Paul R. Milgrom, February 14, 1994, at 10. Professor Milgrom states that the Caltech experiments assumed that all the benefits of aggregating a group of licenses are lost if a single license is missing from the package.

auction design offers many of the aggregation advantages of combinatorial bidding without creating a free rider problem that may bias the outcome in favor of combinatorial bids, (2) full combinatorial bidding is highly complex and we lack a general methodology to simplify the full combinatorial procedure by choosing a limited set of combinations on which to allow bidding, and (3) the software for implementing full combinatorial bidding on a large scale does not now exist, and would be difficult to develop in a short time frame. In the future, however, we may decide to use a combinatorial bidding technique in simultaneous multiple round auctions if significant advances are made in the development of combinatorial procedures and they have been proven to work on a large scale.

109. License Characteristics Leading to Selection of Preferred Design. The two primary characteristics that will determine our choice of auction design are: (1) the degree to which licenses are interdependent, and (2) the expected value of the licenses being auctioned. Because we expect most licenses to be interdependent and of relatively high value, we have concluded that simultaneous multiple round auctions will generally best achieve the Commission's goals and therefore should be the Commission's preferred auction design.

110. When license values are interdependent, simultaneous multiple round auctions provide the information and flexibility for efficient bidding. In such auctions, if two licenses are substitutes, bidders will quickly switch from bidding on one license to bidding on the other if the price disparity does not reflect differences in value. This ensures that equivalent licenses will sell for equivalent prices. When licenses are complementary, bidders will have full flexibility to construct efficient aggregations of licenses based on simultaneous information about their prices. Thus, we would be inclined to select a simultaneous auction design when we believe that license values are significantly interdependent.

111. The other major factor leading us to select simultaneous multiple round auctions as our preferred option is the expected value of the licenses being auctioned. While in some instances, license values may be so low that the administrative costs, both to the Commission and to bidders, of conducting simultaneous multiple round auctions would exceed the value of the license, we anticipate that most licenses can be expected to have a relatively high value. However, as the value of licenses falls, the benefits of simultaneous multiple round bidding diminish relative to the cost and complexity of such auctions.<sup>96</sup> In such cases, the Commission may choose to employ less complex auction methods.

## 2. Alternative Methods

112. Sequential Bidding. We intend to tailor the auction design to fit the characteristics of the licenses that are to be awarded. Given the diverse characteristics of the

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<sup>96</sup> The point is that the choice of auction technique should take into account the cost of running the auction. In some cases the likely benefits of a more complex auction technique may not exceed the additional costs of implementing it.

various services that may be subject to auctions, simultaneous multiple round auctions may not be appropriate for all licenses. The less the interdependence among licenses, the less the benefit to auctioning them simultaneously. Because simultaneous auctions are more costly and complex to run, we may choose a sequential auction design when there is little interdependence among individual licenses or groups of licenses. Such a design may include sequential oral auctions of individual licenses and a sequence of simultaneous auctions of multiple licenses.

113. Single Round Bidding. When the values of particular licenses to be auctioned are low relative to the cost of implementing a simultaneous multiple round auction, we will consider auction designs that are relatively simple, with low administrative costs and minimal costs to the auction participants. For example, with large numbers of low value licenses we may decide to implement single round sealed bidding to reduce implementation cost and expedite the licensing process. Because of the risk of collusion, the Commission may also wish to consider a single round of bidding in certain auctions where eligibility requirements limit participation to very few bidders.

114. Combinatorial Bidding. If we should choose a sequential auction design or single round bidding for some relatively low value licenses, and if we determine that there are some benefits of a particular level of aggregation for those licenses, we may accept combinatorial bids on a limited set of packages. While this does not have the administrative complexities or risks of full combinatorial bidding, it does raise the possibility of bias toward the combination bid. We therefore may consider instituting a premium, i.e., the combinatorial bid would win only if it exceeded the sum of the bids for the individual licenses by at least a specified amount, in order to offset the free rider bias. A premium for combinatorial bids would also increase the incentive of bidders seeking packages of licenses to participate actively in the bidding for individual licenses. If we do decide to permit combinatorial bids, we would also need to specify whether these bids would be accepted before, after, or simultaneously with the individual bids, and when the combinatorial bids would be announced.

