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RADIO FREQUENCY SPECTRUM MANAGEMENT PROGRAM

Evaluation Report

MAY 1991

PROGRAM EVALUATION DIVISION

This Evaluation Report was prepared by the Program Evaluation Division of the Department of Communications, Canada.

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EVALUATION REPORT FOR THE

RADIO FREQUENCY SPECTRUM MANAGEMENT PROGRAM

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EXECUTIVE SUMMARY

Introduction

During the period 1988-1990, the Department of Communications carried out a comprehensive program evaluation of the Radio Frequency Spectrum Management Program (RFS). This was one of the largest and most complex evaluations ever undertaken by the Department. The evaluation focused on issues such as the need for the program, its impacts and effects, and possible cost-effective alternatives to the program. Program managers have been closely involved in each of the studies and therefore have already started to address some of the evaluation findings. Some of the questions which are still at the centre of discussions within the Department at this time include the notions of cost recovery and determining the most effective organizational structure. A full list of the issues addressed by the evaluation as well as the background studies carried out is presented on page nine of this report. It should be noted that although the studies were carried out during 1988-1989 and there have been substantial organizational changes since this time, the findings do appear to still be relevant.

In general, the evaluation findings are positive. The program has been very successful in the past, however, program managers need to focus more on client services. As well, while resolving issues about the true costs of the program, program managers should consider how they will handle the increasing demand for spectrum as new technologies are introduced.

Findings

1) The Program is still needed and there is justification for government involvement. The potential for interference among spectrum users which necessitates regulation, the need to safeguard the spectrum used for public safety concerns, and the need for international coordination are the primary reasons for having both a program and government involvement in spectrum management.

2) An organizational review found the structure at the time of the review (1988) to be appropriate and effective.

3) Evidence from two surveys of clients indicates that, overall, the Program appears to be achieving its objectives. For example, relatively few applications for licences were rejected by the Department and the needs of most of these were met with acceptable alternatives. As well, the Department has been successful at resolving interference problems, although the primary focus is on the prevention of interference.

4) The surveys of clients also revealed that clients are generally satisfied with the Program. They expressed concern about several things, however, including: the cost and complexity of the application process, the lack of opportunities to comment prior to changes in regulations,

inconsistencies in the enforcement of rules and regulations, and the need for more adequate and timely notification of changes to rules, regulations and procedures.

5) The literature on economic efficiency suggests that the present arrangements (e.g., licence fees) do not promote economically efficient use of the spectrum. However, the balance between costs and benefits appears to be reasonable. As well, licence fees do not appear to have negative impacts on licensees as the majority feel the fees are reasonable and fair (although this evidence was collected before the recent increases in licence fees for municipalities).

An additional exercise was undertaken to review the findings with managers to determine if recent departmental changes in organizational structure had an impact on the conclusion about the appropriateness of the 1988 organizational structure. This additional work and consideration of other factors such as the rapidity of technological change suggests the need to study the feasibility of different organizational structures to deal with a rapidly changing environment characterized by the introduction of new products which use the spectrum. The consultation process also contributed to the development and refinement of the recommendations.

Conclusion

The Radio Frequency Spectrum Management Program is well managed, achieving its objectives and needed. More attention should be paid to client services, questions of economic efficiency and cost-recovery. An important area for more work is the question of the most appropriate organization for managing the RFS into the next century (e.g., continuing within the Department or as a special agency).

Recommendations

Recommendations which flow from the evaluation studies and the review of the study results with program officials in the regions and in ADMRS can be grouped under four headings. The main area where improvements can be made is client services. The two areas of economic efficiency and organization require further thought and study. A final recommendation is about future evaluations of the RFS Management Program.

Client Services:

Recommendation 1: Develop a strategy for client services.

It is clear that the program lacks a coherent approach to serving clients and thus, an overall strategy for client services should be developed. Recommendations 2, 3, 4, and 5 address specific elements to be incorporated in this overall strategy which should also include the identification

of responsibility centres for developing, implementing and monitoring initiatives related to client services.

Recommendation 2: Focus on service to clients to a greater extent than at present.

For example, activities such as accessibility of Department personnel to clients, public awareness of Department services and basic service delivery need to be defined and prioritized. The identification of resources for improving and maintaining client services in view of increasing demand for spectrum and decreasing person-years is an important aspect of this recommendation. As well, a communications plan which recognizes the different mechanisms required to reach different client groups and identifies the types of information needed or desired by these different groups should be developed.

Recommendation 3: Develop a deeper understanding of clients' perceptions (e.g., through the use of focused, periodic surveys).

There should be more focused, regular surveys to measure levels and quality of service and to develop a deeper and empirically based understanding of client perceptions and the impacts of program changes.

Recommendation 4: Define acceptable levels of client satisfaction, set appropriate targets for client services and measure progress.

A key element in agreeing to focus on client services is the need to establish standards for levels of client satisfaction and service delivery and to determine the relation between the two to assist with future finetuning of the standards. Appropriate measures should be developed in order to measure progress in attaining these targets at appropriate regular intervals.

Recommendation 5: Develop some notions of efficiency for client services and technological preparedness as compared to other countries and incorporate this in literature for clients and government officials. As well, prepare an annual report for clients.

As part of its services to clients, program officials should prepare material which explains the benefits of managing the radio frequency spectrum. This material could take two different forms and be developed for particular client groups or audiences. One would be a periodic report which includes efficiency and effectiveness measures and comparisons with selected countries to help clients (and government officials) see how Canada compares with others. The second would be a periodic report for clients, preferably annual, which would describe where the main effort has been during the past year and report on such topics as levels of client service and the introduction of new radio services.

Economic Efficiency:

Recommendation 6: Examine the feasibility of moving to a system which more strongly encourages optimal allocation of spectrum.

Increased demand for spectrum represented both by new services and growth in those services will place strains on the existing allocation mechanisms. As well, the economic literature suggests that current mechanisms do not promote economic efficiency. These are complicated issues and they need to be examined in more depth.

Organization:

Recommendation 7: Examine the possibility of a special agency to manage the RFS. This should include examining the full costs of managing the radio frequency spectrum and its organization.

One of the original evaluation issues asked if the organizational structure was appropriate. While the answer to the question is positive, there have been and will be changes in the external environment (e.g., the proliferation of new services) which suggest that the question of organization should be looked at again. The organization study should have two components. First, it should examine the different mechanisms or agencies one could use to manage the radio frequency spectrum. Second, for some selected possible options, the study should look at the full costs of doing so.

Evaluation:

Recommendation 8: Develop a plan for a phased approach to future evaluation of the RFS Management Program.

A program evaluation of the RFS is a large undertaking which, if done on a rolling seven-year basis, will virtually exhaust evaluation resources for a year or more. A more fruitful and manageable approach would be to carry out evaluation work in phases or on a more piecemeal basis now that this evaluation has provided an overall baseline.

SOMMAIRE POUR LA DIRECTION

Introduction

Le ministère des Communications a effectué, entre 1988 et 1990, une évaluation approfondie du Programme de gestion du spectre des fréquences radioélectriques (SFR). Ce fut l'une des évaluations les plus importantes et les plus complexes jamais entreprises par le Ministère. Elle visait notamment à établir la pertinence, les répercussions et les effets du Programme ainsi qu'à dégager, le cas échéant, des solutions de rechange plus rentables. Les gestionnaires du Programme ont collaboré étroitement à chacune des études et, par conséquent, ils ont déjà commencé à prendre des mesures à l'égard de certaines constatations de l'évaluation. Certaines des questions etudiées font toujours l'objet de discussions au sein du Ministère. Il s'agit notamment de la notion de recouvrement des coûts et de l'établissement de la structure organisationnelle la plus efficace. Une liste complète des questions qui ont été traitées dans le cadre de l'évaluation et des études de base effectuées à cette occasion est présentée à la page 9 du présent rapport. Il faut souligner que les conclusions semblent toujours être valables bien que les études aient été effectuées en 1988-1989 et que d'importantes modifications aient été depuis lors apportées à la structure organisationnelle.

Les conclusions de l'évaluation sont, en général, très favorables. Toutefois, les gestionnaires du programme devraient porter une plus grande attention aux services à la clientèle. De plus, tout en résolvant les questions relatives aux coûts réels du programme, ils devraient examiner comment ils pourront répondre à la demande croissante de fréquences du spectre à mesure qu'apparaîtront de nouvelles technologies.

Constatations

1) Plusieurs raisons justifient l'implication du gouvernement dans la gestion du spectre et le Programme est toujours pertinent. Les principales raisons sont liées aux possibilités de brouillage des communications par les autres utilisateurs du spectre ce qui rend nécessaire l'imposition de règlements, au besoins d'assurer la disponibilité du spectre pour fins de sécurité publique et au besoin de coordination à l'échelle internationale.

2) Une analyse organisationnelle a révélé que la structure du Programme était appropriée et efficace au moment où l'analyse a été effectuée (1988).

3) Deux sondages menés auprès de la clientèle ont indiqué que, règle générale, le Programme semble atteindre ses objectifs. Par exemple, le Ministère n'a rejeté qu'un très petit nombre de demandes de licences et dans la majorité des cas, des solutions acceptables sont venues satisfaire les besoins des organismes qui avaient présenté ces demandes. De même, le Ministère a réussi à résoudre les problèmes de brouillage, bien que l'un des premiers soucis en soit la prévention.

4) Les sondages menés auprès de la clientèle ont également révélé que les clients étaient généralement satisfaits du programme. Ceux-ci ont toutefois fait part de réserves à l'égard de

plusieurs aspects du Programme, notamment au sujet du coût et de la complexité du processus de présentation d'une demande de licence, du manque d'occasions de présenter des observations avant que ne soient modifiés les règle et règlements et du manque d'uniformité dans l'application des règlements. Ils ont également souligné la nécessité de fournir, en temps opportun, des avis pertinents concernant les modifications apportées aux règles, aux règlements et aux procédures.

5) La littérature sur l'efficience économique laissent entendre que les arrangements actuels (soit les droits de licence) ne favorisent guère l'utilisation efficiente du spectre au point de vue économique. Toutefois, il semble y avoir un équilibre raisonnable entre les coûts et les avantages. De même, les droits de licence ne semblent pas avoir d'incidence défavorable sur les titulaires de licences, puisque la majorité d'entre eux estiment que ces droits sont raisonnables et équitables (rappelons que ces témoignages ont été reçus avant les dernières augmentations des droits de licence pour les municipalités).

De plus, de concert avec les gestionnaires, on a procédé à l'examen des constatations de l'évaluation pour établir si la récente restructuration ministérielle avait une incidence sur les conclusions relatives à la pertinence de la structure organisationnelle de 1988. Cette initiative additionnelle et d'autres facteurs, notamment la rapidité des changements technologiques, laissent croire qu'il est nécessaire d'étudier la faisabilité de la mise en oeuvre de différentes structures organisationnelles pour composer avec l'évolution rapide du cadre d'exploitation du spectre, qui est caractérisée par l'introduction de nouveaux produits utilisant les fréquences radioélectriques. Le processus de concertation a également contribué à l'élaboration et au raffinement des recommandations.

Conclusion

Le Programme de gestion du spectre des fréquences radioélectriques est bien administré. Il atteint ses objectifs et répond réellement à un besoin. Il faut, néanmoins, accorder plus d'attention aux services à la clientèle ainsi qu'aux questions d'efficience économique et de recouvrement des coûts. Il est également important d'établir quel type d'organisation sera le mieux adapté à la gestion du spectre au tournant du siècle (p. ex. maintien de la gestion par le Ministère ou création d'un organisme spécial).

Recommandations

Les recommandations, qui découlent des études d'évaluation et de l'examen des résultats de l'évaluation effectué avec les gestionnaires des régions et le SMARS, peuvent être regroupées sous quatre rubriques. Le principal champ d'amélioration est celui des services à la clientèle. Les deux questions relatives à l'efficience économique et à la structure organisationnelle exigent plus de réflexion et une étude approfondie. Enfin, une dernière recommandation vise les futures évaluations du Programme de gestion du SFR.

Services à la clientèle :

Recommandation 1 : Élaborer une stratégie concernant les services à la clientèle.

Il est clair qu'il y a absence d'une approche cohérente aux services à la clientèle. Il faut donc élaborer une stratégie globale concernant les services à la clientèle. Les recommandations 2, 3, 4 et 5 traitent d'éléments précis qui doivent être intégrés à la stratégie globale. Il faut également, aux fins de cette stratégie, désigner les centres de responsabilité chargés de l'élaboration, de la mise en oeuvre et du contrôle des initiatives relatives aux services à la clientèle.

