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ECONOMIC ANALYSIS AND RADIO SPECTRUM LICENSE FEES: THE MICROWAVE BAND

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A STUDY OF THE APPLICABILITY OF ECONOMIC COST AND VALUE CRITERIA IN ESTABLISHING LICENSE FEE SCHEDULES FOR RADIO SPECTRUM ASSIGNMENTS, WITH PARTICULAR REFERENCE TO THE MICROWAVE RANGE, 890 MHZ TO 16 GHZ

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

I. INTRODUCTION

The radio spectrum has been recognized as a scarce natural resource that is subject to administrative allocation and assignment by national government and international agencies rather than economic allocation by private markets. An administrative process that allocates valuable spectrum without charging users a "price" has come to be recognized as one that provides incentives to promote inefficiency and even wasteful use of the spectrum resource, and sometimes to encourage uneconomic stockpiling of spectrum licenses.

Suggestions for modifying the existing administrative process of spectrum allocation range from the incorporation of economic criteria into the administrative allocation process to the substitution of private market allocations for the administrative process. In an earlier research study for DOC, herein referred to as the Spectrum I Report,[1/] we examined the feasibility of applying the opportunity cost concept of economic theory to the spectrum allocation process. In the present study we have built on our prior work by focussing attention on the applicability of economic cost and value criteria in establishing license fee schedules for radio spectrum assignments, with particular reference to the range of frequencies known as the Microwave Band, 890 Mhz to 16 Ghz.

In our initial study we observed that with the exception of technical parameters, administrative allocations and assignments suffer from a severe lack of specification of operational criteria upon which basic decisions are made. The spectrum management process has been criticized for the uncertainty

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1/ "Opportunity Cost and Radio Spectrum Allocation", Report to DOC under Contract No. OSU77-00368, March 1978.

that is created by its failure to specify clearly its criteria as well as its failure to incorporate economic factors explicitly. Our analysis led us to the conclusion that the former criticism may be of more significance than the latter. A close examination of the spectrum management process shows that in making administrative decisions, spectrum managers do obtain some important economic information. For example, under Radio Standards Procedure, RSP-113, Issue 2, applications for planned radio stations above 890 Mhz in terrestrial fixed service must include an identification of available alternatives and an economic evaluation of these alternatives.[2/] What is not clear is how this type of information influences spectrum management decisions. We also noted that the objectives of spectrum management always have included more than technical and economic factors. Public needs and the social importance of different uses are factors that are included in most statement of administrative decision criteria. Once again, the major difficulty lies in specifying these criteria in operational terms and applying them in an objective manner.

The criticism relating to economic considerations goes beyond the failure to incorporate specific economic factors as criteria for administrative decisions. Unless licensees are faced directly with charges for their spectrum assignments they still will be provided with incentives to treat the radio spectrum as a resource with almost zero cost, and therefore to use the spectrum inefficiently. The adoption of license fees has brought a change in the direction of forcing licensees to recognize that the radio spectrum is not a free resource, but

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2/ DOC, Telecommunication Regulatory Service, RSP-113, Issue 2, 1975, Appendix B, p. B-2, item 1.k.

the license fee schedules have had no necessary relationship to the economic cost or market value of the spectrum. Rather, in most instances, the fees have been designed to cover the aggregate cost of administration of the spectrum management function, which still does not include any costs of using the valuable spectrum resource and denying its availability for alternative uses.

In our Spectrum I Report, we examined the proposal to adopt the concept of opportunity cost from economic theory as a basis for spectrum allocation and assignment. We observed that the general notion of recognizing that the economic costs of using the spectrum resource in one application is related to its value in the best alternative application foregone is valid. However, an attempt to apply directly the opportunity cost concept of neoclassical economic theory to radio spectrum allocations would be a mistake because the theory has many insuperable deficiencies, including: (1) an assumption of perfectly competitive markets that generate efficient alternatives, that encourage complete freedom of market entry and exit and that permit easy and frequent market exchanges; (2) failure to handle effectively major problems associated with market externalities, the non-competitive nature of the markets in which spectrum users operate - including use by regulated monopolies, participation by government agencies dependent on non-market fiscal budgetary systems, international constraints and recognition of social and equity factors; and (3) the personal and subjective nature of opportunity cost definitions and calculations that are required in markets that are not actively competitive, as would be all spectrum markets.

The Spectrum I Report also reviewed the range of proposals to incorporate economic criteria into the spectrum allocation process that have appeared in the literature over the past quarter century, noting their strengths and limitations. The Report concluded that if the opportunity cost notion is to be applied usefully to improve the process of spectrum allocation and assignment, it will have to be broadly interpreted and selectively applied in very careful, limited ways. It noted three specific areas where further research and analysis could lead to improvements in the economic efficiency of the spectrum allocation process.

1. The role and operational basis of the economic criteria to be incorporated in the spectrum management process. In this respect, the economic theories of rent and taxes may shed more light on problems of incorporating economic criteria into the process of administrative decision-making than theories of opportunity cost pricing in private, perfectly competitive markets;
2. The relation between R & D directed at technical improvement in spectrum utilization and the costs of obsolescence of inherited equipment, which has increased at every stage of growth and expansion of spectrum use; and
3. Problems of spectrum discipline and the creation of co-operative groups to coordinate their common interests in using a portion of the spectrum.

The present study takes as its point of reference the specific process of spectrum assignments in the microwave band. The nature of the spectrum licensing process in Canada is reviewed generally. The licensing process in the microwave band is examined in more detail. The role of, and basis for the current license fee schedule is analyzed. Alternative standards for

determining license fee schedules to the existing cost recovery standard are evaluated. In this evaluation, classical economic theories of rent and taxes are reviewed as possibly a more relevant standard for determining fee schedules. Guidelines for the structuring of fee schedules in the microwave band are suggested in light of the specific market conditions in the industries using the frequencies in the microwave band. The final section addresses spectrum management activities in the areas of the R & D/obsolescence problem (point 2 above) and the spectrum discipline/common user interest problem (point 3 above), to emphasize a much neglected point in the literature, that the issue of economic efficiency in radio spectrum allocation involves much more than determining the appropriate level of license fees.

II. THE MANAGEMENT OF THE RADIO FREQUENCY SPECTRUM: AN OVERVIEW

A. The Allocation Process

At the international level, management of the radio frequency spectrum is performed by the International Telecommunications Union (ITU). This body is a specialized agency of the United Nations and has a membership of approximately 145 nations, of which Canada is one. International radio regulations are established by the ITU and "specify the permissible services and uses of the different radio bands, provide technical rules for particular services and establish arrangements for international notification and discussion of spectrum use".* These regulations are periodically revised at World Administration Radio Conferences (WARC's), the next of which is to be held in September, 1979.

For the purpose of making international allocations of the radio frequency spectrum the world is divided into three regions. Canada is a part of region 2 which covers North and South America, Greenland and adjacent waters and is subject to the table of international allocations governing this region. It is constrained by these allocations, however, only to the extent that they apply to any use of the spectrum that would interfere with the use of the spectrum by another nation, in conformity with the international radio regulations. Further, the international allocations to any particular band are often sufficiently general in character so as to permit a wide variety of possible uses for the band. Bilateral and multilateral agreements

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* DOC Spectrum I Report.

between ITU member countries may also be employed so as to permit a further measure of national discretion in the allocation process.

Chart 1 provides an indication of how allocations may vary between the national and international levels. The chart shows both the ITU region 2 and the Canadian allocations in the 406-960 band and it illustrates several possible ways in which such allocations may vary. First, it should be noted that in the 406.1 Mhz to 410 Mhz band the ITU region 2 allocation is to fixed, mobile and radio astronomy services whereas the Canadian allocation is to Radio astronomy only. Secondly, we see that the ITU region 2 allocation in the 608-614 Mhz band is to broadcasting whereas the Canadian allocation is to Radio Astronomy. Thirdly, we see that the ITU region 2 allocation in the 410-420 Mhz band is to fixed and mobile services and that in Canada this band is split up into smaller bands in each of which either fixed or mobile services have primary status.

It is clear then that Canada can exert a significant measure of influence upon the overall spectrum allocations to which it is subject. This ability stems from both its ITU membership that allows it to influence the region 2 allocations and from the fact that allocations at the international level are not so rigid as to deny a measure of national flexibility. We will briefly examine the nature of the process whereby such allocative decisions are arrived at.

In Canada responsibility for management of the radio frequency spectrum resides with the Federal Department of Communications. This authority is granted to the Minister of Communications by the Radio Act which requires

that it be exercised so as to encourage the development and more efficient operation of radiocommunications facilities in Canada. This authority extends to the securement of Canada's requirements in the international arena. The Act also provides that the Canadian Radio-Television and Telecommunications Commission (CRTC) shall be consulted on all matters relating to broadcasting. To better understand the process by which this authority is exercised, we will review events leading up to a recent series of changes in the Canadian table of frequency allocations.

In 1974 the Canadian Radio Technical Planning Board (CRTPB), an industry group comprised of users, manufacturers, and other parties involved in the provision of radiocommunications in Canada, recommended to the Department of Communications (DOC) that certain portions of the spectrum in the 470-512 Mhz and 806-960 Mhz ranges be reallocated from broadcasting to land mobile services. This report had been preceded by a decision of the U.S. Federal Communications Commission (FCC) to allow land mobile sharing of certain channels in the 470-512 Mhz broadcasting band, in selected urban areas, and to reallocate the 806-890 Mhz band from broadcasting to land mobile.* The FCC decision had been prompted by increasing congestion in the land mobile allocations in major cities, and in Canada raised concerns that similar congestion problems might arise here in the near future. It was also recognized that certain advantages might accrue if the Canadian and U.S. allocations in this region were to be standardized.

Internal DOC studies then were undertaken. They confirmed that with current allocations severe shortages of spectrum for land mobile users were likely to occur in the immediate future in urban Canadian areas. DOC

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* the 890-902 Mhz and 928-947 Mhz bands were also reallocated to land mobile.

consequently requested the CRTC to examine Canadian UHF broadcasting requirements for spectrum and, on August 21, 1976, published a Gazette notice inviting submissions concerning possible future reallocations in the 406-960 Mhz band. Over 60 such submissions were received from over 50 different parties including several provincial and municipal governments, numerous government agencies and associations, and various manufacturers and user groups. Following the issue of a DOC discussion paper in December 1977, the receipt of additional submissions to that paper, consultation with the U.S. Government and various interested Canadian parties, a revised policy governing allocations in the 406-960 Mhz band was announced on the 3rd of March, 1979.

The revised allocations for this region are shown in chart 2 and will form a basis for certain of the Canadian proposals at the 1979 WARC.

Chart 1

TABLE OF PRESENT ITU REGION 2 AND CANADIAN ALLOCATIONS (1976)*

ITU REGION 2	CANADA
406 - 406.1 MHz MOBILE-SATELLITE (Earth-to-Space)	406 - 406.1 MHz MOBILE-SATELLITE (Earth-to-Space)
406.1 - 410 MHz FIXED MOBILE (except aeronautical mobile) RADIO ASTRONOMY	406.1 - 410 MHz RADIO ASTRONOMY
	410 - 414 MHz MOBILE (except aeronautical mobile) Fixed
410 - 420 MHz FIXED MOBILE (except aeronautical mobile)	414 - 415 MHz FIXED Mobile (except aeronautical mobile)
	415 - 419 MHz MOBILE (except aeronautical mobile) Fixed
	419 - 420 MHz FIXED Mobile (except aeronautical mobile)
420 - 450 MHz RADIOLOCATION Amateur	420 - 450 MHz RADIOLOCATION Amateur
450 - 460 MHz FIXED MOBILE 318B 318C	450 - 470 MHz MOBILE Fixed
460 - 470 MHz FIXED MOBILE Meteorological-Satellite (Space-to-Earth)	
	470 - 608 MHz BROADCASTING
470 - 890 MHz BROADCASTING	608 - 614 MHz RADIO ASTRONOMY
	614 - 890 MHz BROADCASTING
890 - 942 MHz FIXED RADIOLOCATION	890 - 942 MHz FIXED RADIOLOCATION
942 - 960 MHz FIXED	942 - 960 MHz FIXED

*Secondary services are denoted by lower case lettering.

CHART 2

REVISED CANADIAN ALLOCATIONS IN THE 406-960 Mhz BANDS

Frequency Band	Allocation
406-407.1 Mhz	MOBILE SATELLITE (Earth to Space)
406.1-410 Mhz	RADIO ASTRONOMY, MOBILE (except aeronautical mobile), MOBILE-SATELLITE except aeronautical mobile satellite (Earth to Space) Fixed
410-414 Mhz	MOBILE (except aeronautical mobile), Fixed
414-415 Mhz	FIXED, Mobile (except aeronautical mobile)
415 - 419 Mhz	MOBILE (except aeronautical mobile), Fixed
419 - 420 Mhz	FIXED, Mobile (except aeronautical mobile)
430 - 450 Mhz	RADIOLOCATION, Amateur
450 - 470 Mhz	MOBILE, Fixed
470 - 608 Mhz	BROADCASTING
608 - 614 Mhz	RADIO ASTRONOMY, Mobile Satellite except aeronautical mobile satellite (Earth to Space)
614 - 806 Mhz	BROADCASTING
806 - 890 Mhz	MOBILE
890 - 902 Mhz	FIXED, Radiolocation
902 - 928 Mhz	FIXED, Radiolocation, Amateur
928 - 942 Mhz	FIXED, Radiolocation
942 - 960 Mhz	FIXED

* Secondary Services are denoted by lower case lettering.

B. Sub Allocations

The Canadian Table of Frequency Allocations states the permitted services, according to the ITU service classification, that may operate in each spectrum band. The process of suballocation refers to instances in which a band allocated to an ITU service category is subdivided and designated for particular user groups. In Canada suballocation is practised, though to a limited extent only, at both the national and the regional level.

Canadian practice, in general, has been to allow all user groups in a particular radio service equal rights of access to spectrum allocated to that service. The U.S. practice of making suballocations on a nationwide basis has been adopted only in instances where a compelling need was shown for a Canada wide assignment of frequencies to a particular user group. User groups for whom such nationwide assignments have been reserved include the Department of National Defense, the railways and paging companies.