115. Testing Alternative Methods. The Congressional directive to "design and test multiple alternative methodologies under appropriate circumstances," 47 U.S.C. § 309(j)(3), implies that we should periodically reevaluate the efficiency of the auction designs we utilize and, where appropriate, test alternative auction design methodologies. Accordingly, in future Reports and Orders where we establish service-specific auction rules we will indicate a preferred auction design method for each particular service and specify any alternative auction design methods that we may test in auctioning licenses within that particular service. In each case, we will indicate the circumstances under which we may test an alternative design methodology and the procedures that will be applied when an alternative methodology is tested.

## **E. Bidding Procedures**

116. We discuss below certain procedures that may be needed to implement the competitive bidding designs described in subsection C, supra. We may choose to incorporate certain of these procedures into the service-specific rules that we will adopt in future Reports and Orders for each auctionable service.

### **1. Sequencing**

117. Whether we use our preferred approach of a sequence of simultaneous auctions or sequential individual auctions, the Commission must choose the sequence of what is auctioned. The importance of the choice of sequence increases with the degree of interdependence among the individual items or groups of items auctioned in sequence. We intend to minimize the importance of the choice of sequence by auctioning licenses sequentially only when there is not a high degree of value interdependence across the licenses (or groups) that are offered in sequence. As noted above, the groupings of the licenses into the various simultaneous auctions will be accomplished by aggregating together those licenses exhibiting the greatest degree of interdependence so that there will be limited interdependence across groups. Generally, we will announce the sequence in which licenses will be auctioned in the service-specific rules adopted in future Reports and Orders. For some services, the sequence of licenses to be auctioned will be announced by Public Notice prior to the auction.

118. Even if there is only limited interdependence among the licenses (or groups of licenses) to be auctioned sequentially, there still may be some tradeoffs in the choice of sequence, especially when implementing new auction procedures. In general, the highest value licenses or groups of licenses should be auctioned first because there is a cost to the public of delaying licensing, and the greater the value of the licenses the greater that cost. However, when implementing novel auction procedures, this general principle may not be appropriate. Auctioning groups of lower-value licenses first would allow the Commission to use its initial auction experience to improve the subsequent auctions for groups of higher-value licenses. Improvements in auction design and procedures are likely to have greater total value when applied to groups of higher-value licenses than lower-value licenses.

119. To the extent that some value interdependence remains among licenses (or groups of licenses) auctioned sequentially, there is an additional justification for auctioning licenses (or groups) in descending order of value. High value licenses or groups of licenses may be linchpins of aggregation strategies for certain bidders.<sup>97</sup> For example, a bidder may feel that it is crucial to obtain a license to serve the New York City metropolitan area in order to develop a service in the Northeastern United States. In a sequential auction, such a bidder would prefer the New York licenses auctioned before other Northeast markets. Knowing who

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<sup>97</sup> See, e.g., comments of Bell Atlantic, Attachment by Barry Nalebuff and Jeremy Bulow at 14.

has won such large markets is likely to be more important for bidding decisions about small markets than the converse. For this reason, the NPRM proposed that if individual PCS licenses are auctioned sequentially, regions should be offered in descending order of population. See NPRM at ¶¶ 53 and 125.

120. Auctioning high value licenses first may also increase auction revenue. Auctioning high value license first would increase the present value of revenue by tending to collect the largest payments first. Furthermore, to the extent that ordering interdependent licenses (or groups) large to small increases efficiency, it increases potential revenue, and might increase actual revenue realized by the government. On the other hand, selling first the licenses that can be expected to have the highest value may reduce overall revenues because of the effect of the winner's curse. If bidders in later auctions learn about common elements of license values from bids in earlier auctions, the incentive to shade down bids to avoid the winner's curse will be greatest with the first licenses, when the least information is available.

## 2. Duration of Bidding Rounds

121. In simultaneous multiple round auctions, bids can be submitted continuously with the high bids announced continuously, or bidding can occur in discrete rounds with high bids announced at the end of each round. NTIA's proposed "electronic iterative combinatorial auction," as demonstrated at Caltech on January 27, 1994, operated in real time with the high bids reported almost instantaneously.<sup>98</sup> PacBell and PacTel, on the other hand, both propose discrete rounds. With discrete rounds, the Commission can more readily control the pace at which the auction proceeds.