Recommandation 2 : Se concentrer davantage sur les services à la clientèle.

A titre d'examples, il faut définir les paramètres relatifs à la disponibilité des employés du Ministère, à la sensibilisation du public aux services offerts par le Ministère et à la prestation de services de base. De plus, il faut établir les priorités à cet égard. La définition des ressources nécessaires à l'amélioration et au maintien des services à la clientèle, compte tenu de l'accroissement de la demande de fréquences et de la réduction des années-personnes, est un volet important de la présente recommandation. Une initiative connexe serait l'élaboration d'un plan de communication qui reconnaîtrait les différents mécanismes nécessaires pour atteindre les divers groupes de clients et qui définirait le type de renseignements demandés par ces groupes.

Recommandation 3 : Acquérir une meilleure compréhension des perceptions des clients (notamment, par le truchement de sondages périodiques et stratégiques).

Des sondages devraient être effectués plus fréquemment et de façon plus spécifique. Les sondages auraient pour objet de mesurer les niveaux de service et de permettre de mieux comprendre, de façon empirique, les perceptions des clients à l'égard du programme et les répercussions que peuvent avoir les modifications apportées au programme.

Recommandation 4 : Définir les niveaux acceptables de satisfaction des clients, établir des objectifs appropriés au regard des services à la clientèle et mesurer les progrès accomplis.

Un élément clé de la décision de mettre l'accent sur les services à la clientèle est la nécessité d'établir des normes qui permettront de mesurer le degré de satisfaction de la clientèle et la qualité de la prestation des service. Une procédure appropriée devra être mise au point pour mesurer, à intervalles réguliers, les progrès relatifs au respect de ces normes.

Recommandation 5 : Élaborer des paramètres permettant de comparer l'efficacité de nos services à la clientèle et notre préparation technologique avec celles d'autres pays dans le but de documenter les clients et les fonctionnaires à ce sujet. De plus, rédiger un rapport annuel à l'intention de la clientèle.

Dans le cadre des services à la clientèle, les fonctionnaires chargés du Programme devraient rédiger de la documentation pour expliquer les avantages de la gestion du spectre des fréquences radioélectriques. Cette documentation pourrait se présenter sous deux formes différentes et être élaborée en fonction de groupes particuliers de clients ou d'auditoires. L'une serait un rapport périodique incluant les mesures d'efficacité et d'efficience et établissant des comparaisons avec un certain nombre de pays pour aider les clients (et les fonctionnaires) à voir comment le Canada se compare aux autres pays. La seconde serait un rapport périodique destiné aux clients, annuel de préférence, qui décrirait où ont porté les efforts au cours de l'année précédente et qui fournirait des renseignements sur divers sujets tels que les niveaux de service à la clientèle et l'introduction de nouveaux services radio.

Efficience économique :

Recommandation 6 : Étudier la possibilité d'adopter un système qui favorise mieux l'attribution optimale des fréquences.

La demande accrue de fréquences radioélectriques, qui découle de la mise en oeuvre de nouveaux services et de la croissance des services, exercera une forte pression sur les mécanismes actuels d'attribution des fréquences. De plus, la littérature économique laisse entendre que les mécanismes actuels ne favorisent pas l'efficience économique. Ce sont des questions complexes qui doivent être examinées plus à fond.

Organisation :

Recommandation 7 : Examiner la possibilité de créer un organisme spécial chargé de la gestion du SFR. L'examen devrait traiter du coût global de la gestion du spectre des fréquences radioélectriques et de l'organisation de cette gestion.

L'une des questions de l'évaluation était de savoir si la structure organisationnelle était appropriée. La réponse à cette question est positive, mais l'environnement extérieur a subi et continuera de subir des modifications (p. ex. la prolifération de nouveaux services). La question de l'organisation devrait donc être étudiée de nouveau. La future étude organisationnelle devrait comporter deux volets. Elle devrait, premièrement, examiner les différents mécanismes ou organismes pouvant servir à assurer la gestion du spectre des fréquences radioélectriques et, deuxièmement, retenir certaines options possibles et établir tous les coûts associés à ces options.

Évaluation :

Recommandation 8 : Élaborer le plan d'une approche graduelle à l'égard des futures évaluations du Programme de gestion du SFR.

Une évaluation du Programme de gestion du SFR est une vaste entreprise qui, si elle est accomplie sur une base continue de 7 ans, épuisera pratiquement toutes les ressources d'évaluation pendant une année ou plus. Maintenant que la présente évaluation a permis de dégager une vision générale de base de la question, une approche plus fructueuse et plus facile à gérer serait d'effectuer le travail d'évaluation en plusieurs phases ou par tranches.

I. INTRODUCTION

A. Evaluation Context

There are a number of reasons why the evaluation of the Radio Frequency Spectrum Management Program was carried out.

First and foremost, RFS is part of the Regulatory Agenda and its evaluation is required by Cabinet. As well, the then Assistant Deputy Minister for Spectrum Management and Regional Operations (ADMSR) identified efficiency issues that needed to be analyzed by an evaluation and would be relevant to program review. An analysis of spectrum operations carried out as part of the Department's evaluation cycle allows spectrum managers to use this as an opportunity to review and improve the service given to licensed users.

Finally, the Department of Justice Federal Statutes Compliance Project asked spectrum managers to conduct a compliance review of their program. The evaluation provided a significant proportion of the information necessary for that review.

B. Structure of the Report

This report describes the physical and economic nature of the spectrum and its management and organization, and the evaluation issues. It then links the background studies and other evidence (e.g., recent technological changes) to the evaluation issues, draws conclusions and makes recommendations. Because of the speed and rate of technological change, occasional qualifiers are added to some of the evidence and conclusions. These do not, however, change the nature of the evidence, the conclusions or the underpinnings for the recommendations.

II. INTRODUCTION TO THE SPECTRUM AND ITS MANAGEMENT

A. Physical Nature of the Spectrum

Electromagnetic radiation is defined as "a form of oscillating electrical and magnetic energy capable of traversing space without the benefit of physical interconnections"[1]. Frequency is the rate of oscillation and is expressed in cycles per second. The entire range of frequencies form the electromagnetic spectrum, and the band from 10 kilohertz to 3 terahertz[2] is known as the radio frequency spectrum. The principal use of the radio spectrum is communication. Technological and economic factors have restricted use of the spectrum to its lower end, although increasingly higher frequencies are being employed.

Various forms of information are transmitted and received between distant points through the radio frequency spectrum. It is apportioned among various telecommunications services and has applications ranging from radio and television broadcasting to land, marine, and aeronautical mobile communications. Required for modern telecommunication services, it is an economically important limited natural resource, the use of which is valued in the billions of dollars. It has considerable social value, as well. The radio spectrum is essential for strategic and national defense, while its role in transmitting information is important to public safety, cultural activities, and education.

The transmission of electromagnetic radiation carried on radio frequencies are not confinable and can cause interference between users on the same or nearby frequencies. The risk of interference is reduced by established standards regulating the amount of power generated, the types of equipment used and the location of users. As well, some radio emissions carried by radio frequencies possess characteristics that are more or less compatible. When these frequencies are not used for purposes appropriate to their characteristics, interference can result.

The radio frequency spectrum is also an international resource. Radio emissions cannot be confined within borders and there is a need to coordinate large numbers and varieties of radio spectrum uses internationally. For example, users of the radio spectrum who are internationally mobile, such as aeronautical and shipping users, must be able to use the same frequency bands wherever they are. Thus, under international agreements the spectrum cannot be used without due regard for international conventions and regulations.

B. Economic Nature of the Spectrum

Just as one can look at the physical characteristics of the radio spectrum, one can also describe its economic characteristics.

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1. H. J. Levin, The Invisible Resource: Use and Regulation of the Radio Spectrum (Baltimore: John Hopkins Press, 1971), p. 15.

2. One kilohertz equals 1,000 cycles per second and one terahertz equals 1,000 billion cycles per second.

Pure public goods are goods, resources, and services that are available for everyone to use and where one person's use does not interfere with another's use, since the goods are jointly consumed by everyone. Government intervention is necessary to maintain the availability of such pure public goods. Pure public goods are very rare. Historical and present use and allocation of the spectrum suggest that it is not a pure public good as defined here. Spectrum users can and do interfere with other users ability to use the spectrum. Therefore, it is possible to consider management regimes which do not treat the spectrum exclusively as a pure public good.

C. Necessity of Government Intervention

There are two generally recognized rationales for possible government intervention within individual markets: economic efficiency and social equity. In purely competitive markets, an efficient allocation of resources is attained without government interference. Input and production costs are kept at a minimum through competition and demand, ensuring that products are made in optimal quantities with the available resources. Under such conditions government intervention is limited to concerns of social inequality.

In the case of pure public goods, government intervention is required to improve economic efficiency. However, the radio spectrum is not a pure public good as defined here. Segments of it can be packaged to benefit individual users and these segments are therefore amenable to pricing mechanisms for allocation. Another possible justification for government involvement in the regulation and management of the radio spectrum is the presence of externalities[3]. There appears to be a role for government regulation of the spectrum if the externalities are large enough to affect economic efficiency. Finally, the radio frequency spectrum is universally managed by governments. Governmental responsibility throughout is no doubt a reflection of the need for international coordination (e.g., bilateral agreements with the United States because radio emissions in Canada can cause interference in the United States), public safety concerns involving governmental bodies (e.g., defense, police, fire, and ambulances) and to regulate use to prevent interference.

Overall, the spectrum cannot rightly be considered a pure public good, but there is some legitimate need for government intervention and regulation to prevent the development of large negative externalities that could result from the use of the radio spectrum.

D. Organizational Structure

This section outlines the functional organization of the management of the radio frequency spectrum. A detailed description is contained in Appendix 1.

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3. Externalities occur when individuals other than the producers or direct consumers experience either benefits or costs resulting from the good's production and consumption. As long as one person who is affected is left out of the group whose consent is necessary, there are externalities. A classic example of a negative externality is pollution.

1. The Overall Structure of the Program

The Department of Communications manages the use of the spectrum under the authority delegated to it by the Department of Communications Act, the Radiocommunication Act and the Broadcasting Act.

The Radiocommunication Act is the most significant of the three for spectrum management. This Act:

- prohibits the installation, operation, and processing of radio stations and equipment without a licence issued by the Minister;
- permits the inspection of installations;
- requires the Minister to secure Canada's rights to the use of the spectrum;
- requires the Minister to regulate and control technical matters relating to radiocommunications (e.g., broadcasting facilities); and,
- permits the Governor-in-council to set fees for licences and establish various regulations.

The Radio Frequency Spectrum Management Program has the following three formal objectives:

i) accommodating as many users as possible;
ii) encouraging as many uses as possible; and,
iii) minimizing interference.

In order to attain these objectives, Spectrum Management has to carry out a number of activities which are described in Appendix 1. One of these activities stands out as so important that a number of managers of the spectrum tend to assign it a specific objective, even though it is not an official one. This fourth objective is:

> To establish Canada as a world leader in spectrum management in order to ensure Canada's fair and economic access to the spectrum resource.

At the present time, the use of radio frequencies is totally regulated. Rules exist as to who will use what frequency with what equipment, where and when. This section does not review the mechanics of this process. It will provide an overview of the regulation function, and a very brief presentation of the frequency assignment criteria.

All of the spectrum management functions are performed within DOC's ADMRS (Assistant Deputy Minister for Research and Spectrum) and the five Executive Directors of the Regions. Furthermore, the spectrum and radiocommunications policies such as the development of spectrum resource

(allocation/utilization) policies, major areas of radio licensing policies (microwave and satellite service), industry structure policy directions governing new public radiocommunications services (e.g., cellular mobile, cordless, air-to-ground public telephone, etc.) and radiocommunications to support telecommunications and broadcasting facilities, and broadcasting service policies are performed by ADMCP (Assistant Deputy Minister for Communications Policy).

2. Functions

There are four functions in the management of the radio frequency spectrum:

a. Planning and Engineering

In this function, spectrum managers develop policies at both the national and international planning conferences. They issue standards and specifications to meet the needs of the Canadian communications industry and the general public, and implement preventive measures such as public education endeavours. They assess the impact of new communication techniques and technologies on the radio spectrum. They also support field operations by developing computer based tools and applications programs, and set out procedures.

b. Authorization

Through this function, licences and broadcasting certificates are issued to the public in accordance with the sub-allocation plan and with specific engineering rules and studies. As well, DOC conducts examinations of professionals and amateurs for the purpose of issuing certificates of competence in radio operation.

c. Control

This area encompasses site evaluations for proposed broadcast services, analysis of current spectrum usage and radio environment, localization of sources of interference, enforcement of standards through site inspections, frequency monitoring, education, warnings, licence suspensions and revocations, etc.

d. International Representation

The management of the spectrum currently requires extensive international cooperation and, therefore, a significant level of international representation. The two main activities are participation in the International Telecommunication Union (ITU) and negotiations with the United States concerning cross-border interference.

