Comments on DA 00-1075,
"MODIFYING THE SIMULTANEOUS MULTIPLE ROUND AUCTION DESIGN TO ALLOW COMBINATORIAL (PACKAGE) BIDDING"
Report No. AUC-00-31-G (Auction No. 31)

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A Blueprint for a Multi-Round
Auction with Package Bidding

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Contents

1. Introduction

The Federal Communications Commission ("FCC" or "Commission") has proposed to implement the Rothkopf, Pekec and Harstad [1995, 1998] suggestion for rows-and-columns package bidding in the 700 MHz auction. This significant step holds the promise of improving the efficient assignment of these licenses.

However, to achieve this promise, the FCC must alter its proposal to take into account the fact that key issues of activity credit, bid retention, stopping rules and minimum bids are far more intricately interrelated when package bids are allowed. The proposal presented in the FCC's Request for Comment in DA 00-1075 (the "Notice"), as originally drafted, is seriously flawed in these regards.

The purpose of this "blueprint" is to proffer a more fit structure that includes a number of changes. These changes are based on experience across auction theory, auction experiments, study of practical auction details, and bidding in prior auctions. And, if adopted, the changes will result in a more successful and efficient auction of the 700 MHz spectrum and will minimize opportunities for gamesmanship by insincere bidders.

Proposals presented in this blueprint are necessarily intertwined. If the Commission adopts the rules as proposed, it will build a structure that can stand up to the stress of a multi-round auction with combinatorial bidding. This would be quite a successful first run with package bidding. The Commission should not try to pick and choose among the proposals presented here. It would have to be expertly judicious in picking and choosing to ensure against a potential disaster. Therefore, the proposals presented here have been judiciously considered to work together to achieve the most efficient auction possible.

As shown below, a particular concern is that, under the FCC's proposal, the potential size of a global bid is quite large, and this factor needs special consideration. The Bureau has never put big bidders in this position before, particularly under tight time constraints. The Bureau must adopt a proposal that will make a big bidder's position tenable.

2. Qualifications

I am a Professor of Economics in the Rutgers Business School and Research Fellow at the Rutgers Center for Operations Research. Auctions have been my principal research topic since 1983, with publications studying theory, experiments, and practical details of auctions and bidding. In addition to the rows-and-columns proposal, the Commission has in the past adopted the withdrawal penalty proposed in Harstad and Rothkopf [1995], and cited Rothkopf and Harstad [1994] as the only paper in the literature assisting it with the implications of bid increments. I have also submitted Briefs to the Commission that have influenced setting of bidding credits, minimum opening bids, and interference standards.

I have been retained by SBC Communications, Inc. and SBC Wireless to advise them in bidding and in preparation for this auction, as I did for the A/B block PCS auction. I have been granted substantial latitude in developing these proposals, as the Joint Commenting Parties, SBC and BellSouth, consider making the auction work well, and reaching an efficient result, to be high on their list of objectives.

3. A Bud or a Dud: The Importance of Clear Clearing Rights

The 700 MHz auction could end up looking like a clear success to any observer, or one which only the most determined spin doctors would dare call a success. In reality, an objective success cannot result from an inconsistent, unbalanced set of rules. Rules that fit

together to bear the weight of an auction will dramatically improve the chances of success. But it is not just the rules of the auction: auctioning a fur coat that has been properly cared for and stored is likely to raise more revenue than the same style of fur coat perforated with moth-eaten holes.

In the existing regulatory environment, the successful bidder for any EAG license will be faced with a license area that is perforated with the protected contours of a myriad of licensed TV stations. This creates significant uncertainty for bidders.

Specifically, the broadcasters have the right to continue to use the spectrum after the auction for years, perhaps indefinitely. And, there is the unfortunate preference that has been granted to the political currency of past decisions awarding them interminable broadcast rights for free, over the economic currency of efficient spectrum usage. To achieve an economically rational and efficient auction, the FCC must promptly redefine broadcasters' property rights in this spectrum.

The Commission should adopt a doctrine of "must move for compensation equal to relocation cost." Under the circumstances, this should be adequate. A ruling that at least the last holdout in any market is subject to this doctrine may be adequate.

The Section 309 (j) mandate for efficient usage of spectrum unambiguously yields the conclusion that the FCC can and must do something to move the broadcasters out of this spectrum. If it does, 700 MHz prices can generally head up from the minimum opening bids. If it does not pave the way for spectrum clearance, the FCC needs to recognize that prices may likely go down from the minimum opening bids, as the FCC may be forced to reduce the opening bids in response to bidders' displayed unwillingness to pay those prices.

Rational bidders facing uncertainty over even the legal basis for negotiations with broadcasters should and will, for the most part, reduce their valuations of licenses by nearly a worst-case-scenario estimate of the post-auction cost of clearing.

The FCC can adopt policies that lead bidders to move the estimates of the cost of clearing built into their bid limits to billions of dollars less than this nearly-worst-case scenario.

Bidders, taxpayers, the FCC, and consumers will all benefit by a significant multiple of the decrease in forced premiums paid to broadcasters to relinquish spectrum which goes virtually unused, and which was acquired for free.

I have made some rough calculations to understand better the size of this impact. My calculations suggest that a bidder for the global package should increase his bid limit by between $1.20 and $1.50 for each $1 less he estimates he will have to pay for clearance, as a result of an FCC clarification of broadcasters' property rights. For a bidder for the nationwide 20 package, the bidding limit should rise by between $1.40 and $1.80 for each $1 less in estimated clearance costs following a sensible FCC ruling.[1]

It is important to realize that bidders in this auction are merely the conduits through whom the financial demands of broadcasters will be delivered. The bidders will rationally bid less because of the size of and the ambiguity surrounding the costs of clearing. Because the bidders will bid less, revenue will be less. The inescapable conclusion is that it is the American taxpayers that are ultimately paying this financial windfall to broadcasters, to free

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[1] If all that happened was that an FCC ruling reduced the expected cost of clearance, this would simply be reflected in $1 of additional auction revenue for each $1 of reduced clearance cost. However, given the awkward and incomplete status of broadcasters' property rights, an FCC ruling would also create less uncertainty for bidders, who would then have estimates of clearing cost that would be less imprecise. It is the change in the precision with which bidders can estimate clearing costs that leads to the larger-than-dollar-for-dollar impact.

up spectrum that belongs to the taxpayers in the first place. However, because the auction means that the taxpayers only pay the broadcasters indirectly, the indirectness of using the bidders as conduits poses an additional cost. It is this cost which I estimated in the previous paragraph.

4. Simplicity: Why Rows and Columns Suffice for Biddable Packages

To implement the "rows-and-columns" proposal for a package bidding auction (Rothkopf, Pekec and Harstad [1995, 1998]), the licenses are arrayed in a grid, as in Table 1. There is a column for each of the six regions of the U.S., labeled with a two-letter code (MA for Mid-Atlantic, etc.). In each column, the upper cell designates the 10-MHz license, the lower cell the 20-MHz license. "Rows-and-columns" means that, in addition to bidding on any of the 12 individual licenses, a bidder can submit a single bid for either row (the 10's row of six licenses is shaded with horizontal lines, the 20's row below it is unshaded) as a package, or a single bid for any column (the MA column is shaded with vertical lines) as a package, or a "global" bid for the package which is the entire grid of 12 licenses.

Table 1
Biddable Combinations

			Regions			
MHz	NE	MA	SE	GL	CM	PA
10						
20						

The proposed auction would utilize, in principle, a "row auction" and a "column auction" each round. High bids on each license and each package are compared as follows,

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using Table 2 as an illustration. Bids submitted are in ordinary type, while sums calculated from the bids are in italics. For each column, the two bids on the 10-MHz and 20-MHz licenses (for example, the $48 and $122 bids in the NE region) are summed (=$*170*, in italics) for competition with the "column bid" (here the $165 bid for the package of NE-10 and NE-20, the bottom entry in the NE column).

The higher of each "column sum" and the corresponding column bid would be the winner in that column for the column auction. In this illustration, these column maxima ($*170*, $179, $*171*, et al.) sum to $*1,026* ("column auction"), shown to the right of the column bids. Similarly, the sum of bids in a row ($48, $50, et al. for the 10-MHz row) is the "row sum" (here, $*303*), which competes with the "row bid," the package bid on the nationwide package of licenses in that row (here, $300) in the "row auction."