122. In determining the appropriate pace of the auction, we must trade off the benefits of rapidly completing the auction -- possibly earlier initiation of service -- against the benefits of providing bidders time to deliberate. With large numbers of high value licenses that may be combined across spectrum blocks and regions, bidders may need a significant amount of time to evaluate backup strategies and consult with their principals. For this reason, PacBell and PacTel argue that for broadband PCS, the benefits of simultaneous auctions are unlikely to be achieved if the auction proceeds too rapidly.<sup>99</sup> Specifically, PacBell proposes one bid per day and PacTel proposes three business days per round for broadband PCS.<sup>100</sup> Such a deliberate pace may not be appropriate, however, when license values are lower and fewer licenses are put up for auction simultaneously. In that case it may be appropriate to have

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<sup>98</sup> Ex parte submission of NTIA, February 28, 1994, Bykowsky-Cull staff paper at 5.

<sup>99</sup> PacBell reply comments, attachment by Milgrom and Wilson at 15-16; PacTel reply comments, attachment by McAfee at 4-6.

<sup>100</sup> Comments of PacBell, Attachment by Milgrom and Wilson at 19; comments of PacTel, Attachment by McAfee at 16.

several bidding rounds per day. The number of anticipated bidders may also affect our choice of the length of bidding rounds and duration between rounds. With more bidders the Commission may need to provide a longer period during which to submit bids, and a longer interval between rounds in which to process bids.

123. The duration of bidding rounds and the interval between rounds in simultaneous multiple round auctions will be announced in service-specific Reports and Orders, and may be varied by announcement during the course of an auction.<sup>101</sup> We generally intend to give bidders a single business day to submit bids, and conduct a new bidding round each business day. We may, however, choose other round lengths and intervals between rounds. To the extent that we do, the length of rounds and the interval between rounds will generally vary directly with the number of licenses put up for bid simultaneously, the anticipated value of the licenses, and the number of bidders expected by the Commission.

### 3. Bid Increments

124. In multiple round auctions, whether they be sequential or simultaneous, the Commission will generally specify minimum bid increments. The bid increment is the amount or percentage by which the bid must be raised above the previous round's high bid in order to be accepted as a valid bid in the current round.<sup>102</sup> Imposing a minimum bid increment speeds the progress of the auction and, along with activity and stopping rules, discussed below, helps to ensure that the auction comes to closure within a reasonable period of time. Establishing an appropriate minimum bid increment is likely to be especially important in a simultaneous auction with a simultaneous closing rule. In that case, all markets remain open until there is no bidding on any license. A delay in closing one market would delay the closing of all markets.

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<sup>101</sup> If we find that bidding is proceeding excessively slowly, we may decide to shorten the duration of rounds and/or intervals between rounds. On the other hand, we may increase the duration of rounds and/or intervals between rounds if an unexpectedly large number of bidders participate in the auction.

<sup>102</sup> PacTel proposes a "suggested" minimum bid increment instead of a required minimum bid increment. Under this proposal (described in further detail infra), if two bids were submitted and both were below the suggested minimum bid, the auction would close with the license awarded to the highest bidder. On the other hand, if both bids were above the minimum suggested bid the auction would continue. This mechanism is intended to provide bidders an incentive to increase bids by a minimum increment without making it an absolute requirement. See comments of PacTel, Attachment by R. Preston McAfee at 16-17. The Commission retains the discretion to use this approach instead of a mandatory minimum bid increment.

125. For broadband PCS, commenters have suggested a minimum bid increment of five percent. PacTel, for example, argues that this provides a reasonable compromise between the goal of completing the auction quickly and that of revealing information about the distribution of valuations among bidders.<sup>103</sup> PacTel also has suggested, in the context of simultaneous auctions where markets close one by one, that the auctioneer should vary the bid increment, reducing it as the number of active bidders declines, in order to bring bidding on all licenses in the auction to a close at approximately the same time. PacBell, in the context of auctions that stop simultaneously, notes that reducing the bid increments in later stages of the auction may also be beneficial (attachment to reply comments at 25). This would move the auction quickly at the beginning while still allowing finer price movements when approaching final prices. Such a refinement would reduce chances of ties by allowing bidders to express relatively small differences in valuations. If any ties do occur, however, licenses will be awarded in the order the bids were received, starting with the earliest bid. This rule would provide bidders an incentive to submit bids early, reducing the chance of the FCC having to accept a large number of bid submissions just prior to the end of each bidding round.

