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## **OPP Working Paper Series**

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# **16**

### **Using Auctions to Select FCC Licensees**

**May 1985**

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\*/ The opinions and conclusions in this paper are those of the authors. They do not necessarily reflect the views of the Federal Communications Commission or any other organization or individual.

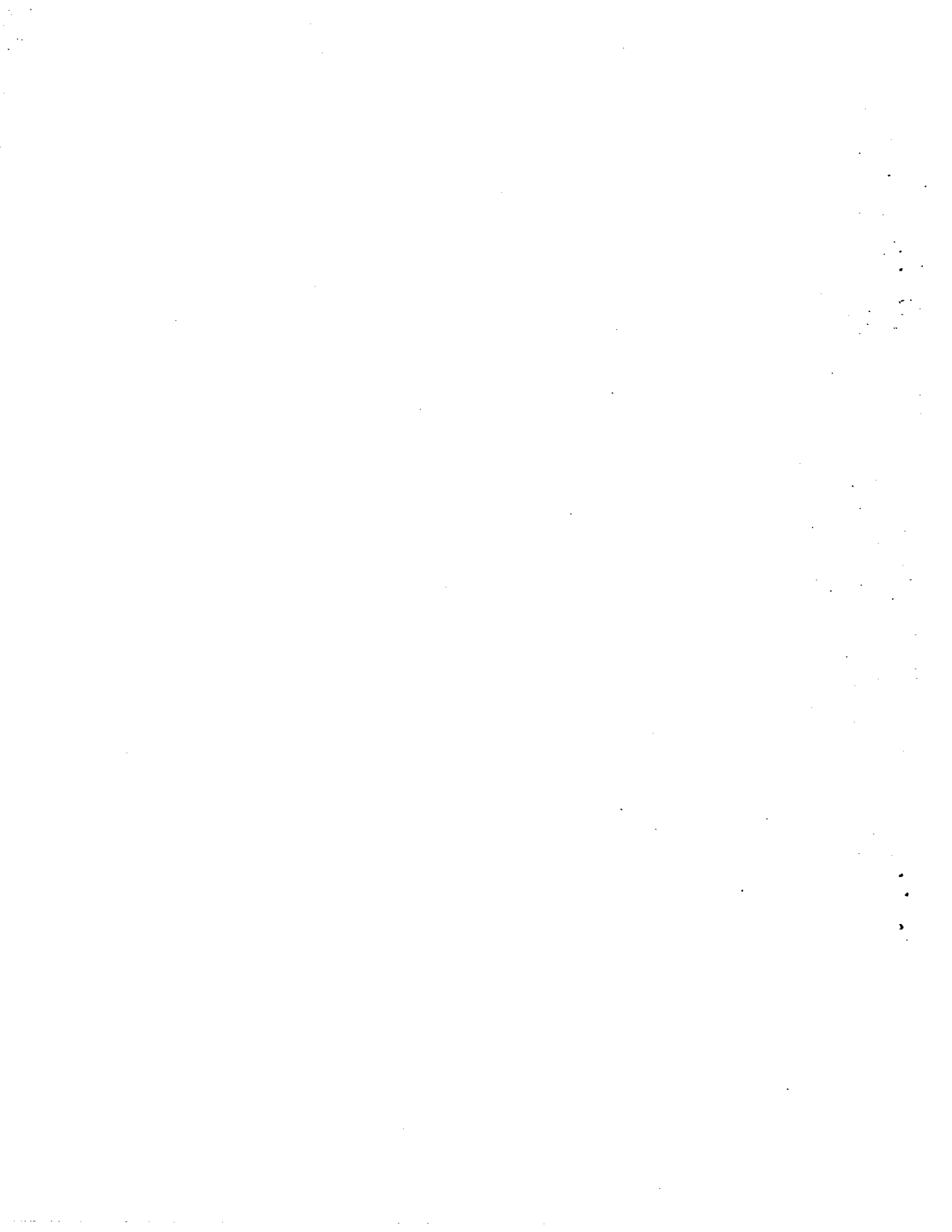
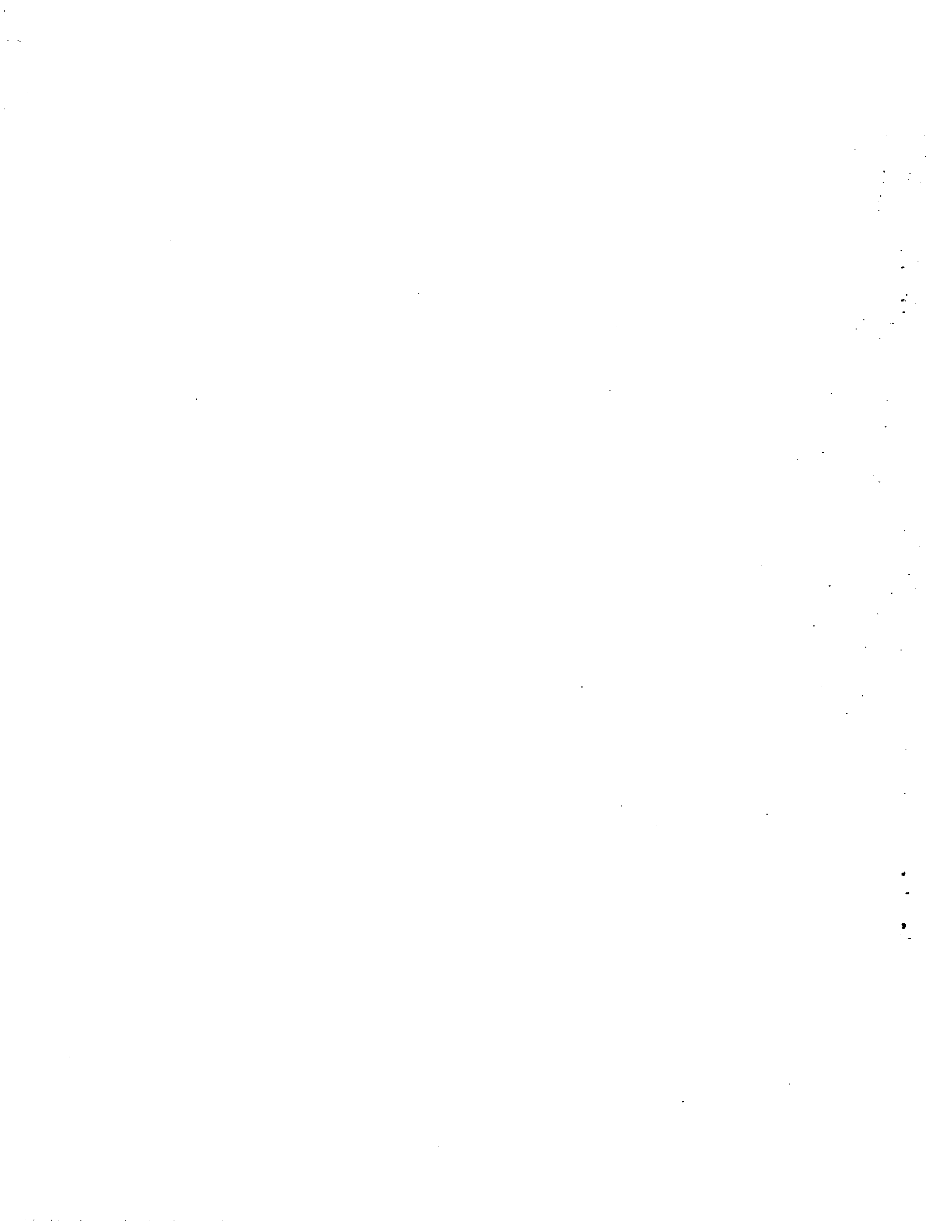