The principle of equal right of access is also modified by technical and other operating requirements that are imposed upon systems operating in particular bands. These requirements are generally incorporated in the Standard Radio System Plans (SRSP) that are issued by DOC at the national level and to which the regions must normally adhere in their operations. Subject to conformance with these requirements the regions may however adopt their own suballocations and it is not required that such suballocations, if made, should be identical between regions.

Regional suballocations in the 410-470 band are illustrated in Chart 3. Both the variation between regions and the fact that suballocations are not everywhere employed should be noted. In fact, few other spectrum regions are as extensively suballocated as this one.

REGIONAL SUBALLOCATIONS IN THE 410-70 MHZ BAND (at 1977)

CHART 3

REGION \ FREQUENCY (Mhz)	410	415	420	450	460	470
Canada Table of Allocations	LM and fx	FX and lm	LM and fx	FX and lm	RADIOLOCATION Amateur	LM and fx
Pacific Region	Reserved for future use / Paired with 419 F3	FX	Reserved for future use / Paired with 414 F3	FX	RADIO LOCATION NO ASSIGNMENTS IN THIS BAND	In Accordance with SRSP 501 on a first come first served basis.
Central Region	Paired with 415-19 (F1 / F2)	FX	Paired with 410-414 (F1 / F2)	FX		
Ontario Region	Strictly to govts., municipal and federal services. e.g. hydro, highways, ambulance, any gov't dept. or agency					
Quebec Region	Paired with 415 -18		Paired with 410-14			Not in accordance with SRSP 401, but on a first come first served basis
	Government Use: LM	FX	LM	FX		
Atlantic Region	Paired with 415-19	FX	Paired with 410-14	FX		In accordance with SRSP 501 on a first come first served basis.
	In accordance with SRSP 501 on a first come first served basis					

M = Mobile primary
FX = fixed primary
LM = Land Mobile Primary
fx = fixed secondary
lm = land mobile secondary

F1 = proposed for useage by CTCA
F2 = proposed for useage in the Public Safety Services
F3 = assigned to RCMP, B.C., Dept. of Highways, Hydro (all province wide)

C. The Licensing and Assignment Process

The Radio Act provides that "no person shall: (a) establish a radio station, or (b) install, operate or have in his possession a radio apparatus at any place in Canada...except under and in accordance with a license and, to the extent that it is a broadcast undertaking, except under and in accordance with a technical construction and operating certificate, issued by the Minister under this Act."* The Minister is thus empowered not only to determine to what uses the spectrum may be put but also to determine by whom it may be put for such uses. This latter function constitutes the licensing process.

All radio stations in Canada must be individually licensed and such licensing must take place at one of DOC's national, regional or district offices. Certain license types, e.g. those relating to satellite use, are only issued by the national office in Ottawa, while others, such as those for Citizens Band or Land Mobile radios, may be issued at either the district or regional office level. Additionally, broadcast licenses are issued by the CRTC and some other government departments may issue licenses for use in the provision of certain of their services. Chart 4 shows the number of such licenses that have been in force for each of the years 1945 through 1976.

The complexity involved in issuing a radio station license can vary greatly. The process is perhaps simplest with regard to the issue of station licenses for items such as a Citizens Band Radio, for which it is not necessary to make individual frequency assignments and which do not entail any inspection of engineering standards, etc. In other cases the process can become significantly more involved and required detailed technical and socio-economic

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* exemptions to this clause exists in a limited number of instances, e.g. television sets and microwave ovens.

consideration, together with the assignment of specific dedicated and shared frequencies to the station. An example of this is provided by the licensing process governing microwave licenses as set forth in Radio Standards Procedures (RSP) 113.

The licensing process is closely intertwined with that of making frequency assignments. A license must specify the particular frequencies on which a station may operate and this specification must include not only its spectrum location, but also a geographic location and in some cases a temporal one. It must specify whether the assignments are dedicated, or if shared, upon what basis. The addition or deletion of assignments attaching to a licensed station require corresponding modifications in the license, and it is necessary to maintain an up-to-date register of all such assignments made.

While the licensing process is primarily an administrative one, being governed by the allocation and engineering decisions that are decided upon at an earlier stage, it is also an allocative process. Where spectrum is scarce it will not be possible always to grant licenses to all who require them. The resolution of such competing needs may involve public hearings, as in the case of broadcast licenses; it may be resolved on a first come first served basis; it may require the formulation of additional administrative criteria; or it may require the revision of the prior allocation and engineering decisions upon which it is based. Where spectrum is scarce it may also be rationed by a set of user charges attaching to radio station licenses. The matter of fees currently attaching to radio station licenses is taken up in the next section.

Chart 4

RADIO STATION LICENSES IN FORCE FROM 1945-46 to 1976-77 Incl.

Licensing Year	Licenses in Force	Numerical Increase	Percentage Increase
1945/46	7,427	-	-
146/47	8,601	1,174	16%
147/48	12,799	4,198	49%
1948/49	13,178	379	3%
1949/50	15,316	2,138	16%
1950/51	16,685	1,369	9%
1951/52	15,685	-1,000	-6%
1952/53	15,900	213	1%
1953/54	24,006	8,106	50%
1954/55	26,358	2,352	10%
1955/56	27,458	1,100	4%
1956/57	34,462	7,004	26%
1957/58	39,716	5,254	15%
1958/59	52,807	13,091	33%
1959/60	59,760	6,953	13%
1960/61	67,742	7,982	13%
1961/62	79,329	11,487	16%
1962/63	98,670	19,386	24%
1963/64	119,773	21,003	21%
1964/65	136,912	17,139	14%
1965/66	163,840	25,928	18.9%
1966/67	191,849	29,009	17.8%
1967/68	219,590	27,741	14.4%
1968/69	229,785	10,195	4.6%
1969/70	245,789	16,004	6.9%
1970/71	256,327	10,538	4.2%
1971/72	268,810	12,483	4.8%
1972/73	296,620	27,810	10.3%
1973/74	334,571	37,951	12.7%
1974/75	395,614	61,043	18.2%
1975/76	515,222	119,608	30.2%
1976/77	893,781	378,559	73.4%

NOTE: - Figures up to 1969/70 are exclusive of any broadcasting service licenses. Figures from 1970/71 include licenses issued for auxiliary broadcasting service stations.

III: RADIO SPECTRUM LICENSING

A. History of Spectrum License Fees in Canada

Radio station license fees were first imposed, in Canada, in the year 1914. A fixed per station fee was, at that time, introduced that varied between seven different station classes and was to be paid on an annual basis. The fees were levied in accordance with section 10 of the Radio-telegraph Act, Chapter 43, Statutes, 1913 and are detailed in Chart 1 following.

From 1914 to 1958, periodic revisions to this schedule were made that involved both the alteration of fee levels and the addition and deletion of various station classes. These revisions were mostly of a fairly minor nature, an exception being the 1948 revision of the levy for Private Commercial Broadcasting Stations. This latter revision involved replacing the fixed fee levied upon such stations with a variable fee calculated as a function of the gross annual revenue of the broadcast undertaking. The level of these fees in 1948 is shown in Chart 2. Their level was not altered until 1968 and was then altered once more in 1977.* The 1968 and 1977 fee schedules are shown in Charts 3 and 4. The reader should note that it was not until 1977 that the schedule discriminated between different classes of broadcast undertakings. The reader should also note that these fees do not apply to rebroadcasting transmitting stations, student carrier current broadcasting undertakings, the CBC, or provincial educational TV network.

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* Amendment to these regulations also occurred in 1972 but did not involve any alterations in the fee structure here discussed. However, alterations in the fee levels did occur.

For stations other than those for Private Commercial Broadcasting, a major revision in the 1914 license fee schedule did not occur until 1958 at which time the number of station classes and the related fee levels were both substantially altered. Minor changes in the number of station classes and some more substantial changes in fee levels have since occurred (1968 and 1975). Chart 5 shows the fee schedule for 1958, 1968 and 1977, to illustrate these revisions. It will be noted that the fee increases over the 20 year period have been in the order of 100-150% for most services. It should be noted, that no fees are charged for Provincial Government service and that reduced fees are charged for municipal services.* This exemption also extends to Provincial crown corporations. Such exemptions were initiated in 1958.

* Also fee exempt are the U.S. military and the federal government, though not its crown corporations.

CHART 1

Annual Radio Station License Fees - 1914

Station Class	Annual Fee
Limited Coast Stations	$ 10
Public Commercial Stations	50
Private Commercial Stations	10
Experimental Stations	5
Amateur Experimental Stations	1
Technical or Training School Stations	1
Ship Stations	1

CHART 2

Annual License Fees in Respect of Private Commercial Broadcasting Stations - 1948

Station Category	Annual Gross Revenue of Broadcasting Undertaking		License Fee
A	$ Under	$25,000	$ 100
B	25,000 and under	50,000	250
C	50,000 and under	75,000	500
D	75,000 and under	100,000	1,000
E	100,000 and under	200,000	1,500
F	200,000 and under	400,000	3,000
G	400,000 and over.		6,000

CHART 3[4]

Annual License Fees in Respect of Broadcasting Undertakings -- 1968

		License Fee
(i)	for broadcasting undertakings where the gross revenue is $200,000 or less	$25 + 1% of gross revenue
(ii)	for broadcasting undertakings where the gross revenue is more than $200,000	$2025 + 1½% of gross revenue in excess of $200,000

CHART 4[2]

Annual License Fees in Respect of Broadcasting Undertakings -- 1977

		License Fee
(i)	for radio broadcast undertakings where the fee revenue is $300,000 or less	$25
(ii)	for radio broadcast undertakings where the fee revenue exceeds $300,000	$25 plus 1½% of fee revenue in excess of $300,000
(iii)	for television broadcast undertakings where the fee revenue is $1,000,000 or less	$25
(iv)	for television broadcast undertakings where the fee revenue exceeds $1,000,000	$25 plus 1½% of fee revenue in excess of $1,000,000
(v)	for broadcast receive undertakings where the fee revenue is $75,000 or less	$25
(vi)	for broadcast receive undertakings where the fee revenue exceeds $75,000	$25 plus 1½% fee revenue in excess of $25,000

1 gross revenue is defined as "the total operating revenue derived from the operation of a broadcast undertaking".

2 fee revenue is defined as "the total revenue from the licensed activity of the broadcast undertaking whether received by the licensee... or by an associated corporation".

CHART 5

Annual Station License Fees

Station Class	1958 Annual Fee	1968 Annual Fee	1977 Annual Fee
1. License for a coast station performing:			
(a) Limited Maritime mobile service	$ 50.00	$ 75.00	$ 98.00
(b) Private Maritime mobile service	10.00	20.00	26.00
2. License for a land station performing:			
(a) Public Commercial Service	100.00	150.00	195.00
(b) Restricted Public Commercial Service	50.00	100.00	130.00
(c) Private Commercial Service	10.00	20.00	26.00
(d) USA Military Service	No Fee	No Fee	No Fee
(e) Provincial Government Service	No Fee	No Fee	No Fee
(f) Municipal Service*	1.00	10.00	13.00
(g) Experimental Service	5.00	20.00	26.00
(h) Amateur Experimental Service	2.50	10.00	13.00
(i) Public Commercial Receiving Service	10.00	15.00	20.00
(j) Private Commercial Receiving Service	2.00	10.00	13.00
(k) Public Commercial Automatic Repeater Service	25.00	75.00	98.00
(l) Private Commercial Automatic Repeater Service	5.00	10.00	13.00
(m) Remote Control Service	1.00	N.A.	N.A.
(n) Model Control Service	N.A.	No Fee	N.A.
(o) General Radio Service (3 years)	N.A.	N.A.	13.50
(p) Amateur Relay	N.A.	N.A.	13.00
(q) Commercial Broadcasting Receiving Service	25.00	25.00	N.A.
(r) Aeronautical Mobile Service	10.00	20.00	26.00
3. License for mobile station performing:			
(a) Public Commercial Service	25.00	35.00	46.00
(b) Private Commercial Service	2.00	7.00	10.00
(c) U.S.A. Military Service	No Fee	No Fee	No Fee
(d) Provincial Government Service	No Fee	No Fee	No Fee
(e) Municipal Service*	1.00	10.00	13.00
(f) Experimental Service	5.00	10.00	13.00
(g) Public Commercial Receiving Ser.	10.00	15.00	20.00
(h) Private " " "	2.00	10.00	13.00
(i) Remote Control Service	1.00	N.A.	N.A.
(j) Model Control Service	N.A.	No Fee	N.A.
(k) General Radio Service (3 yrs)	N.A.	N.A.	13.50
(l) Aircraft Navigational Service	2.00	10.00	13.00
(m) Aeronautical Mobile Service	10.00	15.00	20.00

* Where municipal service is provided by a radiocommunication system comprised of more than one station, one license fee only shall be required.

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CHART 5 (continued

	1958 Annual Fee	1968 Annual Fee	1977 Annual Fee
4. License for a ship station fitted with			
(a) Transmitting and Receiving Apparatus:	N.A.	N.A.	$ 20.00
(b) Receiving Apparatus for Navigational Purposes	N.A.	N.A.	13.00

B. The Current License Fee Schedule in Canada

The licenses fees currently in force for radio stations, other than broadcasting stations, are detailed in Chart 5 of the preceding section. While fee levels and station classes have been substantially modified since that time, the fee schedule is in one key respect essentially as it was in 1914. Specifically, license fees are levied on a per station basis and vary only by station class. In our analysis we will wish to consider both the absolute level of the fees and their structure or variability.

While fees currently vary only by station class there exist numerous other dimensions according to which fees might be varied. These include the licensee's ability to pay, the licensee's valuation of the license, the amount of bandwidth employed, the spectral region in which the bandwidth is held, the amount at which competing applicants value the license, the availability of spectrum substitutes to the licensee, the social desirability of the licensee's activities, the cost of issuing the license, etc. To some extent these attributes are recognized in the current station classification according to which fees vary. The comparatively low fee levied on experimental services, for example, may reflect the need to encourage socially desirable innovation. To a large extent, however, it would appear that such considerations are lacking. Whether this omission is serious will depend on the objectives of the spectrum manager.