In this illustration, the 10's row sum outcompetes the row bid, and the row bid for the 20's row ($720) is higher than its row sum ($*704*). Hence the sum of these two maxima (shown via underlining), $*1,023*, is the total of the row auction (the third entry in the far-right column). Finally, the highest "global bid," a bid submitted on the package of all 12 licenses) is shown in the bottom-right corner, $1,020.

Table 2
Sample Round Results (in $ millions)

	NE	MA	SE	GL	CM	PA	*Row Sum*	Row Bid
10-MHz	**48**	50	**53**	**56**	40	**56**	*303*	300
20-MHz	**122**	116	**118**	**133**	80	**135**	*704*	720
Column Sum	*170*	*166*	*171*	*189*	*120*	*191*		*1,023* *Row Auction*
Column Bid	165	**179**	170	**189**	**126**	185	*1,026* *Column Auction*	1,020 Global Bid

The "provisional winners" are the bids that would be awarded licenses if there were no further bidding after this round. This is found via whether the global bid, row auction, or column auction offers the most revenue (in this illustration, these have been listed in ascending order of revenue offered). The provisional winners have been indicated via boldface. Notice one detail: in the Great Lakes region (GL), the individual license bids, $56 and $133, tie with the column bid, $189. Either could be part of the provisional winners. Such ties should be made unlikely in apt auction rules. The FCC's proposal would be to consider the individual license bids provisional winners if and only if each bid is time-stamped earlier than the column bid.

Notice that this is a simple, elegant design. Rows, columns, and the global package offer all the packages that potential bidders have indicated (in business plans and other *ex parte* filings in this Docket) represent potential synergies. For the bidders' first introduction to package bidding, this is a structure that is easy to comprehend. Since any row intersects with every column, bidders readily realize that a row bid and a column bid cannot simultaneously be provisional winners. This is the package bidding environment most amenable to straightforward strategic analysis—bidders know what to look for in perusing round results.

If a single package bid on the New England 10, the South East 20, and the Pacific 10 were allowed, all other bidders would be baffled as to why it was placed, what it is supposed to mean, and how they ought to alter their bidding plans in response. In fact, such a package bid is neither economically sensible nor strategically necessary. The only reasons I can imagine for submitting it are obfuscatory.

It is imperative not to add any other biddable packages. With the blueprint that follows, rows-and-columns can work and remain simple and coherent.

5. A Blueprint of Integrated Changes

5.1. Rules for Comparing Package Bids with Bids on Individual Licenses

The Notice never explicitly states how the Commission will compare package bids with the bids on individual licenses. It is straightforward only when there are new or standing bids on all licenses. This is insufficient.

Suppose that there are one or more individual licenses on which the FCC is currently listed as placeholder, due to lack of a new or standing bid on that license. This complication has to be dealt with because there is no guarantee that every individual license will receive a bid in round 1. As discussed below in sections 5.2 and 5.4, rules which permit pursuing backup strategies may also lead to the FCC being listed as a placeholder later in the auction.

If there is a row bid, it should be considered to yield more revenue than the row sum if the row bid exceeds the sum of those bids on individual licenses in that row for which there is a bidder. For example, Table 2 lists $40 million for the CM-10 bid, the minimum opening bid. Suppose the FCC were still placeholder on this license, and no bidder had actually bid on it. Then the illustration would change as shown in Table 3. The FCC's placeholding is indicated by bracketing this bid. The column sum is now simply the $80 million CM-20 bid. The row sum is now the $263 million that had been submitted by high bidders on the five 10-MHz licenses that have bids. This means, in this example, that the 10's row bid is the contingent winner for the row in the rows auction, until such time as this license draws a bid, or the other five licenses exceed in sum the row bid. Finally, now the row auction total is only $1,020, the sum of the two row bids. The column auction and provisional winners (in boldface) are unchanged by making the FCC the placeholder on CM-10.

Table 3

Sample Round Results (in $ millions)

	NE	MA	SE	GL	CM	PA	*Row Sum*	Row Bid
10-MHz	**48**	50	**53**	**56**	[40]	**56**	*263*	<u>300</u>
20-MHz	**122**	116	**118**	**133**	80	**135**	*704*	<u>720</u>
Column Sum	*170*	*166*	*171*	*189*	*80*	*191*		*1,020* *Row Auction*
Column Bid	165	**179**	170	**189**	**126**	185	*1,026* *Column Auction*	1,020 Global Bid

For the purposes of establishing a minimum bid on a license temporarily held by the FCC, it is correct to list a non-zero price. But the FCC ought not be viewed as contributing anything to the competition of the individual license bids in the row with the high bid for the row package. This should also be the same for the column sum. Whether to grant activity credit, to retain bids, and to consider row or column bids provisional winners should be done in accordance with this rule. Put succinctly, only bids that would yield the FCC revenue if awarded should count toward sums.

5.2. Activity Credit

The Notice proposes to grant activity credit for any retained bid or any new bid meeting minimum bid increment requirements. This activity rule is too slack in its requirements to allow for a straightforward stopping rule and yet attain expeditious progress in the auction. I propose the workable and rather simple alternative of granting activity credit to new or retained bids on individual licenses only for a limited number of rounds if they fail to remain competitive in either the row auction or the column auction.

The basic point of granting activity credit is to keep alive a bidder's eligibility to bid on licenses and pursue backup strategies, so long as the bidder is actively making bids that

increase auction revenue. Without any need to generate activity, a single bidder would prefer to wait until his opponents have finished bidding before deciding what bids he wishes to submit.

Allowing package bidding would only eliminate the need to allow for backup strategies if a bidder could begin the auction with a clear notion of how expensive the rows, columns, and individual licenses were going to be. Of course, the mere fact that there needs to be an auction belies this presumption. Accordingly, it is still important in a package bidding auction for bidders to be able to switch to a backup strategy when their first choice becomes too expensive. Hence, it remains important for all licenses to be open for bidding until all close simultaneously.

Should the sum of bids in a row exceed the row bid at the end of a round, naturally, the row bid for the next round will have a minimum bid increment set on the basis of the sum, rather than the previous high row bid. Only a new row bid which would increase the maximum of the row bid and the standing row sum can get activity credit. Similarly for a column bid, and for the global bid.

However, it is plausible that the auction could regularly exhibit a situation where row and column sums repeatedly fall below row and column bids; below, I refer to this situation as bids on individual licenses that are "not competitive." It is desirable to give activity credit to new bids on individual licenses, at least initially, even if that new bid does not by itself increase the row or column sum by enough to become standing in that row or column. For illustration, Table 4 shows an example outcome. If these are the round 27 results, bids on individual licenses are not competitive in either row, and are only competitive in the NE, SE and PA columns. Imagine that the only bid submitted in round 28 is a new bid on MA-10, a 10% increase from $50 to $55 million. The 10's row sum and MA column sum rise, but

neither to the level of becoming competitive. (The smallest increase in MA-10 that by itself would make the bid competitive is to $58.)

Table 4
Licenses Not Competitive in Rows, Round 27

	NE	MA	SE	GL	CM	PA	Row Sum	Row Bid
10-MHz	48	50	53	56	44	56	307	**315**
20-MHz	122	116	118	133	80	135	704	**740**
Column Sum	170	166	171	189	124	191		1,055 Row Auction
Column Bid	165	179	170	190	126	185	1,027 Column Auction	1,020 Global Bid

Granting activity credit to bids that are not competitive indefinitely, though, is inconsistent with the basic reason for an activity rule, and creates serious problems for the stopping rule. What is desirable is to put pressure on the bidders for individual licenses to raise their bids by enough to become competitive in their respective rows or columns, or eventually to lose eligibility that would have the auction continue without their bids ever becoming competitive.

"Eventually" is a key word here. This pressure must not arise unpredictably (as a function of how many other individual licenses in the same row get new bids in a round, for example), and must be slow enough to allow bidders in a row or column to make adjustments without synchronization, to a threshold facing them.