TABLE OF CONTENTS

I.	Introduction.....	1
II.	Description of Alternative Procedures for Selecting FCC Licensees.....	2
	A. Comparative Hearings.....	3
	B. Lotteries.....	4
	C. Auctions.....	6
III.	Comparison of Selection Procedures.....	7
	A. Effect on Ownership.....	8
	B. Delay in Making Assignments.....	11
	C. Private Application Costs.....	12
	D. Cost of Administering Selections.....	14
	E. Other Considerations in Choosing Among Selection Methods.....	14
	F. Illustrative Comparison of Selection Schemes.....	16
IV.	Auction Implementation.....	20
	A. Legal Issues.....	21
	B. Auction Design.....	21
	1. Bidding Method: Sealed vs. Oral Bidding.....	22
	2. Multiple Channel Sales.....	23
	3. Minimum Bid Requirements.....	25
	4. Payment Method.....	26
V.	Summary and Conclusions.....	26
Appendix	A Description of the Assumptions Used to Estimate Costs in Table II.....	28
	Number of Applicants.....	28
	Processing Delay.....	29
	Private Cost.....	30
	FCC Costs.....	30
	References.....	31
	Acknowledgements.....	32



## USING AUCTIONS TO SELECT FCC LICENSEES

### I. Introduction

As part of its duties under the Communications Act of 1934, as amended, the Federal Communications Commission (FCC) is charged with managing the radio frequency spectrum.<sup>1</sup> Traditionally, the Commission has performed this duty by first allocating a portion of spectrum in a given area to a particular purpose. Then the Commission assigns channels within an allocation to individual licensees. Both allocations and assignments have important implications for consumer welfare and have been the subject of many public policy analyses.<sup>2</sup> This paper examines only the assignment process and assumes no changes are made in either the current eligibility criteria for holding a license or the terms, conditions or rights of a license. The basic approach used here is the same as that used by Carson Agnew (1983) in his study of alternative licensing arrangements for multipoint distribution service (MDS).<sup>3</sup> We conclude that in most cases auctioning previously unassigned channels is likely to result in the same ultimate assignment as present mechanisms. But because they require winning bidders to make substantial payments in return for being licensed, auctions are an efficient way of reducing the number of applicants. Thus,

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1 See, 47 U.S.C. Section 301.

