Tom Whitehead ———

I thiel thought you might wish, if you think well of it, to put in a word for one of our proposed presidential efforts, in behalf of Mobile Radio. We have some support, but have wandered into a stalemate at FCC between the offices of Plans & Policy and the Chief Engineer, which doesn't help when one has to deal with Al Sherman at NSF. In any event, I leave a copy of the prop for your perusal.

Cordy Bowen
CHES, MIT
2/15/74

Proposal Submitted to the
National Science Foundation
Division of Social Systems and Human Resources

land mobile

by

Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

entitled

ECONOMIC AND TECHNICAL SPECTRUM MANAGEMENT INQUIRIES IN LAND-MOBILE RADIO

Amount Requested $82,130 (total budget of $100,995 includes $18,825 already budgeted in Grant GI-38912 for December 1, 1973 to June 30, 1974)

Proposed Effective Date: December 1, 1973 Proposed Duration: One Year

Endorsements

Co-Principal Investigators:

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Associate Professor of Economics

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Dept. of Electrical Engineering

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C. Cary Brown, Head
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George H. Dummer
Administrative Director
Office of Sponsored Programs

Date: October 3, 1973

CONTENTS

ABSTRACT

Since the appearance of the Final Report of the Task Force on Telecommunications Policy, increasing criticism has been directed towards the F.C.C's regulation of the electromagnetic spectrum. Absent an economic measure of the benefits of spectrum use, informed allocations policies are not easily reached. The proposed research isolates one small, but important, use of the spectrum -- land mobile radio -- seeking to develop a technically informed rationale for measuring the opportunity cost of spectrum among various present and prospective land-mobile uses. This proposal coincides with the first major effort by the Federal Communications Commission to decentralize land-mobile spectrum allocations and to collect detailed data on spectrum usage in Chicago and, prospectively, other sections of the country. This intensive data-gathering effort may be exploited in the proposed research to cast some light upon the important determinants of the demand for spectrum space. Complemented by a variety of technical and economic approaches, the research should lead to a more definitive measure of the value of spectrum in alternative uses than any currently available. This principal result may then be used to evaluate the range of alternatives currently and prospectively facing the F.C.C. as it attempts to develop improved stragegies for allocating and assigning land-mobile channels. Moreover, it is the hope of the principal investigators that the methodology developed in this study will be useful in investigating allocations policy in other areas of the spectrum.

recent criticism of FCC allocating

Many suspect, however, that the current allocation of the spectrum among competing uses has been far less than satisfactory. The President's Task Force on Telecommunications[2] recommended in 1968 that we begin moving towards a market system of allocation by establishing user charges and encouraging the transferrability of rights among users via commercial transactions. Other technical organizations[3] have begun to reach similar conclusions, and even the F.C.C. has been persuaded to begin to examine new means of allocating part of the spectrum--that devoted to land mobile.

measuring value of spectrum

Despite a number of task force reports, and a recent volume written by Harvey Levin,[4] an economist, there has been little progress toward the establishment of market measures of the true opportunity cost of spectrum at different frequencies and in different locations. In large part, this is because the methodology for establishing such measures has not been developed in an operational manner. A few have attempted to measure the gross value of spectrum by calculating the total value of capital equipment devoted to utilizing it[5] while others have sought to measure the cost of performing the same communications tasks without the use of spectrum.[6] Neither of these approaches is very rewarding, however. The former simply reflects the value of a complement to spectrum, while the latter points to a maximum measure of total value, but one which is grossly overstated.

proposed research in spectrum value of land mobile radio

In the proposed research, we intend to focus on one narrow use of the spectrum--that devoted to land mobile--and to

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2. President's Task Force on Telecommunications Policty, Final Report, (1968).
3. See for example the National Academy of Engineering, Report on Selected Topics in Telecommunications; Final Report to the Department of Housing and Urban Development, November, 1968.
4. Harvey Levin, The Invisible Resource. Resources for the Future, 1971.
5. R.L. Casselberry, Industrial Communications, Feb. 9, 1968, pp.15-22.
6. F.C.C., Report of the Advisory Committee for the Land Mobile Services, 1967, pp. 393-423.

calculate the increase in general economic welfare (value) inherent in changing the current allocations and assignment procedure and adopting any of a number of alternatives. This research coincides with an experiment in regional allocations which the F.C.C. is currently conducting in Chicago, and as we shall demonstrate, it promises both to complement that experiment by providing it with some preliminary evidence on the economic value of meaningful allocations alternatives and to draw upon it for a comprehensive body of data heretofore unavailable.

rationale for analyzing value of land mobile spectrum

Our decision to begin with land mobile uses of the spectrum is purely pragmatic; we believe that this use of the has a minimum of delicate issues of economic interdependence which would beleaguer a study of, say, the value of spectrum devoted to television broadcasting. At this preliminary stage of applied economic analysis, we feel that it is better to examine the value of alternative technical uses and allocations patterns of a much more narrowly defined use. The land-mobile allocation question is also especially interesting because of the extremely large user group desiring to operate independently in the same spectrum space, and the shared use of channels which raises issues such as waiting time for communications access.

II. BACKGROUND DISCUSSION

A. Land-Mobile: The Current Problem of Congestion

alleviating congestion through provision of more spectrum

In recent years, there has been a considerable amount of attention paid to congestion problems in land-mobile. The most obvious solution, which has been vigorously espoused by users and manufacturers of land-mobile equipment, is for the FCC to provide more channels for land-mobile use by reallocation of spectrum from other services, notably UHF television. At the same time, technical studies of occupancy rates and the temporal distribution of

occupancy across land-mobile channels have been consummated. From these studies, some have concluded that a more efficient management of the allocations-assignment procedure would lead to greater equality of occupancy rates across channels, thereby reducing congestion on the more crowded channels and perhaps obviating the need for more channels.[7] Specifically, it was suggested that some blocks of channels should be shifted among user classes and greater use of the 450 MHz band should be encouraged. The divergence in both peak and average occupancy rates across existing channels is seen as a major index of allocative inefficiency under current procedures.

FCC response: new band and Chicago experiment

The FCC, responding to the problem, took two important steps in 1971: (i) the reallocation of the 900 MHz band from UHF-TV and government frequencies to land-mobile use, and (ii) the launching of an experiment in improved, decentralized management of existing land-mobile allocations. In the latter pursuit the Commission has created a Spectrum Management Task Force under whose jurisdiction an experiment in regional allocations of land-mobile frequencies has begun. The principal objectives of the first experiment in regional allocation in the Chicago area are to accelerate the applications procedure, to collect data on users and channel occupancy in land-mobile, and to assign frequencies on a regional basis, thus overcoming rigid national block allocations of the older, traditional procedure.

data prospects of FCC Chicago experiment

As this proposal is being written, the Chicago experiment is beginning to accumulate substantial data in the form of new applications forms (Form 425) and will shortly begin monitoring to obtain channel occupancy data. The latter should serve to complement earlier monitoring in Detroit and New York, thus providing a rich source of empirical data for the project to be described below.

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7. This conclusion has emerged from some of the Stanford Research Institute studies such as W.R. Vincent, et al, A Study of Land-Mobile Spectrum Utilization, Part B: Analysis of the Spectrum Management Problem, July, 1969.

Moreover, the results of the proposed research should be of direct use to the FCC's Spectrum Management Task Force in its allocations decisions in the future in Chicago and in San Francisco, the proposed next locus of regionalization of land-mobile allocations policy.

possible gains from FCC Chicago experiment

At present, the only observable criterion on which the FCC has to base its assignments of land mobile frequencies--other than police and fire assignments which have been separated from all other frequency assignments on a priori grounds that these services deserve priority treatment--is the equalization of congestion or occupancy across all channels. It is the purpose of this proposed research to examine not only alternative methods for reducing congestion, but to calculate the value of differential congestion to different classes of users and to determine if equal congestion is a sound economic basis for rationing scarce spectrum space.

value of land mobile services

While land-mobile occupies only a small fraction of all economically exploitable electromagnetic spectrum space, its value and importance in the national economy is considerable, as evidenced by the actual count of three million licensed transmitters in 1969, and a projection of at least seven million by 1980.[8] Without a market for spectrum, it is impossible to quantify this value. One source has estimated the annual expenditures required to use land-mobile frequencies currently allotted at $1.6 billion per year.* In addition, it has been estimated that use of alternative communications media would require an expenditure of another $10.5 billion,** but it cannot be asserted with confidence that such expenditures

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8. J.E. Kluge, "Frequency-Spectrum Dilemna: Crisis or Opportunity?", Electronic Design News (EDN), May, 1969, pp. 34-45.

* Casselberry (Ref. 5)

** Advisory Committee for Land-Mobile Services (Ref. 6)

would be sanctioned by the market. The importance of this research should not be measured in terms of the value of land mobile alone, however, for it is intended to serve as a beginning for efforts directed toward ascertaining the value of the spectrum in other uses. As stated earlier, land-mobile is chosen as a stepping stone simply because it poses the fewest problems in applied economic research.