As well, there are spectrum policy activities within the Department which are distinct from spectrum management and are described below.

e. Spectrum Policy Development

A key area of responsibility of the Department is to develop domestic spectrum allocations and utilization policies for various radio services and specific radio applications or usages to meet existing and future radiocommunication needs. Policies must take into account the spectrum requirements of various services, conflicting demands, the often competing public interest factors of the spectrum resources to be shared, the importance of radiocommunication to advance economic, cultural, industrial and social objectives of Canada and a wide range of public submissions on issues being raised by a particular spectrum policy formulation. Wide public consultation is part of the process to develop well-balanced policies.

Other national related policy activity pertains to the development of licensing policies, assessing major radio applications from a socio-economic perspective and providing recommendations for their approval and conditions of licence. Also, another activity is to determine the policy directions on level of service and the best industry structure for particular public radiocommunication services.

These various components of spectrum/radio policy activities reside in the Telecommunications Policy Branch of the Department. (The Spectrum and Orbit Policy Directorate (DSRS) is responsible for spectrum allocation and utilization policies. Network Policy and Standards Management (DNS) is responsible for providing recommendations to spectrum managers concerning major radio licence applications based on an assessment from a socio-economic perspective and to establish general radio licensing policy. Industry Structure and Services (DSIS) provides policy direction for competition, industry structure and service with regards to public commercial radio services).

III. EVALUATION ISSUES AND EVIDENCE

The evaluation issues are discussed in the Evaluation Assessment Report. Not all of the original studies proposed for the evaluation were approved by Senior Management and some issues are not addressed in as much detail as was originally intended[4]. The issues to be addressed by the evaluation were:

1) Is the Program needed?

2) Has the Program attained its objectives?

3) What have been the costs and benefits to clients of the Program?

4) What is the impact of gathering licence fees?

5) What effect does the Program have on licensed users?

6) Is the organizational structure appropriate?

7) Are there alternatives to the existing Program?

Seven background studies were carried out by outside consultants to assist in examining the evaluation issues. The seven studies were:

1) Economic Nature of the Spectrum: A Review of the Literature (1989), addressing issue 1;

2) Survey of Licence Holders (1989), addressing issues 2, 3, 4, and 5;

3) Survey of Radio Frequency Spectrum Interference Reports (1988), addressing issues 2 and 5;

4) Analysis of the Literature: Cost-recovery and Taxation (1988), addressing issue 4;

5) Analysis of the Literature: Government Structures (1988), addressing issues 4 and 6;

6) Evaluation of Organizational Structure (1989), addressing issue 6; and,

7) Comparison of Canadian and American Technical Standards Applicable to the Use of the Radio Frequency Spectrum (1988), addressing issue 7.

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4. Originally twelve studies were considered for the evaluation and of these, seven were carried out. The five studies which were not carried out reduced the depth of coverage of some issues but did not leave any evaluation issues unaddressed. Further study is suggested in the report where questions remain which would have been addressed by the five studies not conducted.

The background studies and supporting material comprise almost a thousand pages of typewritten material. Although the background material is available in the library of the Department of Communications, it cannot be quickly or easily read by an interested observer. Thus, Appendix II of this report describes the objectives, method and results of each study. This brief summary then concludes with an assessment of the reliability of the evidence and conclusions. Overall, the data collected and analyses performed were of high quality and therefore, confidence can be placed in the findings of the seven studies. Immediately relevant findings from the background studies are discussed at appropriate points in the main body of the report.

A. Is the Program Needed?

The most fundamental issue for any comprehensive evaluation is about the need for the program. The question about the need for the program is usually discussed in two ways. First, what is the reason for government involvement and second, are the main areas of program activity logically linked to the achievement of the stated objectives?

The reasons for government involvement have been discussed earlier. Indeed, a useable spectrum cannot exist without being managed. Every country in the world has some mechanism for managing it. Spectrum management is not a typical program which one can choose to have or not to have. If the program, or a similar one, did not exist, the spectrum would be virtually useless. The international character of the resource combined with its interference potential which can cause negative externalities have provided impetus for government intervention. Therefore, a program is clearly essential.

How and where the spectrum is managed is a separate issue from the need to manage it. Questions of organization are dealt with separately, later in this report. It is worth repeating the point that no matter how one organizes the management of the spectrum, government would be the source of the authority to manage it. This is not to say that the day-to-day management of the spectrum has to be done by government. However, at a minimum, regulations and/or guidelines for spectrum management would have to be established by government and those regulations and guidelines would automatically create a program regardless of how and where it was managed.

B. Has the Program Attained its Objectives?

The Radio Frequency Spectrum Management Program has, as pointed out earlier, four (three formal and one unofficial) objectives:

i) accommodating as many users;
ii) encouraging as many uses as possible;
iii) minimizing interference; and,
iv) to establish Canada as a world leader in spectrum management in order to ensure Canada's fair and economic access to the spectrum resource.

Under objectives achievement the evaluation provides evidence on five topics: easing access to the spectrum (objectives i and ii); and reducing barriers to entry (objective i), sub-optimal allocations (objective ii), interference (objective iii) and levels of congestion (objective iii). Each of these topics is dealt with, briefly, in the next few paragraphs. The fourth objective was not addressed in this evaluation.

1. Easing Access to the Spectrum

On the key issue of easing access to the radio spectrum, the results of the survey of licence holders indicate that relatively few applications for licences were rejected by the Department of Communications[5]. The findings from the survey of licence holders is clear on this point. Specifically, the Department could not satisfy licence application requests for just four per cent of radio licence holders (i.e., those already holding a licence) in the last year. No figures are available for first-time applicants. Furthermore, for those few organizations with rejected or delayed applications, most had their needs met with an acceptable alternative. The incidence of rejected applications was higher for larger organizations which tended to make a greater number of applications; however, the overall number of organizations for which rejections caused a major inconvenience was very low (less than two per cent).

Similarly, only about 5 per cent of broadcasters who ever had an application request rejected experienced a major inconvenience. Sixteen per cent of radio licence holders and 24 per cent of broadcasters expressed dissatisfaction with the overall application process. The cost of the process was a major concern for both broadcasters and radio licence holders, with about one-third of each group agreeing that the process was costly. This is likely due to the time involved to go through the process.

Next to the costs, radio licence holders tended to be most concerned about the time taken by the Department to process applications, with about 24 per cent thinking that the Department took a long time. Broadcasters were most concerned about the complexity of the process, with almost 40 per cent noting the complexity of the process and some of its specific aspects (e.g., the length of time required to complete the form)[6].

Therefore, one can conclude that the program does not present serious barriers to access to the spectrum.

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5. It must also be kept in mind that there exist valid reasons for rejection such as when an applicant requests an improper channel, proposes to use inadequate transmit power to serve the desired coverage area, requests a frequency in a congested spectrum band or proposes to communicate directly with non-Canadian space satellites which is generally against Departmental policy.

6. It should be noted that some of the costs and delays incurred by broadcasters are due to the necessary involvement of the Canadian Radio-television and Telecommunications Commission (CRTC) and thus, are not under the control of the Department.

2. Reducing Barriers to Entry

At the time of the evaluation (1989), barriers to entry for new clients wishing to use the spectrum were not a problem. As the previous discussion indicates, this could become a problem in the future. To some extent, congestion and possible barriers for newcomers may become beyond the control of the program because of the introduction of new technologies and their use by millions of individuals in large urban areas.

3. Reducing Sub-optimal Allocations

At the time of the evaluation, evidence from the survey of licence holders indicated that allocation of spectrum to possibly less efficient uses was not a problem. This may become a problem in the future as new services are introduced and policy officials have to wrestle with the difficult issues of how to accommodate new services and increased demand for old ones. For example, deciding how High Definition Television is delivered (by broadcast or by cable) and how to reconcile the demands of different user groups are not easy tasks. At such a time, the use of market-driven mechanisms may help resolve certain issues. For example, the spectrum now used by broadcasters could be reassigned for use for mobile services and broadcasters could move to the use of cable to deliver their programs. Alternatively, the spectrum now used by broadcasters could be used much more efficiently. One way to decide between competing uses for the spectrum would be to use market driven mechanisms such as lotteries or auctions.

4. Reducing Interference

The main evidence about reducing interference comes from the survey of interference reports. Before presenting the results, a few comments are necessary. Resolving specific cases of interference experienced by the general public is not a priority of the Department and the strategy in recent years has been to reduce DOC's role in resolving interference problems (and to sensitize other actors, such as retailers and hydro companies, to their responsibilities through activities such as the distribution of pamphlets and training); therefore, one would not expect DOC to be a prime actor in the resolution of interference problems. The real value added from the Department in this area is in overseeing and establishing programs to ensure that interference problems are addressed by the appropriate parties. It is also in establishing sound allocation plans (based on technically sound requirements) and in ensuring during frequency assignments that the technical properties of the new station will not interfere with existing users. It is, however, extremely difficult to establish a performance measure related to this strategy since the only indicator would be the sheer number of interference complaints over time but this measure would also be very sensitive to technology breakthroughs and extent of spectrum use. Indeed, the sheer volume of new devices would swamp any meaningful analysis of this issue.

The solution to these difficulties was to examine actual reports of interference. This approach has the merit of basing findings on actual experience from which it is possible to determine some idea

of the nature of problems. The survey of interference reports was designed to address six issues which are outlined in the summary presented in Appendix II of this document.

Information obtained during the evaluation allows one to address issues of satisfaction with service, reduction of interference, program delivery and any differences due to respondent characteristics. The answers to all of these questions are positive. Activities by the staff of spectrum management lead to client satisfaction, reduction of interference and the solution of interference problems. These benefits flow to all clients and are not concentrated in any particular group.

5. Reducing Levels of Congestion

Spectrum congestion is a difficult problem to evaluate because it is largely driven by customer demand and the introduction of new technologies. For example, in 1990 there are an estimated 100 million hand held cellular telephones (worldwide) and this is expected to increase to over 500 million before the end of the decade. Most of these users are concentrated in large urban centres and it is in these centres that congestion can be a problem. Since the spectrum is a finite but non-degradable resource, it is possible to manage the spectrum to reduce interference and alleviate congestion. Respondents to the survey of licence holders did not report serious problems with congestion or being seriously inconvenienced because they were unable to access the channel of their choice. These results, while true in 1989, may well change as more services (particularly mobile services) are introduced.

C. What Have Been the Costs and Benefits to Clients of the Program?

1. Sub-optimal Production Factor Distribution

There is sub-optimal production factor distribution if a producer uses a certain mix of production factors (manpower, raw goods, capital) which would be different if the pricing of these factors was left to the market. Access to the spectrum is relatively cheap for most users. Some may be using radio when other means could be used but are not because radio is priced so low (in comparison with other means of communication). While one could view this as a sub-optimal production factor distribution which could lead to increased spectrum congestion and inefficient use of the spectrum (see next section), it could be argued that, at a societal level, the low cost of spectrum access contributes to national competitiveness and productivity. The evidence provided by the survey of users indicates that a large majority use the spectrum because there is no economically feasible alternative. Thus the question of sub-optimal production factor distribution is not a concern at this time.

2. Opportunity Cost for Newcomers

It is possible that newcomers are located in the spectrum in places where they have to incur higher costs than those already there. The evidence from the survey is that this was not happening in 1989

although for reasons outlined earlier (e.g., demand for new services) it could be a problem in the future.

D. What is the Impact of Gathering Licence Fees?

One of the more important evaluation issues is the impact of the collection of fees on licence holders. Related issues include the financial burden of fees, the level of fees relative to the overall investment in radio, the fairness of the fee structure for the various participants in the system, and the price elasticity of demand for the spectrum (see previous section, however, which noted that a large majority of users has no economically feasible alternative). Financial data and opinions about fees provided by licence holders are the basic types of evidence used to address these issues.