A sensible solution is to grant activity credit in a way that is dependent on how long it has been since the row sum or column sum was competitive vis-a-vis the row or column bid. "How long" should relate to the number of individual licenses in the summation, as a first

approximation to the amount of time reasonably allowed to surmount the threshold problem; the rule of "N+1" ought to work.[2] Hence, with two licenses in a column, I suggest that the column sum be required to be competitive with the column bid at least every third round, in order to continue to generate activity credit. The row sum ought to be competitive with the row bid every seventh round.

It is straightforward to construct examples in which aspects of the bidding process seem strained because the row sum (or, less so, the column sum) falls too far below the row bid. These examples become most unlikely creations when this sort of activity credit rule is in effect. Bidders on the six individual licenses can see that there are only so many rounds left before new or standing bids on individual licenses must reach the row bid, and they have an incentive to submit bids pushing toward competitiveness before that deadline is reached.

An activity credit rule meeting these requirements is the following:

A bid generates activity credit in a round if:

▪ It is the standing global bid that is the provisional winner from the previous round, or is a new global bid;

▪ It is a standing bid on a row and would have been a provisional winner in the previous round had column and global bids been ignored, or is a new row bid;

▪ It is a standing bid on a column and would have been a provisional winner in the previous round had row and global bids been ignored, or is a new column bid;

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[2] This "N+1" rule is a sensible rule-of-thumb when, as in this auction, there are no packages of many individual licenses that are not themselves decomposable into smaller packages. An auction in which licenses were arrayed in a grid of 3 rows and 100 columns might be unworkable as rows-and-columns for many reasons. Among them would be the problem of granting activity credit to individual licenses for 101 rounds before checking again to see if they were competitive.

- It is a new or standing (and not withdrawn) bid on an individual license, and the sum of the bids on the two licenses in this column (region) meets or exceeds the standing column bid in this or one of the previous two rounds; or

- It is a new or standing (and not withdrawn) bid on an individual license, and the sum of the bids on the six licenses in this row (10- or 20-MHz) meets or exceeds the standing row bid in this or one of the previous six rounds.

Note that a new bid on an individual license does not necessarily get activity credit. If it has been seven or more rounds since the row sum in the 10's row was competitive with the 10's row bid, a new bid on a 10 license only generates activity credit if the row sum reaches the standing row bid.

Note further that this activity rule treats package bids differently, as row, column or global bids are not retained if they are not provisionally winning, at least in the "rows auction," or the "columns auction." This creates no problem until the end of the auction. At that point, in theory, bidders could continue to make minimum increases on a column bid. If the column total were sufficiently below the row total, with no other bidding going on, no revenue increases or changes in provisional winners will occur, but the auction continues. In this case, I would augment the above rules as follows:

- If all provisional winners are standing bids, and either the global bid remains standing, or the provisional winners consist solely of row bids and individual licenses, a new or standing column bid generates activity credit if the maxima of column bids and sums of individual license bids in columns sum to meet the provisional winning level of revenue in this or one of the previous six rounds;

▪ If all provisional winners are standing bids, and either the global bid remains standing, or the provisional winners consist solely of column bids and individual licenses, a new or standing row bid generates activity credit if the maxima of row bids and sums of individual license bids in row sum to meet the provisional winning level of revenue in this or one of the previous two rounds.

If any new bid becomes a provisional winner, these rules no longer supplant the activity credit rules above, until the next time that all provisional winners are standing bids.

These rules do not restrict row or column bidding activity from earning activity so long as revenue is rising. If revenue is not rising, and the column bidding is not influencing revenue, they get at most seven rounds to become competitive before the auction ends. In a similar, end-of-auction situation, if row bids are not competitive, they get three rounds to do so.

Note that in all cases, for bids on individual licenses or on packages, if the end of a three-round or seven-round period is reached, a bidder holding waivers does not lose eligibility immediately, unless an automatic waiver is overridden. Otherwise, the bidder starts to use up a waiver per round.

5.3. Pricing Licenses Held by the FCC

The Notice proposes to apply the minimum bid increment, initially 5%, to any license listed as retained by the FCC. This would initially be a license on which there were no bids, but a sensible tuning of the rules will create other situations where the FCC might hold a license with no retained bids. The FCC would end the round with the minimum opening bid listed as the price, or with probably the second-highest prior bid listed as the price for a license which no longer has any retained bids.

It does not make any sense to apply the minimum bid increment to these prices to get minimum bids for the next round. If no one was willing to bid $40 million for one of the 10-MHz licenses in round 1, what makes the FCC think that someone will want to bid $42 million in round 2, or $44.1 million in round 3? If this policy is followed, a license on which there have been minimum bids made in each of the first five rounds, and a license which has received no bids yet, would both be priced at $51.05 million in round 6.

A much better policy is to apply the minimum bid increment in the other direction. A license which receives a minimum bid in round 1 goes up by 5% for its minimum bid in round 2; a license on which no one bids goes down by 5%. (The number need not be 5%; the point is that minimum bids on licenses that continue to lack a willing bidder should fall as fast as prices rise on licenses with competitive bidding.) This could be accomplished by treating the retained price as 19/21sts of the previous minimum bid; then applying a 5% increase across the board will yield a minimum bid for this license which is 95% of what it was before.

This system of having prices fall by 5% a round should be maintained for as many rounds as the FCC remains the placeholder. If bidders on the other licenses in the same row are hoping for a larger row sum to compete, this license is more likely to offer some contribution to the row sum if it can be bid on more cheaply during a round than the price which garnered no bids in the previous round.

5.4. Retaining Bids

The Notice proposes to retain high bids on packages that are competitive in rows or columns, and all standing high bids on individual licenses; bid withdrawals would not be permitted under any circumstances.

Which bids to retain is itself an intricate issue. It makes sense to first figure out which bid retention decisions become clear based on the fewest principles.

♦ (Principle:) A bid on a license or package must be serious, an irrevocable affirmation of a willingness to pay the amount bid for that license or package.

  ➢ (Implication:) Any bid that is a provisional winner is retained, and cannot be withdrawn by the bidder so long as it remains a provisional winner.

♦ A bidder who has been outbid by a new bid on the same license or package must be freed from continued exposure on that losing bid, so that the bidder's limited resources can compete for some other license or package, if he wishes.

♦ There is no advantage to other bidders bidding on licenses in the same row or column who want the row or column sum to exceed the row or column bid in being able to combine with any other bid than the high bid. (This is saying something very simple: if you are bidding on the MA-10, and you want the row total on the 10's to be as competitive as possible, retaining both an $80 million bid and a $75 million bid on the NE-10 does no more for you than just retaining the $80 million bid.)

  ➢ There is no advantage in giving a bidder the opportunity to retain a bid on a license or package when there is a higher bid on the same license or package, and there are certainly disadvantages to forcing its retention. Hence, any such bid is automatically withdrawn.

♦ It only makes sense to retain the high global bid if it is a provisional winner. That is, a higher total from the rows or from the columns is effectively a higher bid on the same package. Similarly, a row sum that exceeds a row bid or a column sum that exceeds a column bid is effectively a higher bid for that row or column.

➢ A global bid that is not the provisional winner is automatically withdrawn. A row bid that is less than the row sum is automatically withdrawn, as is a column bid that is less than the column sum.

♦ Judging whether rows or columns represent the more important synergies can be misleading from prices early in the auction. Until it is clear that the auction is nearly over, it could be a mistake not to retain both the provisional winners in the rows auction, and the provisional winners in the columns auction.

➢ A bid that would be provisionally winning when only rows and individual licenses are considered is retained, and cannot be withdrawn by the bidder in the next round. Correspondingly, a bid that would be provisionally winning when only columns and individual licenses are considered is retained, and cannot be withdrawn by the bidder in the next round.

There is no similar overriding principle implying that the high bid on an individual license should be retained if neither its row sum exceeds the row bid nor its column sum exceeds the column bid. Indeed, there are two conflicting principles:

Availability: if the high bid on an individual license is retained, it is easier for bidders on other individual licenses in the same row or same column to increase their bids by enough to compete with the standing row bid or column bid.