B. Technical Considerations in Land-Mobile Spectrum Management

technical development of spectrum

The major problem in spectrum management is to fit in all the desired services and users of those services with minimum interference among them. Historically, this has been a process of allocating (or re-allocating) blocks of frequencies to different services in a spectrum space that was seemingly ever-expanding as technical developments permitted use of higher and higher frequencies. In the mid-1930's, the useful frequency frontier for communications was in the neighborhood of 300 MHz and most practical uses (including what land-mobile there was) were below 30 MHz. Over the next decade, there was a quantum jump in technology that pushed the frequency frontier to 30,000 MHz and expanded the available spectrum by a factor of about 1,000 over mid-1930's usage. This expanded territory was almost the exclusive province of the military until after 1945, but about 80 percent of this has since been completely allocated to other uses. At the present time, the only spectrum segments listed as "un-allocated" are in the millimeter band (30,000-300,000 MHz) that has been opened up in the intervening years.

discrete increases in land mobile spectrum

The present land-mobile frequency allocations represent an historical record of the above process. Part of the lowest present land-mobile band (VHF low-band, 25-50 MHz) was first allocated in 1940, followed in 1949 by VHF high-band (150-174 MHz). As these new bands became congested as a result of more and more users, plus the phasing out of older, lower-frequency bands, they could not be directly expanded because adjacent spectrum was completely

filled with other services. However, starting about 1960, improved technology permitted exploitation of the UHF band (450-470 MHz) previously reserved for land mobile. Just a few years later, the congestion that had developed in all three of these bands led to enormous pressures for more spectrum, and the FCC responded in 1970 by creating the new 900-MHz band from former UHF-TV and government frequencies. At the same time, the FCC decided to allow shared use by land mobile of the seven lowest UHF-TV channels (470-512 MHz) in the ten largest urban areas on a "not-to-interfere" basis.

technical differences among land mobile bands

No two of these four land-mobile bands are exactly alike from a usage standpoint. This is because of (i) differences in the propagation characteristics of electromagnetic waves at different frequencies, (ii) the uneven spectral distribution of man-made noise, and (iii) differences in device technology at different frequencies. The two lower bands provide greater communication distance for a given power, but are must more subject to interference from vehicle ignition noise and "skip" propagation signals from far-distant transmitters. The two higher bands have a much better noise situation and do not suffer from skip effects, but exhibit more severe "shadow" loss behind man-made or natural obstructions, and have higher path losses, particularly in penetrating in foliage cover. They also require more costly equipment: the cost premium for the 450-MHz band is presently about 15%, and 900-MHz band equipment, when available, is expected to cost perhaps 30-50% more than equipment for the two lowest bands.

technical difficulties in using higher bands

Land-mobile propagation losses increase rapidly with frequency above 1,000 MHz and no further land-mobile allocations above the new 900-MHz band appear possible. In fact, an FCC study in 1967 prior to the new allocation concluded that the optimum bands of frequencies for long-range and short-range systems are 30-200 MHz and 200-600 MHz respectively, and characterized the range of frequencies now occupied by the 900-MHz band as useful only for very short-range mobile communications (less than 15 miles).*

*Advisory Committee for Land-Mobile Services (Ref. 6), pp. 350-355.

Many had argued instead for enlargement of the 450-MHz band by complete reallocation of the low end of the UHF-TV band,[9] a need that was only partially met by the 1970 shared-usage decision. Interest in an enlarged 450-MHz band still abounds--for example, the Land-Mobile Communications Council has recently petitioned the FCC to extend shared usage of 470-512 MHz to a dozen additional cities.[10] The limits of practical usage of the 900-MHz band remain to be demonstrated, but it certainly does not appear to be a satisfactory (or even usable) band for many of the land-mobile applications now active in the 30- and 150-MHz bands, and the same is true to a lesser extent for the 450-MHz band. These technical and economic differences between the bands make it evident that mobile bands are not necessarily interchangeable for all users.

more intensive use of spectrum

In addition to expanding the available spectrum, technology has advanced in terms of efficiency of use of available spectrum. Improved methods of modulation and reception have narrowed the bandwidth needed for many services, and this in combination with more accurate frequency control has permitted spacing users closer together in a given band. For example, land-mobile channels were originally assigned on 100-kHz centers in the UHF band, but these were later split to 50 kHz spacings, then to the present 25 kHz in 1968, and there has been talk of a possible further split to 12.5 kHz, as has been done in England.[11] The sharability of a voice channel among many users has also been improved by selective tone signalling (and more recently digital-

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9. W.E. Detwiler, "Somethings Got to Live!", Electronic Design News, May 1, 1969, pp. 46-52.

10. "Petition offered to relieve urban frequency congestion", IEEE Spectrum, August, 1973, p. 15.

11. J.R. Brinkley, "12.5 kHz Channel Spacing in the 420-512 MHz Band", Proceedings of the 1970 IEEE Vehicular Technology Group Conference, December 2-4, 1970.

address signalling) that activates only those receivers for which a message is intended, thus eliminating the listener fatigue that comes from hearing other users' messages on the channel. Digital message transmission, which is just getting started, offers hope of transmitting more information per unit bandwidth, but will be slow in gaining acceptance for general use because of cost and operational factors.[12]

private LMR use versus common carrier approach

Finally, new ways of organizing all land-mobile communications in a given city into a single computer-controlled, channel-switching system operating more like a telephone system are now being proposed. This could greatly increase channel utilization, but would represent a major change from the present practice of each user having his own channel(s), and operating his own equipment optimized for his own needs. This question is still being argued before the FCC in its considerations under Docket 18262 as to how to make usage assignments in the new 900-MHz band.[13] Many argue that there is a basic operational difference between mobile-telephone and the more prevalent dispatch uses of radio channels, and that the two should not be combined into a common system, while others, notably AT&T, argue that a common system will be the most efficient use of the spectrum.

increasing technical needs for land mobile services

At the same time that technology has expanded the available frequencies and improved the efficiency of their use, it has also created new needs or desires for use of the spectrum, thus increasing the competition for what space there is. Television, microwave links, and satellite communications are just a few of the familiar new uses of the past three decades that have absorbed a substantial amount of spectrum space. In the land-mobile services, which are of interest here, solid-state technology

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12. T.C. Kelly and J.E. Ward, "Investigation of Digital Radio Communications", M.I.T. Report ESL-R-493, March, 1973, (LEAA Grant No. NI-71-129-G).

13. James J. Andover, "Mobile Radio: Sparks Fly", IEEE Spectrum, September, 1973, p. 69.

has reduced the size and power consumption of equipment and sparked a large increase in "personal" communications devices, such as paging receivers and walkie-talkies for public safety and private uses. Also, many new types of services are being experimented with or proposed, such as vehicle-location systems, computer-based monitoring and dispatch systems for public transportation,[14] and vehicular information and control systems--uses which usually require continuous transmission on clear channels that cannot be shared with other users. These new needs for mobile-band channels, coupled with the continuous, rapid growth in demand for traditional mobile communications, make it evident that the social and economic benefits of frequency use are fast becoming major factors in managing the overall spectrum, i.e., depending which services get how much of the available space. It is of interest in this connection to note that a non-trivial amount of present usage of land-mobile channels, particularly in the 450-MHz band, is not mobile communication at all, but is for communication between fixed stations. This is a type of service that clearly can be handled by alternate means, but with perhaps some penalty on the users involved (some combination of cost, reliability, performance, convenience, etc.).*

need for interdisciplinary analysis of land mobile usage

The foregoing discussion makes it clear that technological considerations obviously play an important part in this proposed study of the frequency management problem for land-mobile services. For example, in considering how particular classes of users might be reassigned among the existing band and channel allocations in an effort to equalize congestion, or achieve some other goal, the differing usage characteristics of the various bands must be evaluated and taken into account. Also, the re-equipment problem

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14. See for example: J.E. Ward and R.G. Rausch, "Vehicle Communications for a Dial-a-Ride System", Report USL-TR-70-15, MIT Urban Systems Laboratory, March 1971 (DOT Research Project Mass-MDT-6).

* "Fixed Point-to-Point Service in the 450-470 MHz Band", (Ref. 6, Section 15, pp. 600-619).

in any reassignment of users within a band or between bands must be examined and user costs estimated. Finally, the variety of new technical developments and proposals now appearing that will or can have an impact on the efficiency of land-mobile channel usage must be evaluated in the context of user acceptability on both operational and economic grounds, and their effects on the spectrum management problem estimated.