In general, most licence holders considered the cost of their licences as reasonable and fair in comparison to other factors. Licence holders who were more likely to be concerned about the level of fees include respondents who have accounts of over $10,000 (55.7 per cent indicating they were concerned), who live in the Prairie region (40.1 per cent of Prairie respondents), and who represent public sector organizations (42.2 per cent of respondents associated with public sector organizations[7]). Although most licence holders consider the current trade-off between licence fees and the quality of service as fine, there were also indications that many licence holders would be willing to pay higher fees to receive an improved quality of service and better access to the spectrum. Large organizations and business users in particular were inclined to prefer the notion of higher fees coupled with an improved quality of service.

Although clients stated they would be willing to pay for improved service, more work needs to be done on finding out exactly what is meant by this. Some types of service (e.g., around interference problems) may not properly fall within the work of spectrum management. Some clients also said they would be willing to pay more for exclusive use of a channel. While the Department does assign exclusive channels to some users based on their requirements, many channels are shared in keeping with the objective of accommodating as many users as possible. Thus, the issue of levels and types of service needs to be examined carefully. The extra work to obtain solid information on this point should be a priority for the Department.

E. What Effect Does the Program Have on Licensed Users?

1. Attitudes of Users Toward the Regulation

7. This finding is congruent with the somewhat negative reaction of municipal account holders to their licence fee increase which came into effect in 1990. As public sector organizations (which include municipalities) were among those groups feeling that fees were already too high, it is perhaps not surprising that the increase was not welcomed by all municipalities.

The appropriateness of Department rules, regulations and procedures for radio use and the level of understanding of users about the regulations are important determinants of the quality of the service provided by the Department to its clientele. One of the more significant issues for the evaluation is the effect that the rules, regulations and procedures have on licence holders. Related issues of concern are the levels of awareness of the regulations, the processes by which users become aware of regulations, the consultation process for new regulations, the attitudes of licence holders to the regulations, and the burden imposed on users by regulations.

Most radio licence holders indicated that they were very familiar with the rules, regulations and procedures which apply to their use of the radio frequency spectrum (82.1 per cent). However, for some groups within the population of licence holders, the levels of familiarity with the regulations were somewhat lower than the overall average. These include those who use their radio equipment purely for business purposes, and mobile licence holders. However, even these groups indicated a high level of familiarity with the rules and regulations (69-74 per cent). Most licence holders reported that they found out about the rules which govern radio use from three sources: the materials published by the Department of Communications; departmental staff; and, their radio licence.

Overall, the majority of respondents expressed moderately favourable opinions about Department regulations and procedures. Areas for which licence holders expressed some concern include the adequacy of opportunities to provide input prior to changes in regulations, the consistency of enforcement of rules and regulations, and the adequacy and timeliness of notification of changes to rules, regulations, and procedures.

2. Regulation Burden

Regulatory burden is the amount of effort or the level of cost that the regulation imposes on the regulatees. In general, clients are not concerned about the regulatory burden although larger organizations think the regulations could be simplified and the process (i.e., the length of time required to complete the form) streamlined.

F. Is the Organizational Structure Appropriate?

The evaluation examined various aspects of structure, organization and cost-recovery. The pertinent points from the background studies are summarized below. Since the studies were completed, the Department was reorganized and this significantly changes the context for the findings reported below.

1. Structure

The background study on government structures reviewed the available literature and placed it in the context of spectrum management. The study came to the conclusion that a crown corporation could be the most appropriate structure for the management of the radio frequency spectrum but

there was no urgent requirement to adopt any particular structure. There is, however, enough evidence from that study and the effect of current changes in the environment (e.g., rapid technological developments) to suggest that this issue should be looked at in some detail.

2. Organization

Organizational structure is a means through which services and transactions are carried out. The organizational study concluded that the structure of the RFS Management Program allows it to operate in an exceptionally efficient manner. It has succeeded in implementing an organizational formula that facilitates the conciliation of different and conflicting needs in the external environment, promotes regional diversity, supports a relatively diversified internal structure, and is supported by members of the organization. Its main qualities are that it is conceived and maintained in accordance with clear objectives, flexible in solving problems, modeled to coincide with the market it serves, simple, and controlled.

3. Cost-Recovery

The RFS has in recent years moved to cost-recovery. This change was a governmental response to expenditure restraint requirements and adoption of a general policy that users of specific services should, where possible, pay some or all of their costs. The issue of cost-recovery has implications for government policy and how a service is managed. This section reviews some of the principles of taxation, current practice and the implication of study findings for the management of the RFS.

Principles of Canadian government, tradition, and economic theory all provide a solid rationale for the rule that taxation decisions must be made only at the highest levels of the governmental structure. As well, a rigid distinction should be kept between decisions about expenditure allocation and taxation revenues. These rules give Cabinet sole authority to decide on fiscal measures, channelling all receipts made by a department above cost to be deposited in the Consolidated Revenue Fund without compensation to the collecting department. The application of these rules has been modified in recent years with changes to the management of government finance.

The reason for these changes has to do with the practical problem of delivering government services in a period where there are more claims (demand) for service than resources available. If program recipients can pay for part, or all of a service, then there will be pressure to have user fees which raise costs to those who use a service. It is sufficient to point out that fees can cover some of, or all of the costs of providing a service. One can also imagine fees not reflecting costs, but rather, benefits to users (e.g., the higher the benefit, the higher the fee) although this is often difficult to implement.

A related problem is the issue of cross-subsidization. Some government regulatory agencies and Crown corporations that manage natural monopolies do appear to practise or are encouraged to practise cross-subsidization. Cross-subsidization is equivalent to taxing and allocating the receipts to expenditure outside of the government's normal budgetary process. It is important to note that

in most cases this practice occurs within a specific regulatory context, and within well-defined user groups. However, this practice is criticized as being economically wasteful and lacking in accountability. A long-standing example of cross-subsidization is that between long-distance and local telephone subscribers.

Recent changes to the practice of government finance have included provisions to allow departments or agencies to keep some part of fees recovered. There are many reasons for doing so: 1) departments may incur extra expenses as a result of the need to cost-recover; 2) retention of fees can act as an incentive to make cost-recovery actually work, and 3) retained fees may allow an agency to improve levels of service. There are no doubt other reasons, but these are three of the key reasons.

Tradition and reason suggest that these increases to operating revenues (from cost-recovery) should be spent on service or support which is plausibly related to the service for which the fees are collected. Since the universe of related expenses is quite large (e.g., it could include research and development, evaluation, training and so on), this is not a particularly severe restriction. To the extent that the fees are not spent on plausibly related service, the department or agency will likely face three problems. First, clients who pay the fee may object. Second, people in general (including Parliament) may object that the department is raising taxes (i.e., fees) or spending taxes without the proper authority (which amounts to the same thing). Third, the unrelated services or programs funded by extra fee revenues will exist on a weak, even precarious, financial footing since they are being undertaken without proper authorization. It is worth remembering that the English civil war was fought, amongst other things, over who controlled the purse strings. The King lost and Parliament won. Since that time, parliaments have guarded their financial control with considerable skill.

If the above comments are kept in mind it is easy to see that current arrangements (1990) pose certain interesting problems. First, the total cost of managing the radio frequency spectrum is not known with precision. Current official estimates (i.e., Main Estimates) do not include the cost of providing necessary levels of client services, the need for specific programs (e.g., to address safety questions) or the cost of research and development required to manage the radio frequency spectrum. At a minimum these and all other costs should be identified. Second, it is not clear that excess revenues, if they truly exist, are spent on related services. The Department has known for many years about the need to improve safety measures and awareness around radio use (e.g., the use of the distress channel (16) for marine safety, the misuse of which is a problem in several regions of the country). Using fees which are cost-recovered as well as spectrum management personnel for work not related to spectrum management when there is outstanding work to be done will eventually undermine the legitimacy of the fees themselves.

A second and more long-term question relates to the recovery of costs in general. Since the costs have only been estimated to date (an independent study is currently underway), independent observers could argue that there was over-recovery (or under-recovery) and suggest the Department was entitled to recover fewer fees (or more fees). These issues, while abstract, go to the heart of

the ability of managers to manage the radio frequency spectrum. Clients have indicated they are willing to pay for enhanced services, but at this time it is not clear if their fees would need to increase in order to provide enhanced services let alone how those services might be delivered. These issues should be studied and resolved in an empirical manner.

G. Are There Alternatives to the Existing Program?

1. Market-Driven Alternatives

The main alternatives to the program are market-driven. The most extreme alternative to the present system proposed in the literature is the establishment of a completely free spectrum market. A pure market alternative would involve the establishment of exclusive, transferable rights to the spectrum that could be traded among individuals through a price system that reflects the economic value of the resource. Government involvement would be limited to providing a legal framework for the enforcement and recording of these rights. The advantages to this alternative would be that users would be freer to decide which area of the spectrum they would like to operate in and how much of the spectrum they would like to use. The spectrum would also be allocated to its highest valued economic use. Increased economic efficiency would result because those using the spectrum would acquire the rights to it and would be motivated to economize on their use of it. It would also encourage users to explore alternatives to use of the spectrum. The pure market approach may not be desirable for several reasons. There is a problem in unambiguously defining spectrum property rights. There is also the problem of restrictions imposed by international agreements and of the need to use the spectrum for social and cultural objectives, including defence, intelligence, and emergency communication. There would also be considerable costs in terms of defining and enforcing spectrum rights due to the varying degree of susceptibility of different radio communications services to interference.

A second alternative is to charge users for use of the spectrum. Basically, users would be charged a users' fee that reflects the value of the spectrum. In fact, the current system of funding spectrum management from user fee collection rather than through taxation revenues represents one form of user charge. This alternative, however, proposes a user charge where the user fee collected would reflect more closely the economic value of the allocation made. The economic value of spectrum allocation can be determined in several ways including shadow pricing[8] and public auction. While neither of these procedures would be easy to implement, user charges that reflect free market value would involve several advantages over the present system:

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8. Broadly speaking, a shadow price is the price the economist attributes to a good or factor with the argument that it is more appropriate for the purpose of economic calculation than its existing price, if any. In evaluating the costs and benefits of any project, the economist may effectively "correct" the value of a market price and may also attribute prices to unpriced gains and losses that it is expected to generate. The economist will, for example, add to the cost of a factor or subtract from the cost of a good to make allowance for some extemal interference with establishing the true price. Wherever the value of a good, to be added or subtracted from the existing consumption, is large enough, the economist will substitute for price the more discriminating measure of benefit or consumers' surplus (what people are willing to pay for the good above what they do pay).

- it would create incentives for users not to use more of the spectrum than is essential and increase the economic efficiency of its use;
- it would create an additional source of revenue for government; and
- it would ensure that users benefiting most from use of the spectrum would be those paying the highest cost for its use.

While the literature is clear on these points, the applicability of various options (e.g., lotteries or auctions) to a specific service is not. The main conclusion from this preliminary work is that the issue needs to be looked at in more detail as has been proposed in the September 1990 discussion paper on spectrum policy: **Towards a Spectrum Policy Framework for the Twenty-first Century.**

2. Adoption of U.S. Radio Standards

One portion of the program deals with technical standards. The fundamental conclusion of a comparison between the U.S. and Canadian practice in this area is that, because of the major differences in the legislative processes in each country and different philosophical approaches, Canada, while working closely with the U.S., should continue with its own standard-setting function. Canada and the U.S. should, however, move forward to harmonize their respective standards.

V. CONCLUSIONS

Management of the Radio Frequency Spectrum is a complex, technical and challenging problem. The evaluation results all indicate that the Program is well managed and achieving its objectives. These results are unequivocal and supported by the evidence from the background studies. While there are no fundamental changes required, managers should look at four areas where improvements or further work is required: client services, economic efficiency, organization, and future evaluation work.

Clients, while satisfied with levels of service, do indicate in their responses to various questions that the Department could be more effective in providing client services. With the increasing demands which new technologies will bring and the likelihood of congestion for certain services, the ability to respond in a timely fashion will become more important. The surveys carried out for the evaluation were designed to obtain baseline information because spectrum users had never been systematically surveyed. Response to some items (e.g., about opportunities to comment on proposed changes, desire for services which conflict with Program objectives) suggest that more attention be paid to client perceptions about service and ways to improve these perceptions.

Two areas should be studied further. First, the Department should continue to look at the possible use of measures to promote economic efficiency (e.g., market based techniques). Second, the Department should look at the utility of a special agency to manage the spectrum. Rapid technological change will require flexibility and specially designed levels of service which may be better provided by a special agency. This is a complex topic and there are no easy answers to what is the best type of organization. At this point, all one can say is that the topic warrants further examination. A detailed review of the full cost of spectrum management, including research and development, improved client services and other activities required to carry out the function, should be part of this work.

