be resolved within the context of the service and spectrum in question. Thus, we recommend that enabling legislation be permissive, and that it give the FCC flexibility to tailor auctions to the service and spectrum involved. In this way, the Commission can make its final decisions after public comment. This section suggests some items the Commission may wish to explore in a rule making.

1. Bidding Method: Sealed vs. Oral Bidding

Under the standard sealed bid procedure the high bidder wins and pays the amount bid. Sealed bidding is simple to administer and less subject to manipulation by bidders than an oral auction. The most serious form of manipulation takes place when parties get together before the auction and agree on who will win. Such collusion reduces the return to the seller since the party designated to win could submit a bid well below the value of the item without fearing that he would be outbid.

Collusion is more difficult under sealed bidding for two reasons. First, under sealed bidding colluding parties run a greater risk of an unknown competitor entering the auction and outbidding them. If such a party were to show up at an oral auction, the colluding parties would be able to respond by raising their bids and thereby avoid losing the auction. Second, the colluders run the risk of losing the auction to a firm reneging on its agreement. The breach of agreement would not be discovered until the bidding was closed. Any punishment of such a firm would need to either take place outside of the auction process or wait until the next auction.

Another advantage of sealed bidding is that it will generally provide a greater return to the Government if there is only a single bidder. In an oral auction, a party will know whether he is the only bidder and if so, he could win the auction by submitting the minimum permitted bid. On

the other hand, in a sealed bid auction, a party cannot be sure he is the only bidder, so he would submit a bid closer to the value he places on the item.

Oral bidding, on the other hand, has several advantages over the standard sealed bid auction. First, oral bidding may be more likely to assign a license to the party who values it the most. Assuming bidders do not collude, the party with the highest willingness to pay would ultimately outbid all other parties in an oral auction. The price he would pay would be approximately the value placed on the item by the bidder with the second highest willingness to pay. In a standard sealed bid auction, the price paid is the high bid. Parties would shade their bids below the maximum amount they are willing to pay in order to avoid paying more than necessary to win the auction. In other words, the winner would like his bid to have been only slightly more than the next highest bid. Since in a sealed bid auction, bidders do not know precisely how much other parties will bid, it is possible that the bidder with the highest willingness to pay may not submit the highest bid. If this occurred, either the license would remain with a party who does not value it the most or additional transactions costs would be incurred in reselling the license. The second advantage of oral bidding is that it may have lower private costs than sealed bidding because it does not require estimation of the value other bidders place on the item.

2. Multiple Channel Sales

The Commission should also examine how to best structure an auction when applicants are bidding for multiple channels. If oral auctions were used, channels would be offered sequentially. Sequential auctions do not necessarily assure that groups of channels are assigned to their highest valued use when the value of one channel depends on how many and which other

channels one holds (Riley and Samuelson, 1981, p. 389). For example, suppose mobile licenses were auctioned off in 5 channel blocks, and an efficient trunking system required 20 channels. A new firm might wish to set up a mobile radio system only if it could acquire 20 channels. Such a firm would not know how much to bid in the first round of the auction if it was unsure how much it would cost to acquire the additional 15 channels in later rounds. It would not want to find itself owning only 15 channels at the end of the auction. This would be less serious a problem for the firm if it could resell the 15 channels after the auction or acquire 5 more channels from another firm. This would be like having additional rounds of the auction.

Sealed bid auctions could either be held sequentially like oral auctions, or parties could be allowed to bid simultaneously on all licenses. If applicants could simultaneously bid for as many channels as they wished, they could take account of the fact that the value of a channel may depend on what other channels one owns. If all channels to be auctioned were identical, each bidder could submit a "demand schedule" indicating the amount he would be willing to pay for each number of channels. A simplified variant would be to have each bidder indicate only a single desired quantity and his bid for that quantity. This is essentially the current method use for auctioning Treasury bills. The Treasury Department chooses the highest set of sealed bids that exhausts the total number of securities for sale. The FCC could use a similar procedure for auctioning identical channels.

Simultaneous bidding could also be used when each channel was not identical. Ideally, each buyer would submit bids for each subset of channels. Such an auction would require the FCC to develop a complex rule for determining who wins which items and at what price. In practice, such a system would surely be too complex to administer. Thus, it would appear

that for non identical channels, a simplified system of simultaneous bidding or sequential auctions would be preferable. One simple form of simultaneous bidding would be to allow parties to simultaneously place independent bids on several channels. More study is necessary to determine the best system to use in this situation.