2 See, e.g., Coase (1959), DeVaney et. al. (1969), Mathtech, Inc. (1979) and Webbink (1980).

3 Agnew (1983) builds upon an earlier analysis by Robinson (1979).

auctions are likely to impose lower costs on the Commission and society than the other methods considered.

The plan of the paper is as follows: Section II reviews three possible assignment methods, of which two are currently used by the FCC. Section III compares these schemes in cost/benefit terms. Section IV discusses various auction designs and implementation options. Section V summarizes our results and presents conclusions.

## II. Description of Alternative Procedures for Selecting FCC Licensees

A radio channel that is assigned to only one party is said to be exclusive. If more than one party applies for a given exclusive channel, these applications are said to be mutually exclusive. Because of both statute and court precedent, the Commission is required to consider certain applications as mutually exclusive even if they are not submitted at precisely the same instant.<sup>4</sup>

There are three methods that could be used to select among mutually exclusive applications: comparative hearings, lotteries, and a system of competitive bids (auctions).<sup>5</sup> The first two processes are

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4 See, 47 U.S.C. Section 309(e), United States v. Storer Broadcasting, 351 U.S. 192 (1955), Ashbacker Radio Corp. v. FCC, 326 U.S. 327 (1945), and, Johnston Broadcasting v. FCC, 175 F.2d 351 (D.C. Cir. 1949).

5 A fourth system, "first-come first-served," has recently been adopted by the Commission for FM broadcast allotments. This procedure has two steps. First, applications will be accepted for specific allotments for a specified time period (a so-called filing "window"). Mutually exclusive applications filed during the window will be processed normally, *i.e.*, by either lottery or comparative hearing. If no applications for a particular channel are filed during the window, subsequently filed applications will be processed on a first-come first-served basis. See, Report and Order in Docket 84-750, 50 Fed. Reg. 19,936 (May 13, 1985).



TABLE I

## SUMMARY OF SERVICES WITH PENDING MUTUALLY EXCLUSIVE APPLICATIONS

<u>Service</u>	<u>Frequency</u>	<u>No. of Applications</u>
Common Carrier Paging, 2-way	Low/High VHF UHF & 900 MHz	3,000 <u>a/</u>
Common Carrier Cellular	806 - 890 MHz	5,000 <u>b/</u>
Private Multiple Address	952 - 960 MHz	270 <u>c/</u>
ITFS	2500 - 2690 MHz	580 <u>d/</u>
OFS	2500 - 2690 MHz	2,200 <u>e/</u>
MDS	2150 - 2156 MHz	276 <u>f/</u>
MMDS	2500 - 2690 MHz	16,239 <u>g/</u>
Common Carrier DEMS	10 & 18 GHz	1,754 <u>h/</u>
Private DEMS	10 & 18 GHz	600 <u>i/</u>
LPTV	VHF/UHF-TV	20,000 <u>j/</u>
Total Number of Applications		49,919

## Notes:

a/ As of September 30, 1984.

b/ Figure is approximate and is for markets 91 - 120.

c/ Figure is approximate as of October 1, 1984.

d/ Instructional Television Fixed Service. As of December 31, 1984.

e/ Operational Fixed Service. Approximate as of October 1, 1984.

f/ As of September 30, 1984.

g/ Multichannel Multipoint Distribution Service.  
As of September 30, 1984.

h/ Digital Electronic Message Service. As of September 30, 1984.

i/ Figure is approximate as of October 1, 1984.

j/ Figure is approximate.

loses an income stream; the public is without an additional service. But because delay favors existing licensees, they have strong incentives to file petitions to deny or otherwise utilize the administrative process as a means of retarding competitors' entry.

#### E. Lotteries

In recognition of these and other problems, the Congress in 1982 gave the Commission permissive authority to award licenses by random selection.<sup>7</sup> The FCC's initial experience with lotteries suggests that this method has its own significant difficulties. Once it became known that the lottery entry requirements were reasonably low, many individuals elected to participate. In the Low Power Television Service (LPTV) alone there are about 20,000 applications awaiting lottery. As Table I illustrates, the Commission now has nearly 30,000 mutually exclusive applications in services other than LPTV, most of which will probably be processed through a lottery. The Commission has temporarily suspended accepting applications for many of these services. Once this freeze is lifted, however, it is expected that many tens of thousands of new applications will be filed.