While the topic of further program evaluations of spectrum management was not a specific issue for this study, a number of points should be made. Evaluating the management of the radio frequency spectrum is a large and difficult task. This is especially so if it is done in one step as was this evaluation. This large and expensive evaluation was necessary to answer basic broad questions. Future evaluation work will likely build on this basis as another very large scope evaluation would not be cost-effective. Further evaluations could be divided into discrete phases and the studies carried out in a time and manner suitable to the issues being examined. This would have four benefits. First, the evaluation(s) could provide timely information about ongoing management issues (e.g., how are we doing with client services?). Second, the evaluation(s) would be easier to design, approve, and manage. Third, a summary evaluation carried out at appropriate intervals, could more easily focus on one or two key issues (i.e., without having to mount a major and exhaustive effort which would consume virtually all evaluation resources for a year or more). Finally, this would make reporting results easier and probably enhance the utility of the overall evaluation effort.

IV. RECOMMENDATIONS

Recommendations which flow from the evaluation studies and the review of the study results with program officials in the regions and in ADMRS can be grouped under four headings. The main area where improvements can be made is client services. The two areas of economic efficiency and organization require further thought and study. A final recommendation is about future evaluations of the RFS Management Program. Whereas the present evaluation addressed basic, broad questions that had to be answered, future evaluations can build on this work, focusing on one or two particular issues.

Client Services:

The recommendations under client services all focus on: 1) the need to have a specific strategy for client services; and, 2) various mechanisms which are required to implement such a strategy.

Recommendation 1: Develop a strategy for client services.

From the evaluation studies, particularly those which directly queried clients, and discussions of the results with managers, it is clear that the program lacks a coherent approach to serving clients although independent activities focused on service are occurring in various locations throughout the Department. The single most important step required to deal with this situation is to develop an overall strategy for client services. Recommendations 2, 3, 4, and 5 address specific elements to be incorporated in this overall strategy which should also include the identification of responsibility centres for developing, implementing and monitoring initiatives related to client services.

Recommendation 2: Focus on service to clients to a greater extent than at present.

In order to adhere to service to the public principles outlined in Public Service 2000 and to implement the recommended client services strategy, several areas or topics should be developed or refined. One element is the need to focus on client services as a specific area for program activity to ensure that adequate attention and resources are devoted to service issues. Activities such as accessibility of Department personnel to clients, public awareness of Department services and basic service delivery need to be defined and prioritized. The identification of resources for improving and maintaining client services in view of increasing demand for spectrum and decreasing person-years is an important aspect of this recommendation. One related initiative would be to develop a communications plan which recognizes the different mechanisms required to reach different client groups and identifies the types of information needed or desired by these different groups.

Recommendation 3: Develop a deeper understanding of clients' perceptions (e.g., through the use of focused, periodic surveys).

This evaluation represents the first time that clients have been systematically surveyed. The evaluation results and subsequent discussions with program managers and staff indicate that there should be more focused, regular surveys. This is also in line with the service to the public principles of Public Service 2000. The purpose of these surveys would be to measure levels and quality of service and to develop a deeper and empirically based understanding of client perceptions and the impacts of program changes.

Recommendation 4: Define acceptable levels of client satisfaction, set appropriate targets for client services and measure progress.

A key element in agreeing to focus on client services is the need to establish standards for levels of client satisfaction and service delivery and to determine the relation between the two to assist with future finetuning of the targets. The standards will vary by type of service, for example, interference reports as opposed to the processing of applications. Appropriate measures should be developed in order to measure progress in attaining these standards at appropriate regular intervals. Some of the measurements could be incorporated with those in the surveys of clients and carried out in such a way that comparisons between and among regions can be made.

Recommendation 5: Develop some notions of efficiency for client services and technological preparedness as compared to other countries and incorporate this in literature for clients and government officials. As well, prepare an annual report for clients.

As part of its services to clients, program officials should prepare material which explains the benefits of managing the radio frequency spectrum. This material could take different forms and be developed for particular client groups or audiences. At a minimum, two types of material could be developed. One would be a periodic report which includes efficiency and effectiveness measures and comparisons with selected countries to help clients (and government officials) see how Canada compares with others. Some of these comparisons could be written up as case studies showing how different countries have introduced a similar service (e.g., for cellular telephones). The point of such a case study would be to indicate the long planning period, perhaps any research required, the international dimensions involved, and Canada's relative success.

A more obvious need is for a periodic report for clients, preferably annual, which would describe where the main effort has been during the past year and report on such topics as levels of client service, the introduction of new radio services and so on. This annual report would act as a "bottom line" statement pointing out what was done, how well it was done, and the resources required to do it.

These two types of material would help provide justification for the charging of licence fees so clients understand to what uses their money is being applied.

Economic Efficiency:

Recommendation 6: Examine the feasibility of moving to a system which more strongly encourages optimal allocation of spectrum.

Increased demand for spectrum represented both by new services and growth in those services will place strains on the existing allocation mechanisms. This is especially so where a large number of applicants desire access when only one or two can be accommodated. For such a circumstance, market driven allocation mechanisms may be appropriate. The economic literature also suggests that current mechanisms do not promote economic efficiency. These are complicated issues and the most that can be said at this time is that they need to be examined in more depth as was proposed in the Department's Towards a Spectrum Policy Framework for the Twenty-First Century (1990).

Organization:

Recommendation 7: Examine the possibility of a special agency to manage the RFS. This should include examining the full costs of managing the radio frequency spectrum and its organization.

One of the original evaluation issues asked if the organizational structure was appropriate. While the answer to the question is positive, there have been and will be changes in the external environment (e.g., the proliferation of new services) which suggest that the question of organization should be looked at again. The organization study should have two components. First, it should examine the different mechanisms or agencies one could use to manage the radio frequency spectrum. Second, for some selected possible options, the study should look at the full costs of doing so. Costs for example, should include the full costs of the necessary research and development required to manage the spectrum, and the full costs of providing appropriate client services. This review would serve as a response to aspects of Public Service 2000 as it would address the questions of how to provide the best service to clients and to remain responsive to local needs across the country.

Evaluation:

Recommendation 8: Develop a plan for a phased approach to future evaluation of the RFS Management Program.

A program evaluation of the RFS is a large undertaking which, if done on a rolling seven-year basis, will virtually exhaust evaluation resources for a year or more. A more fruitful and manageable approach would be to carry out evaluation work in phases or on a more piecemeal basis now that this evaluation has provided an overall baseline. For example, if the recommendations on client services are accepted, an evaluation framework could be developed to identify data collection needs and the timing for an evaluation of client services. A series of

focused evaluations have the advantages of providing timely advice to managers and being more easily managed within existing resources available for evaluation work.

APPENDIX I
ORGANIZATIONAL STRUCTURE

APPENDIX I - ORGANIZATIONAL STRUCTURE[9]

A. Detailed Structural Overview

1. Importance of the Regions: Decentralization

The regional offices occupy a central position within spectrum management. This is true in terms of resources (nearly 80% of the total resources) and in terms of their autonomy, the recognition they receive from the centre, and the influence they exercise on the organization. This status is uncommon in public service organizations and will tend to increase even further under the Department's decentralization of arts and communications (i.e., the reorganization of 1990).

There is a relatively high level of differentiation among the regions. Various factors distinguish the regions from one another. Four factors in particular significantly affect the configuration of the territories and consequently, the content of the demand on the regions: the local economic structure, the population density, the geography of the territory and the organization of provincial public services. These four variables take on different forms from one region to another and require each region to develop specific strategies, target different clienteles, conceive distinct work methods, and establish their own networks. The basic functions remain essentially the same, but they are altered by the conditions under which they are performed. The multiplicity and complexity of these factors cause the environment of the regional offices to be relatively unpredictable beyond a limit of three years.

The level of autonomy in the regions is uncommon and complex. It is uncommon in that decentralization has conferred real zones of power to managers on the periphery, rather than keeping it centralized. It is complex in that the autonomy of the regions is not only a result of the organizational structure, it is also conditioned by a culture and attitudes in the organization that are sensitive to local characteristics. The existing management model could be described as somewhere between co-planning and co-management. For example, after consultation, centralized top management establishes the organization's priorities and defines the ground rules. This procedure is preceded by systematic discussion exercises in which all members of the organization have a chance to respond. Once this operation is completed, the regions define their own priorities and action plans, which is also carried out in a co-planning model. The result is presented to top management for confirmation to form a contract between the two parties. Once the contract is established, it is the region's responsibility to manage the resources. A complex communication network ensures coordination between the regions. Also, a rigorous control and evaluation process conducted by the centre requires the regions to account for their actions.

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9. This discussion of the organizational structure is based on the Evaluation of Organizational Structure (1989).

Thus, the regions have autonomy over several areas:

- establishing their objectives;
- defining their strategies;
- organizing their resources;
- structuring their teams;
- adapting work methods;
- developing external networks;
- negotiating agreements with corporate services;
- actively participating in evaluating results;
- influencing technological orientations; and,
- influencing the priorities adopted by specialized corporate services.

Consultation, association, and accountability are present within the management system in the regional branches. District Directors actively participate in a significant manner in the organization's definition and orientation. District Directors have a similar level of autonomy as Regional Executive Directors, but on a smaller scale. This situation changes at the level of the sub-offices, however. The sub-offices are almost always operational units that apply programs conceived by the regional specialists and the district management. These are specialized operational units, limited to control and supervisory functions. Although informed and consulted in matters relevant to their expertise, consultations with the sub-offices are usually brief and limited.

The regional specialists offer three basic services:

- technical and professional support for operations;
- adaptation of national regulations and procedures to regional characteristics; and,
- representation of the region.

Without the presence and support of regional specialists, the regions would not succeed in conceiving and implementing services that respond to local characteristics and would have to standardize and centralize operations on a national scale. This situation would result in a loss of effectiveness, delays in response time, and increased operation costs.

The integration and coordination mechanisms in the organization are well developed. At the local or district level, lateral integration is achieved through either mutual adjustment or direct supervision and through the use of permanent or temporary work committees. These mechanisms exist at the regional level as well, with the addition of teleconferencing. There are five mechanisms that impact significantly on the organization's vertical integration and coordination:

- the periodic review mechanisms (i.e., 5, 9, and 12 month reviews);
- the functions performed by regional specialists;
- the automated management system;
- the national sector management committees and their sub-committees; and,

- the periodic evaluation of service point locations.

Some of the results of this high degree of integration and coordination are as follows:

- continuity and complementarity of objectives in the organization's different sub-systems;
- organizational roles that are clearly defined and understood at all levels;
- awareness among the staff of the various centres of responsibility and the operating processes they use;
- common language throughout the organization;
- few complaints addressed to the organization concerning differential treatments between regions; and,
- few membership conflicts within the organization.

2. Radio Regulation Branch

The functions carried out by the Radio Regulation Branch (DGRR) are described in management terms as part of the organization's techno-structure. Its role is to regulate, order, and standardize the organization's practices. Its mandate is described as:

> elaborating regulations and operating policies to govern the orderly operation of the spectrum, while taking into account both technical progress and the changing needs of the Canadian population.

The branch is also responsible for operational functions: the maintenance and operation of the computerized licence system, elaboration of telecommunications programs in emergency situations, and conducting international negotiations affecting use of the spectrum. Functions left to the regional level include supervision, professional training, and local modulation or follow-up operations. This branch includes three directorates:

- the Spectrum Management Operations Directorate, which oversees all operational services;
- the Regulations Directorate, which includes the regulatory and emergency planning functions; and,
- the Automated Applications Directorate, which manages the computerized licensing and financial systems.

This branch occupies a central position in the organization as it plays a coordinating role in spectrum management. It sets spectrum management regulatory policies and procedures for Canada in coordination with the regions, it joins with headquarters branches in determining international positions for the allocation of spectrum and it manages the licensing and financial systems used by spectrum managers. Regulatory and operational policies are developed in the branch with full consultation. The operational functions which are carried out by the branch are limited to the main operations that cannot technically or economically be delegated to the regions. Coordination with

the regions is exercised through meetings of the sector management operations committee (SMOC) and its two affiliated sub-committees on authorization and spectrum control and ongoing consultation.