The objectives of spectrum management may include such factors as recovery of the costs of spectrum management, recovery of spectrum value, a simple increase in government revenues, the promotion of efficient resource allocation, the promotion of particular social objectives, the promotion of

user equity, etc. In this section, we will not attempt either to enumerate the full range of such government objectives nor indeed to state those objectives that we ourselves find most compelling. Rather we will discuss briefly a few known objectives of the spectrum management authority that the current fee schedule fails to serve and will then comment upon whether such failure implies a need for fundamental revision in the spectrum fee structure.

One important objective of the spectrum management authority is that the license fee schedule should recover the direct costs of spectrum management. This objective appears to have been adopted as a consequence of discussions held by the Cabinet and clarified by DOC consultation with the Treasury Board. However, while this consideration seems to have been a prime factor in determining the design of the proposed new fee schedule (discussed in the following section) it does not of itself entail any need for structural revisions in the fee schedule. A straight recovery of costs could as easily be engineered by a flat percentage increase in all current fee levels. Such a strategy, however, under current circumstances would appear to require that the fee schedule be altered frequently if license fee revenues are to be held in balance with spectrum management costs. As spectrum management costs are closely correlated not only with the number of licenses issued but also with the number of frequency assignments accorded under each license, a fee schedule that was capable of meeting the cost recovery objective over time, without frequent adjustments, would require some measure of frequency assignments to be included as a parameter in the determination of fee levels.

A second stated objective of the Department of Communications is to promote the provision of telecommunications services to rural areas and it has been argued that the annual fee of $195. that is levied for licenses for a land station performing a public commercial service constitutes a major deterrent to this goal. The removal of this deterrent could be achieved by structural revisions whereby either a new station class corresponding to this category was created and accorded a lower fee or by basing the station fee upon the station's channel capacity, it being assumed that this will result in lower fees for stations serving a remote area. Alternatively, the same end could be achieved by a simple lowering of the current annual fee for this station class, with no consequent structural revision in the fee schedule being implied.

A third objective of the spectrum management authority is that not only should total fee revenues match spectrum management costs but that this equality should hold for all separate service classes. As in the case of the overall recovery of costs it would appear that a simple revision of fee levels could accomplish this end but that a structural revision would be required if frequent fee revisions are to be avoided.

A fourth objective of the spectrum management authority is that the license fee schedule should be administratively simple, easily understandable and compatible with existing licensing files. At the extreme this objective, which is somewhat meaningless when considered in isolation, would argue for the removal of all license fees. More realistically there is probably a presumption in favour of the current schedule and against any increase in fee variability.

A fifth objective of the spectrum management authority concerns the promotion of efficient resource allocation and it is on this count that the current schedule of license fees is most easily criticized. This matter was dealt with at length in an earlier paper and here it will suffice to say that by making station fees independent of usage factors such as R.F. channels and of location, an incentive is created for stockpiling of spectrum, a bias is created in favour of spectrum as opposed to alternative communications inputs, a bias is created away from needed R & D, and an incentive is created to employ overly spectrum intensive communications equipment. To remove this bias, a structural revision in the fee schedule is required.

While the five objectives discussed above are not the only ones that are relevant to determining whether structural revisions in the spectrum license fee schedule are desirable, they do appear to be the principal ones that were considered by DOC in its current attempts to revise the schedule. A strong case for a basic structural revision is only given by the fifth objective, namely that of efficient resource allocation. In that instance, consideration of the fourth objective, would further seem to imply that such a revision should occur by means other than an expansion of service classifications and that the introduction of a variable fee structure within particular service classifications should be considered.

Our discussion also has touched upon various concerns regarding the level, as opposed to the structure, of the current fee schedule. One further concern that might be raised in this regard relates to the question of fee exemptions and reductions accorded various user classes. The argument for efficient resource

allocation that provides the basic rationale for a structural fee revision also argues against the granting of such exemptions. The argument is perhaps weakest with regard to government department licenses and strongest with regard to provincial crown corporation licenses. The current practices in this regard would seem in need of review. It is particularly hard to understand the rationale where provincially owned hydro and telephone companies obtain exemptions not accorded to their privately owned counterparts in other provinces.

C. The Proposed New License Fee Schedule for Canada*

In this section we will briefly discuss the new License Fee Schedule put forward by DOC in a November 1977 document titled License Fee Study. The new schedule does not apply to private commercial broadcasting stations. It is reproduced in Chart 6. Chart 7 juxtaposes the current and proposed fee schedules so as to facilitate their comparison.

The most significant changes that have been incorporated in the new fee schedule are as follows: (1) The number of station classes has been drastically reduced, (2) The distinction between Public commercial and Private commercial stations has been discarded, (3) The General Radio Service station fee, which is a major source of DOC license fee revenues, has not been altered, (4) Space and Fixed stations performing a fixed satellite service must now pay a license fee, that is calculated on a variable basis, (5) Variable fees have been introduced for fixed stations performing either a fixed service or a land mobile service and (6) all current fee exemptions and reductions have been retained.

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* A new radio licence fee schedule for non-broadcast stations will be implemented on April 1, 1979. The new schedule is the same, in almost all major respects, as that proposed in the License Fee Study reviewed here.

With respect to items (4) and (5) above, the fees for Fixed stations performing either a fixed service or a fixed satellite service are identical and are an increasing function of a number of R.F. and equivalent voice channels received and transmitted at the station. The fees for Space stations performing a fixed satellite service are also calculated on the above basis but are increased by an equivalent space factor derived on the basis of the equivalent number of terrestrial hops covered by actual Canadian satellites. For Fixed stations performing a land mobile service the fees are a function of the radio coverage area of the station, the number of receive only channels at this station, the number of transmit only channels at the station and the geographic location of the station. Due to this last factor land mobile fees in metropolitan areas will, ceteris paribus, be twice as high as in rural areas.

In analysing this fee schedule we will follow the same procedure as was used when discussing the current fee schedule. This is to say that we will evaluate it in the light of the five main objectives that were considered by DOC in constructing the new schedule.

The first of these objectives was that the fee schedule should yield revenues sufficient to cover the costs of spectrum management. DOC has further stated that revenue losses due to fee exemptions should be treated as if they had been collected for cost recovery purposes and the DOC broadcasting costs are to be offset by corresponding CRTC revenues rather than from other DOC revenues. Chart 8 records DOC's estimated Spectrum Management costs and it's estimated revenues, adjusted in the manner noted above, under the current and the proposed fee schedules for each of the years 1977-1980. It will be noted

that with the new fee schedule a much better degree of cost recovery is achieved and further that a better tracking of such costs is attained than with the old schedule. The time frame over which the estimates are provided is too short to permit any firm conclusions on this latter point but our earlier analysis would suggest that the introduction of variable fees that are a function of station capacity would support this end. The objective of cost recovery would thus appear to be well served by the new fee schedule.

The same cannot however be said with regard to the objective that the spectrum management costs relating to each service class should be recovered by revenues from users in that class. Chart 9 shows spectrum management costs and revenues under the new and proposed schedules broken down by four station classes, (Fixed, Mobile, Space and GRS), for the year 1977-78. The chart does not include either broadcast costs or revenues as the latter are collected by CRTC and we have no means of allocating them between CRTC and DOC. From the chart we see that Fixed station license revenues offset only a small portion of DOC's associated license costs under the current schedule and that while this portion increases under the new schedule it remains small. Further, under the new schedule GRS revenues continue to exceed greatly their associated costs, and revenue from space stations is less than half of the associated costs. Estimated data for other years would be required to more fully analyse these circumstances but it is evident from Chart 9 that while the new fee schedule reduces the level of cross subsidization implicit in the old schedule, it does not do so significantly. We may further note that the station types in Chart 9 are heterogenous in many important respects and that there is likely significant cross subsidy between different users within each station type. Once again we have inadequate data to treat this question fully.

As to the promotion of telecommunications services to remote and rural areas the introduction of a variable fee for fixed stations performing a fixed service should prove beneficial. The lower channel use of remote area stations will ensure consequent fee reductions for such stations and thus increase the incentive for their provision. The removal of the distinction between public commercial and private commercial stations is also helpful in this regard.

On the grounds of administrative simplicity the new schedule also cannot be seriously faulted. The reduction of the number of station classes and the simplicity of the variable fee structures both contribute to this goal and DOC does not appear to have any major concerns re the administration of the new schedule. Only in determining the radio coverage area of fixed stations performing a land mobile service are serious problems likely to be encountered in the near future.*

The fifth objective considered here concerns the promotion of an efficient resource allocation and we have argued earlier that it is this objective that implies the greatest need for a structural revision in the fee schedule. The introduction of a variable fee schedule, for large classes of users, must be commended as a positive step in this direction. It is, however, only a very small step. Variable fees are not applied to all user classes and numerous fee exemptions are permitted. Further the level of the fees is such that even though variable they are likely, in many instances, to have a negligible effect on resource allocation and DOC in its License Fee Study makes no attempt to assess this impact. We stated in an earlier paper that any fee schedule that was limited to the recovery of administrative costs was unlikely to have a significant impact in that area. This conclusion is still warranted.

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* This feature of the license fee schedule was in fact not adopted in the schedule to be implemented April 1, 1979.

An overall assessment of the new fee schedule thus leads one to conclude that while it constitutes in most respects an improvement over the current schedule, it fails to fully achieve DOC's stated objectives. This failure is most conspicuous with regard to the elimination of user cross subsidy and the promotion of an efficient resource allocation.

CHART 6

PROPOSED TARIFF OF RADIO LICENCE FEES

	Annual Fee
1. Licence for a Fixed Station performing a:	
- Aeronautical Mobile Service	$26.00
- Amateur Service	13.00
- Experimental Service	26.00
- Fixed Service	variable*
- Fixed Satellite Service	variable*
- Land Mobile Service	variable*
- Maritime Mobile Service	26.00
- Municipal Service	13.00
- General Radio Service	4.50
- Other Services	**
2. Licence for a Mobile Station performing a:	
- Experimental Service	13.00
- Aeronautical Mobile Service	20.00
- Maritime Mobile Service	20.00
- Land Mobile Service	15.00
- Municipal Service	13.00
- General Radio Service	4.50
- Other Services	**
3. Licence for a Space Station performing a:	
- Fixed Satellite Service	variable*
- Other Services	**

TABLE IV

* Minimum of $26 per station

** For the purpose of this study, this classification covers a number of services in which there are few licencees, generally exempted by law, and permits the addition of specific other services as required.

CHART 7

TARIFF OF RADIO STATION FEES

PRESENT AND PROPOSED

(1978/79)

Actual Categories	Present Annual Fee	Proposed Annual Fee	Affected Number of Licensees
1. Licence for a coast station performing:			
a. Limited Maritime Mobile Service	$ 98.00	$ 26.00	0
b. Private Maritime Mobile Service	26.00	no change	17
2. Licence for a land station performing:			
a. Public Commercial Service	195.00	variable*	1,450
b. Restricted Public Commercial Service	130.00	variable*	1,050
c. Private Commercial Service	26.00	variable*	35,000
d. United States of America Military Service	(no fee)	no change	(N/A.)
e. Provincial Government Service	(no fee)	no change	8,500
f. Municipal Service	13.00	no change	2,400
g. Experimental Service	26.00	no change	440
h. Amateur Experimental Service	13.00	no change	19,400
i. Public Commercial Receiving Service	20.00	variable*	100
j. Private Commercial Receiving Service	13.00	variable*	600
k. Public Commercial Automatic Repeater Service	98.00	variable*	1,000
l. Private Commercial Automatic Repeater Service	13.00	variable*	2,200
m. General Radio Service	4.50	no change	**
n. Aeronautical Mobile Service	26.00	no change	1,500
o. Amateur Relay	13.00	no change	300
3. Licence for a mobile station performing:			
a. Public Commercial Service	46.00	15.00	19
b. Private Commercial Service	10.00	15.00	230,000
c. United States of America Military Service	(no fee)	no change	(N/A.)
d. Provincial Government Service	(no fee)	no change	37,000
e. Municipal Service	13.00	no change	2,700
f. Experimental Service	13.00	no change	640
g. Public Commercial Receiving Service	20.00	15.00	0
h. Private Commercial Receiving Service	13.00	15.00	165
i. General Radio Service	4.50	no change	**
j. Aircraft Navigation Service	13.00	20.00	4
k. Aeronautical Mobile Service	20.00	no change	16,600
4. Licence for a ship station fitted with:			
a. Transmitting and Receiving Apparatus	20.00	no change	17,800
b. Receiving Apparatus for Navigational Purposes	13.00	20.00	2
5. Licence for a space station performing:			
a. Space Service	(N.A.)	variable*	3
6. Licence for an earth station performing:			
a. Space Service	(N.A.)	variable*	120

TABLE V

* Minimum fee of $26.00

** The total GRS licenses expected to be issued in 1978/79 is 690,000

CHART 8

Spectrum Management Cost Revenue Estimates ($1000's)

Fiscal Year	Spectrum Management Costs	Current Fee Schedules		Proposed Fee Schedules	
		Revenues	Revenues as a % of cost	Revenues	Revenues as a % of cost
1977 - 8	24,543	17,450	71%	N.A.	
1978 - 9	27,146	22,327	82.2%	25,335*	93.3%
1979 - 80	29,979	26,329	87.8%	29,771	99.3%
1980 - 1	33,036	29,108	88.1%	33,075	100.1%

*Assuming proposed fee schedule was implemented April 1, 1978

CHART 9

($000's) 1977 Spectrum Management Cost and Revenue Estimates by Station Type*

Station Type	Spectrum Management Costs	Current Fee Schedules		Proposed Fee Schedules	
		Revenues	Revenues as a % of cost	Revenues	Revenues as a % of cost
Fixed	10,472	2,087	19.9%	3,383	32.3%
Mobile	4,831	3,752	77.7%	5,116	105.6%
Spare	183	0	0%	80	43.7%
GRS	3,796	5,940	156.5%	5,940	156.5%
TOTAL	19,282	11,779	61.1%	14,519	75.3%

*Does not include DOC broadcast costs or corresponding CRTC revenues which are assumed to be identical for purposes of Chart 8.