Flexibility: a bidder is exposed and unable to pursue alternative strategies if he believes his standing bid, say for $100 million, is unlikely to become a winning bid: if he cannot withdraw this standing bid, an increase in other bids in the row or column some number of rounds hence will suddenly put his $100 million on the table. In the meantime, his ability to

compete elsewhere can be seriously limited if this $100 million is tied down by a bid that is, after all, not a winner in either its row or its column.

Flexibility is the bigger concern. Suppose bidder A holds the high bid on NE-10 at $100 million after round 23, and the NE column bid exceeds the sum of high bids on NE-10 and NE-20. Suppose the row bid, that is, the nationwide 10's bid, exceeds the row sum by 35%. Bidder A's budget may be low enough that he cannot afford to bid elsewhere if $100 million has to be set aside against the possibility that this NE-10 bid comes alive in its row or column. Moreover, he may not be able to afford a 35% increase in his bid, so he may be convinced that he can never afford to win the NE-10 license. If he cannot withdraw this standing bid, he is effectively (and perhaps unfairly) shut out of further competition in the auction. Moreover, he is not really in a position to be of much help to other bidders trying to get the 10's row sum up by 35%.

If bidder A's $100 million could be freed up, he may choose to raise the current bid on a cheaper 10 MHz license by 35% or some amount much closer to 35%. For example, if the MC-10 license currently stands at $58 million, bidding about $78 million for it would constitute a full share for that license in trying to bring up the 10's row sum by 35%. Of course, this will not immediately help: bidder A will withdraw his $100 million bid on NE-10, and the immediate net impact is that the 10's row sum falls by $80 million. However, the FCC becomes the placeholder on the NE-10, say at $95 million, and if a bidder steps in and bids that, the 10's row sum is now higher than before bidder A withdrew on NE-10. More importantly, bidder A may now be exposing his money on a license he believes he has a better chance to win.

Conjectures have been made that allowing standing but not competitive bids on individual licenses to be withdrawn would allow tacitly collusive signaling. I have not seen

anyone present an example of such a potential that withstands a few seconds' cynicism. Allowing package bidding would only prevent all needs for bid withdrawals if the final auction prices of various packages and individual licenses could be predicted in advance. In that case, there would be no need to hold an auction.

In fact, signaling is not a serious issue if a bidder's withdrawal of a standing but not competitive bid occurs in the same round as the submission of a new bid. Their ability to compete elsewhere is more important.

♦ Flexibility is a bigger concern than Availability.

  ➢ A high bid on an individual license is retained whether or not it is competitive in the row or the column. However, if going into a round, the standing bid on an individual license is not competitive in the row or the column auction, the holder of that standing bid should have the right to withdraw it, without penalty and without restrictions on being allowed to bid for that license later in the auction, so long as he makes one or more new bids in the same round, totaling at least as many bidding units as the total number of bidding units of the withdrawn bid(s).

It is slightly simpler to run an auction without allowing any withdrawals. However, that would not be good policy, as it would needlessly interfere with the flexibility to pursue backup strategies.

If complications were not an issue, I would recommend preceding the bid submission phase of any round after round 1 with a withdrawal phase, and then announcing any withdrawals of standing but not competitive bids on individual licenses. This would allow bidders to know which retained bids would still be present at the end of the round for attempting to reach a row (or column) sum that competes with the standing row (column)

bid. It would also let a bidder who wished to move into the withdrawn bid spot to do so without delay. In my judgment, however, this introduces more complications than it is worth, especially if prices in the auction have risen high enough that large dollar differences stem from the withdrawal, and bidders might reasonably want a goodly amount of time to think over a withdrawal's consequences before the bid submission period started.

5.5. Minimum Bid Increments

The Notice suggests having minimum bid increments follow a simple percentage rule, but asks about more complicated alternatives. All alternatives add substantial complications unnecessarily, and reduce transparency. The simple minimum bid rule needs adjustment only for the absolute size of the minimum increase on global bids.

A significant part of the reason for mild complications in the activity credit rule above is to avoid much more serious complications in minimum bid increments and the stopping rule (the latter is considered below in section 5.7). With an activity credit rule that checks every several rounds whether bids on individual licenses have reached competitive levels, there is no need to force a complex minimum bid rule on bidders for licenses that are not currently provisional winners.[3] If the minimum bid increment is 5%, then simply apply 5% to each license. A retained package bid is also subject to a 5% rule. If the bid on a package is not retained, the minimum bid increment is applied to the sum of bids on licenses that outbid the package in the prior round. Thus, for example, if the high bid in round 22 for the 20's row is $1 billion, but the row sum on 20's is $1.08 billion, then a 5% rule would set the minimum bid on the 20's package at 5% above $1.08 billion.

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[3] Pekec and Rothkopf [2000] propose a rule that could be part of a baroque blueprint, but not a simple blueprint.

The other minimum bid rules that have been suggested are all needlessly complicated, and in general flawed.[4] For the most part, the more complicated minimum bid rules are designed to force bidders on individual licenses each to do "their fair share" in the immediate next round to overcome a potential threshold problem.[5] These rules ignore the fact that bid limits and budget constraints are a bidder's private information, and so only a bidder may know that he cannot meet this more complex minimum bid proposed, but he may be able to contribute 5% or more to solving the threshold problem.

A far simpler solution is not to straightjacket bidders, but simply to give them more rounds in which to overcome the threshold problem. As already mentioned, this is not an auction to force along at the highest possible speed. No complex minimum bid increment formula is needed when the activity credit rule properly affords time. The Commission should realize that the policy of letting the revenue that comes from bidders' bids drive the auction, rather than having rules drive the auction, argues strongly for a simple minimum bid increment rule. The Bureau can give the bidders time, not indefinite, but several rounds, for the straightforward activity credit rule discussed above to guide them toward competitive bid levels.

When prudent, the FCC must reduce the minimum bid increment. This is far more crucial in the new design than it has been before. Before, bidders with a lot of money on the table were asked to make a number of much smaller decisions about adding 5% to the amounts bid on individual licenses. Now, a global bidder will be asked to make a single decision on a scale that is almost unfathomable.

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[4] I refer to the alternatives suggested in the Notice, section II.D, page 6, the Vohra and Weber [2000] bids-and-offers proposal, and the Pekec and Rothkopf [2000] comment.

[5] The threshold problem is that bidders on individual licenses must compete in sum with a package bid, but each only controls how much he increase his own bids.

Suppose the FCC contemplated keeping 5% as the bid increment when the bidding on the global license rose above $10 billion. Suppose bidder C held the high bid after an even-numbered round, and got outbid in the next odd-numbered round. In the following even-numbered round, he will either have to bid the global bid again, bid elsewhere on at least 126 million bidding units, or lose the eligibility required to bid on the global bid at any later time in the auction.

Two bid increments have been applied: 5% to his last bid to get the minimum bid that outbid him, and another to that bid in the odd-numbered round which he must now outbid by 5%. Hence, even if no rows-and-columns bids have pushed the global bid, he will now have to raise his last bid by 10.25%, over a $1 billion increase. If the FCC at some point pushes this auction faster than two rounds per day, and a global bidder is unsure whether his bid will be topped in the next round, then he could find himself in the position of having a severely limited time to decide whether to put another 1-billion-plus dollars on the table. There is something wrong with this picture.

At such prices, a bid increment anywhere near 5% is unconscionable; it is simply trying to run an auction too fast when package bidding is being encouraged. Based upon what is known at this stage, I expect any bidder to be in a position where top-level executives of that entity (or bidding partnership) would properly insist on being in the loop for decisions increasing exposure by more than $1 billion in one fell swoop.

A rule needs to be adopted yielding an absolute dollar amount beyond which minimum bid increments cannot go. Specifically, I propose:

▪ The minimum bid increment in percentage terms be scaled down as needed, to insure that the minimum bid increment on the global license is never more than $250 million.

(This implies that the absolute size of a bid on an individual license or on a smaller package is capped proportionately. If the minimum bid increment global bid could be no more than $250 million, the minimum bid increment on a license or package for which the current price was 1/10th of the current revenue would be no more than $25 million.)