3. Broadcasting Regulation Branch

The Broadcasting Regulation Branch (DGBR) is an organization within an organization. It has its own market, it works within the context of its own legislation, transacts with its own politico-administrative environment, and uses its own mode of operation. The uniqueness of its market results from several factors: broadcasting is concentrated in the hands of a few corporate actors; it has a much larger scope; and, its technology involves political, social, and cultural stakes for Canada. It is this environment that DGBR is structured to serve. That is, DGBR was created to centrally serve the closed market of broadcasting. Thus, DGBR simultaneously performs techno-structural and operations functions. This branch is responsible for the following functions:

- managing the broadcast-related radio frequency spectrum;
- issuing operating certificates for broadcasting stations;
- conceiving and writing up policies, procedures, and broadcasting engineering standards;
- consulting with industry on matters affecting clients;
- maintaining long term planning of spectrum to accommodate new technology;
- providing advice to industry and other government departments;
- developing and maintaining computerized work systems;
- conceiving and implementing standardized engineering methods and practices in broadcasting;
- negotiating bilateral agreements concerning either spectrum sharing or operational procedures and ensuring compliance; and,
- representing Canada in works carried out by the ITU.

The branch also performs two support functions:

- promoting technological innovation to ensure that the Canadian public benefits from new developments; and,
- ensuring the coordination and support of operations performed at the regional level.

The functions of the branch have been segmented into two functional groups:

- the Planning and Standards Branch, which includes the policy functions; and,
- the Applications Engineering Branch, which includes the operations functions.

Functions left to the regions include analysis, evaluation and approval of applications for cable TV certificates; and analysis, and approval of proofs of performance.

4. Engineering Programs Branch

The Engineering Programs Branch (DGEP) is the centre of essential technical expertise and specialized resources within the organization for non-broadcasting technical matters. The engineering branch operates in a field that is broad and diversified, making it complex to both describe and manage. Like the Radio Regulatory Branch, it covers all the other thirty-two non-broadcasting radio communications services. Its direct external clients are the equipment manufacturing industries as well as the Department of Defence. It identifies, develops and promulgates the appropriate technical rules, standards and frequency plans as well as the computational tools and the technical aspects of procedures necessary to avoid interference while authorizing specific frequencies to individual users. Its activities have two main bases:

- production and regulation protecting the integrity and effectiveness of the Canadian communication system and ensuring the technical integrity of the spectrum management program for non-broadcasting services; and,
- support for the organization's services and especially for its regulatory functions.

One particularly important orientation within the branch is towards international promotion. More specifically, the branch is responsible for many functions:

- conceiving and circulating, on the national scale, standards that affect both the production of radio equipment;
- verifying and certifying radio equipment appearing in the national inventory (Radio Equipment List);
- providing technical information to the public;
- conceiving standards for connection to the Canadian telecommunications network (TAP) and the verification and certification involved in the national inventory (Terminal Equipment List);
- managing the Ionosonde program on behalf of National Defence;
- revising international standards to ensure they conform to GATT agreements; and,
- representing Canada's technical interests and positions at the international level and negotiating technical elements involved in sharing frequencies with the United States.

The branch also has responsibilities in supporting other services in the organization:

- maintaining long term technical planning to provide for the potential addition of new communications services;
- conceiving technical bases used to develop rules for interference;
- conceiving, developing, and implementing data processing systems seeking to optimize the functioning of the different elements of the program;
- providing specialized advice to other groups (internal or external) involved in radio communications engineering; and,
- supporting and stimulating efforts made by Canadian industry to export domestic spectrum management technology.

Like the Radio Regulatory Branch, the Engineering branch operates at several levels: a purely operational level, a regulatory level, and a support level. The structure of the branch represents a professional bureaucracy, with its functions grouped to create homogeneous, synergistic professional groups within the organization.

5. Sector Policy, Planning and Assessment Branch

The Sector Policy, Planning, and Assessment Branch was at the time of the evaluation an executive secretariat for the entire organization. It acted as a centralized administrative logistics service with a support function for internal administrative control and an interface function with the central supervising agencies. Administrative and financial responsibility in the organization was the responsibility of managers. The branch assisted managers in fulfilling this function. It had several specific responsibilities:

- piloting and carrying out sectoral mechanisms for administrative planning and professional training;
- seeing that the organization has Management Information Systems that are appropriate and effective;
- conceiving and keeping up-to-date records of policies and administrative procedures; and,
- providing advice to management concerning projects, activities, and the performance of the various administrative units.

Strained relationships between the branch and managers due to the ambiguous line separating an advisory function from a control function were avoided. First, ground rules had been clearly established in the system and had been coherently maintained. Second, the branch implemented consultative and collaborative mechanisms that were used when significant action was to be taken so that all actors were involved. Further, the branch's projects were designed and carried out so that managers in the organization gained from participating in them.

6. Telecommunications Policy Branch (Spectrum and Orbit Policy Directorate)

The Telecommunications Policy Branch of the Communications Policy Sector has a distinct policy responsibility for spectrum and certain radiocommunications services. These responsibilities (duties and power) of the Minister derive from the Radiocommunication Act (formerly the Radio Act). The Spectrum and Orbit Policy Directorate is part of DGTP with a distinct responsibility to develop domestic spectrum allocation and utilization policies for the orderly development of radiocommunications.

7. Liaison with the Rest of the Department

Spectrum management has a number of different links with the rest of the Department of Communications. These are described in the background study on organizational structure.

B. Financial and Personnel Resources

Over the years, the program was allocated the resources shown in Exhibit 1. A breakdown by sub-activity is also provided in Exhibit 2. Non-spectrum operations (e.g., regional representation) are excluded from this evaluation because these activities are carried out by DOC field offices on behalf of other program components not related to spectrum management.

Exhibit 1

Radio Frequency Spectrum Management Resources

	1989-90	1988-89	1987-88	1986-87
PERSON-YEARS				
Department	2,416	2,449	2,295	2,311
Spectrum Mngt.	798	816	832	852
Spectrum Mngt. %	33.0	33.3	36.3	36.9
EXPENDITURES ($000)				
Department	316,631	309,501	278,678	277,383
Spectrum Mngt.	50,660	50,753	46,832	45,372
Spectrum Mngt. %	16.0	16.4	16.8	16.4

Source: Main Estimates, 1989-90, excluding non-spectrum operations.

Exhibit 2

RFS Management Activity Expenditures and Person-Years

	Estimate 1989-90	Forecast 1988-89	Actual 1987-88	Actual 1986-87
EXPENDITURES ($000)				
Ensuring Access	21,114	21,024	19,824	18,179
Spectrum Availability	17,633	17,556	16,368	16,150
Spectrum Quality	12,543	12,803	11,250	11,653
Revenue Credited	(630)	(630)	(610)	(610)
TOTAL	50,660	50,753	46,832	45,372
EXPENDITURES (% of total program)				
Ensuring Access	41.7	41.4	42.3	40.1
Spectrum Availability	34.8	34.6	35.0	35.6
Spectrum Quality	24.8	25.2	24.0	25.7
Revenue Credited	-1.2	-1.2	-1.3	-1.3
PERSON-YEARS				
Ensuring Access	308	314	316	311
Spectrum Availability	299	307	326	339
Spectrum Quality	191	195	190	202
TOTAL	798	816	832	852
PERSON-YEARS (% of total program)				
Ensuring Access	38.6	38.5	38.0	36.5
Spectrum Availability	37.5	37.6	39.2	39.8
Spectrum Quality	23.9	23.9	22.8	23.7

SOURCE: Main Estimates, 1989-90, 1988-89.

APPENDIX II
BACKGROUND STUDIES

APPENDIX II - BACKGROUND STUDIES

A. Economic Nature of the Spectrum

Objectives of the study: The purpose of this study was to examine the rationale for current spectrum management in light of possible alternatives, and secondly, to evaluate alternatives for relevance to spectrum management. The general issue addressed by this study is whether the program is needed in order to attain the government's objectives.

Method: The approach used was to review literature relevant to spectrum management.

Results: The radio spectrum is universally managed by government. There are several reasons for government regulation of the radio spectrum. Specific reasons for government regulation of the radio spectrum are that it prevents interference between frequency bands, assures the compatibility of bands with different purposes, and allows international coordination to achieve consistency in radio frequency use.

More generally, two accepted rationales for government intervention in any market are to establish economic efficiency and social equity. That is, the failure of the market to efficiently allocate resources through perfect competition has been considered a major justification for government intervention. The report then considered the three kinds of market failure:

- Government intervention is justified to maintain the availability of public goods — goods, services, and resources which when produced are available to everyone. However, whereas public goods are characterized by nonrival consumption, fixed available amounts, and are nonexclusive, users of the radio spectrum do interfere with others ability to use it, it is used as a private good, consumption is not equal across people, and licensing fees exclude potential users, implying that the spectrum must be considered a market commodity and not a pure public good.
- Externalities, when third parties may incur costs or benefits attached to certain goods, are also major justifications for government intervention when negative externalities are great enough. Although negative externalities do exist with the radio spectrum (e.g., congestion, interference, etc.) this may be due to legal definitions of spectrum rights.
- Common pool resources can be overused leading to their eventual destruction, and thus justifying government regulation. Unlike most common pool resources, though, the spectrum can be restored to its original state simply by removing users.

Overall, the spectrum cannot be considered strictly as a public good, but there is some possible need for government intervention and regulation to prevent the development of large negative externalities that could result from the use of the radio spectrum.

The current principles and practices of spectrum allocation are based on a conceptualization of the radio spectrum as a free good:

- fees are levied on a cost recovery basis at a flat rate;
- licences are issued on a first-come-first-served basis; and,
- once assigned, spectrum assignments are difficult to change.

The advantages of the current system of federal regulation and management are as follows:

- licence holders can be required to cooperate with the overall objectives of spectrum management without legal recourse, although this is difficult and rare in practice;
- reallocation of rights to the spectrum can be altered to increase efficiency; and,
- non-economic objectives can be enforced on the system.

The disadvantages of the current system are described below.

- It creates distorted demand and overuse because it is seen as a free resource. However, the supply is limited and diminishing. There is also a lack of economizing by users resulting in inefficient or a lack of use of some frequencies.
- The system is also rigid. It is difficult to adjust frequency allocations after initial assignments are made.
- The system creates opportunity costs, those actions forgone because of the actions taken. For instance, opportunity costs are the benefits that could have been gained by the next best alternative. This is an important consideration because current spectrum allocation on a first-come-first-serve basis does not necessarily result in the most efficient use of allocations.
- Economic rent is not derived from the resource. Economic rent is the difference between what is being paid for the use of a resource and the price that would be paid in the best alternative system.
- For the government to administer the spectrum requires a use of resources, with a lack of incentive contributing to a lag in innovation and productivity, disincentives through maximized budgets, less than efficient working rules to preserve accountability, and bureaucratic administrative burden.

The most extreme alternative to the current system of spectrum management would be to allow the spectrum to be maintained through a pure market mechanism that would provide exclusive transferable rights to spectrum allocations and that could be traded through an open price system.

The advantages of such a pure market system would be as follows:

- whereas users may presently get less than optimal bands, get smaller allocations than requested, get placed on waiting lists, the pure market system would allow pursuit of frequencies of choice;

- the economic worth of the spectrum would be revealed and would determine the use to which the resource was put;
- users would have an incentive to economize and increase efficiency of their use of the spectrum to maximize their investment; and,
- substitute and alternative resources would be encouraged to develop.

Some constraints on the free market system would be the need for international coordination, involving the need to renegotiate current international agreements. Defense, intelligence, and diplomatic concerns would also be threatened, although even in a free market certain frequency bands could still be assigned to these services outside of the market.

There would also be disadvantages to a free market system:

- there would be loss of government control over non-economic objectives, possibly threatening essential services; and,
- there would be increased costs of enforcing spectrum rights through the legal system.

Several alternatives that fall somewhere between the status quo and free market were suggested.

- Shadow pricing is a technique that estimates the economic value of a resource. This method would be expensive and there is no way of determining the validity of estimates made. However, it could be used to distinguish between high and low value users and to determine user prices.
- User charges based on spectrum value could be determined by shadow pricing, auction, or amount of benefits derived from use of the resource (profits). The advantages of this option are:
    - fees reflecting better the market value would promote efficient use of the resource;
    - allows the retention of government regulation;
    - creates new revenue for the government; and,
    - user charges ensure a return to society for the use of a public resource, particularly considering that private gain is made.

- Auctioning leases would have several advantages:

    - it allows a fair way of selecting from among multiple applicants;
    - it would increase the economic efficiency of spectrum use; and,
    - it would allow government to assess the value of different frequencies.

On the basis of this review of the literature, the policy options presently open to the government are to continue with the status quo, open the spectrum to free market, or implement a hybrid approach. There are several additional considerations which must be made clear.