To some extent the Commission anticipated the flood of lottery applications. It has attempted to reduce its administrative burden by creating narrow filing "windows" and encouraging settlements among applicants. These techniques have enjoyed some success. But applicants

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<sup>7</sup> See, 47 U.S.C. Section 309(i). For a discussion of when lotteries may be used and how they should be structured, see, Communications Amendments Act of 1982, Conference Report, 97th Congress, Report No. 97-765, August 19, 1982.

have, in turn, adjusted their filing strategies. Hence, with each new call for lottery applications, larger numbers of applications are received.

### C. Auctions

A third possible selection method is a competitive bidding system where licenses are awarded to those users willing to pay the most for them. Although they have never been used to award radio licenses, federal government experience with auctions is longstanding and extensive.

The U.S. Department of the Interior (DOI), for example, has been successfully auctioning leases on tracts in the Outer Continental Shelf (OCS) for 31 years. The OCS is a major source of domestic oil and gas production, and between 1954 and 1983 total revenues from the auctions program were approximately \$68 billion. Under the OCS Lands Act of 1953, private parties submit sealed bids for the right to explore and develop a specified tract on the OCS.<sup>8</sup> The DOI has used a number of different systems for auctioning leases. Currently, a tract is leased to the party offering the highest up front "cash bonus" provided there are at least three bids. If there are fewer than three bids, the high bid is not accepted unless it exceeds the U.S. Geological Survey's estimate of the tract's value. In addition to paying a cash bonus for a tract, the lessee must also pay the government a fixed share of the revenues produced on the tract. The "royalty rate" is typically 16 2/3 percent of the market price of the oil and gas at the wellhead. About 30 percent of the total government revenues from OCS leasing have come from royalty payments. The primary economic reason for relying on a royalty system in addition to cash bonus bids is

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8 See, 43 U.S.C. Sections 1331 - 1356.



#### A. Effect on Ownership

The initial method of selecting a license may have little effect on who ultimately holds it because FCC licensees have considerable freedom to trade their authorizations.<sup>10</sup> , <sup>11</sup> There is some evidence to support this

<sup>10</sup> It was obviously Congress' intent to allow licensees to trade authorizations when it is in their economic interest to do so. Even though the Act requires Commission approval prior to license transferral or assignment, it prohibits the Commission from considering the possible effects of transferring or assigning a license to any entity other than the one proposed. See, 47 U.S.C. Section 310(d).

Between 1962 and 1982 broadcasters were required to hold their station licenses at least three years. On the grounds that the competitive broadcast environment would prevent significant service deterioration in the absence of this restriction, the FCC relaxed the antitrafficking rules in 1982. At present, most broadcast authorizations may be reassigned at any time. However, licenses won in a comparative hearing or due to lottery preferences are still subject to a one year holding period. Furthermore, for-profit sale of construction permits is generally prohibited. See, Report and Order in Docket 81-897, 47 Fed. Reg. 55,924 (December 14, 1982). Common carrier microwave licenses are also subject to a one year holding period if they are awarded through a comparative hearing. See, 47 CFR Section 21.40. In the Public Mobile Services, 35, 43, and 900 MHz paging construction permits and licenses are freely transferable, while other authorizations may be transferred for profit only after systems have been constructed. See, 47 CFR Section 22.40. Private radio licenses may be assigned directly to a new entity, or they may be assigned indirectly via a transfer of control of the firm which holds the licenses. See, 47 CFR Section 1.924.

<sup>11</sup> Two qualifications to this statement come to mind. First, if all applicants are equivalent, the initial selection method will determine the final user because by assumption no other party would be willing to offer to pay the initial licensee more than it is worth to him. Of course, in this case it doesn't matter, from the viewpoint of economic efficiency, which applicant receives the license. Second, high transactions costs may prevent resale even if applicants differ in their valuations of the license. For example, suppose there are only two parties who put a positive value on the license and that party A values it \$100 more than party B. If the government held an oral auction party A would bid the highest and receive the license. If, however, the government used a comparative hearing or lottery to assign the license, party B might receive it. If reselling the license cost more than \$100, party B would be the ultimate holder of the license because the cost of reselling it would exceed the additional value party A placed on it. This just illustrates the inefficiency of not using an auction initially.

that oil exploration is an extremely risky enterprise and royalties provide for a sharing of this risk between the government and private parties.

Discussions with DOI officials indicate that the sealed bid auctions have been relatively simple to administer and free of any charges of corruption.

Sealed bid auctions are also used to award Federal coal leases.<sup>9</sup> The DOI estimates the value of the tracts before the auction. These estimates are used to determine whether or not to accept a high bid. Although the DOI does not disclose its estimate of a tract's value before the auction, it does set a minimum bid of \$100 per acre.