3. Minimum Bid Requirements

The FCC should also consider establishing a minimum bid level. Certain theoretical studies of bidding suggest that the seller can increase his expected return by setting a "reservation" price below which it will not sell the item. (See Riley and Samuelson, 1981). For example, in a sealed bid auction the government's return might be greater because a reservation price could induce some buyers to raise their bids.

If it is decided to set a reservation price several additional questions must be addressed. First, should the reservation price be announced prior to the bidding? Currently, the Department of the Interior does not announce its reservation prices for oil or coal lease auctions. A second issue is how should the reservation price be determined? If the reservation price is not announced prior to the auction, should the FCC combine information provided by the bids with its own independent estimate of the license's value? In setting a reservation price should the FCC consider the value of the spectrum in other uses? For example, suppose the FCC does not know the value of a license to use 10 MHz for use A but it knows that the spectrum is worth approximately $5 million in use B. Should it set a reservation price of $5 million when auctioning the license for use A? A third question is how long should the Commission wait before reoffering the license if no bid exceeds the reservation price? If the FCC reoffers the license immediately and lowers its reservation price, the

original reservation price will be less effective in bringing forth the highest possible bids. On the other hand, waiting to reoffer the license would delay the onset of the benefits of using the spectrum.

The benefits of setting a reservation price are likely to be greatest when there are very few bidders. The primary cost of setting a refusal price would be estimating the value of the license. When competition is intense the benefits of setting a reservation price may not be worth the cost.

4. Payment Method

Finally, the FCC should examine various methods of receiving payment from winning bidders. The winner may be required to pay the entire amount of his bid in one payment or may be allowed to pay in installments. Allowing installment payments is equivalent to extending credit to the winner.

V. Summary and Conclusions

This paper has examined three possible methods of selecting among mutually exclusive radio license applicants. The method used for selecting an initial licensee does not appear to determine license ownership over the long term given the relative ease of reselling licenses. On the other hand, the costs of selection do vary depending upon the method employed. We considered private application costs, delay costs, and FCC costs. Our analysis suggests that auctions are superior to lotteries and comparative hearings in all three respects. The reason for this is that requiring the winner to pay for a license is an efficient way to reduce the number of parties seeking to obtain a valuable resource. In a cost comparison of the

three methods for a hypothetical cellular license, we estimate that auctions would roughly cost only 15% of either hearings or lotteries.

Auctions also have two other features to recommend them. First, they provide a return to taxpayers for the valuable consideration granted to licensees. Auctions also provide useful information about the relative value of services which could aid the FCC in its allocations proceedings.

It appears, however, that enabling legislation is needed prior to Commission use of auctions. Moreover, there will be some significant start-up costs to establish auctions. Nonetheless, the advantages of auctions far outweigh these disadvantages.

Assuming such authority is forthcoming, we recommend the Commission consider using auctions only in awarding licenses for currently unassigned channels. We do not recommend using auctions for license renewals because they would tend to diminish licensees' investment incentive without providing any offsetting efficiency gains, and they would also be inequitable. We also suggest that restrictions on trafficking of radio authorizations continue to be relaxed to assure that as circumstances change a license can be easily transferred to the party who values it the most.

Auctions should be seriously considered for making cellular radio assignments for markets beyond 120, assignments made following allocation of the land mobile reserve bands, and future satellite assignments. Auctions might also prove an efficient selection mechanism for common carrier paging assignments, and for assignments in the private and common carrier digital electronic message services (DEMS).

APPENDIX

A Description of the Assumptions Used to Estimate Costs in Table II

Number of Applicants

To develop a rationale for our assumptions about the number of applicants we begin by examining the behavior of a typical applicant. For this analysis we assume that a license ultimately has the same value to all applicants, but that this value (V) is not perfectly known until after the service has begun. Each applicant starts with the same beliefs about the value of a license and then conducts a market survey to improve his estimate of the license's value. After the surveys, applicants will differ in their beliefs about the value of a license. Additional risk neutral applicants will continue applying for a license provided the expected revenues from obtaining a license exceeds the cost of applying (C). In equilibrium the expected revenue will equal the expected cost of applying. The expected revenue can be expressed as the probability of winning (P) times the assignment's anticipated revenue. Given that all individuals are identical and sampled from the same population, each would expect to have the same probability of winning. With N applicants that probability would be 1/N.

In the case of a lottery, the typical applicant's estimate of the expected revenue if he wins is V. Thus in equilibrium $(P)(V) = C$, or $(1/N)(V) = C$, so $N = V/C$. That is, the equilibrium number of applicants in a lottery equals the value of holding the license divided by the cost per firm of entering the lottery. Note also, that in equilibrium, total

expenditures, (C)(N), equal the value of a license, V.