Two illustrations will help make this clear. First, suppose that in round 81, the provisional winning bid is the global bid, which stands at $9.52 billion. Then $250 million is 2.62% of $9.52 billion, so the minimum bid increment for all licenses and all packages in round 82 would be set at 2.62%. (It could be prudent to set it lower, or to use a more prominent number, like 2.5%.) Of course, this would make the minimum bid on the global license $9.77 billion.

If a global bid in that amount was made in round 82, and became the provisional winner, then the minimum bid increment would have to be cut slightly further, to 2.55%, so that the minimum bid on the global license would go up by no more than $250 million, to $10.02 billion. Notice that is still the case that the global bidder who was high in round 81 and got outbid in round 82, still has to come back in round 83 with a bid that is $500 million larger than the last global bid he made.

For our second example, suppose that a global bid of $9.77 billion in round 82 supplanted the $9.52 billion bid, but that this round 82 global bid was not provisionally winning. This may be that aggressive bidding on the row bids raised their total to 1.6% above the global bid, to $9.93 billion. Then our proposal would still be to require the global bid to rise by no more than $250 million *over the minimum global bid for the previous round*, still to $10.02 billion. This would imply that the minimum bid increment would be set to 0.91% on all licenses.

Under this proposal, the minimum bid increment could in percentage terms be smaller in one round, and then larger in the next. The smaller bid increment would have followed a round in which revenue went up by more than the minimum increase in the global bid. Revenue would still go up by an average of $250 million per round on rounds when either a new global bid was submitted, or the set of provisional winners changed.

5.6. Helping Prices Keep Roughly in Line: Jump Bids

The Notice proposes allowing bids on individual licenses to increase by 1 to 9 bid increments, and to allow the minimum bid as the only new bid on any package.

Consider a situation where after round 8, the sum of high bids on individual licenses in a row is quite close to the row bid, say within 2%. Moreover, suppose the sum of the two row bids is within 2% of the global bid. Now tack on 5% for minimum bid increments, as described in the previous section. Let there be a new global bid, 5% higher. If minimum bids are made on both row bids, they will stay in line. However, if there is one new row bid, and the other remains standing, the sum of the two will have risen by something more like 1% to perhaps 3.5%, depending on the relative size of the new and the standing bid.

Because a new bid in both row bids cannot be counted on every time there is a new global bid, with only minimum bids, there will be a tendency for the global bid to rise above the sum of the two row bids. Similarly within a row: if a new row bid is 5% higher, but there are new bids on only 2-4 of the individual licenses, all minimum bids, the sum of these individual bids will probably rise by notably less than 5%.

It is best if the rules are crafted to make such a disparity as unlikely as possible. The economics of synergies are going to push toward prices getting out of line, and the rules

ought to allow that to happen as slowly as is practicable. The Notice's proposal is better than a free-for-all, but sub-optimal.

The following is a simple improvement to the FCC's plan. It is likely best among rules with this degree of simplicity. Let the maximum bid on a license or a package be equal to 12 bid increments divided by the number of licenses covered by the bid. Hence, a bid on an individual license can range between 1 and 12 bid increments; on a column (a regional 30) by between 1 and 6 (=12/2, 2 licenses in the package) bid increments, on a row (nationwide 10's or 20's by between 1 and 2 (=12/6) bid increments. The global bid cannot rise by more than 1 bid increment (but see the minor adjustment to avoid ties, below in section 5.9).[6]

5.7. Stopping the Auction, Temporarily and For Good

The Notice proposes keeping all licenses open until the auction closes after two consecutive rounds in which no new bids are submitted. A reasonably simple stopping rule is wise, but it must accommodate pauses for bidders to think and reflect, in duration commensurate to the size of decisions.

The rule of keeping all licenses open until bidding ceases on all, originally recommended in a report provided by a subsidiary of SBC, has worked well in simultaneous multi-round auctions. Its logic is even more important to any system introducing package bidding. There is a potential problem with a rule that provides that the auction closes when there are two consecutive rounds with no new bids, however. This problem arises when bids that are not provisional winners are retained.

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[6] Naturally, if it creates delays in getting software ready, limiting bids on individual licenses to 9 bid increments is not a critical variation on this rule.

Specifically, a bidder could keep the auction open almost indefinitely by bidding on an individual license that is not close to being in competition. The activity credit rule proposed above in this blueprint goes a long way toward solving the problem of the auction continuing forever because of meaningless raising of bids on individual licenses: after seven rounds, the bidders start to use up waivers.[7]

However, the stopping rule needs more careful adjustment if it is to work well with only negligible added complications.

The biggest concern is that a round with no new bids could suddenly signal that the next round is a bidder's last chance to compete. With package bidding, that could easily mean deciding over new bids that increase a bidder's current exposure by perhaps many billions of dollars. A bidder on the 20's row may finally feel comfortable that it can narrow down what it would cost to step up and bid for the national 30, assuming it had maintained adequate bidding activity. But the bidder would have to make the decision immediately, or risk having lost the chance.

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[7] The activity credit, bid retention, and stopping rules proposed here interconnect. Together, they avoid rushing the auction toward a close whenever doing so might interfere with efficient allocation, with a bidder's chance to pursue backup strategies, or with allowing some time to think through decisions that are either enormous financially, or novel in terms of the interconnections introduced by package bidding.

It could happen that the auction might appear to be near the end, but seven further rounds lie ahead to see whether bids on individual licenses can rise by enough to become competitive. If they do become competitive, it turns out that the auction is not as close to the end as was thought. The package bidders next raise their bids, if they choose to, and again become provisional winners. Then there may be another occasion where we seem to be seven rounds from the end. In theory, this "seemingly seven rounds left" stage could happen a few times during the auction. In practice, I think once it becomes clear whether package bidders will outbid individual license bidders, whichever side is doomed to losing will make only one or two more attempts to get back into the provisionally winning set. Below in this section I offer tools to have six of these seven rounds occur fairly quickly, so that a seven-round episode will mean one day plus one round, not several days.

It needs to be understood that putting up with a few episodes of seemingly seven rounds left is a price that needs to be paid if the auction rules are to be reasonably simple, reasonably transparent, and fair in the sense of giving small bidders a legitimate chance of winning individual licenses.

Thus, a bidder may have to decide whether to submit a bid that is perhaps $8 billion larger than any bid he submitted so far. No comparable last-round problem arose in auctions without package bidding.

> ➤ If there is a round with no new bids, and the FCC might allow a following round with no new bids to end the auction, the auction must be halted immediately, until 10 a.m. the following day, to give bidders enough time to consider potentially large bids. The remaining rounds scheduled for the rest of that day must be postponed until the next day.

This is not the only time that the remaining rounds in a given day should be foregone:

> ➤ If a round ends with revenue $1 billion or more higher than at the beginning of the day, the remaining rounds that day should be postponed until the next day.

Whatever the pattern of new bids that led to the $1-billion-plus increase, the bidders need to rethink the situation, to reconsider the relative expensiveness of rows, columns and individual licenses. These needs weigh more heavily than any FCC desire to wring yet more revenue out of the auction before nightfall.

These rules still leave situations where the auction could just be hobbling along with little bidding but still possibly many rounds from an end. One such scenario: suppose that the provisional winners include the 10's individual licenses. The only bidding that remains is two bidders continue to battle for the GL-10 license. Following the above rule, that the global bid increase cannot be set to more than $250 million per round, may imply a minimum bid increase on the licenses of under 1%. With only one new bid, on one small license, revenue might be rising by less than $1/100^{\text{th}}$ of 1% per round.

A second scenario has no revenue increase: suppose the provisional winners are row bids, and the sum of the row bids exceeds the sum of the column bids by a large percentage, perhaps 45%. Nonetheless, two bidders alternately bidding on, say, the SE column would continue to receive activity credit and with it eligibility.

The FCC can give itself adequate tools to deal with both situations, so long as they are designed carefully:

➤ Since, in such late-auction scenarios, most bidders do not have to rethink their bids or situations every round, and the new bid decisions that are being made are not large, the FCC can announce both [i] that it is temporarily instituting a large number of rounds per day, perhaps 6 to even 10, and [ii] that any round in which the provisional winning licenses change will be the last round of the day, and will lead to at most two rounds the following day.