APPENDIX TO SECTION III*

The U.S. Experience

Management of non-government uses of radio spectrum in the U.S. is conducted by the FCC, which levies the fees for such uses. In this appendix we will briefly review FCC practices in this regard, particularly as they are relevant to recent Canadian experience.

The FCC fee schedule of 1963 was established at nominal levels designed only to recover approximately 25% of commission costs and was subsequently revised in 1970 so as to provide for the full recovery of commission costs. The new schedule while aiming primarily to satisfy the cost recovery objective also sought to reflect more accurately the value to the recipient of the license granted. Among the more interesting features of this schedule were the following items; (1) annual broadcast station fees based upon commercial station rates, (2) annual cable television fees based upon the number of system subscribers and (3) variable fees, based on construction costs, for new point to point microwave and satellite stations and (4) separate application and grant fees for many services.

A further revision to the fee schedule was to have occurred in 1974. Prior to its adoption, however, the 1970 fee schedule was set aside by a U.S. court ruling and in 1975 a new schedule was instituted that attempted to meet the concerns of the court. This schedule was again set aside by the courts in 1976 and the FCC then suspended the collection of fees and is now in the process of undertaking a full review of its fee schedules. A fee refund program has

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* See Gen. Docket 78-316, FCC 78-695.

also been instituted that will refund all fees paid the Commission between 1970 and 1976, net of any amounts that would have been paid under a schedule that conformed with the court's requirements. The process of the schedule review together with the details of the refund program provide many useful insights into the possible workings of the licensing mechanism.

A 1976 court ruling stated the U.S. legal requirements to which the FCC fee schedule must adhere as follows:

> "Firstly the Commission must justify the assessment of a fee by a clear statement of the particular service or benefit which it is expected to reimburse. Second it must calculate the cost basis for each fee assessed. This involves (a) an allocation of the specific direct and indirect expenses which form the cost basis for the fee to the smallest practical unit; (b) exclusion of any expense incurred to serve an independent public interest; and (c) a public explanation of the specific expenses included in the cost basis for a particular fee, and an explanation of the criteria used to include or exclude particular terms. Finally, the Commission must set a fee calculated to return this cost basis at a rate which reasonably reflects the cost of the service performed and the value conferred upon the payor ... the agency must look not at the value which the regulated party may immediately, or eventually derive from the regulatory scheme, but at the value of the direct and indirect services which the agency confers."

While DOC is not subject to the same statutory constraints as the FCC and thus need not accept the constraints defined above, the quotation does identify several key aspects of the fee setting process that are of a more general application. First, there is a clear need to define the service performed by the licensing agency. Second, there is a need to determine the various costs incurred in providing the service in the "smallest practical units" and to determine for whose benefit these costs were incurred. Third, there is a need to determine value accorded the licensee and then to form a basis upon which these cost and value elements are to enter the fee schedule.

For the purposes of undertaking its fee refund program the FCC has decided to calculate its allowable fees on the basis of direct costs incurred only. To this end it has devoted great effort in allocating such costs as closely as possible to existing service categories, and thus has created a data bank and has embarked on devising a cost accounting system that allows it to match costs and fees on a much closer basis than is available under DOC's corresponding data breakdowns. If DOC wishes to avoid between service cross subsidization, while remaining within the framework of a cost recovery based fee schedule, it too in the future will need to embark upon such an effort.

Of equal relevance are the FCC's current efforts to move towards a revised fee schedule. Its efforts in this regard are occurring along two separate avenues. First, it is considering a prospective fee schedule that conforms with existing legislative authority. In this regard, it has undertaken to review fully and to categorize the various services rendered by the Commission and to institute a corresponding system of cost accounting. This system then will be employed to allocate all such costs between services. Direct costs that confer benefits on particular private interests will be allocated to such parties through the fee schedule, with indirect and other costs being allocated on the basis of the value of service principle.

A second avenue of approach that is being considered by the Commission is to seek legislative relief that will permit it to employ a fee schedule that will yield revenues that are not constrained to match the Commission's budget. In this regard the Commission is examining not only fees that are based on cost recovery but also fees that are based on spectrum value and that would undoubtedly yield revenues far in excess of Commission costs. Issues raised in the course of this examination will undoubtedly be of considerable interest to DOC in Canada, which is not constrained in its fee schedule options to the extent that the U.S. FCC is constrained by Court decision.

IV: THE MICROWAVE BAND

A. Users

The microwave band is generally defined to consist of all spectrum above 890 Mhz. Frequency allocations within this region are detailed in the Department of Communications' Table of Frequency Allocations. Of the 29 service categories listed therein, we find that 22 of these have allocations in the microwave region. Chart 1 lists these 29 service categories and denotes by an asterisk (*) those services that have allocations in the microwave region.

Allocations in the microwave region are of course, as in all other spectrum regions, subject to periodic revision. We noted earlier, for example, that recent changes have occurred in the 890-960 Mhz band and that these changes will be reflected in Canadian proposals made at the 1979 WARC. Other Canadian proposals that will be made at WARC relative to allocations in this region include additional allocations to amateur services, maritime mobile services, radionavigation and other services. Canada will also propose that allocations be made in formerly unallocated bands at the extensive margin of allocated spectrum and has included several proposals relating to satellite service allocations in this region.

We have been unable to obtain comprehensive statistics on the breakdown of assignments in this region but have been furnished with several documents that together contain sufficient information to provide us with a reasonably accurate picture as to the main user groups holding assignments in this region.

The first of these documents is entitled "Microwave Communications Systems in Canada" (Draft) and, while being undated, is believed to have been presented recently as the basis of a DOC internal seminar held in Ottawa. Chart 2 is derived from that document and shows for each band in the 890 Mhz to 14 Ghz* region, the principal users, and the number of assignments.**

Perusal of Chart 2 indicates that the major holders of assignments in the microwave region are the Hydro Companies, the telecommunications Common Carriers, Pipeline Utilities, Broadcasters and the CATV industry. The two other major users identified are the School Boards which employ spectrum in the provision of instructional TV services and the government which uses it in the provision of such diverse services as Aeronautical Radio Navigation, Radio Location, Radio Astronomy, and Metereological Aids. The nature of these latter two users is very different from the former and it is to the former group that we shall devote the bulk of our attention.

The breakdown of assignments as between members of this former group is shown in Chart 3 which is derived from an August 1978 study by T.A. Kubacki of DOC's Ottawa Policy group. The breakdown is given by major user group in each of the microwave bands in which they operate. Telephone companies emerge as the clearly dominant spectrum user, holding fully 63% of all assignments in the band. Other major users are seen to be the Hydro companies (10.9%), the Railway companies (19.3%) and the broadcast industry (4.5%). Pipeline

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* There is currently little or no use being made of spectrum above 14 Ghz.

** The chart may contain some minor errors or omissions, where present in the original source document.

utilities hold only 0.4% of such assignments, and the remaining 1.9% includes miscellaneous users. These then are the major users that we will need to consider in our study. Together with them it will also be important to recognize usage by the CATV industry, which in the above classification appears to be entered in the broadcast category, and by Telesat Canada.

CHART I

Service Classes Listed in the Table of Frequency Allocations

Aeronautical Mobile Service
Aeronautical Mobile Satellite Service*
Aeronautical Radionavigation Service*
Aeronautical Radionavigation Satellite Service*
Amateur Satellite Service*
Amateur Service*
Broadcasting Satellite Service*
Broadcasting Service
Earth Exploration Satellite Service*
Fixed Satellite Service*
Fixed Service*
Inter-Satellite Service*
Land Mobile Service
Maritime Mobile-Satellite Service*
Maritime Mobile Service
Maritime Radionavigation Satellite Service*
Maritime Radionavigation Service*
Meteorological Aids Service*
Mobile Satellite Service
Mobile Service*
Radio Astronomy Service*
Radiolocation Service*
Radionavigation Satellite Service*
Radionavigation Service*
Space Research Service*
Space Operation Service*
Standard Frequency Satellite
Standard Frequency Service

N.B. * Denotes that service has allocation in microwave region.

CHART 2

Microwave Frequency Bands and Their Uses

Band	Principal Users	# of Assignments	
890-960 Mhz	Common Carriers Oil Pipelines Broadcasters (STL)	783	
960-1215	MOT	250	*
1215-1300			*
1300-1350	MOT		*
1350-1400	DND		*
1400-1427	GOVT	2	*
1427-1525	Experimental		
1525-1535	Nil		*
1535-1542-5	Nil		*
1542-5-1543-5	Nil		*
1543-5-1558-5	Nil		*
1558-5-1636-5	Nil		*
1636-5-1644	Nil		*
1644-1645	Nil		*
1645-1660	Nil		*
1660-1700	GOVT	5	*
1710-1900	Common Carriers Hydros	2446	
1900-2290	Common Carriers	1387	
2300-2500			*
2548-2686	School Boards	503	
2690-2700	GOVT	4	
2700-2900	MOT & Private	38	*

*indicates civil assignments only.

CHART 2 (Cont'd)

Band	Principal Users	# of Assignments	
2900-3100	Private	47	*
3100-3500			*
3500-4200	Common Carriers	4900	
4200-4400	Nil		*
4900-5000	Nil		*
5000-5250	Nil		*
5250-5925	?	13	
5925-6425	Common Carriers	2694	
6425-6590) Mhz	Common Carriers	410	
6770-6930)	Hydro		
6590-6770)	T.V. Networks	642	
6930-7125)	Common Carriers		
7125-7725	Common Carriers Hydro	1589	
7725-8275	Hydro Common Carriers	265	
8275-8500	CATV & Broadcast MOT Common Carriers	198	
8500-10550	MOT & Private	350	*
10-55-10-68 Ghz	Nil		
10-68-10-7	GOVT	1	*
10-7-11-7	Common Carriers	187	
11-7-12-2	Nil		*
12-7-12-95	CATV	?	
13-25-13-4 Ghz	Nil		*
13-4-14-0	Nil		*
	TOTAL	16,713	

CHART 3

Band (Mhz)	Total	Telephone	Hydro	Railway	Broadcasters	Pipeline/Gas Utility	Misc.
890-960	1167	497	87	297	94	70	122
1427-1525	27	27	0	0	0	0	0
1710-1900	2873	1746	467	628	4	6	27
1900-2290	1683	1177	74	418	12	0	2
3540-4200	4945	4616	0	305	0	0	24
5925-6425	1920	854	26	1016	0	0	24
6425-6590) 6770-6930)	946	399	14	312	201	1	19
7125-7250) 7300-7725)	2787	1249	784	394	65	0	7
7725-7975) 8025-8275)	298	173	390	2	21	0	0
8275-8500	487	278	0	34	76	0	99
8500 +	558	130	86	5	328	0	9
Total	17,696	11,146	1,928	3,411	801	77	333
% of Total	100.0%	63.0%	10.9%	19.3%	4.5%	0.4%	1.9%

B. Trends

No statistics were made available to us that allowed us to gain a good insight into the question of possible future congestion in the microwave spectrum. Chart 4, which is derived from DOC annual reports, may however be of some use in this regard. It shows for each of the three major microwave user groups, the increase in the number of radio licenses that has occurred since 1974. Growth, over a three year period, has been substantial in all three categories and particularly so by the telephone and electric power systems. The statistics may however be misleading in two respects. First, the statistics include licenses held by these users in non microwave regions. Second, licenses are not homogenous with respect to permitted spectrum capacity.

In informal discussions in Ottawa we were advised that in general spectrum scarcity in the microwave region was unlikely to become at all serious in the foreseeable future. While we are not in a position to argue this issue, the statement clearly requires several qualifications. Primarily, it should be noted that while abundant portions of the microwave spectrum remain either under or unutilized, scarcity may nevertheless constitute a relevant concern in either a particular geographical area or in a particular bandwidth. On the former point we may note that in British Columbia, for example, the microwave region is said to be heavily congested in the area of Vancouver and Prince George. On the latter point we should mention the recent decision to turn the 12.7-12.95 Mhz region over from CATV companies to the telephone common carriers. The fact that such a decision was necessary must imply scarcity of the latter sort. This form of scarcity is in fact implied by the very need to regulate spectrum usage.

CHART 4

Total # of Licenses held by Major Users

Year	Telephone Systems	Electric Power Systems	Railway Transport
1974/5	9,543	12,189	10,793
1975/6	10,272	13,677	11,207
1977/8	12,383	15,753	12,679
Period Growth	29.8%	29.3%	17.5%

C. Licensing Procedure

Regulations governing the application for and issuance of licenses in the microwave region of the spectrum are clearly outlined in DOC's Radio Standards Procedure (RSP) Manual 113. We do not intend to reproduce that document here, but rather only to comment upon a few areas of concern that will be relevant to our later analysis and some of which were discussed at a meeting held by us with regional office personnel in Vancouver.

We should note first that while particular bands in the microwave region are associated typically with particular user groups, the RSP guidelines do not specify any restrictions as to who may or may not use a particular bandwidth. However, such restrictions are implicit in the technical and economic standards that an applicant for a particular assignment must meet. Additionally, we were informed, Hydro license applications are generally accorded priority due to the special nature, involving safety and emergency considerations, of Hydro's need for spectrum.

The unique role of telecommunications common carriers is also recognized in the application process. RSP 113 states that non-Hydro applicants, other than the carriers themselves, must provide a quotation for equivalent services from a telecommunications common carrier and states that "where the equivalent annual cost approximates the lease rate quoted by a telecommunications common carrier, it is assumed that there will be little economic justification for a private system". We were informed that a 30-35% dollar preference margin is accorded to the common carriers* although other factors such as the impact on final product cost, or factors of a social nature may be considered. We were

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* Discussions with DOC regional staff, Vancouver.

also informed that in the case of contemporaneous competing applications, the common carriers and other major users would generally be accorded priority.