Other examples of federal auctions are: Treasury Bill auctions (31 U.S.C. Section 3121(a)); leases of geothermal steam land (Geothermal Steam Act of 1970, 30 U.S.C. Section 1003); auctions of seized and unclaimed property (Tariff Act of 1930, 19 U.S.C. Sections 1491, 1609, 1612); disposing of surplus equipment by the General Services Administration (40 U.S.C. Section 484(e)); and, disposing of dead seamen's effects (46 U.S.C. Section 621).

### III. Comparison of Selection Procedures

In this section comparative hearings, lotteries, and auctions are compared with respect to their ownership effects, processing speeds, private costs, and government costs. Other considerations in choosing among selection methods are also discussed.

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<sup>9</sup> See, Mineral Leasing Act of 1920, as amended, 30 U.S.C. Section 181 et. seq.

December 1984, for example, the FCC approved over 100 license reassignments. This represents roughly 5% of the total number of SMRS licenses granted to date.<sup>14</sup> The satellite aftermarket has also been quite active, although here activity has been in the sale and lease of individual transponders rather than complete satellites.<sup>15</sup>

Lotteries have been in use too short a time for there to be much evidence of trading of licenses awarded in this manner. But there is every reason to expect that such trading will occur. In fact, because the Commission was concerned that post grant trading could thwart the goals of its minority and ownership preferences used in the LPTV lottery, it prohibits reassignment of these licenses for a minimum of one year after grant.

Since the assignment method has little effect on who holds a license in the long run, we conclude that ownership distributions would not be significantly changed if initial authorizations were awarded by auction. But, as will be argued in the following section, auctions would reduce the delays and transactions costs involved in initial assignments and avoid the need for resale.

This conclusion about the ultimate ownership distribution should lay to rest any concerns that under an auction large firms would monopolize

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14 Source: official FCC records. In spite of this active trading, the SMRS market is in no sense concentrated. The top 20 operators control less than 35% of all the systems and only about 12% of all the mobiles currently in use. [Source: Telocator (1985)].

15 Of the 750 authorized satellite transponders, 128 have been sold for use by non-common carriers. See, The Western Union Telegraph Co., mimeo no. 5049, June 26, 1984; and, letter from James R. Keegan, Chief, Domestic Facilities Division, Common Carrier Bureau, FCC, to Philip Walker, GTE, dated January 30, 1985.

view. For example, in 1983 sixty-five percent of commercial television licenses were held by someone other than the initial licensee.<sup>12</sup> Thus, the qualifications of most present-day broadcasters were never considered in a comparative context.

Transfers and assignments are also common in the Public Mobile Services (PMS). In recent years, for example, the FCC has annually processed over 600 applications for reassignment or transfer of licenses.<sup>13</sup> Although many of the major radio common carriers' first radio licenses were initial grants, many of their subsequent licenses were acquired from other parties. In the cellular service many applicants have elected to reach settlements amongst themselves rather than face the uncertainties of either comparative hearings or lotteries. The Commission has generally honored these agreements and in those cases where all mutually exclusive applicants have settled, the agency has issued an authorization without utilizing any selection procedure. Although the item being traded is an expectation of an authorization rather than an actual license, these settlements may amount to de facto trafficking and add additional support to the proposition that the type of selection mechanism employed by the FCC is irrelevant to the public.

Even though the private carrier Special Mobile Radio Service (SMRS) is much younger than either broadcasting or PMS, there has been some activity in the license aftermarket in this service, too. Between May and

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<sup>12</sup> A study of ownership of radio and television stations (licenses and construction permits) was conducted by FCC staff in July 1983. Records for 995 commercial television stations were examined. Of these, 650 (65%) licenses were assignments rather than original grants. Records of a sample of 823 commercial radio stations (roughly 10% of the total) were also examined. Of these, 615 (75%) were assignments rather than original grants.

<sup>13</sup> Source: discussions with FCC officials. This total includes applications for cellular settlements.



the assignment's value, a two year delay imposes a 17% penalty, and a three year delay a 25% penalty.<sup>16</sup>

Comparative hearings are generally lengthy proceedings. Broadcast cases often go on for two years or longer. Even the especially streamlined hearings used to grant cellular radio licenses in the top 30 markets averaged 18 months in length.<sup>17</sup>

Lotteries have proven to be slower than expected. Most of the delay is created by huge numbers of applications, each of which must be logged, filed and prescreened prior to selection. Over 5000 applications were filed for cellular radio markets 91 - 120 (Round IV), and it is our best guess that the processing delay in these cases will average at least 12 months.