C. Economic Considerations in Land-Mobile Spectrum Management

economic choices from technical alternatives

The allocation of land-mobile spectrum space requires not only a thorough knowledge of the technological alternatives, but also a grasp of the costs and benefits of alternative allocations plans. In this proposed research, we plan to examine a variety of alternative technical possibilities for using the spectrum space currently allocated to land mobile, including reduced channel separations, computer-controlled channel switching systems such as those currently under consideration for the 900 MHz band, transmission of data in digital form, and the possibilities for improving current use by simply re-assigning users to different allocation blocks.

measuring the costs of congestion

At the heart of any allocations plan, however, is the necessity of selecting among potential uses or users for different channels. One must determine the value of spectrum among these alternative uses or users under any technological orientation, for without such an inquiry, it is impossible to determine if resources spent on improved technology increase or decrease social welfare. Therefore, the major goal of the proposed economic research is to begin to measure the value of spectrum to different users under various levels of congestion. In order to do this, we shall borrow heavily upon the data being generated by the FCC's Chicago experiment--data on the degree of congestion in each land-mobile channel and information on the users of those channels. In this pursuit, it is our attention to direct ourselves specifically to

the following questions:

1. What is the occupancy level for different users in each segment of the spectrum allocated to land mobile?

occupancy levels

The Chicago experiment, and the New York, Detroit and Los Angeles monitoring which preceded this experiment,[15] have generated occupancy data for each channel currently assigned to land-mobile users. Detailed data on an hour-by-hour basis are available, and these data may be divided by user and by spectrum segment (i.e., 30 MHz, 150 MHz, and 450 MHz).

2. What is the effect of congestion in land-mobile upon users?

responses to congestion

Faced with congested land-mobile channels, users may choose to exploit a variety of alternatives to accomplish the required communications task. They may choose to purchase equipment for using the 450 MHz band rather than the lower frequencies even though it is somewhat more costly to operate at 450 MHz. They may choose to purchase equipment capable of receiving and transmitting on several channels, and therefore to apply for licenses to more than one channel. Or, finally, they may choose non-spectrum communications.

occupancy as measure of avoiding congestion

The occupancy data for each of the three different spectrum segments will give us a measure of the willingness of each category of user to use the most expensive current land-mobile bandwidth as other channels become congested. Differences in the occupancy levels can be taken to measure the differences in the perceived value of reduced congestion to those users when combined with technical data on the costs of transmitting at various frequencies.

nonspectrum alternatives to congestion

In addition, by obtaining user data on the alternative nonspectrum communications techniques used by various potential or

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15. T.I. Dayharsh, et al, "A Study of Land Mobile Spectrum Utilization. Part A: Acquisition, Analysis, and Application of Spectrum Occupancy Data", Final Report, Stanford Research Institute, July 1969 (Dept. of Commerce, No. PB184983).

actual land-mobile spectrum users, we can calculate the cost of avoiding the spectrum altogether for different users. If such data can be correlated with congestion levels in land-mobile frequencies, it should be possible to determine the opportunity cost of congestion.

3. What is the value of additional spectrum space to different users?

estimating cost of relieving congestion

Given the great diversity of uses and users, the very large number of land-mobile channels currently in use, and the data on occupancy rates now available from Chicago, New York, Detroit, and Los Angeles, it should be possible to determine the cost of operating in each of the three discrete blocks of frequencies and to construct measures of the economic value (at the margin) to each type of user of avoiding congestion. In addition, from other market data, we may be able to determine the cost of avoiding spectrum use and substituting other types of inputs for this type of communication or for any communication at all. While the initial results, based upon differential congestion and differences in cost of avoiding congestion, will allow us only to make calculations at the margin of use, all measures of economic value are based upon calculations at the margin. Greater care and more refined approaches will be required, however, if we are to examine discrete technical changes such as channel splitting or a central computer-based switching system. It is for this reason that we require as many different observations on user behavior as possible, and the data forthcoming from Chicago will be compared with New York data wherever possible in order to generate more than a single point estimate of value for each user category.

III. THE RESEARCH PLAN

evaluating allocation alternatives

It is our intention to combine the technical and economic expertise of the principal investigators to develop an approach for evaluating alternative allocation and assignment plans for land-mobile radio. We begin with the assumption that the total spectrum space devoted to land mobile is given. Our interest lies in evaluating the appropriate use of that fixed spectrum space so as to maximize its economic value. To this end, it is crucial that feasible alternative technical configurations be investigated. From this set of alternatives, described in outline form above, it is our intention to attempt to estimate the configuration which adds most to the value of the economic product offered to the market by the various user groups.

assembling and analyzing use and user data

The initial steps in the research must involve the assembly of data on the nature and extent of current and prospective uses of land mobile frequencies. There is very little data in the public domain on the identity and nature of land-mobile use in various markets. Only recently have studies of the intensity of use of each channel been begun, and we expect to borrow heavily upon such information. But without more extensive data on users, it will be impossible to ascertain the potential for alternative allocation or assignment schemes.

Data on uses and users may be obtained from the major manufacturers of equipment -- Motorola, General Electric, and R.C.A. -- and from user groups. The principal investigators have already made arrangements to obtain such information from both sources, but the data-gathering effort has not begun.

estimation of alternative costs

We shall next proceed to estimate the alternative costs of spectrum or nonspectrum communications for each major user group. Data on the cost of operating in the various land-mobile bands may be obtained from the equipment manufacturers. The cost of alternative technologies outlined above may be estimated from <u>a priori</u> assumptions concerning equipment costs and the cost of operating the equipment.

modeling production functions

Finally, we propose to pursue at least two alternative strategies in seeking a measure of the economic value of spectrum space. In the absence of a price mechanism for allocating the spectrum at present, market observations on economic value are impossible to obtain directly. In the previous section, we have outlined an approach for deducing the cost of congestion. As this effort unfolds, it will also be useful to proceed more deductively, building models of "production functions" for certain major user groups. These functions should relate the use of spectrum and other inputs to the output of the users' services. With these a priori models and some estimates of the demand functions for the users' services, it is a straightforward exercise to determine the value of the given finite increments of spectrum space.

IV. MANAGEMENT PLAN

The background for the proposed research involves the review of the available applied economic and technical literature on land-mobile radio. Much of this review has already been accomplished, and it is our feeling that there is virtually no satisfactory measure of the economic value of spectrum space upon which we may build. Instead, we plan to utilize data on occupancy rates, equipment cost, user alternatives, and alternative allocations possibilities to build more satisfactory models of the economic value of spectrum.

first and second quarters

Our first and most urgent task is to assemble all of the available evidence from the F.C.C.'s Chicago experiment, the Land Mobile Communications Council, user groups which are members of the L.M.C.C., equipment manufacturers, and other sources. Published data on industries identified as intensive users of land mobile may then be assembled to complement the primary data. Unfortunately, the usual secondary sources for economic data are not rich in information about many of the services which utilize land mobile most intensively. The Census of Business, Selected Services contains little information on taxi services, ambulance services, or other service industries which require land mobile communications. Moreover, the Census of Manufactures provides little evidence on the distribution of the capital equipment produced by the major equipment suppliers since the degree of detail required is too fine for Census standards and confidentiality problems are particularly acute. We have already begun to make arrangements for collecting much of the primary data from the sources outlined above.

third quarter

One of the most difficult tasks in the proposed research is the construction of models of user behavior which may be tested against the available data. To this end, we intend to begin to construct models of production functions for various important user groups as soon as their identities can be verified. We shall not attempt such modelling for unimportant users since it is clear that land-mobile is used in a very large number of different ways. The domain of the production function can only be specified after

intensive investigation of the technical alternatives and the cost of these alternatives. To this end, it is imperative that our technical analysis be compared with the perceptions of the equipment manufacturers. We would thus propose to concentrate on the modelling effort while the primary and secondary data are being gathered in order to be able to utilize the data approximately next spring.

fourth quarter

From the estimates of the value of spectrum or the opportunity cost of congestion which emerges from technical-economic analysis detailed above, we may then proceed to analyze the benefits and costs of alternative allocations plans. For instance, we might be able to evaluate proposals to allow for differential congestion across channels as a matter of policy. Alternatively, we might be able to estimate the benefits of shifting to digital transmission from voice-grade transmission. Or, we may be able to assess the benefits of a central switching system for the 900 Mhz. band.

fourth quarter

Our final tasks will be to draft technical reports and to prepare final reports for publication. In addition, if it is deemed appropriate, we might air our findings by convening a symposium of major users, equipment manufacturers, and regulatory groups at the end of the research term.

responsible M.I.T. organization

Since this is an interdisciplinary investigation, both of the principal investigators will be about equally involved in most phases of the above. The research management of the program at M.I.T. will reside in the Electronic Systems Laboratory (ESL), Department of Electrical Engineering, of which one of the co-principal investigators, John E. Ward, is Deputy Director. ESL will be responsible for coordinating the overall program activities through regular meetings and internal reporting, and for submission of all reporting to the sponsor, including the semi-annual review and final report. It also has facilities for up-to-minute fiscal monitoring to augment the formal fiscal management by the M.I.T. Office of Sponsored Programs.