➤ The FCC can announce [a] that it is **temporarily** raising the minimum bid increment, to 10% or even perhaps 25%, [b] that any round in which the provisional winning licenses change will be the last round of the day, and will lead to only two rounds the following day, with small minimum bid increments, and [c] that the next round in which there are no new bids *cannot* be the first of the two rounds in the two-round stopping rule. If there is a round with no new bids, the FCC will return to the minimum bid increment that keeps the global bid increment to $250 million or less, and announce one final round of the day, which could be the first round of a two-round stopping rule.

These treatments may be combined, but [i] and [ii] must go together, and [a], [b] and [c] must go together.[8] That is, efforts to speed up the pace and to push bidders who are not competitive must not interfere with two key properties: bidders must have at least overnight to consider large decisions with potential revenue impacts at the end of the auction, and competition to the provisional winners must be able to express itself with small bid increments at the end of the auction.

5.8. Waivers

The Notice proposes to continue the practice of allotting each bidder five waivers, which can each be used to preserve eligibility in a round when activity would otherwise cause eligibility to fall. As before, the Notice proposes to allow a bidder to override automatic usage of a waiver and pro-actively reduce his eligibility.

Continuing these practices may be sensible at a time when a number of other details must change to accommodate package bidding. Actually, waivers are a less important topic than other parts of this blueprint. Yet simply the added complexities—having to understand how both new row bids and new column bids in a round affect what a bidder wants to do next—yield additional cases when a bidder finds a waiver useful. Such circumstances will lead a bidder to think carefully and use a waiver if he has several remaining, but make a snap decision if down to his last two or three waivers.

Given the tools to speed up irrelevant activity near the end of an auction just discussed at the end of section 5.7, I have always felt that waivers cost the Bureau next to nothing to supply, and that five is a miserly allotment.   For package bidding, it should be at least eight

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[8] Returning to the issue of the previous footnote, these temporary speed-ups may occur more than once, as the "seemingly seven rounds left" situation may arise more than once. Patience in letting these issues resolve

waivers, and more if the Bureau at all contemplates using four or more rounds per day in any situation where a change in provisional winners does not postpone remaining rounds that day.[9]

5.9. Reducing the Likelihood of Ties

The Notice neither comments on this topic, nor asks for comment. But it is worth consideration.

In prior auctions, it was both legally defensible and transparently fair for the FCC to say: "We announced in advance that we would use time stamps to break ties, and so we are calling bidder A the provisional winner of license X because bidder B's bid had a later time stamp. If B wants the license, he will have to bid 5% more for it." Ties can arise in many more ways in this auction. It remains legally defensible to say, "We announced in advance that we would use time stamps to break ties, and that when comparing a collection of bids with a package bid, we would use the latest time stamp from the individual bids. So we are declaring bidder A's 20's row bid the provisional winner because bidder B's bid for the PA-20 license has a later time stamp, and the sum of individual 20's bids matches the row bid." However, transparent fairness has been thrown out the window; just ask bidder C, who bid for one license 25% of what bidder A bid for six, and whose bid has an earlier time stamp than A's, perhaps even an earlier round.

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themselves is important to the efficiency and fairness of the auction.

[9] There is actually a good case for allotting bidders 15-20 waivers. If the auction gets above $10 billion in revenue, I can imagine that rows-and-columns issues lead a bidder with East Coast corporate offices to want to use a waiver every time some significant decision arises after 3 p.m. Eastern time. A bidder with West Coast corporate offices may want to use one or two waivers every time some significant decision arises before 9 a.m. Pacific time. It may be in the best interests both of the FCC and the bidders collectively to allow such regular waiver usage, rather than confine the auction so that all significant decisions arise only between noon and 3 p.m. Eastern time. Remember, this will be a more complicated auction for bidders, and single decisions about bids will loom larger.

Moreover, legal defensibility should not be relied upon when economic defensibility might be available, or at least encouraged. It is far better to declare the row bid the provisional winner because the bidder indicated that he was willing to pay strictly more than the sum of the bids in the row. As much as possible, the rules should attempt to make ties rare.

The proposal in the Notice has this exactly backward: it makes ties as frequent as possible. Suppose all 9 packages and all 12 individual licenses get bids in round 1. Even after setting aside every bid that does not have the earliest time stamp for that license or package, a convoluted algorithm will have to use time stamps to sort out a 73-way tie for provisional winning bids. If there were no bids on one license, it becomes a 35-way tie.

Click-box bidding also encourages ties. If each license and package got 5 new bids in the first 8 rounds, some getting new bids in the 8th round, but others not, and no bids were above minimum bids, suddenly a small tie after round 7 becomes another 73-way tie after round 8.

With package bidding, ties interfere much more with the aggregation of information during the course of the auction than arose in prior auctions. If the two row bids sum to more than the sum of the six column bids in round 10, this might indicate that bidders are tentatively judging the nationwide synergies to be more important than the bandwidth synergies, or it may simply be due to some inscrutable way that timestamps were used to break a tie in round 9 (or earlier).

While this is far from the worst aspect of the proposal in the Notice, it is simply bad auction design. It is relying too much on the rules, and not enough on the bidding, to run the auction.

If nothing else was done about this, the number of ties could be greatly reduced simply via adjusting minimum opening bids so that they do not add up precisely:

Table 5

Recommended Adjusted Minimum Opening Bids, in $

	NE	MA	SE	GL	CM	PA	Nationwide
10-MHz	40,000,008	40,000,010	40,000,012	40,000,006	40,000,002	40,000,004	240,000,003
20-MHz	80,000,020	80,000,025	80,000,030	80,000,015	80,000,005	80,000,010	480,000,007
Regional	120,000,024	120,000,030	120,000,036	120,000,018	120,000,006	120,000,012	720,000,009

This table makes slightly more populous regions slightly more expensive initially. The particular numbers are unimportant; what is important is that the columns and rows do not sum exactly to the minimum opening bid for the column or row package. A minor property of the particular numbers selected is that if minimum bids are submitted on all licenses, the individual licenses slightly beat the packages, so that the package bids would not be retained into the following round. This could be termed favoritism for individual licenses in terms of tie-breaking: expecting that a package bid will be a provisional winner only if some degree of synergies is exhibited in the bidding.

While this is an improvement on the Notice's proposal, it still has the rules, rather than bidding, attempting to govern the flow of the auction. It is far superior to give bidders an opportunity to avoid ties. I turn next to sensible ways to do so.

Click-box bidding has never been a good rule. It is a much worse choice for package bidding. The simple fact is that click-box bidding strongly encourages ties, and would enforce far too many ties in a package-bidding auction.

Click-box bidding was originally created in a huge overreaction to the problem that bidders could use insignificant digits of large bids for signaling purposes. The sensible solution to that problem was, and remains, simply reporting at the end of each round only the three most significant digits of each bid. This system, which has always been better, is dramatically superior when package bidding produces so many intricate ways that ties can occur, and can interfere with the aggregation of information.

The strongest suggestion is simply to allow bidders to submit bids in dollar amounts. Report only the three most significant digits of any bid, but of course use all the digits to determine provisional winners, retained bids, and the like. I do recommend reporting whether or not a bid was a minimum bid; this will avoid phone calls to the FCC by bidders who made the minimum bid and had an earlier time stamp, and thus wondered why their bid was not standing. The Bureau should use time stamping to break ties only when two sums are exactly the same dollar amount. Round a bid down to five significant digits before applying a bid increment percentage, so that a bidder cannot infer any useful details of unreported digits from learning what the new minimum bid is. (It is an alternative to first calculate the exact minimum bid that would result from the 5% rule, or whatever percentage, and then round this down to a prominent number of four or fewer significant digits to set the actual minimum bid. However, the rule I just proposed is superior in terms of reducing the probability of ties.)

With this rule, an allowable bid would be any dollar amount between the minimum and the maximum bid for the license or the package. Following the jump bids rule above

(section 5.6), the maximum bid would be equal to 12 bid increments divided by the number of licenses covered by the bid. The one exception to this rule is that something needs to be done to give global bidders a chance to break ties. So I suggest that global bidders would be allowed to bid any dollar amount between 1 and 1.25 bid increments.