Auctioned assignments will probably attract far fewer applicants than lotteries because under an auction the winner must pay for the license. Thus, administrative delays will likewise be much shorter.

### C. Private Application Costs

Comparative hearings and lotteries use up a great deal of real

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16 This assumes delay is of the form of pushing back in time all costs and revenues by the amount of the initial delay. The delay costs would be greater if some benefits are reduced in addition to being postponed, or smaller if the delay in getting a license only marginally delays the beginning of the benefit stream. These calculations use the fact that the present discounted value of I dollars received T years from now, with a nominal interest rate of r per year, is  $I/(1+r)^T$ .

17 Source: Personal Communications Magazine (1985). Not all cellular licenses in these markets were awarded following a hearing. In some markets all applicants reached mutually beneficial "settlements" prior to hearing. Eighteen months is the expected delay between application date and date of construction permit grant for all non-wireline licenses in the 30 markets regardless of whether a hearing was actually held.

spectrum. We believe that this is unlikely for at least four reasons. If such firms were willing and able to monopolize spectrum under auctions, they could also do so under the current selection schemes by purchasing licenses from parties that won the initial assignment. Yet monopolization has not been observed in spectrum, nor has it been observed for other resources such as land that are also fixed in supply. Moreover, apparently no firm has sufficient wealth to buy up all the spectrum. Thirdly, since much of the usable radio spectrum has already been assigned, monopolizing the spectrum is unlikely to be a profitable strategy unless it could be accomplished without alerting the present holders of licenses. Otherwise existing licensees would hold out for high prices so as to reap much of the potential gains from monopolizing the market. Finally, any move to "corner the spectrum market" would presumably violate existing antitrust laws.

B. Delay in Making Assignments

Each assignment mechanism imposes a delay cost upon both the licensee and the public. The public's cost due to loss of service is difficult to estimate. But the cost imposed upon the successful applicant can be estimated by calculating the difference between the present value of the assignment under both delayed and non-delayed scenarios. With a nominal annual interest rate of 10%, a one year delay imposes a cost equal to 9% of

D. Cost of Administering Selections

There are two components to the cost incurred by the FCC in selecting among mutually exclusive applicants. One is "professional" cost. This includes the money spent on salary and support for professionals to review and analyze applicant documentation, and select a licensee. For example, professional costs are the major component of the FCC expenditures for a comparative hearing before an administrative law judge. We refer to the other cost category as "administrative." It includes money spent on space to house applications, as well as salary and support for the staff who records applicant information and maintains the documents. For lotteries and auctions, FCC costs are primarily administrative. Auctions would have lower administrative costs than lotteries because they would attract fewer applicants.

E. Other Considerations in Choosing Among Selection Methods

Auctions could prove attractive to taxpayers not just because they would reduce FCC costs but because they would provide a return for the valuable consideration granted licensees. The revenues raised through auctions would also help reduce the budget deficit.

Auctions could also provide the Commission with useful information on the value of spectrum in alternative uses. The amount bidders are willing to pay for a license reflects their estimates of the value customers place on the service they propose to provide. The Commission should consider reallocating spectrum to the higher valued use if it were to find that the bids on licenses for one use greatly exceeded

resources (primarily the time of legal, engineering, and economic consultants).<sup>18</sup> Auctions, however, involve primarily a transfer of resources (to the government in the form of the winning bid). Hence the use of auctions to award licenses could substantially reduce the total private and public resources expended in the process.

Consider the case of identical risk-neutral buyers.<sup>19</sup> Here the total spent by the private sector applying for a license would, on average, be equal to the value of the license under all assignment methods.<sup>20</sup> But with an auction, part of the private cost is the payment to the government for the license. So in this particular case an auction would reduce the real resources used up in "rent-seeking" by the amount of the payment to the government.<sup>21</sup>

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18 Note that much of these resources are not "wasted" for successful applicants, because presumably the contribution of these consultants would be valuable in formulating a business. For unsuccessful applicants, however, all these expenditures are truly wasted, and represent a waste to society as well.

19 A risk-neutral buyer would be indifferent about accepting an actuarially fair bet (one with a zero expected value, *i.e.*, an equal chance of winning or losing) and would take a bet whose expected value is positive. A risk averse buyer would not accept an actuarially fair bet.

20 The total expenditures by the private sector could be less than the value of the license if firms differ in their cost of applying for a license. For example, suppose the value of a license were \$1,000 and it cost firm "A" \$100 to enter a comparative hearing application, firm "B" \$400 to enter, and firm "C" \$750 to enter an equivalent application. Assume further that each firm has an equal chance of winning a comparative hearing. Firms "A" and "B" would enter, but firm "C" would not. Firm "A"'s expected return would be  $0.5 \times \$1000 - \$100 = \$400$ ; firm "B"'s expected return would be \$100. The total private expenditure would be \$500, only half the value of the license.