V. THE POLICY IMPACT OF THE STUDY

importance of LMR analysis to management of total spectrum

Since the electromagnetic spectrum represents an increasingly valuable economic resource, it is critical that future decisions on its allocation by the F.C.C. be based upon the best estimates of technical and economic efficiency in its use. We believe that the proposed research can serve as a valuable beginning for a reexamination of the F.C.C.'s entire allocations policy. The immediate goal of reducing congestion in land-mobile may be aided considerably by this type of research, for it is important not only to reduce congestion but to do so in a manner consistent with maximizing social output. Thus, the Spectrum Management Task Force should find the results of our research quite valuable in its present and future tasks.

applicability of LMR methodology to management of the total spectrum

It is our intention to demonstrate a methodology for proceeding to other uses of the spectrum. Land mobile is far from the most extensive use of the electromagnetic spectrum, and there is little doubt that a technical-economic analysis of regulatory alternatives in other uses could be extremely useful in guiding future F.C.C. decisions. Whether less space should be devoted to television broadcasting and more to land mobile, for instance, is a question which deserves technically-informed economic answer. Our research promises to be an introduction to the development of the methodology required to find empirical answers to such difficult problems.

VI. BUDGET

relation to Grant GI-38912

The budget for the proposed study is based on a one-year program which is an outgrowth of the present land-mobile demonstration project under NSF Grant GI-38912 (effective July 1, 1973) and which will overlap that grant in time. The total estimated cost of the proposed program is $100,955, of which part would come from funds already budgeted under GI-38912, the exact amount depending on the starting date of the new grant. The budget under Grant GI-38912 identified with ongoing work which the proposed work will augment or replace is $32,271. Based on an anticipated starting date of December 1, 1973, the pro-rated share of this to be subtracted from the $100,955 total is $18,825 (7/12 x $32,271). The total new funding requested is therefore $82,130.

information on budget items

The detailed budget attached identifies the co-principal investigators, and other staff requirements associated with the proposed work. The budgets for computer time and travel shown are based on best estimates at this time of the amounts that will be necessary for the proper conduct of the work.

It is anticipated that expenditures under the proposed program will be at a level rate. Since the indirect M.I.T. cost rate for NSF-sponsored programs changes from 58% in fiscal-'74 to 62% in fiscal-'75, the total for this item will also depend on starting date. The amount shown is based on a proposed December 1, 1973 starting date.

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A.	SALARIES		
	1. Senior Personnel		
	J.E. Ward	3 MM	$8,145
	R.W. Crandall	4.5 MM	7,500
	C.G. Bowen	1.2 MM	2,600
	2. Other Personnel		
	Graduate Students @ $670/mon.	33 MM	22,110
	Electronic Systems Lab. Staff @ av. $1,130/mon.	2.5 MM	2,815
	Secretarial @ av. $600/mon.	6 MM	3,600
	Total Salaries		$46,780
B.	BENEFITS @ 17.3% (excluding students)		4,265
C.	TOTAL SALARIES AND BENEFITS		51,045
D.	PERMANENT EQUIPMENT		------
E.	EXPENDABLE EQUIPMENT AND SUPPLIES		2,000
F.	TRAVEL, DOMESTIC		4,000
G.	PUBLICATION COSTS		1,000
H.	COMPUTER COSTS @ av. $600/hour		15,000
I.	OTHER COSTS (e.g. Subcontracts ...)		------
J.	TOTAL DIRECT COSTS		73,045
K.	INDIRECT COSTS @ 58% of SALARIES FOR FY '74, 62% for FY '75		27,910
L.	TOTAL COSTS		$100,955

- -

Funds available from Grant GI-38912 (based on December 1, 1973 starting date)	-$18,825
Total new funds requested	$82,130

VIII. VITAE Robert W. Crandall

Address: 31 Service Drive, Wellesley, Mass. 02181

Current Position: Associate Professor of Economics, M.I.T.

Business Address: Room E52-353, Massachusetts Institute of Technology, Cambridge, Mass. 02139

Education: A.B. in Economics, University of Cincinnati, 1962
M.A. in Economics, Northwestern University, 1965
Ph.D. in Economics, Northwestern University, 1968

Professional Experience: Instructor, Northwestern University, 1964-65
John Research Fellow, The Brookings Institution, Washington, D.C., 1965-66
Assistant Professor of Economics, M.I.T., 1966-72
Associate Professor of Economics, M.I.T., 1972 --
Consultant to Antitrust Division, U.S. Department of Justice, 1967-68
Consultant to The Urban Institute, Washington, D.C. 1971-present.

Publications: "Vertical Integration and the Market for Repair Parts in the United States Automobile Industry", Journal of Industrial Economics, July 1968

"The Decline of the Franchised Dealer in the Automobile Repair Market", The Journal of Business, January 1970

"Motor Vehicle Repair, Repair-Parts Production, and the Franchised Vehicle Dealer", Hearings: Automotive Repair Industry, U.S. Senate Antitrust and Monopoly Subcommittee, 1969

"The Effect of Television-Network Program 'Ownership'", Journal of Law and Economics, October 1971

"F.C.C. Regulation, Monopsony, and Television Network Program Costs", Bell Journal of Economics and Management Science, Autumn 1972

Contemporary Issues in Economics: Selected Readings. (Edited with Richard S. Eckaus), Little Brown, and Co., 1972

"Economic Subsidies in the Urban Ghetto", (with C.D. MacRae), Social Science Quarterly, December 1971

Study Guide for Basic Economics. (with Richard S. Eckaus), Little Brown and Co., 1972

Current Research: Nonprice rivalry in television broadcasting. The potential for national cable television. Antitrust in the motion picture industry. Wage subsidies as a means for increasing the employment of the disadvantaged. Economic issues in land-mobile spectrum allocation (under NSF Grant GI-38912).

BIOGRAPHICAL SKETCH

JOHN E. WARD

John E. Ward was born in Toledo, Ohio, on January 4, 1920. He attended the University of Toledo, Ohio, from 1938 to 1940, and received the B.S. and M.S. degrees in electrical engineering from the Massachusetts Institute of Technology, Cambridge, in 1943 and 1947, respectively.

From 1943 to 1945 he was a staff member in the Airborne Systems Division at the M.I.T. Radiation Laboratory, working on airborne radar. In 1945 he joined the M.I.T. Servomechanisms Laboratory (now Electronic Systems Laboratory), as a Research Assistant, and was made a Staff Member in 1947. His work during the period 1945 to 1961 included servo design, system design for radar-oriented bomber turrets, analog and digital flight test instrumentation for airborne accuracy tests, analog-to-digital conversion devices, integration of digital computers in control and data processing systems, and numerical machine tool control. From 1962 to 1968, he was in charge of display systems and man-machine interface developments for the ESL Computer-Aided Design Project and for Project MAC, the time-shared computer project at M.I.T. The ARDS storage-tube remote display and the ESL Console (with 3-dimensional hardware picture rotation) were developed in this period. During the past five years he has directed studies on digital communications over both wire and radio links, of cable television system technology, and of computer-based highway traffic control systems. He was appointed Deputy Director of the Electronic Systems Laboratory in December, 1966.

Mr. Ward is the author of numerous reports and papers, and has contributed to several books and the Encyclopedia Britannica. He was an organizer of the IEEE Automatic Control Group in 1954 and its Chairman from 1968 to 1960. He was President of the American Automatic Control Council from 1963 to 1965. He is a member of Sigma Xi, the Society for Information Display, and the Institute for Electrical and Electronics Engineers (Fellow, 1968).

Sept. 1973

BIOGRAPHICAL SKETCH

CARROLL G. BOWEN

Carroll Bowen is a Research Associate at M.I.T.'s Center for Advanced Engineering Study. He is a former president of Franklin Book Programs, Inc. (1969-71), and for seven years previous served as director of the M.I.T. Press. Mr. Bowen has also held research appointments with Harvard University's Center on Education and Development and M.I.T.'s Center for International Studies.

Mr. Bowen is currently co-principal investigator of a research program organizing long range telecommunications planning at M.I.T., with particular responsibility in cable television and spectrum management (NSF Grant GI-38912 , of which the proposed program is an outgrowth). In addition, Mr. Bowen has participated in recent municipal cable TV task force studies for Boston and Cincinnati.

In the area of publishing, Mr. Bowen has undertaken policy, management and economic studies for the Committee on Institutional Cooperation of the Big Ten Universities, American Association for the Advancement of Science, the National Institutes of Health, the German Foundation for Technical Assistance and other institutions. His articles have appeared in Science, The Economist (London), Book Production Industry and The Library Quarterly.

Mr. Bowen is a graduate of Swarthmore College in 1948, and is a Fellow and Life Member of the American Association for the Advancement of Science.

Sept. 1973

J. E. WARD APR 5 1973

FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20554

April 2, 1973

IN REPLY REFER TO:

6010

Mr. Carroll G. Bowen
Research Associate
Massachusetts Institute of Technology
Center for Advanced Engineering Study, Room 9-228
Cambridge, Massachusetts 02139

Dear Mr. Bowen:

I have your March 22, 1973 letter outlining the analysis that your group proposes to undertake - with funding from the National Science Foundation - of this Commission's regional spectrum management program.