In the case of an auction the winner must pay for the license. Let B be the expected value of the winning bid. The expected revenue given that a bidder wins is (V-B). We assume as suggested by Wilson's (1977, p. 517) theoretical analysis, that the expected "profit" percentage given that the bidder wins, (V-B)/V, is proportional to 1/N. This says that the greater the number of bidders the smaller the percentage difference between the winning bid and the value of the item. Assume for simplicity that the proportionality factor is unity so (V-B) = V/N. In equilibrium, (P)(V-B) = c, or (1/N)(V-B) = c, where c is the cost of entering an auction. Substituting in the expression for (V-B) gives the equilibrium condition (1/N)(V/N) = c, or (N)(N) = V/c. Thus, under these assumptions, the number of applicants in an auction equals the square root of the value of a license divided by the cost of making a bid. Note too that the equilibrium conditions for an individual bidder, (1/N)(V-B) = c, imply that expected total private expenditures on obtaining a license, Nc + B, will equal the expected value of the license, V.

Processing Delay

We have assumed an average delay of 18 months for comparative hearings and 12 months for lotteries. These figures are consistent with the Commission's experience in cellular selections. Because far fewer applications are expected, auctions are assumed to impose a much shorter processing delay than lotteries. Some processing delays are probably not sensitive to the number of applications filed. Therefore, it is estimated that it will take roughly 25% as long to conclude an auction as it does a lottery (3 months) even though we expect only 5% as many applications.

Using the expression developed in footnote 16 above, these delays translate into $91,205 for comparative hearings, $62,304 for lotteries, and $16,162 for auctions.

Private Costs

Based on discussions with cellular industry officials, we estimate that the average cost of preparing and pursuing an application is on the order of $130,000 for a comparative hearing and $3,500 for a lottery. We estimate that the cost of preparing an application and bidding strategy for an auction would be about three times greater than a lottery, or about $10,000.

FCC Costs

FCC officials suggest that the cost of logging, filing, storing and prescreening the 5000+ Round IV lottery applications is about $140,000.[28] This figure translate into about $5,000 for an average market (170 applications). Because an auction will attract fewer applicants, we estimate FCC costs to be about 20% ($1,000) of those incurred in a lottery. With respect to the professional costs for comparative hearings, we observed that 13 professionals (estimated average annual salary $40,000) worked full time for two years to dispose of the 60 Round I cellular comparative hearings. This is an average of about $20,000 per mutually exclusive case. This average was used in constructing Table II.

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28 This assumes about 800 square feet of storage space at $25/sq ft/year, and 4 full time staff positions at $30,000/year.

References

Agnew, Carson E. "Alternative Radio Licensing Arrangements: A Case Study of the Multipoint Distribution Service," Telecommunications Policy, (June 1983).

Bhagwati, Jagdish. "Directly Unproductive, Profit-seeking (DUP) Activities," Journal of Political Economy (October 1982).

Coase, R. "The Federal Communications Commission," Journal of Law and Economics, vol. II (October 1959), pp. 1-40.

"Fowler Asks Congress for Auction Legislation," Communications Daily, May 3, 1985.

DeVany, A.S., R.D. Eckert, C.D. Mayers, D.J. O'Hara and R.C. Scott. "A Property System for Market Allocation in the Electromagnetic Spectrum: A Legal-Economic-Engineering Study," Stanford Law Review, vol. 21 (1969), pp. 1499-1561.

Englebrecht-Wiggans, Richard. "Auctions and Bidding Models: A Survey," Management Science, (February 1980), pp. 119-142.

Krueger, Anne. "The Political Economy of the Rent-seeking Society," American Economic Review (June 1974).

Mathtech Inc. and Telecommunications Systems. Economic Techniques for Spectrum Management: Final Report, (December 20, 1979).

"Cellular Checklist," Personal Communications Magazine, January/February 1985.

Riley, John G. and William F. Samuelson. "Optimal Auctions," American Economic Review, (June 1981), pp. 381-392.

Robinson, John O. "Assignment of Radio Channels in the Multipoint Distribution Service by Auction," Proceedings of the Sixth Annual Telecommunications Policy Research Conference (Lexington: Lexington Books, D.C. Heath and Co., 1979).

"SMR Database," Telocator vol. 9, no. 1, January 1985.

Webbink, D.W. Frequency Spectrum Deregulation Alternatives, Office of Plans and Policy Working Paper No. 2, Federal Communications Commission, (October 1980).

Wilson, Robert. "A Bidding Model of Perfect Competition," Review of Economic Studies, (October 1977), pp. 511-518.

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