Several other features of the assignment process in the microwave region that may be noted briefly for possible future reference are:

1. Renewals are automatic.
2. Less than 1% of new microwave license facilities are inspected annually.
3. Traffic and cost forecasts contained in the license application are not monitored subsequently.
4. Where an existing system is in conformity with DOC standards, DOC will not require it to be modified to facilitate another party's license application. DOC is however willing to assist in any resulting negotiations between the parties involved.

D. License Fees

Under the current license fee schedule there is no single fee applicable to all microwave licenses. Rather the fee varies according to the nature of the service performed by the licensee. The fees are levied on a per station basis and do not vary with system capacity or bandwidth used. Chart 4 lists the eight service classes, and the annual station fee relating to each, under which stations in the microwave region may be licensed. It will be seen that the fees range from $13 to $195 per year and vary according to whether the service is private or public and according to whether the station is for reception and transmission or for reception or transmission only. There are no fees for either space or earth stations performing a space service; furthermore, the federal and provincial governments and their agencies are fee exempt and municipalities pay greatly reduced fees. Included among those who are fee exempt

are provincially owned hydro and telephone companies, though their privately owned counterparts enjoy no such exemptions.

Using DOC's November 1977 License Fee Study report we may also derive Chart 5 which estimates the number of microwave licenses in each of the service categories listed in Chart 4, for the communications sector and in aggregate and only for those users who are not fee exempt. The chart also excludes fees for stations operating both in and outside the microwave band. Total revenue accruing from the licenses listed in Chart 5 was approximately $95,000. Total revenues accruing from licenses for stations operating both inside and outside the microwave sector was approximately $153,000, and DOC estimates that $107,000 of this amount was attributable to the microwave sector. The breakdown of licenses by service category and by sector appears to be very similar in the case of licenses for stations operating only in microwave and both in and out of the microwave region. On the basis of the detailed tables in the DOC study we would estimate that of the $202,000 in revenue from microwave licenses in 1976-77, approximately 91% is attributable to the communications sector.

Under the proposed new fee schedule, microwave charges are drastically altered. The current fee exemptions are retained and the experimental service license fee is unchanged, but little else is. The distinction between private and public services is removed and the fees are no longer levied solely on a per station basis. Rather, a single variable fee is levied on all land microwave stations and does not distinguish between alternative service uses. The

variable fee formula is given by

$$F_i = \$3.00\ (Ti + Ri) + \$0.025\ (VC_{Ti} + VC_{Ri})$$

where:

F_i = annual fee at station i.

T_i = number of transmitted R.F. channels from station i.

R_i = number of received R.F. channels at station i.

VC_{Ti} = number of equivalent voice channels transmitted from station i.

VC_{Ri} = number of equivalent voice channels received at station i.

The new fee is thus a function of station capacity and in all cases a $26 minimum annual fee is required. If applied during the 1976-77 year it is estimated that this fee schedule would have yielded revenues of $403,000 approximately, from the land microwave sector. This is approximately double the amount of such revenues that were actually yielded by the current fee schedule. Charts 6 and 7, which are taken from Appendix C of DOC's 1977 license fee study, show the breakdown of the $403,000 as between major user groups and for individual users.

The new fee schedule also introduces a fee for earth and space stations licensed under the Fixed Satellite Service category. The fee for space stations is variable and is calculated according to the following formula:*

$$F_i = \alpha(3.00\ (Ti + Ri) + \$0.025\ (VC_{Ti} + VC_{Ri}))$$

where the variables Fi, Ti, Ri, VC_{Ti}, VC_{Ri}, are as previously defined and $\alpha = 40$ is a conversion factor based on "the equivalent number of terrestrial

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* The fees for earth station in the Fixed Satellite Service Category are calculated on the same basis as land microwave stations.

hops covered by actual Canadian satellites". The fee schedule, it is estimated, would yield revenues of approximately $81,000 in 1978-79 with Telesat Canada being the sole fee paying licensee. The breakdown of the fees is given in Charts 8 and 9 which are taken from Appendix E of the 1977 DOC License Fee Study.

CHART 4

Radio Station Fees (1978-9)

Service Category	Annual Station Fee
License for a land station performing	
a. Public Commercial Service	$195
b. Restricted Public Commercial Service	130
c. Private Commercial Service	26
d. Public Commercial Receiving Service	20
e. Private Commercial Receiving Service	13
f. Public Commercial Automatic Repeater Service	98
g. Private Commercial Automatic Repeater Service	13
h. Experimental Service	26

CHART 5

Microwave Licenses by Fee Class *(1976-77)

Service Category	Communications Sector	Total
License for a landstation performing		
a. Public Commercial Service	228	272
b. Public Commercial Automatic Repeater Service	396	426
c. Private Commercial Service	33	113
d. Private Commercial Automatic Repeater Service	9	17
e. Experimental	2	2
Total	668	830

* . includes only licenses for microwave only stations.

CHART 6

TYPE OF COMPANY	ESTIMATED REVENUES ($)
Telephone	271,300
Railway	104,100
Hydro Power	14,400
TV-CATV	12,400
Other	600
TOTAL	402,800

Summary of Estimated Licence Fee Revenues
From the Microwave Sector

(Based on 1976/77 figures)

Source: DOC License Fee Study, November 1977, Table C-II, p. C-7.

CHART 7

SUMMARY OF MAJOR MICROWAVE USERS

	Estimated Fees ($)
Pacific Region	
B.C. Telephone	44,056
C.N. Railway	7,390
Okanagon Telephone Co	114
Canadian Pacific	1,800
B.C. TV System	570
B.C. Hydro	no fee
B.C. Railway	no fee
Central Region	
Calgary Power	318
C.N. Railway	4,060
Canadian Pacific	2,990
Alberta Government Telephone	no fee
Manitoba Telephone	no fee
Saskatchewan Telephone	no fee
Manitoba Hydro	no fee
Ontario Region	
Bell Canada	128,470
Ontario Hydro	12,750
Canadian Pacific	20,600
Ontario Northland Transportation Commission	5,525
C.N. Railway	3,615
Grand River Cable T.V.	2,917
Connad Lavigne Ltd	756

(Cont'd).../

CHART 7 (CONT'D)

	Estimated Fees ($)
Quebec Region	
Bell Canada	31,478
Quebec Telephone	15,600
Telephone du Nord du Quebec	7,170
Télébec Ltd.	666
Quebec Northshore and Labrador Railways	5,550
Société d'Enérgie de la Baie James	1,205
C.N. Railways	6,410
Canadian Pacific	3,915
Bonaventure and Gaspé Telephone	990
Quebec Hydro	no fee
Atlantic Region	
C.N. Railways	14,018
Newfoundland Telephone	3,918
Maritime Tel. & Tel.	18,780
New Brunswick Telephone	17,120
Quebec Northshore and Labrador Railways	2,136
Eastern Tel. & Tel.	2,087
TOTAL MAJOR MICROWAVE USERS	366,975

Source: DOC License Fee Study, November 1977, Table C-III, pp. C-8, C-9.

CHART 8

PROJECTED REVENUES FROM FIXED SATELLITE SERVICE CATEGORY

(FIXED STATIONS)

1978/79

Institution	Type of Equipment	No. of Fixed Stations	Total Fee
Telesat Canada	Earth station	76	$2,970
Telesat Canada	Telemetry, Telecommand and Control Equipment (TAC)	2	30
Department of Environment	Teledetection and Weather	34	no charge*
Department of Communications	Control Equipment Experimental E.S.	29	no charge*
Teleglobe	Communications	3	no charge*
Natural Resources (Québec)	Communications	2	no charge*
TOTAL		146	$3,000

* Exempted under Section 2(2) Radio Act

Source: DOC License Fee Study, November 1977, Table E-II, p. E-6.

CHART 9

PROJECTED REVENUES FROM FIXED SATELLITE SERVICE CATEGORY (SPACE STATIONS)

1978-79[1]

Institution	Satellite Name	No. of licenced Channels	Annual Cost for Licensing
Telesat Canada	ANIK A-I	24	25,920
	ANIK A-II	24	25,920
	ANIK A-III	24	25,920
Telesat Canada	ANIK A-I, II, III	Telemetry, Tracking and Control Equipment	90
DOC	HERMES	experimental	no charge[2]
DOC	ISIS I	experimental	no charge[2]
DOC	ISIS II	experimental	no charge[2]
TOTAL	6	-	77,850

(1) Early 1979, the ANIK B satellite will be launched to replace possible ANIK A-1. The 4/6 GHZ plus the 12/14 GHZ payload will totalize thirty-six RF channels to be licenced.
(2) Exempted under Section 2(2) Radio Act.

Source: DOC License Fee Study, November 1977, Table E-III, p. E-7.

V. ECONOMIC RENT: A BASIS FOR TAXING THE UNEARNED INCREMENT

Our Spectrum I Report concluded that, although the economic theory of opportunity cost provided a sound conceptual basis for charging license fees in excess of the costs of spectrum management, it provided no guideline for determining the appropriate level or structure of such fees. There are inherent and probably insuperable conceptual and administrative barriers to all of the proposals which have been advanced. One reason for the conceptual and administrative difficulties with the "opportunity cost" approach is the assumption that the cost to be imposed on the use of the radio frequency assignment should be determined prior to the act of licensing and on the basis of facts which at that time are conjectural. The basic difficulty is that encountered by all before-the-fact remedies for problems, i.e. the difficulty of anticipating what would happen in unpredictable and unforeseen circumstances. As soon as this is realized, the question arises: is it possible to meet the need for imposing some incentive to use the radio frequency assignments economically by devising an after-the-fact arrangement which would accomplish the desired result?

Investigation of this question inevitably turns our attention to the literature on taxation - a form of public policy which uniquely, but not exclusively, deals with events after-the-fact. Income taxes conspicuously have this character. All income taxes are taxes on the results of the use of property rights - whether real or personal. One great advantage of formulating a procedure for imposing an "economizing" burden on the users of the radio

spectrum through the medium of taxes is that the object of the tax has taken place. It is not conjectural. Neither the conceptual nor administrative aspects of it depend upon controversial economic models inspired by generalized market behaviour. The application of a tax model to our problem thus has the advantages of being specific to the problem itself, as well as dealing with real, as distinct from conjectural, facts.

What are the implications of the property aspects of the radio spectrum? It is well-settled international law that the radio spectrum is a form of property which is sui generis.[1/] It is not susceptible, legally, of being treated as private property, regardless of the duration of licenses and regardless of the duration of the assignment and bands of radio frequencies to particular classes of users. Therefore we are dealing here with a form of universal public property. Even the regulatory (or taxation) practices of nation states must take this fact into account. And it is the very reasons that require the radio spectrum to be treated as public property that also underlie the conceptual and administrative barriers to opportunity cost based proposals. They founder on the probabilistic nature of the behaviour of the radio spectrum and the impossibility of imposing justiciable metes and bounds on property rights that some analysts would like to apply to the radio spectrum.

Approaching the present problem from the standpoint of taxing the use of the radio spectrum as a form of public property leads us into consideration of a vast economic literature which has focussed on the taxation of economic rent as the "unearned increment" from private ownership of land - a form of property that has been, and is easily susceptible to exact legal description as private property.

1/ Codding, The International Telecommunications Union (1952).

A. Adam Smith

That control of the use of land by ownership produces an "unearned increment" has been a central proposition in economic theory. It began with the Physiocrats in France and Adam Smith in England in the late 18th century. For the Physiocrats[2/] the sole productive source of a "net product" i.e. output greater than all inputs of productive factors, was agriculture. Accordingly in their view a tax on income from the ownership of land should be the sole and sufficient source of revenues from taxes. The influence of the Physiocrats on the classical economists, Smith, Malthus, Ricardo, James Mill and John Stuart Mill was pervasive and it is not surprising, therefore, that land and rent were basic to classical economic theories of value, distribution, and taxation.

With Smith the crudity of the Physiocrat's theoretical analysis is replaced by the testing of theory against detailed, specific and realistic practice in various countries and at various times. Smith implicitly recognized the distinction between the extensive and intensive margins of production that was first rigourously stated by Ricardo. And he derived his theory of rent from inductive studies not only of agronomy, but of animal husbandry, fisheries, and mines (especially coal and precious metals). Some relevant excerpts follow:

> "The rent of land, therefore, considered as the price paid for the use of land, is naturally a monopoly price. It is not at all proportioned to what the landlord may have laid out upon the improvement of the land, or to what he can afford to take; but to what the farmer can afford to give....

2/ See Gide, Charles, and Rist, Charles. A History of Economic Doctrines. London, D.C. Heath, 1947.

> "Rent, it is to be observed, therefore, enters into the composition of the price of commodities in a different way from wages and profit. High or low wages and profit are the causes of high or low price; high or low rent is the effect of it. It is because high or low wages and profit must be paid, in order to bring a particular commodity to market, that its price is high or low. But it is because its price is high or low; a great deal more, or very little more, or no more, than what is sufficient to pay those wages and profit, that it affords a high rent, or a low rent, or no rent at all.
>
> "I shall conclude this very long chapter with observing that every improvement in the circumstances of the society tends either directly or indirectly to raise the real rent of land, to increase the real wealth of the landlord, his power of purchasing the labour, or the produce of the labour of other people."3/

When he comes to taxation, Smith distinguishes two sources of public revenues; (1) those derived from the sovereign's property; and (2) those derived through taxes. Because our concern is with a form of the sovereign peoples' property, the radiomagnetic spectrum, it is helpful to note that Smith begins a detailed analysis of the then current practice of renting crown property by observing:

> "Land is a fund of a more stable and permanent nature [than capital and credit]; and the rent of public lands, accordingly, has been the principal source of the public revenue of many a great nation that was much advanced beyond the shepherd state."4/

For advanced nations, Smith found that revenues from crown property were insufficient to defray state expenditures, and that therefore it was necessary to tax private revenue to make up sufficient public revenue. Smith disagreed with the Physiocrats about the appropriateness of a single tax on land rent

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3/ Smith, Adam. An Inquiry into the Nature and Causes of the Wealth of Nations. London, J.M. Dent, 1924, Vol. I, Book I, Chapter 11, pp. 132-228.