Our prime concern at this time is, as you know, the validity or efficaciousness of the methodology that we have chosen for implementing our initial venture into a formal spectrum management program. Thus, we are concerned with both the methods or techniques of manipulating the intensive margins of the spectrum and the organization or concept of applying and evaluating these techniques on a regional as opposed to a national basis; and whether the costs associated with so doing are reasonably related to the benefits that will accrue.

An analysis of the opportunity costs of regional management as opposed to centralized management of the spectrum would be of considerable value in enabling the Commission to determine whether its spectrum management program is worthwhile.

Raymond E. Spence
Chief Engineer

AUG 17 1973

Honorable Dean Burch
Chairman
Federal Communications Commission
Washington, D. C. 20554

Dear Dean:

The allocation of additional frequencies for the mobile radio services which is under consideration in Docket No. 18262 presents the Commission with a unique opportunity to expand the availability of improved mobile communication services. The Commission has available, for the first time in many years, sufficient additional spectrum to enable the adoption of new and improved procedures for allocating and using the radio spectrum to assure the continued development of mobile communications.

Naturally, this new allocation poses major policy issues whose resolution is extremely important to the public. The Office of Telecommunications Policy has undertaken analyses of these issues and has reviewed the comments of the various parties to this proceeding in the light of fundamental goals and objectives of national communications policy. On the basis of this analysis, we have arrived at certain conclusions which are set forth in the enclosed statement.

This proceeding affords the Commission with an excellent opportunity to make mobile communications widely available to large numbers of businesses and consumers alike, and to significantly enhance both the quantity and the quality of mobile radio services. We believe that the policy which we propose achieves those objectives.

The need for a policy commitment to a nationwide, standardized mobile telephone system has not been demonstrated at this time. Indeed, such a commitment could unduly restrict technological and marketing innovation. The Commission should, however, require a capability for interconnection of all mobile telephone systems with the landline telephone network and with each other so that local or regional systems can evolve into a nationwide system if justified by future demand.

We recommend a regulatory approach to mobile communications services that relies as much as possible on competition in meeting customers' needs for mobile communications services. In general, all technically and financially qualified entities should be permitted to offer any mobile communications services. This policy should result in more diverse service offerings at competitive prices and vigorous technological innovation to improve and expand those services.

The frequency allocation and assignment process should be as flexible as posssible to accommodate future needs, while at the same time providing incentives to make efficient use of the spectrum. We believe that these objectives can best be achieved by holding a substantial portion of the spectrum in reserve to be made available as required in the future. The remaining available spectrum should be allocated for the provision of (1) mobile telephone service by wireline common carriers and (2) all mobile radio services by any qualified entity on a competitive basis, with no further detailed suballocations within these blocks. This will not deter financial commitments on the part of potential entrants, and will afford maximum flexibility within each allocation for new or expanded service offerings.

Finally, we believe that the availability of the 900 MHz band for mobile radio services offers an opportunity for experimentation with procedures which would permit market mechanisms to augment the regulatory process in the area of spectrum efficiency. Such methods might include pro forma transferability of licenses between mobile users and the adoption of license fee schedules reflecting spectrum value.

We believe that this policy will enable the widest possible flexibility for serving the mobile communications needs of the public. It will also lead to more efficient use of spectrum resources, provide incentives for technological innovation by means of competition and permit the benefits of such innovation to flow directly to consumers of mobile services.

Sincerely,

signed
TOM

Clay T. Whitehead

Enclosure
cc:
DO Records
DO Chron
Mr. Sutter
Mr. Goldberg
Mr. Keller
Mr. Whitehead
GOLDBERG/SUTTER/KELLER/WHITEHEAD:jm 8-11-73

Conclusions and Recommendations of the
Office of Telecommunications Policy Regarding
Land Mobile Radio Service in the 900 MHz Band
(FCC Docket No. 18262)

I. Introduction

In the past, the availability of mobile radio services has been largely restricted to commercial and business users, as well as state and local governmental agencies. The general public has benefited greatly by the use of mobile radio by these private and public entities, but only indirectly. There is a need to make low-cost mobile communications services available directly to the consumer and to allow for the expansion of mobile radio use by entities providing goods and services to the consumer. In this regard the allocation of additional frequencies in the 900 MHz band provides an excellent opportunity for the Commission to foster the development of new service concepts and new technologies so that the benefits of mobile communications can be brought to all members of the public.

A major issue posed in this proceeding is whether the increased availability of mobile communications services is best achieved by a regulatory commitment to a monopoly system premised upon a particular technology or by the

creation of a diverse competitive environment. OTP believes that the needs of mobile communications users can best be met by an approach which enables customers themselves to determine, through market mechanisms, the most efficient and cost-effective use of the spectrum resource.

II. Nationwide Standardized Mobile Telephone System

Although a nationwide, standardized mobile telephone system, dependent upon a particular technology, might well come to supplement the nationwide public message telephone system, no need has been adequately demonstrated for immediate commitment to or implementation of such a system. The mobile telephone service market does not appear to exhibit strong natural monopoly features, and there is no conclusive information as to whether there are economies of scale sufficiently substantial to justify a policy commitment to a single system or a particular technology. In a period of rapid technological change, there are significant risks attendant to a commitment of a substantial portion of spectrum to a particular technology (however innovative it may presently appear) for the provision of mobile telephone service on a nationwide basis. Such a commitment could unduly inhibit further technological development and impede the growth of mobile telephone services.

Moreover, the propagation characteristics of the 900 MHz band make it most suitable for use in the top 25 to 30 major markets where high capacity systems may be required, whereas remaining areas of the country might be better served by smaller systems operating at lower frequencies.

Despite the lack of justification for a regulatory commitment to a single nationwide mobile telephone system, there is, nevertheless, a need to create an environment for mobile communications that would not preclude the development of a nationwide service in the future if justified by consumer demand. Such an environment can be created by the adoption of a spectrum allocation and assignment policy which will be responsive to future changes in demand.

III. Frequency Allocation and Assignment

The Commission's allocation and assignment policies should facilitate the availability of new services as rapidly as possible. However, in view of the many technical and market issues which are as yet unresolved, the Commission should preserve flexibility with respect to future spectrum needs in the 900 MHz band. OTP

recommends that the total 115 MHz available be allocated initially into "blocks" of sufficient size to motivate industry to undertake the necessary investments for product and market development. These allocations, however, should not exhaust at the outset the total available spectrum so as to result in overcommitment in any particular service category. Such a course could inhibit or distort growth in other service categories as consumer demand shifts in the future.

To this end, approximately 14 MHz of the available 115 MHz should be allocated for the exclusive use of wireline common carriers for the provision of tariffed mobile telephone services and ancillary dispatch services. Based on current market projections available to the FCC, it appears that this amount will be sufficient to accommodate present and near term mobile telephone service needs in the major markets.

Approximately 40 MHz of the available spectrum should be allocated for any mobile service to be offered on a non-rate regulated competitive basis (e.g., mobile telephone, dispatch, paging, etc.).

The balance of approximately 61 MHz should be held in reserve so that the Commission can expand or modify its initial allocations if warranted by demand. This will afford both common carrier and competitive entities a reasonable expectation that additional frequencies adjacent to their respective initial allocations will be available if and when warranted.

It is recognized that the new, so-called cellular technology which has been proposed for mobile telephone service might eventually require systems of relatively high channnel capacity. However, this technology has not yet been proven and, as stated earlier, the demand for mobile telephone service has not been sufficiently demonstrated to justify a present allocation of a substantial portion of the spectrum to this service, either to wireline carriers or to others who might wish to introduce this technology.

Nevertheless, the development of cellular technology should not be discouraged -- it should be permitted to develop in steps keyed to technological progress and growth in consumer demand. In order to avoid the need for subsequent re-engineering of equipment if the use of high capacity cellular technology proves justified by demand, parties proposing the use of this technology may wish to incorporate into their initial equipment design the capability for eventual high capacity operation.

The Commission should, therefore, identify specific frequencies within the initial allocations where possible, or within the reserve, if necessary, which could be incorporated into the initial equipment design for these systems in addition to those frequencies already allocated. These frequencies could not be assigned or used for other types of services until after the present uncertainties surrounding market demand have been resolved and technical results for high capacity mobile telephone service have been satisfactorily evaluated. Further, these additional frequencies would be assigned for mobile telephone service only as necessary to provide sufficient capacity to meet substantiated customer demands.

In this manner, parties would be permitted to design cellular systems with the assurance that, if warranted by demand and system performance, specific additional frequencies eventually will be allocated for this type of service. Conversely, if the expected demand for a high capacity mobile telephone service does not materialize within a reasonable, pre-established period of time, these frequencies would become available for allocation to other mobile services as needed.