- The status quo first-come-first-served system that treats the spectrum as almost a free good is prone to misallocations and overconsumption by users. On the other hand, using the free market system to redefine spectrum rights and to enforce them would be costly.
- Users are beneficiaries of the present system and are able to bring in abnormally high profits for those with choice frequencies. The public is not compensated for the use of this resource. However, users would be likely to see increased fees as unfair to them, since the radio spectrum has up until now been a free good. Further, equipment costs are not equal among users, making equal fees inequitable even among users profitability.
- In terms of social considerations the present system allows maximal discretion by government regulators. However, the hybrid systems still allow flexibility but with the addition of encouraging efficient use of the spectrum.
- Major structural changes in the present system would require legislative changes involving significant start-up costs for policy development and legislation development.
- Changes would involve increased expense to other government agencies and departments currently using the spectrum. Thus, the possible sources of resistance to altering the present system would likely come from users, international organizations, as well as from spectrum management itself.

Assessment of the reliability of the evidence and conclusions: This study appears to provide a reasonably thorough review of the relevant literature, although it was noted that some references are somewhat dated. This however may simply be a function of the subject matter. The study present a good analysis of the advantages and disadvantages of both the current system of operation and what would be expected under a free market. As the study itself points out, however, advantages and disadvantages of the various approaches are less clear. Therefore these approaches would need to receive careful study before being seriously considered as options.

While the economic literature is nearly unanimous on the theoretical desirability of moving to a different system, the literature does not, because it is theoretical and largely based on the American experience, discuss the applicability of different allocation mechanisms to Canada. In fact, the applicability of different mechanisms is probably limited. The main reason for this is the absence of spectrum congestion in most regions of Canada. It is one thing to talk of an auction, of paging services for example, in Montreal or Toronto because of congestion and quite another to talk about an auction in Moose Jaw or Rimouski. However, for some services in some centres (mainly Toronto, Montreal and Vancouver) different allocation mechanisms (e.g., an auction) may be worth considering.

B. Survey of Licence Holders

Objectives of the study: A survey was conducted of a large sample of radio licence holders and broadcasters. The objective of this survey was to provide information regarding five separate evaluation issues:

- has access to the spectrum been eased?
- has the program led to sub-optimal allocation?
- what is the impact of licence fees on users?
- what are the attitudes of users toward the regulations?
- how satisfied are users with the services provided by the Department?

Method: The survey was conducted by mail by an independent consulting firm between November, 1988 and March, 1989. Two survey instruments, one for radio licence holders and one for broadcasters were prepared in both official languages. Comprehensive lists of the study populations were obtained from the RFS database manager. The final sample consisted of 2,051 completed surveys from radio licence holders and 233 completed surveys from broadcasters. These numbers represent response rates of 45.6% and 38.3% respectively.

Results: The results for the five separate evaluation issues were as follows:

1. Has access to the spectrum been eased?

The results indicate that relatively few applications for licences are rejected by the Department of Communications. Furthermore, for those organizations with rejected or delayed applications, almost all had their needs met with an acceptable alternative. Only a small proportion of licence holders expressed dissatisfaction with the overall application process. Although the application process does not appear to limit access to the spectrum, there were some concerns expressed about its cost, time and complexity.

2. Has the program led to sub-optimal allocation?

Evidence about the issue of sub-optimality was obtained from radio licence holders by asking about problems such as congestion, interference, wasted air time, etc. resulting from shared frequency use. While the majority of radio licence holders did not report experiencing any difficulties from shared frequency use, there was a substantial number who had experienced one or more specific problems. For broadcasters, the issue of sub-optimality was addressed by asking about the incidence of denials of requests for specific radio frequencies and about the consequences of application rejections. There were relatively few respondents reporting difficulties from rejections of requests for specific frequencies.

3. What is the impact of licence fees on users?

Approximately 30 per cent of radio licence holders thought annual licence fees were too costly in comparison to "what I think I should pay", 44 per cent reported that their fees were "just right", and 26 per cent thought that fees were not too costly. On the whole, broadcasters were more likely than radio licence holders to think that their current fees are too costly. While about one-third of radio licence holders found fees to be too high, very few indicated that they would prefer lower fees if it meant a drop in the quality of service. In general, most licence holders regarded the cost of their

licence fees as reasonable and fair in comparison to other factors such as the benefits they obtain from using radio.

4. What are the attitudes of users toward the regulation?

Most users reported high levels of familiarity and understanding of the current regulations. The majority of radio licence holders were positive toward all of the different aspects of the regulatory process about which they were asked, however survey respondents expressed some difficulties with a number of aspects of the system. Licence holders were concerned about the adequacy of opportunities to provide input prior to changes in regulations, the notification of changes and the consistency of enforcement. For broadcasters, concerns were greatest about the number of rules and regulations and about the restrictive effects of current regulation on technological innovation.

5. How satisfied are users with the services provided by the Department?

A very high proportion of radio licence holders and broadcasters were very satisfied with the services provided by the Department. A majority of respondents also agreed that the Department has a good understanding of their radio frequency spectrum needs.

Assessment of the reliability of the evidence and conclusions: The survey was well and carefully designed and the evidence and conclusions are properly supported by the evidence. This survey was the first systematic national survey of clients and was intended to provide sound baseline information. In this it was successful. It was not designed to address specific problems or be analyzed at a detailed level (e.g., to analyze results at a provincial or regional level). This would have made the survey very expensive and less efficient.

C. Survey of Interference Reports

Objectives of the study: A survey was conducted of a sample of members of the general public and licensed users who have registered interference reports with the Department of Communications. The objective of this survey was to collect information addressing two major evaluation issues:

- has interference been reduced through program efforts?
- how satisfied are the respondents with program delivery?

Approach and Methodology: The survey was conducted by a private consulting firm. The data were collected through telephone interviews carried out between April 11 and May 12, 1988. The sample of interference reports was drawn using the ROMIS database. A total of 609 general public and 612 licensed user interviews were completed. The refusal rates were 28% for the general public and 7% for licensed users. Approximately 240 interviews were conducted in each region, one-half with general public and one-half with licensed user respondents. The sample was found to be representative of the total population of people reporting interference.

Results: Six specific research questions were addressed, as follows:

1. Has interference been reduced through program effort?

A majority of respondents felt that the Department was responsible for identifying the problem source. It was also found that the identification of the source of the interference was associated with a greater frequency of the removal of the interference. As well, the Department's brochure on identifying sources of interference was identified as being very useful. Thus, it appears that program effort has led to the reduction of interference or at least of interference effects.

2. How satisfied are respondents with program delivery?

Respondents were predominantly satisfied with program delivery. The highest ratings were of courtesy, competence, overall handling, speed of response and clarity of advice. The lowest satisfaction was with effectiveness in source identification and providing suggestions. There also were some regional differences on the ratings of satisfaction with the provision of suggestions and clarity of advice. For both of these items, the highest percentage of satisfied respondents was in the Central Region and the lowest percentage was in the Quebec Region with the other regions falling in between.

3. Does interference reduction differ by type of respondent?

A greater percentage of general public than licensed user respondents report that the interference is still a problem. This may by related to differences in source identification and to who was identified as being responsible for fixing the problem.

4. Does satisfaction with program delivery differ by type of respondent?

Licensed users were generally more satisfied than general public respondents with the various aspects of program delivery.

5. What factors contribute to overall satisfaction?

High satisfaction overall was related to high satisfaction with the first action taken by the Department, minimal seriousness of harm in terms of money loss and damage to equipment, identification of the source, correction of the problem and anticipating that a great deal of effort would be needed to track down the right person at the Department. Higher rates of satisfaction also occurred when the first action suggested was something that actively involved either the respondent or the Department (e.g., an inspector would be sent or the respondent should monitor the problem).

6. Are respondent characteristics related to program satisfaction?

It appears that respondent characteristics are, for the most part, not related to satisfaction with program delivery and that the program does not unduly privilege any specific group.

Assessment of reliability of the evidence and conclusions: The survey was well designed and executed. The findings and conclusions are supported by the evidence.

D. Analysis of the Literature: Cost Recovery and Taxation

Objective: The purpose of this study was to provide an analysis of cost recovery and taxation and the conditions under which these are justified. The general issue being addressed is the impact of gathering licence fees from licensed radio spectrum uses.

Approach and methodology: The approach taken in the study was to review, critique, and synthesize relevant literature and current practice from the perspective of accepted economic theory. The literature that was reviewed came from law, public administration, and economics.

Results: The policy on cost recovery is based upon the Financial Administration Act (FAA) Section 13. This has been interpreted in several additional documents but the clearest is Treasury Board Circular (July 22, 1986). The circular discussed three key elements in regards to cost recovery.

- Rule of taxation: a department may not collect more than the cost of the services it provides.
- Rule of expenditure: funds collected above the cost of administering a program are deposited into the government's central Consolidated Revenue Fund (CRF). The department collecting the money cannot have access to those funds without going through the normal budget application process.
- Threshold: the dividing line between cost recovery and taxation. Whereas there is strong justification for the first two of these elements, justification for the cost recovery threshold is weak at best.

The rules of taxation and expenditure are based on the government's policy of keeping financing and expenditure decisions separate for the departmental level, making it the responsibility of "government as a whole" as represented by Cabinet. That is, government expenditures are, in principle, to be decided independently from the taxation used to support them. There are two principal reasons for this separation:

- with public goods, everybody benefits equally regardless of their contribution; and,
- the objective of redistributing income requires that the citizens contribute their fair share.

Rationales for establishing the cost recovery threshold based on simulating a fair market, management of a common resource, benefit taxation, or management of a natural monopoly were found to be inadequate. The rationale that government services be run on the same basis as a private service is not a possible justification because of the non-competitive nature of the market. Further, the rationale that government services simulate a free market is not consistent with the present policy of collecting uniform fees. If this were the rationale, for example, fees for radio spectrum licences would reflect region, locality, and frequency location. If fees were paid relative to the value of the resources, prices would have no relation to the costs of administering them.

The most defensible rationale would be benefit taxation, which ensures that the beneficiaries of a service pay compensation on the benefits they receive to reduce the subsidization by other tax payers. Currently certain users receive advantages through flat fees because the fees associated with the use of the spectrum are equally distributed but the benefits derived from different allocations are not.

Of the few exceptions that do exist in the relation between taxation and allocation, these occur in regulatory contexts or in crown corporations that perform this function. However, even for the exceptions, fees collected above cost are reapplied to the same well defined group from which they were collected.

The conclusion of this report is that freedom in charging for use of radio frequencies and then using the receipts would be difficult if not impossible to negotiate. Such a situation could only come about if radio spectrum management were to become an independent regulatory body or assume crown corporation status. However, the fee structure could be changed from a flat rate to an adjusted rate based on the value of the spectrum allocation to promote fairer contribution consistent with a benefit taxation approach. Although this would not increase resources for DOC, it would promote the rational and efficient use of spectrum allocations.

Assessment of the reliability of the evidence and conclusions: Overall this study appears to have performed a reasonably thorough review of the relevant literatures and to have developed conclusions and recommendations that clearly follow from this review. The practical applicability (i.e., whether the proposed changes could be made to work) of the theory has not been seriously examined because the work is theoretical and largely based on American experience. Trade-offs between and among different policy goals have not been examined. However, the review is a useful starting point and entirely adequate for the purposes for which it was designed.

E. Analysis of the Literature: Government Structures

Objective: This study was carried out to determine whether the Department is the appropriate place for spectrum management given how far removed this activity is from the policy nature of government activity generally and the Department specifically.

Approach and Methodology: An extensive review of the relevant literature was conducted for this study.

Results: The report looks at three categories of government structure: departmental, crown corporation and regulatory agency.

The review of literature yielded a general conclusion on the relationships between structures and functions: the links between the two are not as strong as theoretical considerations alone would imply. Only in a few cases can it be shown that a specific structure must be used. Numerous examples can be cited of theoretical "incorrect" structures which have successfully weathered the test of time, which nobody has deemed necessary to go to the trouble and expense of changing. In short, the congruence between theory and the actual structures and functions in government is rather low.

The literature reveals that the departmental structure is especially desirable, from the point of view of decision makers, in situations of high political visibility where decisions are likely to touch upon governmental priorities, to involve a large fraction of the electorate and to require very tight control methods to insure financial and political accountability. The results are essentially ambiguous with respect to the capacity of this structure to facilitate change, and smooth adaptation to technological or social shifts. The closeness of this structure to the political process favours rapid adaptation. Bureaucracy and the level of competition for decision makers' time and attention impedes change.