4/ Op. cit., Vol. II, Book 5, Chapter 2, p. 302.

for several reasons. In the first place, because it violated his four "maxims" regarding taxes.[5/] And in the second place, because he was sufficiently pragmatic to discern a number of other taxes which were so unshiftable, or otherwise equitable that they too should be used. Nevertheless he accorded high priority to a tax on rent:

> "Ground rents and the ordinary rent of land are, therefore, perhaps, the species of revenue which can best bear to have a peculiar tax imposed upon them. Ground-rents seem, in this respect a more proper subject of peculiar taxation than even the ordinary rent of land. The ordinary rent of land is, in many cases, owing partly at least to the attention and good management of the landlord. A very heavy tax might discourage too much this attention and good management. Ground-rents, so far as they exceed the ordinary rent of land, are altogether owing to the good government of the sovereign, which, by protecting the industry either of the whole people, or of the inhabitants of some particular place, enables them to pay so much more than its real value for the ground which they build their houses upon; or to make to its owner so much more than compensation for the loss which he might sustain by this use of it. Nothing can be more reasonable than that a fund which owes its existence to the good government of the state should be taxed peculiarly, or should contribute something more than the greater part of other funds, towards the support of that government.[6/]

5/ They are so timelessly valid that they bear repetition: "I. The subjects of every state ought to contribute towards the support of the government, as nearly as possible, in proportion to their respective abilities; that is, in proportion to the revenue which they respectively enjoy under the protection of the state....II. The tax which each individual is bound to pay ought to be certain, and not arbitrary. The time of payment, the manner of payment, the quantity to be paid, ought all to be clear and plain to the contributor, and to every other person....III. Every tax ought to levied at the time, or in the manner, in which it is most likely to be convenient for the contributor to pay it....IV. Every tax ought to be so contrived as both to take out and to keep out of the pockets of the people as little as possible over and above what it brings into the public treasury of the state...." Op. cit., p. 308.

6/ Op. cit., p. 326.

B. Ricardo's Theory of Economic Rent

The theory of economic rent as developed by David Ricardo[7] illuminates our problem. He was concerned with economic rent to provide a theory that would distinguish the relation of "land" (standing for natural resources) from that of labour and that of capital to value (and price). We may read "spectrum" for "land" to test the relevance of his theory. He defined rent as "...that portion of the produce of the earth which is paid to the landlord for the use of the original and indestructible powers of the soil."[8] Rent in the commercial sense of the term is a compound of economic rent, interest and profits on the capital goods with which land has been "improved". He could have been speaking of the spectrum when he said,

> "It is only, then, because land is not unlimited in quantity and uniform in quality, and because in the progress of population, land of an inferior quality, or less advantageously situated, is called into cultivation, that rent is ever paid for the use of it... With every step in the progress of population, which shall oblige a country to have recourse to land of a worse quality, to enable it to raise its supply of food, rent, on all the more fertile land will rise."[9]

Given that land is not homogenous in its productivity, the level of economic rent is determined at the margin of cultivation. But, the margin of cultivation is divisible into the extensive margin and the intensive margin. The former is that land which is cultivated and least productive, which yields no rent and barely returns product enough to cover the cost of capital and labour inputs, and which would not be cultivated were the market price of the product to fall. The latter is that land which, being more productive, has

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7/ Ricardo, David. Principles of Political Economy. London and Toronto, J.M. Dent, 1817, 1926 (Everyman edition).

8/ Op. cit., p. 33.

9/ Op. cit., p. 35.

inputs of capital and labour added to the point where the yield of the intensive margin has fallen to that at the extensive margin. The level of economic rent on any particular parcel of "land" tends to be set by the difference between the productivity of two equal quantities of capital and labour at the extensive and intensive margins.

Ricardo generalized his rent theory in terms which include our application of it to the radio spectrum:

> "If air, water, the elasticity of steam, and the pressure of the atmosphere were of various qualities; if they could be appropriated, and each quality existed only in moderate abundance, they, as well as the land, would afford a rent, as the successive qualities were brought into use. With every worse quality employed, the value of the commodities in the manufacture of which they were used would rise, because equal quantities of labour would be less productive."10/

It follows from such analysis that while what is termed rent in ordinary business is a cost of production for the enterprise, economic rent is a result of price, not a cause of it, and it accrues to the owner of supra-marginal portions of the scarce natural resource, "land".

Ricardo applied his theory to taxation and the incidence of taxes in particular. "A tax on rent would affect rent only; it would fall wholly on landlords, and could not be shifted to any class of consumers."11/ But he hastened to point out that a tax on commercial rent would be shifted to consumers, to the extent that the rent taxed exceeded economic rent, i.e. included return on capital improvements on the land. Similarly,

> "A land-tax, levied in proportion to the rent of land, and varying with every variation of rent, is in effect a tax on rent; and as such a tax will not apply to that land which

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10/ Op. cit., p. 39.

11/ Op. cit., p. 110.

> yields no rent, nor to the produce of that capital which is employed on the land with a view to profit merely, and which never pays rent [e.g. at either the extensive or intensive margins of cultivation]; it will not in any way affect the price of raw produce, but will fall wholly on the landlords. In no respect would such a tax differ from a tax on rent."12/

A land tax which taxed capital improvements as well as economic rent, would do that degree be shiftable to consumers.

C. John Stuart Mill

John Stuart Mill was the last substantial creator of classical economic theory and for this reason his analysis of land, rent, and the taxation of rent is particularly relevant. He begins his analysis of rent with the statement:

> "It is at once evident, that rent is the effect of a monopoly; though the monopoly is a natural one, which may be regulated, which may even be held as a trust for the community generally, but which cannot be prevented from existing. The reason why landowners are able to require rent for their land, is that it is a commodity which many want, and which no one can obtain but from them."13/

Mill followed Ricardo in distinguishing clearly between the extensive and intensive margins of production. He also affirmed what had been first said by Smith, that rent is an effect of price (value), not a component of it.14/ Like his predecessors, Mill's analysis of taxation found that

> "A tax on rent falls wholly on the landlord. There are no means by which he can shift the burthen upon any one else. It does not affect the value or price of agricultural produce, for this is determined by the cost of production in the most unfavourable circumstances, and in those circumstances, as we have so often demonstrated, no rent is paid."15/

12/ Op. cit., p. 115.

13/ Mill, John Stuart. Principles of Political Economy. N.Y. Kelley, 1965, p. 422.

14/ Op. cit., pp. 424, 427, 435.

15/ Op. cit., p. 823.

He quickly adds, however, that such portion of commercial rent as is based upon "improvements" is really a charge for capital inputs, the proceeds of which should be excluded from a tax designed to tap economic rent per se.

D. Taxing Economic Rent: Applications

What became known as the "Single Tax Movement" was inspired by Henry George's Progress and Poverty[16/] published at a time when readily-appropriable land at the frontier was disappearing in the United States. For a time, it sparked a radical political movement aimed at substituting a single tax on unearned increment from ownership of land for other types of taxes in the United States. It failed politically because of conservative opposition based on resistance to diminution of private property rights on the one hand, and labour and socialist opposition because it did not envision outright public ownership of land and capital, on the other hand. After 1887 when independent political action had failed, the Single Taxers continued to work within the Democratic Party with steadily dimishing numbers and influence.[17/]

Our interest in the Single Tax movement is two-fold: its impact on the theory of rent and of taxation, and evidence of its being put into practice in taxation at the level of local governments. At the level of theory, the treatment of the "unearned increment" constituted a contentious issue in the second and third decades of this century in the United States. There, numerous articles from economists (e.g. Harry Gunnison Brown and John R. Commons) sustained the classical economists' insistence on the unique characteristics

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16/ George, Henry. Progress and Poverty. San Fransisco, 1879.

17/ Young, Allyn A. The Single Tax Movement in the U.S. Princeton, Princeton University Press, 1916.

of economic rent from natural resources, and on the appropriateness for tax purposes of taxing economic rent as a tax on unearned increment which could not be passed on to others, was progressive rather than regressive, and was non-inflationary.

The practical experience concerned the adoption of property taxes which discriminated between the value of the land and the improvements. In Western Canada (from Manitoba to British Columbia), many communities adopted tax policies which levied higher taxes on unimproved land than on improved land. Vancouver and Victoria were conspicuous examples about 1912. New York and Pennsylvania moved in the same direction.18/ Practical applications were not limited to North America. In 1904 special taxes on unearned increment were applied in Frankfurt-am-Main, Germany and by 1910 in 457 cities and towns in Germany. "In 1911 an Imperial unearned increment tax was adopted which replaced in the main the local taxes."19/ And in England, the Lloyd George budget of 1909 introduced an unearned increment tax which took for the state one-fifth of all increases in land values greater than 10 percent. Similar tax reforms were apparently introduced in Australia, New Zealand, the Union of South Africa, Denmark, Argentina, and Hungary.20/

The conclusions to be drawn from the theory of rent and the issue of taxing unearned increment are as follows. Over time the development of use of a limited natural resource such as land (or the radio spectrum) does

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18/ Haig, Robert Murray. The Exemption of Improvements from Taxation in Canada and the U.S. New York, 1915. And Young Allyn, sup. cit., p. 278.

19/ Young, Allyn, sup. cit., p. 277.

20/ Brown, H.G., Buttenheim, H.S., Cormick, P.H. and Hoover, Glenn E. Land Value Taxation Around the World. N.Y. Robert Schalkenbach Foundation, 1955.

generate economic rent which is received by those who use the scarce resource productively at points within the extensive and intensive margins. This is what is referred to as unearned increment. If it be conceded that unearned increment does exist and is created by the progress of society, then it is possible to devise taxes or fees which will take back for society as a whole, part or all of the unearned increment.

Efforts to recover unearned increment from private owners of land failed of acceptance because of the fundamental attachment which public opinion in capitalist states has to the institution of private property. No such stigma attaches to taxing the unearned increment from public property. Note in this connection the distinction Adam Smith made between the revenue from Crown land and revenue derived from taxation of private incomes. The moral, economic and political arguments which ran against taxing away the unearned increment from resources which are susceptible of being private property, like land, therefore can not apply to taxing away part or all of unearned increment from the use of a resource which cannot be private property, such as the radio spectrum.

E. Implications for the Radio Spectrum

The radio spectrum appears to be of finite dimensions, and many of the recent economic writings on it simplistically assume that it is a scarce resource of fixed supply. In the interest of clear analysis, it is important to emphasize that it is a "limited" resource where the limits have been demonstrated again and again over the past century to be revised and extended

through research and development (R & D). If we are willing to pay the price in terms of R & D, (and in terms of writing off obsolete investment), it appears realistically that no finite boundaries to spectrum use have been found.

"The latent communications capacity of the spectrum far exceeds any projected demand, if one is interested in paying the price or imposing technical standards which extract the price from the user."[21/] Yet at any given time there is a general "scarcity" which is unevenly distributed throughout the spectrum and which is imposed by our social organization and our unwillingness to pursue further R & D.

The uneven incidence of interference and congestion within the radio spectrum suggests the applicability of Ricardo's extensive and intensive margins of "cultivation". And we find Staff Paper Seven of the President's Task Force on Communications Policy making a distinction in the same terms:

> "By intensive spectrum use, we refer to the simultaneous compatible use of the same spectrum resources by more than one party; as contrasted with extensive spectrum use, which means use of hitherto completely unused spectrum resources."[22/]

If we reflect on the historical development of use of the spectrum, it is easy to trace the displacement of the extensive margin from the "Low" frequency portion of the "Medium", the "Short-wave", and so on, as R & D mostly concentrated around the military needs of World Wars I and II, and the Space Race progressively moved the extensive margin into higher and higher frequency bands. And likewise if we reflect on the regions where "congestion"

21/ Rostow, Eugene V. The Use and Management of the Electromagnetic Spectrum. Part 1, Washington, U.S. Department of Commerce, 1969, p. 78.

22/ Op. cit., p. 75.

and "interference" became intolerable, a similar historical development traces the locus of congestion into more and more sophisticated applications of R & D at higher and higher frequency bands.

Economic rent in the case of the radio spectrum, as in the case of land, is a reality which is obscured by superficial phenomena analogous to commercial "rent" which includes (as noted above) returns on capital investment and labour in "improvements". But we would argue that in many instances a rough index to the portions of the spectrum where economic rent accrues most heavily to license holders is the amount of concern with interference between particular spectrum users.

The practice of charging fees for radio licenses that has existed in Canada since the early days of development of the spectrum is consistent with the notion of taxing the income from the use of the radio spectrum. In order to explore the possibilities of developing fees as a means of providing the public treasury with some part or all of the unearned increment, several questions may be posed for consideration.

1. Should the policy on fees for use of the radio spectrum be based on the notion that only the cost of administering the regulation of the spectrum should be recovered through the fee structure? United States policy on this issue is strictly governed by the provision in the United States Constitution which states that all federal tax measures must originate in the House of Representatives. It would be perfectly constitutional for the U.S. Congress to legislate a tax measure which would recapture for the Treasury all unearned increment from the use of the radio spectrum. But in the absence to date of

such legislative action, the FCC has been constrained by the U.S. courts to restrict its efforts to charge license fees for the use of the radio spectrum to recovery of the actual cost of administering the regulatory process. This does not inhibit analysis of the merits or demerits of taxing policy which would recover more than the cost of administration, even in the United States.

In Canada and in other countries where no consititutional constraint prevents recovery of more than the cost of regulation in the form of taxes on unearned increment from the use of the public property such as the radio spectrum, there is every reason why students on public finance and taxation as well as students of the regulatory process should freely explore the matter. In this connection we note that in the studies of license fees by the DOC and CRTC that we have seen, there appears to have been uncritical acceptance of the notion that the purpose of such fees is limited to recovering all or only part of the cost of administering the radio spectrum.