Beyond the allociation of frequencies for common carrier and competitive services, there should be no further initial

suballocation within the band to particular user categories such as public safety, transportation, industrial etc. These user groups should be permitted to take full advantage of the availability of multi-user trunked systems, private single or multi-channel arrangements, or private trunked systems, depending on their needs. This should afford the opportunity for all private and governmental entities to use high quality and efficient systems which will conserve spectrum and which may avert future reliance on exclusive suballocations.

Naturally, the advantage of mobile communications must be readily available to local government and public safety institutions which are significantly dependent upon such services. In this regard, local government entities should be encouraged to accommodate, where possible, all their mobile service functions on a single shared trunked system, either private or multi-user. Similarly, adjacent municipalities may wish to combine their services on such a single system. While there may be a need at some future time to reassess the need for exclusive suballocations in view of the unique characteristics

of public safety functions, we believe that, for the present, all users including local governments should attempt to make maximum use of the emerging high quality and spectrum-efficient systems.

IV. Competition in Mobile Services

Mobile communications services heretofore have been provided on a common carrier basis or by private systems. In the course of its deliberations in Docket No. 18262, the Commission has been presented with numerous innovative proposals including new technologies and new service concepts. For example, several parties have proposed to offer multi-user, multi-channel (trunked) dispatch services for hire. Such services would provide the mobile communications customer with an alternative to privately-owned systems and to the services offered by tariffed mobile telephone systems. In addition, this service concept should afford more efficient use of the spectrum than a proliferation of private systems.

The history of the mobile communications industry has been characterized by competitive free enterprise which has stimulated growth even in the face of spectrum limitations. Further policies should foster and expand this competitive environment. OTP recommends a policy which will permit existing and new services

to be made available in a timely manner and at competitive prices in response to consumer demand. Such a policy is consistent with the Commission's recent approach to domestic satellite communications and specialized common carriers. There is every indication that a competitive policy will be even more fruitful here, since it is capable of benefiting the consumer directly.

The Commission's allocation of frequencies in the 900 MHz band should allow the provision of all types of service (mobile telephone, dispatch, paging, etc.) on a competitive basis by all potential entrants. All mobile communications services, with the exception of those provided by wireline common carriers as discussed below, must be permitted to develop without the encumbrances of rate regulation. By creating an environment which will accommodate numerous, competitive suppliers, the need for rate regulation is obviated; the multiplicity of competing systems (and the potential for new entrants) will assure competitive pricing. Accordingly, the Commission should authorize systems upon a showing of minimum technical and financial qualifications and in accordance with the minimum spectrum efficiency standards it establishes. There should be no necessity for a showing of continued economic viability.

Questions have been raised in the course of the Commission's deliberations in Docket No. 18262 concerning the participation of wireline common carriers, mobile radio equipment manufacturers and radio common carriers in the mobile communications services market.

A. Wireline Carriers

Because of the local monopoly advantages enjoyed by wireline common carriers in the provision of switched telephone service and the consequent potential for interservice cross-subsidy, telephone carriers should not be permitted to participate in the non-regulated portion of the mobile communications market in their own telephone service area. In any event, it would appear that the largest such carrier, AT&T, would necessarily be limited by the terms of the Western Electric consent decree from participating in a non-regulated activity. However, wireline common carriers should be permitted to provide rate regulated mobile telephone service, whether by means of cellular or other technology, as an extension of their regulated public switched telephone service. These carriers could also offer dispatch services on a rate regulated basis only as an adjunct to their mobile telephone services.

B. Radio Common Carriers

Unlike wireline common carriers, radio common carriers need not operate on a local monopoly basis. Hence, there is no justification for precluding them from offering licensed but otherwise non-regulated mobile services (mobile telephone, dispatch or other) on a competitive basis. However, it is central to OTP's policy that the non-regulated environment essential to competitive market activity be preserved. There may, therefore, be a need for federal preemption regarding all licensed competitive services in order to assure that radio common carriers (or their subsidiaries) and others providing multi-user services would not be subject to rate regulation by other jurisdictions.

C. Radio Equipment Manufacturers and Suppliers

We see no justification for excluding mobile radio equipment manufacturers and suppliers from the operation of mobile communications systems, whether multi-user systems for hire or otherwise. However, in order to provide mobile service customers adequate flexibility in the choice of equipment and to assure full and fair competition in both

the mobile radio service and equipment supply markets, interoperability of all mobile equipment with any base station and terminal equipment should be required by the Commission. The actual development of specific interoperability standards to implement this requirement should, however, be left to the industry. In addition, the Commission might require as a condition to any license that the licensee place its customer on notice that mobile equipment from any manufacturer may be used with the system.

In order to allow full competition among and between mobile communications services, all land mobile radio systems should be guaranteed access to the public switched telephone network on a non-discriminatory basis. This access might be by manual or automatic dial capability by private or multi-user dispatch systems.

D. Fair Competition

While it is expected that the policy we have proposed will permit full and fair competition in the market for mobile communications services, we believe that there will be a continuing need for FCC and Department of Justice oversight

as the industry develops. Both the public message telephone industry and the mobile radio manufacturing industry are characterized by companies with substantial economic power. Therefore, both the Commission and the Department of Justice should closely scrutinize the use of large financial and marketing resources by these companies in the emerging mobile communications markets and should take appropriate action to correct abuses if and when they occur. Particularly, the FCC should safeguard against the anti-competitive dangers presented by cross-subsidization between the landline public message telephone service and mobile communications services on the part of the wireline carriers.

V. Technical and Economic Efficiency in the Use of the Spectrum

For all of the mobile communications services we have discussed, the Commission should impose at the outset enforceable, minimum standards of spectrum efficiency for the allocation, assignment and use of the 900 MHz frequencies. We expect that the FCC's Spectrum Management Task Force, as well as the Interdepartmental Radio Advisory Committee, will continue to make significant progress in the area of spectrum efficiency standards.

It is important that the Commission continue to encourage industry experimentation in areas such as channel spacing, through experimental assignments and other means, in order to further improve spectrum efficiency, particularly with regard to cellular technology. If past technical innovation through such experimentation is any guide, even the most optimistic projections of market demand for mobile communications may be accommodated in less spectrum than has been specified in some of the cellular system proposals submitted to the Commission.

Furthermore, in order to foster greater economic efficiency in the use of mobile radio frequencies, the Commission should permit the transferability of operating rights for licensed services on a relatively pro forma basis to allow market mechanisms to provide added flexibility in spectrum utilization by mobile users.

But on a long term basis, it would be appropriate to introduce stronger economic incentives for efficient spectrum use. One possibility would be to adopt a schedule of license fees reflecting in part the scarcity value of the spectrum

being used. In this manner, inefficient systems would be discouraged in those areas where spectrum or channel congestion is a major problem. The feasibility of a plan to assess such fees in the government bands for which OTP has responsibility is now under consideration, and we urge the Commission in the same direction.

Land mobile

OFFICE OF TELECOMMUNICATIONS POLICY
EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON, D.C. 20504

AUG 17 1973

DIRECTOR

Honorable Dean Burch
Chairman
Federal Communications Commission
Washington, D. C. 20554

Dear Dean:

The allocation of additional frequencies for the mobile radio services which is under consideration in Docket No. 18262 presents the Commission with a unique opportunity to expand the availability of improved mobile communication services. The Commission has available, for the first time in many years, sufficient additional spectrum to enable the adoption of new and improved procedures for allocating and using the radio spectrum to assure the continued development of mobile communications.

Naturally, this new allocation poses major policy issues whose resolution is extremely important to the public. The Office of Telecommunications Policy has undertaken analyses of these issues and has reviewed the comments of the various parties to this proceeding in the light of fundamental goals and objectives of national communications policy. On the basis of this analysis, we have arrived at certain conclusions which are set forth in the enclosed statement.

This proceeding affords the Commission with an excellent opportunity to make mobile communications widely available to large numbers of businesses and consumers alike, and to significantly enhance both the quantity and the quality of mobile radio services. We believe that the policy which we propose achieves those objectives.

The need for a policy commitment to a nationwide, standardized mobile telephone system has not been demonstrated at this time. Indeed, such a commitment could unduly restrict technological and marketing innovation. The Commission should, however, require a capability for interconnection of all mobile telephone systems with the landline telephone network and with each other so that local or regional systems can evolve into a nationwide system if justified by future demand.

We recommend a regulatory approach to mobile communications services that relies as much as possible on competition in meeting customers' needs for mobile communications services. In general, all technically and financially qualified entities should be permitted to offer any mobile communications services. This policy should result in more diverse service offerings at competitive prices and vigorous technological innovation to improve and expand those services.

The frequency allocation and assignment process should be as flexible as posssible to accommodate future needs, while at the same time providing incentives to make efficient use of the spectrum. We believe that these objectives can best be achieved by holding a substantial portion of the spectrum in reserve to be made available as required in the future. The remaining available spectrum should be allocated for the provision of (1) mobile telephone service by wireline common carriers and (2) all mobile radio services by any qualified entity on a competitive basis, with no further detailed suballocations within these blocks. This will not deter financial commitments on the part of potential entrants, and will afford maximum flexibility within each allocation for new or expanded service offerings.