21 In this case, rent-seeking is the private pursuit of valuable government licenses. The term "rent-seeking" was coined by Krueger (1974). For a more general discussion of such "directly unproductive, profit-seeking activities," see Bhagwati (1982).

There is no offsetting efficiency gain to be achieved by either levying a fee on current licensees or conducting an auction as part of the license renewal process. Neither of these things would do anything to reduce the delay in getting a license to the user who values it the most. Given that licensees are free to resell stations, the license has already been assigned to the party willing to pay the most for it. Moreover, neither spectrum fees nor renewal auctions can recover the transactions costs expended by the private sector and the FCC in making the initial assignment. Finally requiring existing licensees to pay the imputed value of their assignment through fees or auctions would be inequitable to the parties who already implicitly paid for their spectrum either when they bought a station or when they incurred the expenses of a comparative hearing.

#### F. Illustrative Comparison of Selection Schemes

In this section we develop estimates of the costs incurred in selecting non-wireline cellular licensees in a "typical" Round IV market (i.e., 91 -120) under a comparative hearing, a lottery, or an auction. Table II summarizes our results. The assumptions used to construct these cost estimates are detailed in the appendix, but will be briefly discussed here. The central assumption in constructing the illustration is that in equilibrium the total expenditures made by private parties in obtaining a valuable resource will on average equal the value of that resource. If total expenditures were less than the expected value of the resource, it would pay another party to apply since the expected gain would exceed the expected cost of applying, assuming all applicants are identical and risk neutral. If, however, applicants differ in their cost of applying or are risk averse, the total expenditures by private parties would be less than

the bids on licenses for similar spectrum allocated to another use.<sup>22</sup>

These findings of efficiency gains from auctions only apply in the case of selecting licensees for unassigned channels. Allowing auctions for vacant assignments is not a first step toward establishing license fees for current users or conducting an auction as part of the license renewal process.<sup>23</sup> Establishing license fees based on annual revenues or auctioning licenses already assigned would, in effect, change the terms of licenses. Either policy might reduce economic efficiency. A license fee that was some percentage of the revenues of the firm holding the license would be equivalent to an excise tax and thus tend to reduce the output of the firm. To the extent that investment is tied to a particular channel, auctioning licenses at renewal appears to be analogous to having the government own all the land in a city and auction off parcels for five year terms. Such a system would tend to discourage investors from building long lasting structures. Such a system might allow the government to appropriate part of the gain in property value resulting from the lessee's investment. Similarly, under auctions of licenses at renewal, licensees would tend to be discouraged from investing in equipment, training, and marketing that would have little value without a license.

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22 It is important to understand the limited nature of the proposal discussed here. We are proposing that auctions be used only to choose among potential users. The use of the spectrum would continue to be determined by an administrative process. Even greater public benefits could be achieved, however, by allowing winning bidders increased flexibility in what they do with their assignments.

23 One must distinguish between license fees based purely on revenues and those based on the cost the licensee imposes on others, including the government. To the extent that the "cost of regulation fees" the FCC recently proposed to Congress reflect the social marginal costs caused by a licensee, these fees would be efficiency enhancing.

TABLE II

Comparison of Methods of Selecting Non-Wireline  
Cellular Licensees in a Hypothetical Market  
(Typical of Markets 91 -120)

	Comparative Hearings	Lotteries	Auctions
<b><u>ASSUMPTIONS</u></b>			
Value of a License w/o Delay	\$657,304	\$657,304	\$657,304
Value of a License w/ Delay	\$566,099	\$595,000	\$641,142
Private Cost per Application	\$130,000	\$3,500	\$10,000
Number of Applicants	4	170	8
Processing Time Mths.	18	12	3
Annual Interest Rate	0.1	0.1	0.1
<b><u>COSTS</u></b>			
Private Application Costs	\$520,000	\$595,000	\$80,000
Delay Costs	\$91,205	\$62,304	\$16,162
FCC Costs	\$20,000	\$5,000	\$1,000
Total Costs	\$631,205	\$662,304	\$97,162
<b><u>REVENUES</u></b>			
Government Revenue	0	0	\$561,142





the expected value of the resource in equilibrium.<sup>24</sup> Moreover, an equilibrium may not prevail if the procedure used to award licenses is not used repeatedly in similar markets. Without such repetition, applicants may not have a good estimate of how many others will apply. Despite these qualifications, the assumption that total private expenditures equals the value of the license is a useful benchmark case for illustrating the differences among selection methods.