2. How would one go about designing a license fee policy aimed at recovering for the public treasury the unearned increment from the radio spectrum which the progress of population and industry has generated? Here we encounter immediately the fact that only the broadcast services generate their unearned increment exclusively from using the radio spectrum. For all other users of the spectrum the radio spectrum has been an alternative resource without the use of which the users could still function, albeit not so efficiently, e.g. radio dispatching of taxicabs, use of radio for railroad operations, etc. Inputs of primary importance for such activities other than the radio spectrum are characteristic of all non-broadcast users of the spectrum. In practical terms it appears difficult if not impossible to devise administrative criteria

which would distinguish reliably the economic rent arising from the use of the radio spectrum from returns on private capital inputs in the form of land, and physical plant other than spectrum-based. The practical implication of this analysis is that the theory of appropriating unearned increment from the spectrum would justify increasing the present nominal levels of license fees charged to non-broadcast spectrum users. However, the practical limits to such increases will not be found in any theoretical ceiling representing the full unearned increment to be taxed. And no attempt should be made to implement a policy that justified fees for non-broadcast spectrum users as being tailored to unearned increment alone or per se.

A second major constraint will pertain to fees for the use of the spectrum by non-broadcast users, namely the shift of incidence of the fees when they reach materially significant levels. While a tax on unearned increment from the use of the radio spectrum is un-shiftable when the radio spectrum is the sole primary input into the productive activity of the taxpayer, this is not true where the taxpayer is in a position to shift to consumers the burden put upon him by virtue of the fact that the price of his produced product or service is determined by the market or by market surrogates such as public utility or communications common carrier regulatory processes. In those cases the incidence of increased fee levels for radio frequency assignments simply may be rolled over in higher prices for consumers.

3. There remains to be considered the matter of designing a fee structure relevant to recapture the whole, or some significant part, of the unearned increment from broadcast users of the spectrum. Here several comments are in order. Analysis of the most recent study of broadcast license fees available to us, (Weir, Nigel, A Now License Fee Policy, October, 1974, CRTC) is

notable. First, the policy is anchored on the fact of the public ownership of the radio spectrum. Second, the study poses a trade off in the allocation of the unearned increment between license fees and regulatory enforced public service requirements. It states:

> "Clearly this rationale [i.e. the use of public property] is relevant to the broadcasting industry where licenses are granted the use of various frequency bandwidths. The argument could only be countered by proving that the Commission asserts so much pressure on profits through service requirements (i.e. the broadcasting rate of return is below the average rate of return in the economy as a whole), that the industry must be compensated by free use of the airwaves. As well as being empirically weak, this case becomes confusing when the structural makeup of the broadcasting system is considered, since it is composed of elements of varying size and technology and therefore varying profitability, and simply becomes an argument in favor of a progressive fee system - which is what we now have." (p. 3)

The present fee schedule for broadcast licenses is almost totally lacking in the features of a progressive tax, because above a low-revenue cutoff point, a single tax percentage (1.5%) applies to licensees with fee revenue above $300,000 per annum for radio and $1 million for TV; and for licensees with revenues below those cutoff points the fee is a nominal $25. Clearly, further study should be given to demonstrating the extent to which substantial public revenues could be generated for the Canadian government from an unshiftable tax of all or most of the unearned increment from the use by broadcasters of the publically-owned radio spectrum.

The changes in the structure of license fees proposed in the DOC License Fee Study, and to be implemented April 1, 1979, introduce several improvements when evaluated in terms of economic efficiency. Such changes as: (1) the combining of service classifications for which there are no economic distinctions; (2) the establishment of some fees in relation to spectrum capacity rather than simply by station will provide at least a small economizing incentive for some licensees; (3) the introduction of fees for space and earth stations removes them from an apparent exempt category, again introducing a mild economizing incentive.

However, there are several significant areas where further modifications to improve economic efficiency could be implemented. First, the continued exemption of the federal and provincial governments and agencies is unjustifiable on economic grounds. These users can be divided into two distinct classes: (1) those selling services directly to the public such as telephone and hydro government corporations or agencies; and (2) those supplying social services financed by the public treasury and general taxes. The former operate directly as public utilities and should be treated in the same manner as other public utilities. There is no reason for exempting them.

The treatment of government social services is not as clear. The basis for providing social services includes matters of equity, tax policy and government budgeting processes. In theory, it is appropriate to charge fees to governments so that the taxing structure accords more closely with the benefit structure of the spectrum management service. However, recognizing that

government taxing and service structures are replete with cross-subsidies of costs and benefits, it cannot be demonstrated that the result of levying spectrum fees upon such users would be an improvement. Nevertheless, some fee is warranted at least as a symbolic indicator that the spectrum is not a completely free good. And the discrimination between federal and provincial governments on the one hand, and municipal governments on the other, should be eliminated. An appropriate initial step would be to raise federal and provincial fees to the level of municipal fees immediately and then develop a plan to raise that fee level to cover costs over a reasonable period of time.* The matter of exemptions is particularly important in terms of DOC's concern about establishing a long term policy of efficiency in spectrum assignments. Exemptions build in cross-subsidies that severely dilute - and if the exemptions are large enough and stimulate use in congested areas, can defeat - achievement of the efficiency objective.

A second area where improvement in the license fee structure can be obtained readily is the elimination of cross-subsidies among service classes. Under the new license fee proposal, revenues cover costs in the aggregate, but there are major distortions in the revenue/cost relationships among service classes. The license fee structure should be changed so that each class of service pays fees that cover the costs of the class. The DOC also should consider undertaking a more detailed analysis of its costs so that the revenue/cost allocations can be made to more detailed categories within each class of service.

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* Removal of the exemption for the Federal and Provincial Governments would require a change in the law. The low fees charged municipalities are determined by DOC regulations. At the present time, raising federal and provincial government license fees to the levels charged municipalities would be largely a symbolic act, involving relatively small payments. However, its long run significance will be much greater and more difficult to address, if adjustments of the type recommended are not made in the short run.

In fact, the DOC objective of promoting rural service use might well be facilitated by establishing rural services as separate categories for cost allocation. Presumably the cost of license processing and spectrum management in rural areas, with reduced or non-existent problems relating to congestion and interference, should be lower than it is in urban areas. Also, if exemptions from license fees are to be considered on grounds of social policy, exemptions for rural use in uncongested areas, where the use of spectrum does not deny spectrum availability to others, will have the least adverse impact on the overall efficiency objective.

The new license fees for space and earth stations have not been determined on the basis of the costs associated with spectrum management services for satellite systems. Rather, they are based on the equivalent number of terrestrial hops covered by actual Canadian satellites. If this equivalency is designed to calculate a fee approximating that which would be paid if a landline microwave system had been built instead, it is not an appropriate economic standard. If, however, the equivalency measures the relationship between the spectrum used by satellite systems in comparison to the spectrum used by terrestrial systems, so that fees per equivalent use of spectrum are the same, it may be justifiable on grounds of resource allocation efficiency. The specific basis for the determination of satellite license fees needs additional explication. In any event, the initial step should be an allocation of the costs of spectrum management services for satellite systems.

B. Economic Efficiency of Spectrum Management Practices

Economic efficiency of spectrum management depends upon more than efficient cost allocation and the design of appropriate license fee structures. Other decision criteria that affect frequency assignments and spectrum management practices influence the efficiency of the process. In our review, we sought out areas where changes in present practices might improve the efficiency of selected spectrum management practices that go hand in hand with the application of license fees in the microwave band. We will not review the many existing practices that now comport with efficiency objectives.

As a rule, hydro companies and telecommunications common carriers are provided preference in licensing. Hydro is granted priority for safety and emergency reasons. All other users, except the telcos, must provide a quotation for equivalent service from the telco. As a guideline, a 30-35% dollar preference margin is accorded the telco's before private systems are licensed. In competing applications, the telco's are accorded priority. These guidelines will not necessarily encourage efficient use of the spectrum. Hydro companies have little incentive to economize and are not even required to consider alternatives. Telco's are given preference and priority when a private supplier may make more efficient use of the spectrum in supplying the identical service.

It is suggested that all users, including Hydro and telephone companies be required to examine the costs of their best non-spectrum using alternative ways of providing equivalent service when seeking licenses. In addition,

dollar preference margins and automatic priorities should be eliminated. In each instance, the standard for selection should be the efficient use of the spectrum. At most, it might be appropriate to require the private suppliers to show some advantage over telco supply in terms of spectrum efficiency or cost, with equivalent spectrum efficiency. Beyond this, preferences and priorities clearly would result in less efficient use of the spectrum.

License renewals should not be automatic. A demonstration of past efficient use and planned future use should be required. Licensees should be required to supply actual traffic and cost data for comparison with the forecasts contained in the license application. The inspection rate should be increased from its current inconsequential level (less than 1%) to a level that will provide at least some minimal testing. Current practices indicate that once the license is granted, there is no significant continuing accountability enforced by the DOC. It is recommended that a program of continuing accountability be developed incorporating the suggestions immediately above.

As part of this accountability program, criteria for penalties and license revocations should be established for application in those instances when the spectrum is not used efficiently. DOC should establish annual reporting requirements of the capacity and use of licensed frequencies and develop its own indexes of capacity, utilization and congestion.

Under present practice, DOC will not require an existing system to be modified to facilitate another party's license application. This relatively passive role of the spectrum manager may have been appropriate in the past.

However, with increasing demands for spectrum, economic efficiency in the use of the spectrum will require the spectrum manager to take a more activist role. DOC's role in this respect should change to active mediator, arbitrator and initiator of modifications that will best serve the public interest and of assignment of the modification costs to the affected parties. The role of the spectrum manager that will facilitate efficient spectrum use in the new, dynamic future environment, is discussed in Section VII below.

C. Recovering the Unearned Increment

Establishing license fees to recover the costs of spectrum management fails to incorporate any costs for use of the spectrum resource itself. Section V above noted that the spectrum resource can be the basis for the creation of economic rent, the unearned spectrum increment. If license fees are increased above the costs of spectrum management, and licensees are reaping this economic rent, then the higher license fee can be structured so that it will be borne entirely by the licensee. It need not be passed on to consumers of the licensee's service by increased prices, and it need not affect the licensee's investment decisions. It would simply appropriate the unearned increment created by the unique economic characteristics of the spectrum resource.

Section V demonstrated that it is justified on grounds of economic efficiency and equity for the government to tax the unearned increment of a social resource. It is simply recovering the monopoly rent created by the spectrum licence. Perhaps even more significant is the fact that a license fee need not begin to reflect any cost of using the spectrum resource

itself, and need not affect economic resource allocation, until it has been raised sufficiently high so as to recover all of the unearned increments. Only when the license fee exceeds that level which recovers the entire unearned increment will resource allocation be affected.*

Recovering the unearned increment of economic rent from spectrum licenses has not been recognized by DOC as an objective of spectrum management license fee policy. The analysis in this paper concludes that it should be an objective of license fee policy. In fact, since one of DOC's objectives is to promote an efficient allocation of resources, recovering the unearned increment is a necessary prerequisite to achievement of that objective. We recommend that DOC explictly adopt a license fee objective of recovering the unearned increment of economic rent from spectrum licenses.

D. Promoting the Efficient Allocation of the Spectrum Resource

After spectrum license fees have been established to cover the costs of spectrum management and the economic rent from spectrum licenses, it may be appropriate to raise fees further to recognize the cost of using a particular portion of the spectrum in one application, and thereby denying its use in others. Economic theory provides sound grounds for including such a cost, but poor guidelines as to the measurement of that cost. In those instances where there are no competing uses or users for that portion of the spectrum in that defined geographical area, no costs should be assigned.

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* Of course a fee structure could be formulated that affected resource allocation but allowed licensees to retain a part of the unearned increment.

Including an additional element of cost for the spectrum resource assignment will affect economic decisions. A portion of the fee increase to cover this resource cost will be passed on to the customers of the licensee, and it will affect the licensee's investment decisions. It will affect the economic trade-offs at the margin relating to the amount of spectrum employed, alternative spectrum frequencies, alternative non-spectrum resource inputs, equipment quality, alternative non-spectrum using equipment, research and development and obsolescence of old equipment. How significant these changes at the margin will be depends upon the relative magnitude of the resource cost included in the license fee and the particular circumstances of the licensee.

It would seem that there is very probably a strong relationship between the extent of congestion, potential interference and spectrum management activity and the general magnitude of spectrum resource costs. It may well be that in large urban areas, significant spectrum resource costs are justified for inclusion in license fees. In rural areas, zero spectrum resource costs may be appropriate.

E. Industrial Structure of Licensees in the Microwave Band

The applicability of an increase in license fees in the microwave band to recover the unearned increment of economic rent, and possibly some additional spectrum resource costs, depends upon the particular circumstances of the licensee, and particularly the structure of the industry in which it operates.

The telecommunications common carrier, railway, hydro, and pipeline companies all use the radio spectrum as one resource input in the production of their services. None of these services are derived solely or essentially from use of the spectrum. Alternative resource inputs to the spectrum may be more expensive, but can be obtained. These companies are either monopolies, or quasi-monopolies in their own service markets. They must be licensed to operate in their service market, by regulatory authority, or they are federal or provincial government corporations. The rates for the services they charge are limited by regulatory authority, or by a non-profit objective, to the recovery of incurred costs.

It is apparent that for these companies the unearned increment of economic rent from spectrum licenses is quite small and virtually impossible to determine. Moreover, when we recognize the objective of setting prices for these regulated utility services on the basis of incurred costs, then the benefit of the unearned increment now should be passed on to the consumers of these services, and not reaped by the licensees.

Thus, any increase in license fee should affect resource allocation decisions. However, an examination of industry circumstances indicates that an increase in license fees will have almost no impact on investment decisions and be passed through to consumers of the licensee's public utility or transport services virtually in entirety. Firms in these industries set their rates for essential telephone, electricity, gas and oil and transport services on the basis of incurred costs. Increased license fees mean increased costs and

prices to consumers of these essential services. On the other hand, at present, Bell Canada spends less than 0.01% of its annual costs on spectrum license fees. License fees are an inconsequential portion of the costs of major investments in terrestrial microwave satellite and other systems. The magnitude of the license fee increase necessary to impact upon investment decisions is enormous. When these conditions are considered in light of the public service objective of maintaining essential public utility and transport services at the lowest possible cost to consumers, the case for license fee increases above the recovery of spectrum management costs is not strong for such users.