Finally, we believe that the availability of the 900 MHz band for mobile radio services offers an opportunity for experimentation with procedures which would permit market mechanisms to augment the regulatory process in the area of spectrum efficiency. Such methods might include pro forma transferability of licenses between mobile users and the adoption of license fee schedules reflecting spectrum value.

We believe that this policy will enable the widest possible flexibility for serving the mobile communications needs of the public. It will also lead to more efficient use of spectrum resources, provide incentives for technological innovation by means of competition and permit the benefits of such innovation to flow directly to consumers of mobile services.

Sincerely,

Clay T. Whitehead

Enclosure

OFFICE OF TELECOMMUNICATIONS POLICY
EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON, D.C. 20504

August 17, 1973

NEWS RELEASE

OTP ANNOUNCES POLICY ON LAND MOBILE COMMUNICATIONS

The Office of Telecommunications Policy (OTP) today released a policy statement on the allocation of new frequencies for mobile radio use. The statement recommends an approach which would maximize competition and minimize regulation in the mobile communications industry. In the past, the frequency spectrum for mobile communications has been limited and these services have been largely restricted to state and local governments and commercial users. Now that new frequencies will be available, OTP forsees an opportunity to make low-cost mobile communications available directly to consumers.

According to the OTP plan, the new portion of the radio spectrum available for mobile services would be allocated in blocks of sufficient size to encourage industry investment in new technologies and services. However, in order to preserve flexibility and to avoid initial overcommitment to any particular service or technology, OTP recommends that a substantial portion of the available spectrum be held in reserve to be allocated at a later time as warranted by consumer demand.

OTP recommends that one portion of the spectrum (approximately 40 MHz) be allocated for all mobile radio services on a competitive, non-rate regulated basis. This approach would create an environment which would accommodate numerous competitive suppliers and would obviate the need for rate regulation. It would also encourage the development of new services and technologies.

Another portion of the spectrum (approximately 14 MHz) would be allocated to telephone common carriers for the provision of rate regulated mobile telephone service and ancillary dispatch services as an extension of their regular telephone service.

OTP also recommends that procedures be adopted to permit the operating rights for licensed mobile services to be transferred on a relatively pro forma basis in order to allow market mechanisms to provide added flexibility in spectrum utilization. In order to provide economic incentives for efficient spectrum use, the Office suggests that the FCC consider adopting a license fee schedule to reflect the scarcity value of the spectrum.

In a letter to FCC Chairman Dean Burch forwarding the OTP policy statement, OTP Director Clay T. Whitehead said:

> "We believe that this policy will enable the widest possible flexibility for serving the mobile communications needs of the public. It will also lead to more efficient use of spectrum resources, provide incentives for technological innovation by means of competition and permit the benefits of such innovation to flow directly to consumers of mobile services."

* * * * *

Copies of the policy statement may be obtained by calling 395-4990.

Land Mobile

OTP PROGRAM AREA:

LAND MOBILE RADIO

HAND-OUT FOR BRIEFING OF C. T. W.
DECEMBER 13, 1971

1. FIFTY PERCENT OF ALL LMR TRANSMITTERS LOCATED IN LESS THAN EIGHT PERCENT OF LAND AREA.

2. ALL MOBILE RADIO -- 1,745,709 LICENSEES

A	B
. AVIATION	. PUBLIC SAFETY
. MARINE	. INDUSTRIAL
. CITIZEN's	. LAND TRANSPORTATION
. AMATEUR	

3. FCC DATA INDICATES:

1968:	293,000 LICENSEES	3.8 MILLION TRANSMITTERS
1970:	316,977* "	OVER 4 MILLION TRANSMITTERS
1972:	214,723 "	OVER 4 MILLION TRANSMITTERS

(* 102,000 ERROR)

4. EXPECTED GROWTH BY 1980:

. FCC ESTIMATE -- 7.3 MILLION TRANSMITTERS

. MST ESTIMATE -- 5 MILLION TRANSMITTERS

5. GENERAL MARKET GROWTH TO PRESENT: 10% TO 15% (PAGING: 40%)

MARKET SEPARATION IN PERCENT OF TRANSMITTERS:

. PUBLIC SAFETY -- 30 %

. PRIVATE AND BUSINESS USERS -- 50% TO 60%

. OTHERS -- 10% TO 20%

LEASED SERVICES TELEPHONE COMPANIES --1% RCC's --2%

FOUR MAJOR ISSUES:

1. IS THE PRESENTLY ASSIGNED 42 MHZ BEING USED EFFICIENTLY?

2. IS THE PRESENT ALLOCATION SYSTEM ADEQUATE?

3. WHAT INSTITUTIONAL STRUCTURE IS NEEDED?

4. IS LAND MOBILE RADIO VIABLE AND WHO WOULD BENEFIT MOST?

VIEWPOINTS ON THE FOUR ISSUES:

INTERESTED PARTY	ISSUES			
	1	2	3	4
RCC's	YES	NA	STATUS QUO	YES/NA
MST	NO	NO	NA	QUESTIONABLE/NA
EQUIP. MANUFACTURERS	YES	NO	STATUS QUO	YES/NA
FCC	NO	YES	NA	YES/EQUIP.MANUFACTURERS
USERS	DK	DK	NA(DK)	DK

(NA: NOT ADDRESSED
DK: DON'T KNOW)

SHEET TWO

OTP LAND MOBILE PROGRAM

OBJECTIVES

1 • GUIDANCE TO THE FCC IN THE FORM OF NATIONAL POLICY.

2 • ALLOCATION OF THE MINIMUM REQUIRED SPECTRUM BANDWIDTH TO THE TELEPHONE CARRIERS IN ORDER THAT THEY EFFECT A NATIONAL SYSTEM.

3 • ALLOCATION OF MINIMUM SPECTRUM BANDWIDTH TO AN OTHER ENTITY IN ORDER THAT THEY MAY EFFECT A NATIONAL SYSTEM.

4 • ALLOCATION OF THE BULK OF THE REMAINING SPECTRUM TO COMMON USER APPLICATIONS WHICH OPTIMIZE SPECTRAL EFFICIENCY THROUGH INCREASED CHANNELIZATION.

5 • ALLOCATION TO PRIVATE SYSTEMS OF LARGE SIZE WHO ADOPT SPECTRALLY EFFICIENT SYSTEMS (POSSIBLY A REDUCTION OF BANDWIDTH FROM WHAT THEY NOW HAVE).

6 • THE PROPOSITION THAT URBAN SYSTEMS AND HIGHWAY SYSTEMS MUST BE INTEGRATED IN THE COMMON PUBLIC SYSTEMS AND AT LEAST COMPATIBLE IN BUSINESS AREAS AMONG ADJOINING CITIES.

7 • STIMULATE COMPETITION IN TERMINATING EQUIPMENT AREAS (MOBILES), AND AMONG RCC'S IN URBAN BUSINESS AREAS.

8 • ATTEMPT TO IDENTIFY INCENTIVES FOR MONOPOLIES WHICH WILL RESULT IN GREATER BENEFITS TO THE USERS THAN WOULD BE POSSIBLE THAN WITH COMPETITION.
(PASS ECONOMIES OF SCALE ON TO USERS)

OTP LAND-MOBILE RADIO PROGRAM EFFORT -- PHASE I

- IN-HOUSE RESEARCH AND ANALYSIS
- CONTRACTOR STUDY EFFORT

  "FUTURE DEMAND FOR LAND-MOBILE COMMUNICATIONS AND PUBLIC POLICY IMPLICATIONS"

OTP IN-HOUSE WORK PROGRAM

1. . TECHNOLOGY ASSESSMENT

   A. VARIOUS TECHNICAL CONCEPT PROPOSALS

   B. ASSESSMENT OF PROJECTED TECHNOLOGY APPLICATIONS

   C. TECHNOLOGY DEPENDENCE ON DEMAND

   D. PRICE ELASTICITY

2. . DEVELOPMENT OF NEW ALLOCATION SYSTEM ALTERNATIVES

3. . DEVELOPMENT OF NEW MANAGEMENT/INSTITUTIONAL STRUCTURE AND ALTERNATIVES

4. . FEDERAL USE OF LMR

STUDY OBJECTIVES

- QUANTIFY AND OTHERWISE DEFINE THE CHARACTERISTICS OF CONVENTIONAL USES AND APPLICATIONS OF LMR DEMAND.

- IDENTIFY THE IMPORTANT QUALITATIVE CHARACTER OF CONVENTIONAL DEMAND AND IMPORTANT AREAS OF EMERGENT INNOVATIVE DEMAND AND THE CHANGES TO INNOVATIVE DEMAND FOR LMR.