On crown corporations, the literature review concludes that they are appropriate when the activities pursued are extensive and subject to complex and/or fast changing technological and market constraints. The main paradox evidenced by the literature has to do with the difficult and general lack of balance between the commercial and governmental imperatives of the corporation: it if is successful commercially, it is often at the expense of its governmental mission and vice-versa. All in all, a crown corporation offers maximum flexibility and adaptability but carries with it substantial risks in terms of control and accountability.

The key advantage offered by regulatory bodies is their capacity to deal with natural monopolies and, more importantly, to handle complex and politically awkward distributive issues (i.e., those involving target populations which cannot be defined within the standard set of rules governing the budgetary process). Regulatory bodies provide the structure most likely to be captured by small groups and least able to favour efficient adaptations to technological and market changes.

The general conclusion in the literature indicates that a crown corporation could be the most appropriate structure for managing the radio frequency spectrum, essentially because it would provide the flexibility which will be needed in the forthcoming years to face the challenges arising from pricing, congestion and technological competition issues. The literature also shows, however, that the use of a particular structure is only rarely "compulsory"; consequently, changing the present departmental structure to a crown corporation cannot be viewed as an urgent necessity. This

conclusion needs to be reviewed in the light of technological developments not evident at the time (1988) the study was carried out.

At the time this study was carried out some observers were optimistic that spectrum congestion would not be a severe problem in part because of the development and application of fibre optics to telecommunications. What these observers failed to predict was the explosive growth of new techniques and tools which require spectrum. This explosion has been described as the wireless revolution. The most well-know example is the cellular phone. However, numerous other devices are either developed (e.g., mobile facsimile) or about to be developed (e.g., greater use of personal communications, wireless LANS and radio monitoring mechanisms in hospitals, and new services in mobile communications).

Assessment of reliability of the evidence and conclusions: The literature review was thorough and complete. The conclusions are equivocal because the evidence does not clearly favour one decision about structure over another.

F. Comparison of Canadian and American Radio Standards

Objective: This study was to review comparatively the technical standards put forth by the Federal Communications Commission (FCC) and by Canadian authorities. The objective of this study was to establish how different the Canadian standards are from the American standards, and to discover what the likely impacts of adopting the FCC standards would be.

Approach and Methodology: This study consisted of a detailed review of all relevant documents from both Canada and the United States as well as interviews with a number of persons in the communications industry and within the Department of Communications.

Results

Legislation: The legislation on which the Canadian regulations depend, the Radio Act of 1938, is different in scope from the Communications Act of 1934 under the authority of which the Federal Communication Commission (FCC) was established. The differences in legislation and in the underlying philosophy have created very different regulatory frameworks.

Management: The Department of Communications has full control of the standards governing suitability of radio equipment and except for the delegation of management of parts of it to National Defense and to Transport Canada, the Department manages the entire radio frequency spectrum.

The FCC manages all non-governmental spectrum use and as well, performs many of the functions which in Canada are the responsibility of the Canadian Radio-Television and Telecommunications Commission (CRTC).

Both Canada and the United States are member states of the International Telecommunication Union (ITU). This organization develops standards which member states agree to meet or better in their national regulations. Standards applicable to spectrum use in Canada are developed jointly by the Department of Communications and the radio industry through the work of several committees including the Broadcast Technical Advisory Committee, the Cable Television Technical Advisory Committee, the Advanced Broadcast System Committee and the Radio Advisory Board of Canada.

All radio equipment must be licensed or established as being exempt under provisions of the Radio Act. Certification for licensing or exemption from licensing is granted or withheld based on the results of tests carried out by a registered professional engineer or by the Department of Communications.

In the United States responsibility for management of the radio frequency spectrum is divided between the FCC and the National Telecommunications and Information Administration (NTIA). The FCC regulates all non-government stations while the NTIA is responsible for those of all departments and agencies of the federal government.

The FCC has the authority to assign frequencies, regulate the kinds of apparatus to be used with respect to its external effects and the purity and sharpness of its emissions. It also has the power to make regulations required to prevent interference and to prevent the use, manufacture, importation, sale or the offering for sale of equipment not meeting its standards.

Standards: FCC standards are established following procedures set out by law. These require the Commission to respond to a petition that a rule be made in a manner which provides for intervention by interested persons at several points.

Equipment may be authorized for licensing by the FCC by showing that it complies with the applicable rules. Equipment to be used by the government must comply with the standards established by the NTIA.

NTIA standards are concerned with efficient use of the spectrum by clean stable emissions and are thus generally similar in scope to those of the FCC.

Frequency Allocation: In the U.S. frequency allocation is by user whereas in Canada it is by use. Within bands allocated to a particular service in Canada, assignment of specific frequencies is on a first-come first-served basis under the direct control of the Department of Communications. In the U.S. frequency assignments are the responsibility of the industrial sector to which a particular band has been allocated.

The numerical values which the standards set as acceptable limits are generally similar (in many cases identical) in Canada and the U.S. where both countries require equipment to be licensed. However, Canadian regulations are broader in scope covering much receiving equipment as compared with the American concentration on the purity and stability of emissions.

To minimize interference between the broadcast transmissions of the two countries, regulations applicable to the various broadcast services are subject to bi-lateral agreements.

Summary: The study reviewed the standards for the two countries for land mobile service, fixed service, aeronautical service, marine service, General Radio Service and cellular radio service. Differences between the two countries ranged from non-existent to differences in restrictiveness and specificity of the standards, depending on the type of service.

The interviews carried out for this study showed that there is little concern with the numerical values applied to parameters defined in standards. There was also general satisfaction with the implementation of the management process itself. Most concerns dealt with frequency allocation or assignment. Throughout the industry the matter of electromagnetic compatibility presents problems. There is interference with radio equipment from non-radio sources and poorly designed electronic equipment, including radio receivers, is susceptible to unwanted effects from legally permitted transmissions as well as interference resulting from spurious emissions. While there are technical solutions to many of these problems they are often not applied because of economic considerations.

Conclusion: Despite the correspondence between Canadian and American values for certain parameters, major differences in the legislative bases and underlying philosophy provide ample justification for uniquely Canadian standards.

Assessment of the reliability of evidence and conclusions: The study is a careful and thoughtful review of differences in the two systems and its conclusions are reasonable and appropriate.

G. Evaluation of the Organizational Structure (1988)

This study, carried out in 1988 examined the organization of the RFS at that time. As such its conclusions are restricted to the situation prevailing in 1988. In 1990 the Department was reorganized and the Management of the RFS split into two areas: headquarters and regions. The headquarters functions report to an assistant deputy minister responsible for spectrum and research, while the regional functions report through executive directors to a deputy minister. To some extent this reorganization reflects a natural evolution as the Department has continued to strengthen the delivery of programs and services in the regions of Canada.

Objective: Four questions were to be answered by this study:

- is the sector's organizational structure adapted to the context and pressures of the environment?
- does the existing structure allow for optimum use of human, technological, and financial resources?

- do alternatives exist which would allow the organization to increase its effectiveness and efficiency?
- where applicable, what are the areas of change and what implementation strategies should be promoted?

The underlying issue being addressed is whether radio frequency spectrum delivery has an appropriate organizational structure.

Approach and methodology: The approach of this study is based upon three premises:

- the two basic variables in any structure are differentiation and integration;
- differentiation is most advantageous when the environment is complex and unpredictable; and,
- the more differentiation in an organization, the more difficult it becomes to maintain internal integration and coordination.

The methodology used in this study was to examine spectrum management's formal documentation, interviews with program administrators, and a content analysis of orientation and coordination group reports.

Results: The structure of an organization contributes to its efficient operation to the degree that it is compatible with the dynamics of the organization. These dynamics are a function of the organization's external and internal environments.

For spectrum management the external environment is relatively predictable, affected mainly by technological developments, territory configuration, and international relationships. Given these influences, spectrum management has a three to four year period to respond to any developments in its environment.

The administrative units of spectrum management are organized to deal with specialized markets in its environment. Rather than a hierarchical structure, spectrum management units are interrelated. While the units have a significant amount of autonomy, they are controlled through their accountability to periodic reviews, a collaborative management system, and formal coordinating mechanisms that serve to promote vertical and horizontal coordination and integration.

The internal environment of spectrum management (1988) is organized around its two main markets, broadcasting and radio. The two branches are relatively independent of one another and use different methods of operation. Broadcasting Regulation (DGBR) is centralized whereas Radio Regulation (DGRR) is more fragmented and decentralized. This differentiation is functional and efficient because it reflects the actual markets it serves, allows for an economy of resources, and a high degree of integration. Overall, the internal structure of spectrum management is divided into five different branches:

• The Regional branches. (1988) The regional branches are of central importance to spectrum management, and have a considerable amount of autonomy, recognition, and influence within the entire organization. This situation is likely to increase as the department continues to move toward increasing decentralization.

The regions are differentiated based on the local economic structure, population density, geographic territory, and the organization of provincial services. Despite the differences the basic functioning of each branch is quite standardized. Management within the regions is similar to that in the central organization, with regional and district administrators actively cooperating and consulting and having high levels of autonomy and accountability. Below the district level, however, management takes on a mechanistic and bureaucratic style. Although increasing the autonomy and responsibility of district units could be possible it would be expensive, requiring increased staffing, and more complex communications and coordination.

Finally, horizontal integration at the regional and local levels occurs through the practice of mutual adjustment, direct supervision, the use of permanent or temporary work committees, and regular staff meetings. Vertical integration and coordination is accomplished through periodic reviews, the functioning of regional specialists, automated management, the national sector management committees, and periodic evaluations of service points. Through these various mechanisms the spectrum management function maintains a high level of integration and coordination.

• The Radio Regulation Branch. The mandate of DGRR is to elaborate "regulations and operating policies to govern the orderly operation of the spectrum, while taking into account both technical progress and the changing needs of the Canadian population." It is also responsible for maintaining and operating the computerized licensing system, elaborating telecommunications programs for emergency situations, and conducting international negotiations affecting spectrum use. Only the most essential functions have been centralized under DGRR's two sub-branches, Spectrum Management Operations and Regulations, all other functions have been delegated to the regional branches and coordinated through the sector management operations committee and its sub-committees. Although such a structure has the potential to result in decision delays, this has not been the case.

• The Broadcast Regulation Branch. The structure of DGBR reflects the centralization of the broadcast environment, with its concentration in the hands of a few corporations. Because of the political, social, and cultural implications of broadcasting, the Broadcast Regulation Branch operates within its own market, with its own legislation, and with its own operational procedures. All functions are managed by the centralized structure. The branch's functions have been divided between the Planning and Standards branch, which deals with policy, and the Applications Engineering branch, which deals with operations. Analysis, evaluation of applications for cable TV certificates, and approval of proofs of performance are the only functions performed at the regional level. This structure is appropriate and efficient for the market it deals with. However, pressures for increased regionalization may make it necessary to implement a permanent inter-sector collaborative structure on broadcasting.

• The Engineering Programs Branch. The Engineering branch is the centre for expertise and specialized resources for spectrum management. Within the past two years this branch has undergone modifications to simplify and strengthen its roles in the production and regulation of standards and procedures and support the organization's service and regulatory functions. The branch is structured around the specialized professional functions or orientations of its members rather than around markets to facilitate its functions, which encompass the entire range of markets served by spectrum management.

• The Sector Policy, Planning, and Assessment Branch.(1988) This branch performs the function of executive secretariat for spectrum management, supporting internal administration and acting as an interface with central supervisory agencies. Managers within each branch are responsible and accountable for their own administration and it is the role of Policy, Planning, and Assessment to provide them with the necessary assistance. The branch's role of support rather than control is kept through clearly established rules and through operating on a collaborative and consultative basis with managers.

In conclusion, the structure of an organization is a means by which it carries out its services and transactions. The structure of spectrum management at the time of the study was very functional, efficient, and well-integrated with its environment. In brief, the structure was intentional, supple, natural, simple, and controlled. The main recommendation of the study was to preserve and protect the (then) current structure and operations of the sector against possible future budgetary restrictions and changes in the external environment.

Assessment of the reliability of the evidence and conclusions: This study appears to have done a competent job of reviewing the structure of spectrum management, as well as considering possible criticisms and alternatives to the current organization. Largely because of the topic area, many of the interpretations and evaluations of the structure are subjective and impressionistic. This does not seem to detract from the overall quality and reliability of the findings. Although this report is very positive, it has limited itself to a consideration of structure and may not be used to generalize to other aspects of spectrum management. Finally, because the study was carried out before the recent (1990) reorganization of the Department of Communications, its conclusions are possibly dated. Depending on the interest of officials it may be worthwhile to re-examine at least some aspects of the study given the large scale nature of the changes made in 1990.