This assumption along with information about the results of the lottery held for cellular licenses in markets 91 - 120 was used to derive the value of a license. There were approximately 170 applicants (on average) for each non-wireline license in markets 91 - 120, and we estimated that the average cost of preparing and pursuing an application for a lottery was \$3,500. Multiplying these two numbers together gave the total expenditures of lottery applicants in a typical market. This number, \$595,000, was used as the value of a license to a typical applicant. The value would have been greater if the license were awarded immediately instead of at the end of a long selection process. We assumed that the processing delay in using a lottery would be approximately 12 months. Absent this delay a license would be worth \$657,304, assuming a 10% annual interest rate (compounded monthly).

The number of applicants in a comparative hearing was calculated by dividing the estimated private cost per applicant, \$130,000, into \$566,099, the value of a license awarded after an 18 month comparative hearing process. We rounded down because if more than 4 applicants entered,

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24 See footnote 20 for an illustration of this for the case of variation in application costs across firms.



under comparative hearings. For the same reason, auctions would also impose the least costs on the FCC.

Adding up the three cost categories, the total cost of assigning a license using an auction would be under \$100,000 per market, while the cost would be over \$600,000 per market using comparative hearings or lotteries. The reason auctions have lower social costs is that making the winner pay for the license is an economical way to reduce the number of applicants, while generally assuring that the license is awarded to the applicant who values it the most. In our illustrative example, the expected value of the winning bid is \$561,142, the difference between the private application costs and the value of the license. This bid goes to the government. Thus, under our assumptions, auctions would have generated almost \$17 million in government revenue if they had been used to award all 30 non-wireline cellular licenses in markets 91 - 120.

Auctions were predicted to have significantly lower costs than other assignment mechanisms in a similar study by Carson Agnew. Agnew (1983) estimated that the cost of assigning a license in the Multipoint Distribution Service using auctions would be only 25% the cost of comparative hearings and 27% the cost of using lotteries.

#### IV. Auction Implementation

Regardless of the selection mechanism employed, there are start-up costs that must be considered. For example, the comparative hearings that were used to award many Round I cellular licenses required the development of comparative criteria, the assembling and training of professional staff, and the establishment of acceptance and filing procedures for applications. Lotteries required the acquisition of enabling legislation, the development

the total private expenditures would exceed the value of the license.<sup>25</sup> For auctions the private expenditures include the amount of the bid paid by the winner, as well as the application costs incurred by all applicants. Under these circumstances the number of applicants will clearly be less than the number obtained by dividing the assumed average application cost of \$10,000 into \$641,142 the value of a license awarded after a three month delay. A theoretical bidding model developed by Wilson (1977) suggests that the equilibrium number of applicants in an auction will approximately equal the square root of the value of a license divided by the cost of making a bid. Thus, for our hypothetical example we estimate that there would be eight auction applicants. The intuition behind this result is discussed in the appendix.

In our hypothetical example, auctions are clearly superior to either comparative hearings or lotteries in all respects. First, private application costs (which do not include the winning bid since it is a transfer) would be only \$80,000 in a typical market if auctions were used as opposed to over \$500,000 if either comparative hearings or lotteries were used. In other words, adopting auctions would release over \$400,000 in legal, economic, administrative, and other resources which would otherwise be used in applying for licenses. Second, the cost of delay under an auction would be only about \$16,000 per market as opposed to approximately \$62,000 under lotteries and \$91,000 under comparative hearings. Auctions would have the least delay because they would generate fewer applicants than lotteries and not require the extensive judgmental decisions necessary

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<sup>25</sup> We note that when the FCC used comparative hearings to make the 30 Round I non-wireline cellular assignments, it received an average of about 4 applications per market.

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

of application and processing requirements through rule making, the creation of selection procedures, and the assembling and training of the staff necessary to make the random selection.

Auctions, likewise, will incur start-up costs. First, we believe the Commission must obtain explicit legislative authority to establish auctions. Application, processing and selection details must also be resolved. These are likely to be much more complex for auctions than lotteries. In this section we briefly review the Commission's legal authority to conduct auctions and suggest some issues the Commission should use to frame an analysis of various auction designs.

#### A. Legal Issues

There exists considerable uncertainty as to whether the Commission presently possesses the necessary legal authority to conduct auctions of unassigned radio channels.<sup>26</sup> This fact suggests that should they be employed absent new legislation, litigation is likely. The magnitude of the costs associated with litigation is difficult to estimate, but it is likely to be substantial. Since we see auctions as a way of reducing social cost, we recommend the Commission obtain requisite enabling legislation prior to using them.<sup>27</sup>

#### B. Auction Design

A number of subtle issues regarding the form of an auction must

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<sup>26</sup> See, e.g., Report and Order, Cellular Lottery Selection, 55 RR 2d 8 (1984).

<sup>27</sup> FCC Chairman Mark Fowler recently submitted draft auction legislation to Congress. See, Communications Daily (1985).

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 used 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

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



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

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

## 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

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).

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

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.

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E.K.

A.D.F.

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