Nevertheless these users should not be exempted from justifiable license fee increases over time. As congestion and demands increase for particular spectrum, license fees should be increased to reflect this. The dominant licensees in the microwave band should not be excluded.

The broadcast and CATV industries operate under different circumstances. For over-the-air broadcasters, the spectrum resource is the dominant input that determines the structure of the broadcast firms as well as the industry. Broadcasters are in a position to reap the unearned increment of economic rent from spectrum licenses.*

Broadcast stations are subject to regulation by the CRTC. But that regulation does not limit broadcast prices or profits. Broadcast regulation is directed primarily toward the content of programming and does include requirements, for public service programming. It is possible that public service programming requirements may use up a small portion of the unearned

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* It is recognized that broadcast stations are licensed outside the microwave band. However, the principles being discussed here apply equally to all bands, including the small use in the microwave band and the station licensing outside it.

increment from broadcast spectrum licenses. However, for most broadcast stations, there would appear to be substantial economic "spectrum" rent that could be recovered by significantly increased license fees for broadcasters. In order to recover the spectrum rent, a differential structure of fees would need to be established to reflect the different profitability of different sizes of broadcast markets.

Further license fee increases beyond that necessary to capture the unearned increment may be justified on the basis of the cost of the spectrum resource itself. Increases beyond this point will affect the broadcaster's resource allocation decisions. How this increase in cost will be apportioned between the consumers of broadcast services (i.e. advertisers), public-funding sources, and broadcaster profits cannot be determined at present. However, it seems clear that the cost increase will not be passed through to consumers in entirety and, in any event, the consumer is not a member of the public at large purchasing essential public services.

CATV companies have operating characteristics much closer to broadcasters than to the utility companies. Although CATV firms do not distribute their programs using the over-the-air radio spectrum, most of their programming is picked out of the air and transmitted to the CATV head-end by microwave. Although obviously not in as clear cut a position as the broadcasters, the CATV companies are in a position to realize some amount of unearned increment from spectrum licenses. CATV regulation includes approval of subscriber rates. But it does not establish limits on prices and profits. An increased license fee, structured to reflect the differing profitability in different markets, and designed to capture the unearned increment would be justified.

Additional license fee increases again may be justified on the basis of the cost of the spectrum resources itself. These additional increases would be apportioned between cable subscribers and the companies in most instances. They would not be passed through to consumers in entirety. However, CATV subscribers are members of the general public and CATV services border on the category of public service.

F. Conclusions

After spectrum management costs have been allocated in accordance with the recommendations of part A above, and related spectrum practices have been modified in the directions indicated in part B above, it is appropriate to consider raising license fees far above those costs on the basis of economic efficiency criteria.

The initial step should be to recover the unearned increment of economic rent from the spectrum license. This would justify raising fees substantially for broadcast licenses and CATV companies. This might be difficult because the vast majority of broadcast licenses are granted outside the microwave band. And in fact, broadcast license fee revisions were excluded from the new structure proposed by the License Fee Study, and to be implemented, for the most part, in April 1979.

However, the principles of license fee structures designed to improve the efficiency of spectrum allocation cannot be limited in their application to the microwave band. The allocation of spectrum between the microwave band and other spectrum bands is a fundamental step in the spectrum allocation process. Our conclusion regarding broadcast and CATV

license fees applies to licenses obtained both within and without the microwave band.

After license fee structures have been increased to recover all the unearned increments of economic rent, it is appropriate to increase the fees further to reflect spectrum resource costs. Again, this should be done uniformly across all bands simultaneously if it is to be efficient. Economic theory provides no basis for determining the magnitude of the spectrum resource costs. Our analysis indicates that there should be a separation of urban and rural locations, the development of indexes of existing and potential congestion, and a gradual increase in fees to reflect the extent of congestion.

VII. SPECTRUM MANAGEMENT POLICY ANALYSIS: DYNAMIC CONSIDERATIONS

As was pointed out in the Spectrum I Report, (p. 22 and 53-6) policy and practice for spectrum management is now in one of the periodic cyclical surges when spectrum users exert overwhelming pressures on the policy and practice which emerged from the last cyclical peak of pressures. It is important to identify the present ferment of debate and criticism of spectrum management policy as produced by the need for the "next generation" of spectrum engineering that will best accommodate growing spectrum use to whatever results emerge from WARC-1979.

The current debate over incorporating economic criteria in the spectrum management process is traceable almost entirely to economic theory which assumes competitive private markets with consequent free play of opportunity costs in resource allocation. The Spectrum I Report analyzed such theoretical models and found them substantially irrelevant to the real conditions of spectrum use which are characterized by monopoly and oligopoly and inescapable state intervention in the process of spectrum allocation. Further investigation confirms this conclusion.

The theory of rent and of public taxation has provided a different set of economic theoretical tools that we have considered and found to be more directly relevant to spectrum management policy problems. It points us in the direction of using the authority of spectrum managers to devise policies and institutions which are appropriate to the predominantly monopolistic

corporations that represent the "first" level of spectrum users. And it focusses on the relationship between the nodes of congestion in spectrum use to: (a) further R & D aimed to alleviate interference at such nodes, and - the other side of the coin - forced acceptance of obsolescence of equipment responsible for that interference; and (b) stimulated organizational innovation for spectrum economy (SOIFE).

It will help to put the present problems of radio spectrum management in perspective if we can direct our attention to the specific portions of the radio spectrum where interference now and in the foreseeable future is most likely to present difficulties which must be surmounted in the public interest. What seems to be missing from the literature and from spectrum management practice is sufficient recognition of the relation, on the one hand, between frequency assignment congestion in specific parts of the spectrum and in specific geographic areas where interference is most counter-productive and, on the other hand:

(a) the trade-off between congestion (i.e. too many users for a finite number of frequency assignments) and more R & D plus recognition and acceptance of obsolescence in equipment;

(b) the possibilities of curing the specific problems by changing the institutional structure of the users of the spectrum, i.e. by stimulated organizational innovation in frequency economy;

(c) the possibilities of curing the specific problems by changing circuit discipline.

All three of these options are interrelated, and all of them are possible if SOIFE is applied.

The first, focussed R & D, linked with required acceptance of obsolescence is self explanatory and in principle available for use at all congestion nodes in radio frequency allocation.

The second, stimulated organizational innovation in operation for the use of the spectrum requires elaboration. Such innovations are by no means new in radio spectrum management. "Undivided joint interests" are a familiar example in the field of submarine cable communications. The creation of ARINC in the United States as a result of spectrum managers' pressure to economize on the use of radio frequencies by the many American airlines is an example now some half-century old. There is a curious indifference to the possibilities of spectrum economy by fostering more such joint operation entities. Perhaps the indifference stems from the way in which spectrum managers on the one hand, and private licensees in the radio spectrum, on the other hand, regard the interface between them. Customarily that interface is dealt with by promulgating general standards, after consultation between spectrum managers and private licensees, which are supposed in effect to legislate the conditions under which potentially and actually interfering signals may be generated and received. The result of this "legislative" approach is to erect a technical curtain of standards which is thereafter dealt with respectfully and formalistically on both sides. Positive organizational initiatives are <u>not</u> encouraged by this common state of affairs in radio spectrum management. Both the regulators and the regulated tend to regard the standards as the only, or the best mode of dealing with the problem. Our suggestion is that there should be <u>conscious</u> and planned facilitation by the spectrum managers of

appropriate joint entities to provide the modus vivendi for integrated operation of facilities jointly owned by different user institutions. Necessarily this suggestion calls for spectrum managers to initiate negotiations.

An illustration of possible SOIFE is provided by Leland Johnson:

> "User C may feel great pressure to engage in research and development in the higher frequencies because continued expansion of C's services in the lower frequencies would lead to interference with the services provided by D and E. Yet, perhaps only at a small cost (relative to that involved in C's using the higher frequencies), D and E might be able to protect themselves from this added interference. But today there is no easy way by which C can compensate D and E for these added costs, or for C even to determine what the magnitude of the costs would be. On the other hand, B might not feel under pressure because his allocations in the lower region are "adequate" for his needs. Yet F and G may be badly squeezed in their allocations; while they could not themselves employ the higher frequencies due to the very nature of their operations, they might find extremely valuable the spectrum allocation that B is now occupying if somehow B could be induced to move into the higher frequencies and vacate his existing allocation."1/

Such a hypothetical situation, in our view, calls for a spectrum manager's initiative to bring B, C, D, E, F, and G together to negotiate the "best" mutual solution. It must be emphasized that typically the private parties in such a situation are oligopolists or monopolists with widely divergent power. The spectrum manager as initiator of such negotiations must be cognizant of the relative power of the different parties at interest and should seek to enforce a rule that the outcome of the negotiations should not

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1/ Johnson, Leland. "New Technology: Its Effect on Use and Management of the Radio Spectrum". Washington University Law Quarterly, 1967, p. 525.

weaken further the weaker participating entities. Much of the literature currently advocates introducing "market processes" into radio frequency spectrum management, but in an automatic, unrealistic way. Our proposal contemplates dealing with real market processes in ways which will serve the common interest, not least that of the spectrum manager in optimizing use of the spectrum. In our view engineers and entrepreneurs should hold the centre of the stage in implementing this function, not economists.

A second example, this one related to interference between satellite and terrestrial microwave facilities, is also drawn from Johnson:

> "To say that a satellite system should not operate in a shared band if it interferes with terrestrial microwave, or vice versa, is clearly to miss the point: many trade-offs exist between cost and reductions in interference. Site shielding of ground antennae and changes in relative locations of interfering stations immediately come to mind. Among other things, special equipment can be installed at one antenna site to cancel the sidelobe interference emanating from another site. Quite conceivabley, the added cost to either satellite users or to terrestrial microwave users of reducing interference to a tolerably low level would be less than the social value gained by conserving the spectrum through greater shared use. In such cases, society would benefit, on balance by permitting the expanded shared use in combination with some means by which the cost of protection from interference would be appropriately borne. Unfortunately, current practice in spectrum management simply avoids this issue. In general, users of existing facilities are accorded assurance that new or proposed interfering facilities will not be permitted; little, if any attention is directed to the possibilities of trade-offs between cost and interference protection."2/

2/ Op. cit., p. 526.

Again the solution seems to require stimulated organization innovation for spectrum economy (SOIFE).

Still a third example from Johnson concerns the U.S. policy on satellites.

> "One must distinguish between the structure of ownership and the structure of operation... Since current spectrum management does not include a satisfactory mechanism for isolating the cost of a given case of interference between users, or for providing a means by which the cost can be appropriately borne, one might argue in favor of a single entity owning all facilities within which interference is likely to arise. With all costs and benefits "internalized," the single entity would be better able to adjust use of the various facilities -- install special interference - reducing equipment here, alter the location of an antenna there, tolerate interference situations elsewhere -- in order to minimize cost for a given total output. In the hands of separate entities these adjustments would not so easily be made. Given the arbitrary character of existing practices, requests for frequency allocations for new facilities would likely be disapproved if this would lead to interference with existing facilities. Desirable trade-offs between spectrum conservation and interference protection would remain unexploited; and more generally, the total cost to society, would be greater than in the case of a single ownership". [sic]

From the context it is evident he meant to say "...single operating structure".[3/]

The third line of attack is circuit discipline as a means for curing specific interference problems. This tool is an old and familiar one for spectrum managers but it needs to be recognized as an invaluable one for dealing with the real problems of spectrum congestion at specific locations and in specific frequency ranges. Johnson, when he was Research Director for the President's Task Force on Communications in 1967, emphasized its value:

> "Another possibility for sharing involves "spread spectrum" techniques for use by fixed and mobile radio. Each transmitter sharing the common band would hop rapidly from one frequency to another in a pattern to which only the receivers in the

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3/ Op. cit., p. 532.

> the network of that particular transmitter would be keyed. With a unique time pattern of hopping for each transmitter-receiver network, the level of interference would be reduced to permit more use of a given frequency band than is now the case. Also, the fact that outsiders could not tune into the broadcasts would constitute an added advantage, especially for police radio. Spread spectrum techniques are attractive particularly as a means to conserve spectrum precisely in those bands serving mobile radio in which crowding is severe today, and so much concern is being expressed that vital future demands will not be met."4/

Why is spectrum-conserving circuit discipline not the object of greater emphasis by spectrum managers? Probably for the same reason that stimulation of joint-user institutions is not more emphasized. Yet initiatives for such circuit discipline are very promising and challenging to imaginative spectrum managers.

Conclusion

The current focus in the literature on spectrum management has been in the direction of substituting economic markets and prices for the administrative decisions of spectrum managers. However, even with the employment of license fees based upon economic cost and/or value criteria, the process essentially remains one of administered decisions and not market decisions. Our analysis has led us to the conclusion that economic considerations can improve spectrum management decisions by modifying the decision criteria and by adding complementary information to that presently employed.

Increased attention to the deficiencies of the spectrum management process in incorporating considerations of spectrum resource costs and

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4/ Op. cit., p. 535.

prices (fees) have been stimulated by the focus of spectrum growth and increasing demand for spectrum. These same forces provide equal justification for intensifying efforts to improve spectrum efficiency by new spectrum management initiatives.

Our analysis on this project indicates that continued research is likely to be useful in the following areas:

1. extension of the analysis of this paper to the fees for licenses in other spectrum bands;
2. further development of the relationships between economic factors that affect external market behaviour, e.g. license fees, and improvements in spectrum management practices that can improve the economic efficiency of spectrum allocations;
3. development of the applicability of the economic theory of a common property resource to spectrum management;
4. comparative studies of similar common property resources such as the fishery or timber industries;
5. the development of indexes of spectrum use, capacity, congestion and other variables, the development of information reporting requirements and the establishment of a program of effective accountability by the spectrum manager;
6. gathering specific information relating to licenses, in particular industries, e.g. broadcasting, as a basis for implementing the license fee recommendations in this report.

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