If for some reason the Bureau is unwilling to go along with this clear improvement, and insists on sticking closer to click-box bidding, then it should adopt my second-best proposal. This would allow click-box bidding, with maximum bid increments as set out above. However, there would be a Bid Adjustment Box. In that box, a bidder could enter any dollar amount from $0, the default, up through 0.25 bid increment. The bid adjustment would be added to the number obtained by the click box and would thus be part of the bid, but would not be reported; merely whether the bid was a minimum bid or not would be reported.

It is easy to underestimate the importance of this section. Activity credit rules, the stopping rule, and perhaps bid retention rules are of greater importance. But avoiding ties, and letting amounts bid determine provisional winners as much as is possible, is a more important part of good auction design than generally seems to be realized.

6. Proposals that Can Be Considered Separately

6.1. Default Rules

While the default rules may be considered separately, in that they do not *per se* interact much with the auction rules, there are few places where the rules more critically demand changes when package bidding is introduced than with the default rules. In prior auctions, if bidder D defaulted, only those licenses D defaulted on were affected. A rival bidder E may

have been prevented from acquiring all the licenses E wanted, but still obtained those where E was the high bidder. Moreover, licenses where E believed he might have been the high bidder, had not D bid beyond his means, become available for re-auction.

Everything changes with package bidding. Defaults are far more serious, infinitely messier. There is no good solution following a default, so the rules must be so draconian as to virtually guarantee against defaults. Moreover, default rules have to consider the possibility that an unforeseen inability to come up with funds was *not* the reason for defaulting.

The first huge difference is that a default can, and likely will, change the outcome on all licenses, not just those won by the bidder who defaults. A default on an individual license almost certainly changes whether a package bidder would have won. Licenses end up in the hands of non-defaulting bidders when there is often clear evidence that those bidders would not have won. Indeed, the defaulting bidder aside, the licenses are typically not in the hands of those who offered the FCC the most revenue.

Interestingly, in the extremely unlikely event that a global winner defaulted, there would be little added complication. However, that is about the only case where a default creates less than an utter nightmare.

Consider the example the Bureau brings up in its Notice. Suppose the two row bids win, and then the 20's row bidder defaults. The Bureau supposes that with only serious bids, neither row bid would have won, but the columns, the regional aggregations of 30 MHz, would have won. In that case, the Bureau proposes to award the 10's row to the high bidder, whose bid should not have been a provisional winner, and to then sell the 20's at re-auction. In so doing, the Bureau proposes to have observed incontrovertible evidence that

regional aggregations achieve greater synergies than nationwide aggregations, but to refuse to award any regional aggregations.

This seems even less sensible, if that is possible, when one considers the motivations of the defaulter. When a default carries with it a high likelihood that all of the licenses end up in the wrong hands, this introduces an entirely new reason for pursuing a strategy that leads to default. The future profitability of some corporation, bidding consortium, or even some loose-knit conspiracy not fully revealed on the defaulter's Form 175, may vary hugely according to whether bidders are able to attain the efficient 30 MHz regional aggregations in this auction.

It may be far cheaper to outbid them and default, if that means that a 10 MHz license gets siphoned off before re-auction. If the 20-MHz nationwide package defaulted on is later re-sold for 95% of the bid needed to alter the outcome, the defaulter has completely reallocated the licenses and thwarted an efficient allocation for a total cost, under the Notice's proposal, of 7.85% of the amount bid. That penalty clearly is insufficient in discouraging defaults.

There is, truthfully, no alternative following a default in a package bidding auction that is not inexorably messy. However, among the alternatives that do not throw out efficient allocation of licenses, one must be preferable to the Notice's proposal. All such alternatives involve refusing to award any license after a default unless the winning bidder clearly still would have won, had all bids been serious and binding.

> The FCC must inform parties prior to the auction that by bidding, they agree to rules whereby other licenses may be returned to the FCC in event of a default, not just those won by the defaulter.[10]

One extreme alternative is to start the auction again from the beginning, barring and severely penalizing the defaulter. Do not let the messiness of this alternative cloud the clear judgment that it is preferable to the proposal in the Notice, which would reward an undeserving bidder on the 10-MHz package and scuttle hopes of efficient allocation.

However, it is not necessary to go back to the start of the auction, and if that did happen, the auction's progress and revenue may well be affected by information bidders learned from the first time. The other extreme alternative would be to return to the end of the auction, remove the defaulting bid, replace it with the FCC as placeholder at a bid made on the same license or package by some other bidder, and see what bids win.

This alternative is not great, either—in particular, it makes bidders pay prices that were artificially inflated by the defaulter's unfair competition. It can also have the reverse effect: had not the defaulter driven up some prices artificially, some bidders that were discouraged by the defaulter's bidding might otherwise have made more aggressive bids for other packages.

I favor the alternative of rewinding the auction back to the last place where it is clear that the defaulter started manipulating the outcome. Manipulation via pivotal bids that the defaulter never intended as serious may have begun earlier, but just when is likely open to debate. It is unambiguous that any bidding after some rival to the defaulter last bid on

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[10] I presume the FCC should also adjust the anti-collusion rule so that it applies not until the day down payments are due, but instead until such time as the FCC puts out a public notice saying that down payments have been received on all licenses.

exactly the same package defaulted on (or on any defaulted license, if the default is on one or more individual licenses) has been manipulated. Past that round, all bids on this license were not serious competition with the packages that would have won but for the defaulter. Restore the auction to the end of that round, barring the defaulter, restoring to all other bidders the activity credit and eligibility they had at the end of that round, re-announce the provisional winners and minimum bids, and continue from there.

Though this alternative is billions of dollars higher in social value than the Notice's proposal, it is still so messy that it should be avoided at all costs. I propose the following to deal with defaults:

- Bidders must deposit 50% of winning bid amounts within 8 business days after the close of the auction, or be considered in default.

- A defaulter and its real parties in interest are barred from this and all future FCC radio spectrum auctions.

- Each defaulter and its real parties in interest are jointly and severally responsible for the entire shortfall of revenue, across all 12 licenses, from the level that was due at the point of default. There is no guaranteed upper bound on this responsibility.

- Each defaulter and its real parties in interest are jointly and severally responsible for a default penalty of 25% of the total revenue on all licenses that are placed in different hands because of the default.

- To the extent permitted under Section 312 of the Communications Act, all of a bidder's lines of business regulated or chartered by the FCC, and those of its real parties, are subject to suspension during the time a default penalty remains uncollected.

6.2. Eligibility Rules: Stage Transitions

The Notice proposes to set initial eligibility in proportion to upfront payments, as before. This is sensible policy. It further proposes that the auction consist of a single stage, for which eligibility in round t is the minimum of eligibility in round t-1 and twice activity credit in round t. In other words, a bidder must remain active on at least half of the amount of eligibility he wants to maintain ("Half Rule").

The format of this rule continues to work well as package bidding is introduced, and it would be no major mistake to effectively run the entire auction in "Stage 1" with this Half Rule. However, I encourage the Bureau to plan on introducing a Stage 2, at or near the end of the auction, with a Two-Thirds Rule, where a bidder must remain active on at least two-thirds of the amount of eligibility he wants to maintain.

This has two advantages. First, it can generate a small spurt of bidding at some point when the auction is proceeding slowly. It bears emphasis, however, that the spurt of bidding should be expected to be much smaller under rows-and-columns bidding than has been seen without package bidding. The previous spurts have had a lot to do with bidders trying to delay exposure problems as long as possible.

Second, a stage transition has provided some information to bidders about the amount of excess demand still in the auction which has not been as discernable by the round-to-round results within a stage. That information could be particularly useful when there has been no experience with package bidding before.

It is crucial not to go beyond a Two-Thirds Rule. Auction observers have found that auctions without package bidding tend to exhibit a general top-down closing pattern. After

four or five auctions conducted with package bidding, we might be in a position to speculate about a similar tendency. But we are not there now.

Any rule more strict than two-thirds will enforce a top-down closing when no one knows whether that is sensible or logical. Two-thirds is the highest ratio that still allows bidders to move back and forth between the nationwide 20's row and the global bid. At this point, one cannot predict that either of those bids would naturally settle before the other, and it would be foolhardy to limit bidders' options.