- THROUGH CONTINGENCY ANALYSIS, ESTIMATE THE RANGE AND SENSITIVITY OF DEMAND FOR THESE NEW ELEMENTS OF LMR DEMAND AND THROUGH STATISTICAL TECHNIQUES, PROJECT THE SIZE OF CONVENTIONAL DEMAND HAVING STABLE USAGE CHARACTERISTICS, AND

- IDENTIFY THOSE NEW LMR APPLICATIONS (THE REALIZATION OF WHICH DEPENDS CRUCIALLY UPON DECISIONS OF THE FEDERAL GOVERNMENT) AND DESCRIBE THE SPECIFIC PUBLIC POLICY IMPLICATIONS OF THESE CHANGING AND EMERGENT INNOVATIVE LMR NEEDS WITH REGARD TO:

  .. POLICIES DIRECTLY AFFECTING LMR TECHNOLOGIES, SYSTEMS, SYSTEM SUPPLIERS AND SYSTEM USERS,

  .. POLICIES PERTAINING TO PUBLIC PROGRAMS EXPECTED TO HAVE A MAJOR IMPACT UPON THE DIVERSITY AND QUALITY OF FUTURE APPLICATIONS OF LMR BY COMMERCIAL AND STATE AND LOCAL GOVERNMENT USERS.

STUDY TASKS

TASK 1. A QUALITATIVE AND QUANTITATIVE IDENTIFICATION OF CONVENTIONAL LMR DEMAND.

TASK 2. IDENTIFY QUALITATIVE CHANGES TO LMR DEMAND CAUSED INTERNALLY OR DUE TO CHANGES IN THE OPERATIONAL ENVIRONMENT. TYPE I DEMAND

TASK 3. IDENTIFY INNOVATIVE DEMAND DUE TO: ECONOMIC REASONS -- LMR UNIQUENESS -- NEW APPLICATIONS. TYPE II DEMAND

TASK 4. IDENTIFY TECHNICAL/ECONOMIC DETERMINANTS.

TASK 5. FORMULATION OF DEPENDENCE RELATIONSHIPS BETWEEN TECHNICAL/ECONOMIC DETERMINANTS AND QUALITATIVE AND QUANTITATIVE ATTRIBUTES OF DEMAND.

TASK 6. FORECAST TECHNICAL/ECONOMIC DETERMINANTS.

TASK 7. PERFORM SENSITIVITY AND CONTINGENCY ANALYSIS AND ESTIMATE RANGES OF DETERMINANTS.

TASK 8. PRODUCE BASE-CASE AND CONTINGENCY FORECASTS.

TASK 9. DERIVE NEW REQUIREMENTS FOR LMR TECHNOLOGIES.

TASK 10. PERFORM ANALYSIS OF QUALITATIVE REQUIREMENTS AND EXPECTANT USAGE PATTERNS.

TASK 11. DERIVE PUBLIC POLICY IMPLICATIONS.

SAMPLE QUESTIONS THE PROGRAM WILL ATTEMPT TO ANSWER

1. WHO IS USING LMR TODAY? WHERE? WHAT FOR? HOW OFTEN? WHEN? HOW?

2. WHO IS PROVIDING LMR AS A PROFIT MAKING SERVICE? WHAT PART OF THE MARKET IS INVOLVED?

3. WHAT KIND OF SERVICE REQUIREMENTS COMPRISE THE LMR LEASED SERVICE MARKET? MESSAGE? PAGING? LOCATION AND IDENTIFICATION? MANAGEMENT AND CONTROL? DISPATCH ACKNOWLEDGEMENT?

4. WHAT ARE THE EXACT GEOGRAPHIC BOUNDRIES (OR OTHER BOUNDRIES) OF USE IN ALL USER GROUP CATEGORIES?

5. SHOULD AND CAN SPECIFIC INPUT REQUIREMENTS BE DEVELOPED AND WHAT WILL RESULT IN THE MARKETPLACE?

6. WHAT ACCEPTABLE TECHNICAL DEFINITIONS (CRITERIA) SHOULD BE ESTABLISHED TO IDENTIFY CHANNEL OR SPECTRUM SATURATION?

7. WHAT IS THE TRANS-CONTINENTAL LMR DEMAND AND DOES IT INDICATE THE NEED FOR A NATIONAL SYSTEM?

8. WHAT CHANNEL ALLOCATIONS SHOULD BE MADE TO MEET EXPECTED TRANS-CONTINENTAL DEMAND?

9. WHAT ARE THE BENEFITS OF GREATER SPECTRUM SEPARATION ACCORDING TO USE (e.g., POLICE ONLY IN THE 150 MHZ BAND)?

10. IF THE TELEPHONE COMPANIES IMPLEMENT A SPECTRALLY EFFICIENT SYSTEM, WHAT PORTION OF PRESENT USERS IN THE EXISTING 42 MHZ CAN BE EXPECTED TO MOVE INTO THIS NEW AREA?

11. WHAT IS THE HAND-OVER PROBLEM IN CELLULAR SYSTEMS AND ITS IMPLICATIONS?

12. SHOULD PUBLIC SAFETY RADIO BE ALLOCATED FROM WITHIN THE FEDERAL GOVERNMENT MANAGEMENT SYSTEM RATHER THAN BY THE FCC?

13. IF THE FCC NEEDS TO IMPLEMENT FURTHER MANAGEMENT WHO SHOULD PAY FOR IT - THE TAXPAYER - LMR USER

14. WHAT ENTRY REQUIREMENTS SHOULD BE ESTABLISHED FOR LMR USE AND TO WHAT END RESULT?

15. SHOULD THE TELEPHONE COMPANIES BE CONFINED TO PROVIDING ONLY MESSAGE TELEPHONE SERVICE?

A BRIEF HISTORY OF LMR

- WWII ENDS LMR BEGINS

- LMR EXPANDS THROUGH THE FIFTIES TO SATURATION IN THE SIXTIES

  1949 42 MHZ AND 11,600 LICENSEES (155,000 TRANSMITTERS)

  1968 42 MHZ AND 293,000 LICENSEES (4 MILLION TRANSMITTERS)

  (TIGHTER TECHNICAL STANDARDS
  EXTENSIVE CO-CHANNEL SHARING, PLUS
  CHANNEL SPLITTING: 120KHZ TO 20KHZ IN THE 25-50 MHZ BANDS
  30KHZ AND 15KHZ IN THE 150-162 MHZ BANDS
  25KHZ IN THE 450-470 MHZ BANDS)

- PERFORMANCE GROWS WORSE REGARDLESS OF EQUIP. MANUFACTURER TECHNOLOGY:

  PROBABILITY OF BLOCKING RANGES FROM .1 (NO ONE USING THE CHANNEL)
  TO .9 (EVERYBODY WANTS THE CHANNEL)

- REQUEST FOR MORE FREQUENCIES, AND

- DOCKETS NO'S. 18261 AND 18262 ARE BORN

FCC DOCKET NO. 18261 July 26, 1968 Notice of Proposed Rule Making

IN THE MATTER OF

AMENDMENT OF . . . ;

GEOGRAPHIC REALLOCATION OF UHF-TV CHANNELS 14 THROUGH 20 TO THE LAND-MOBILE RADIO SERVICES FOR USE WITHIN THE 25 LARGEST URBANIZED AREAS OF THE UNITED STATES.

LMR INTERESTS ASKED FOR OUTRIGHT REALLOCATION OF THE LOWER SEVEN UHF TV CHANNELS (470-512 MHz) -- 42 MHz

WHAT THEY ACTUALLY GET DEPENDS ON THE AREA INVOLVED AND THE PRESENT UHF USAGE. IN SHORT, UHF CHANNELS BETWEEN 14 AND 20 NOT IN USE, MAY BE USED FOR LAND-MOBILE -- PROVIDING THERE ARE OTHER EXISTING UNUSED TV CHANNELS AVAILABLE. A SAMPLE DISTRIBUTION PLAN FOR 15 OF THE MAJOR MARKET AREAS WAS PROVIDED AS PART OF THE DOCKET DECISION.

FCC DOCKET NO. 18262 July 17, 1968 Notice of Inquiry and Notice of Proposed Rule Making

IN THE MATTER OF

AN INQUIRY RELATIVE TO THE FUTURE USE OF THE

FREQUENCY BAND 806-960MHz, AND

AMENDMENT OF PARTS ... RELATIVE TO OPERATIONS

IN THE LAND-MOBILE SERVICE BETWEEN 806 AND 960 MHz.

BASICALLY THE FCC INTENDS TO ALLOCATE 115 MHz FOR LAND-MOBILE USE BY TAKING PART OF THE TOP UHF TV CHANNELS AND SHIFTING SOME OTHER USERS AS WELL.

THE INTENTIONS WERE TO ALLOCATE 75 MHz TO THE TELEPHONE COMMON CARRIERS AND 40 MHz TO BUSINESS AND PRIVATE USERS AND THE RADIO COMMON CARRIERS (RCC's). OBJECTIONS TO THIS BROUGHT OUT ANOTHER FCC PAPER: SECOND MEMORANDUM OPINION AND ORDER ON AUGUST 2, 1971.

NO ALLOCATIONS HAVE BEEN MADE TO DATE.