126. We reserve the right to specify minimum bid increments in dollar terms as well as in percentage terms. The dollar minimum may be needed to ensure that the auction moves forward expeditiously if bidding begins at a very low dollar level. Based on the comments, our preferred basic minimum bid increment is five percent or x dollars, whichever is larger, where the dollar amount is set at approximately five percent of the expected license value. We shall retain discretion in future Reports and Orders establishing service specific rules to set and, by Public Notice before or announcement during the auction, vary the minimum bid increments for individual licenses over the course of an auction. We also may wish to vary the minimum bid increments with respect to different licenses being awarded in one auction. The dollar minimum bid increment would likely vary across classes of license, with larger bid increments set for more valuable licenses.

#### **4. Stopping Rules for Multiple Round Auctions**

127. Prior to each multiple round auction, the Commission will announce by Public Notice a stopping rule for determining when the auction is over. We seek a stopping rule that will (1) terminate the auction in a reasonable period of time, (2) be simple and clearly understood by participating bidders and observers of the auction process, and (3) in the case of simultaneous auctions, close all markets at approximately the same time. If markets were to close at very different times, important back-up bidding strategies could be foreclosed as in sequential auctions -- once the auction for a particular license has closed it is too late to bid on that license as additional price information becomes available during the course of an auction.

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<sup>103</sup> Comments of PacTel, Attachment by R. Preston McAfee at 16.

128. When licenses are auctioned one at a time, deciding when to close a multiple round auction is a largely a matter of determining how long to wait after bidding ceases.<sup>104</sup> Typically, such auctions close when a brief amount of time passes with no one offering to raise the current high bid by the minimum bid increment. In oral auctions this is generally a matter of seconds. In the case of discrete bidding rounds, one must specify the number of rounds. For example, we could specify that, if there were no valid new bids for one round, the auction would close. Such a rule would be simple and help bring the auction to a close quickly. Allowing more than one round might cause bidders to hold back (absent any activity rules) since they would not face the risk of losing the license if they did not bid in a given round. This same reasoning would apply to simultaneous auctions in which markets close one at a time and there is no activity rule. However, in a simultaneous auction with an activity rule to deter such holding back, it may be desirable to allow several rounds to pass without bidding before closing the auction. This would avoid any surprise endings to an auction, thus minimizing the possibility that a bidder is thwarted from exercising a back-up bidding strategy. It could also prolong the auction, however, and PacBell, the main proponent of simultaneous auctions with activity rules, proposes that such auctions close if a single round passes in which no new acceptable bids are submitted for any license.<sup>105</sup>

129. Stopping a Simultaneous Auction Market-by-Market. In simultaneous auctions, the stopping rules must also specify whether to close markets individually or simultaneously. PacTel proposed allowing markets to close one at a time, but also proposed a mechanism to increase the likelihood that all markets close at approximately the same time. Under PacTel's plan, minimum bid increments would be reduced as bidding activity (as measured by the number of active bidders) slows down. This would tend to result in rapid price movement in markets far away from final prices and slow movement in markets close to final prices. However, this mechanism may not work well when the top few bidders have much higher

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<sup>104</sup> Stopping rules in the context of a single auction (or simultaneous auctions with markets closing one at a time) are not uniquely defined in terms of the length of time or the number of discrete rounds without bids. For example, McAfee, as noted above, proposes a stopping rule that differs depending on whether bids are below or above a "suggested minimum bid." Under McAfee's proposal, a market would close if no new bids are submitted in a round or if bids are submitted but there are fewer than two that exceed the previous round's high bid by more than the suggested bid increment. Comments of PacTel, Attachment by R. Preston McAfee at 16. The second part of this rule would appear to provide bidders an additional incentive to participate actively in an auction. Under this provision, a high bidder in the previous round would not have the opportunity to make a counter offer to the high bidder in the current round if there is only a single bid which exceeds the suggested minimum bid. This would seem to provide an added incentive for the high bidder to continue to raise its bid by the suggested bid increment in each round. The Commission retains the discretion to employ such a stopping rule.

<sup>105</sup> Comments of PacBell, Attachment by Paul Milgrom and Robert Wilson at 19.