The stage transition from Half to Two-Thirds constrains the following types of bidders: bidders on a single license or a single region, and bidders who might want to move between an individual 10 and an individual 20, or who might want to move between the 10's row and the 20's row, as a function of relative prices. In the first round of stage 2, these bidders will have to bid on the larger of their principal options, and or forego it completely. Afterwards, they would face a one-way street.

So the Bureau should be careful not to introduce stage 2 too early, or with too little warning. Bidders on the 10's and 20's rows may legitimately need more than a day's warning of such a stage transition.

A final note about eligibility: the Half Rule permits bidders to make package bids on rows and columns, and there is really no need to park eligibility. Consequently, it is not necessary to foul up relatively simple rules with attempts to foil eligibility-parking.

6.3. Eligibility Rules: Overlapping Bids

The Bureau ought to encourage bidders to make overlapping bids, which may add to revenue and certainly ease threshold problems for other bidders. In an auction in which a package bid could be made on any combination of licenses, allowing bidders to make

overlapping bids could add significant computational problems. However, Rothkopf, Pekec and Harstad [1998] have shown this is not a problem in the rows-and-columns format.

The question that arises is: how much eligibility is needed when the bids a bidder wishes to submit constitute overlapping bids. For one example, suppose a bidder holding a standing bid on the MA region wishes to submit a bid on the 10's row. Both bids cannot become provisional winners, as each asks for the MA-10 license. A second example would be a bidder competing on the global license who also wishes to place a bid on any other license or package.

Three rules are conceivable. All apply to the set of retained bids plus new bids that the bidder would make in a given round.

- Rule A: the eligibility required for a collection of bids is the sum of the eligibility required for each bid, without regard to overlaps.

- Rule B: the eligibility required for a collection of bids is the sum of the eligibility required for each license that is covered by the collection.

- Rule C: the eligibility required for a collection of bids is the maximum eligibility on licenses that could conceivably be awarded to the bidder.

Consider the first example. The MA column bid by itself requires 42 million bidding units, and the 10's row requires 84 million. So Rule A would say that a bidder can only bid on both if he has 126 (=42+84) million units of eligibility. Rule B would require that he have 112 million units of eligibility, which is the 42 for the MA column plus the 84 for the 10's row, less 14 for the MA-10, which was counted in each. Rule C would say that either the MA column or the 10's row could be provisionally winning, but not both; 84 million is then enough eligibility to make both bids.

For the global bidder who wishes also to make other bids, Rule A requires more eligibility, while Rules B and C coincide, requiring only the eligibility to make the global bid.

About the only advantage I can imagine for Rule A is that it might lead to slightly more money deposited as upfront payments. If every bidder who would have participated given Rule C still participates given Rule A, then I estimate that the government obtains a few months' interest on between $84 million and $126 million extra (summing across all bidders). I do not think it will be any more than that. Indeed, I think there is on the order of a 10% chance that using Rule A rather than Rule C discourages one or more bidders from participating, in which case it is likely that total upfront payments are less.

The more important consideration is encouraging overlapping bids. Revenue could go up by a lot more than the difference in interest earnings. Hence, Rule A should be avoided. The difference between Rules B and C only matters much for bidders whose interests in licenses do not mesh well with the rows-and-columns structure. In that sense, relative to Rule B, I think Rule C mildly favors small bidders.

In conclusion, there are strong reasons for avoiding Rule A, and sensible reasons for preferring Rule C to Rule B.

7. Over-responding to the Threshold Problem

7.1. "Or" Bids

The Notice entertained, but did not propose, allowing a bidder to submit bids like, "I bid either $101 million for the MA-20 license, or $173 million for the PA column package." It asks for comment.

The notion of "or" bids comes from single-round auctions, and auctions taking place in continuous time. There seems to be little that they would offer a bidder here, beyond the capability to seriously complicate the auction. With package bidding, which part of an "or" bid gets accepted may change provisional winners of all licenses. The problem of finding the set of bids that maximizes revenue in the presence of "or" bids is computationally manageable so long as every "or" bid has a time stamp and a stated preference among the bids, but it is so convoluted, so far from transparent, so dependent on the time stamps of seemingly unrelated bids, that it would be hopeless for a bidder to be able to anticipate it or to know what impact a bid would have on the provisional winners. The auction is likely to work better if bidders have some hope of figuring this out.

There's nothing wrong with simply picking a license to bid on, among some set for which the bidder is approximately indifferent. If that license stays inexpensive, fine. If not, you can switch to a substitute after the first license gets expensive. Simple.

7.2. Bid Composition Restrictions

A bid composition restriction rule would not allow a bidder to bid on an individual license if he had currently, or in any prior round, submitted a bid for a package containing that license. It also would not allow a bidder to bid on anything other than the global package if he had ever submitted a global bid in the past.[11] The Notice asks for comment on this possibility.

During the discussion at the Wye Woods conference on the morning of May 7, 2000, this idea was panned by nearly every auction theorist present. Even Paul Milgrom, who'd

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[11] Preston McAfee and Paul Milgrom have applied for a patent on this idea. No economist present at the Wye Woods conference seemed to begrudge them this application.

proposed it earlier ([2000a]), backed away from it (though it wasn't removed from the presentation slides in [2000b]). Of course, it remains a bad idea: putting in bid composition restrictions would notably reduce the efficiency of the allocation reached, and would reduce revenue by 30-40%.

I limit myself to one of the many scenarios where this hurts. Suppose bidder A wishes to acquire the nationwide 20's package, and so bids on it. The whole point of package bidding is that he should not have to be exposed to fighting on all six licenses separately. But now suppose bidder B is bidding up the PA-30 so high that A concludes the nationwide 20's package is unlikely to be in the winning set at any reasonable price. If bidder A now concludes that the other five 20-MHz licenses are still worth pursuing, why on earth would the FCC forbid him from bidding for them?

7.3. Other Proposals: Does the Threshold Problem Merit Additional Concern?

There are also other proposals flying about to deal with the threshold problem. John Ledyard and Charles Plott at CalTech have various plans that would utilize bidding in continuous time, which appear to have worked well in laboratory and field environments involving amounts in the tens of dollars. Rakesh Vohra and Robert Weber [2000] have a bids-and-offers proposal which adds dimensions of complications, continuous-time bidding being only one. Aleksandar Pekec and Michael Rothkopf [2000] are proposing a minimum bid rule which, while insightful, is so complex that it almost escapes definition. Others are likely to show up in the comments.

These proposals represent huge departures from simultaneous multi-round rules. None I have seen would sit well with bidders.

There is no need for such overkill. First, the threshold problem is only a problem if either [a] there are no synergies across licenses, or [b] there would be but a single bidder interested in packages, whose only competition would come from bidders on individual licenses. It is inconceivable that either of these applies to the 700 MHz auction. Second, the threshold problem is only serious if there are significant frictions in transferring or cross-licensing spectrum rights in secondary markets. These markets appear active, relatively frictionless.

Moreover, if the threshold problem were thought to arise in a future auction, and if the rules proposed above (particularly the activity credit rule) did not give bidders on individual licenses enough assistance in dealing with it, it would still be wise to give the bidders a chance to drive the auction, so rules facilitating bidders should be preferred to rules restricting them. Smaller changes to the rules should be considered first. Contingent bidding, as proposed by Dan Levin [2000] is a much simpler way to give these bidders a coordinating device.

8. The Timetable, and Another Seminar

Bidders will face new challenges as well as new opportunities in a rows-and-columns auction. The Bureau staff will have to adapt the bidding and bid-tracking software. For both reasons, the Commission must promulgate an integrated set of rules promptly following the reply comments deadline. To that end, I have provided a blueprint, making sure that a fair and simple set of rules which nonetheless holds together is available.

The first experience with package bidding means that a bidder's task of preparation for bidding strategy has some novel complexities. Some key considerations of valuations, bid limits and auction strategy can only be considered after the upfront payments have been

made public. I encourage the Commission to increase the amount of time between public notification of upfront payments and the start of the auction, perhaps by as much as one week.

Finally, once the rules have been promulgated, enough will have changed that it makes sense to schedule another 700 MHz auction seminar well in advance of the Form 175 filing deadline.

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