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/ A Study of User Needs
in Mobile Radio /

Vol. 1 Main Results



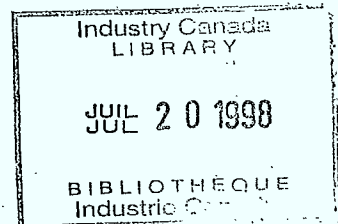
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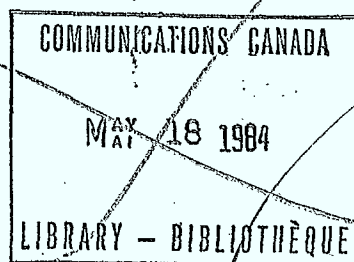


Prepared for the Spectrum and Terminal
Systems Policy Branch
Department of Communications

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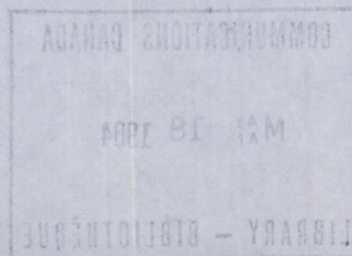
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ABSTRACT

The research reported is concerned with the present and future needs of mobile radio users in Canada. It has applications such as use by the federal Department of Communications to assist in formulation of future policy.

The work described is based upon the needs of three categories of users: business and commercial, federal and provincial, and municipal. These user categories are discussed in detail in terms of the present status of mobile radio systems in use, their functions and historical development. Other characteristics such as size, technical features etc. are also dealt with, as are future needs of these classes of radio users.

The results of the study are presented at various levels. General conclusions are reached in the summarising chapter concerning growth of each service category, future technical needs, and degree of satisfaction in D.O.C. policy. Each preceding chapter (discussing a particular user category) ends with an executive summary of the detailed findings to be found in that chapter. A statistical account of the results of the survey, carried out to achieve the objectives mentioned, is included in the Appendix.

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CHAPTER 1

INTRODUCTION

The purpose of the study is to examine the present and future needs of mobile radio users in Canada. The results are intended for use by the Federal Department of Communications to assist in formulation of future policy.

Mobile radio use has undergone a rapid increase in the past few years. This may be attributed, in part, to recent tremendous growth in technology, new needs of more responsive public services, increasing urbanization, constraints due to the energy crisis, etc. This demand also shows an increasing awareness on the part of the general public of the advantages mobile radio brings in improving daily life. These new or rapidly evolving public and private needs, for example in public safety, mass urban transit, aids to motorists, innovative industrial applications etc., could aggravate problems such as congestion of available communications channels, interference between adjacent channels, and could likely require new service offerings and new mixes of services. The Department of Communications thus requires knowledge of the present status of the problem in all aspects to assist in its task of developing new services etc.

Specifically the report is intended to supply information not previously available from other sources. Much data of interest are not available on radio licences e.g. patterns of operational behaviour, daily channel occupancy rates, characteristics of information transaction etc., and must be obtained from other sources. This study also provides an opportunity for user criticism of presently available services, that is a chance for feedback and improvement. The study will be one input of many, all interweaved to give a better overall picture.

The problem (characterization of mobile radio user needs) is broken down into its constituent elements to gain a better understanding and attempt a solution. The work described divides into three user categories (presented in the order listed): private business companies (Chapter 2); federal and provincial government departments (Chapter 3); and municipal departments (Chapter 4). There are a number of specific types of radio services available to the licensee in Canada (see Appendix 1) and each category of user (business, federal and provincial, and municipal) is discussed basically in terms of two parameters of the radio service chosen: (a) profile of usage characteristics, and (b) present and future quality requirements. Considered are such topics as the comparison of one user system performance with another (based in part upon choice of radio service), potential for substitution of one service

by another, service growth predictions etc.

Methods used in this report for the evaluation of mobile radio user needs consist of literature searches, personal interviews with both individual users and user groups, and a questionnaire-type survey carried out across the country. These methods are detailed in Appendix 2.

Due to the large amount of data accumulated during the course of study, Chapters 2 to 4 for the most part discuss the needs of each user type in the shape of a summary of a large amount of quantitative information. The presentation of this detailed information (from the survey) is deferred to Appendix 3. Verification of these results is established at each stage whenever possible by comparison with other data not used in the report, such as available D.O.C. information, technical reports etc.

Finally, conclusions are drawn on the basis of the work carried out, and suggestions for further research are made.

CHAPTER 2

BUSINESS AND COMMERCIAL USERS

2.1 Introduction

This section deals with that segment of mobile radio users which is engaged in business enterprises as distinct from the public administration sector (which is treated separately under Municipal and Federal and Provincial categories).

Information presented in this section has been derived from 405 user companies who responded to the mailed survey, supplemented by personal interviews, analysis of contemporary literature, convention attendance and specific knowledge of the mobile radio industry.

Aggregate figures concerning the firms who participated in the mail survey are given in Table 2.7.

Responses to the survey were in sufficient quantity to enable inferences with high levels of confidence both with respect to industrial classifications of users and with respect to regional characteristics, except for the Maritimes. In the latter case only Nova Scotia generated a large enough sample to be reasonably reliable. Data has been presented for New Brunswick, Prince Edward Island and Newfoundland users, but because of the small sample, these must be considered as not being representative of a broad cross section.

2.2 Present Status and Historical Development

2.2.1 Category of Service

2.2.1.1 Total Picture

On a national basis, lumping all business and commercial users together, almost half (see Table 2.1) of the existing systems began as private systems. Approximately one-quarter began as MTS, and the remainder began as GRS, RCCMRS or ship-to-shore. Only 1% began as one-way paging systems and were subsequently licensed as two-way services.

Table 2.1 Distribution of Service Categories by Provinces
(Original) *

Category of Service	BC %	ALTA %	SASK %	MAN %	ONT %	QUE %	NB %	PEI %	NS %	NFLD %	TOTAL %
Paging	1	1	-	-	2	1	-	-	-	-	1
MTS	22	19	27	5	29	15	17	67	19	-	23
S/S	9	-	10	2	1	1	8	-	-	-	6
RCCMRS	6	17	3	25	5	5	50	33	4	-	10
GRS	5	6	10	4	10	26	-	-	17	-	12
Private	56	57	50	65	53	52	25	-	60	100	48

Although mobile radio has been in use since the late '40's, more than half the systems came into service in the 1971 - 75 period. Table 2.2 highlights this accelerated pace.

Table 2.2 Year of Original Licence

Year	BC %	ALTA %	SASK %	MAN %	ONT %	QUE %	NB %	PEI %	NS %	NFLD %	TOTAL %
'50 and before	-	-	3	-	1	-	-	-	-	25	3
'51 - '55	8	1	-	4	5	-	-	-	-	-	2
'56 - '60	10	4	1	4	12	3	-	-	-	25	6
'61 - '65	7	5	27	6	19	5	-	-	18	-	9
'66 - '70	21	26	18	18	36	43	40	-	23	25	25
'71 - '75	54	65	51	68	26	48	60	100	59	25	55

The distribution of service categories as of early 1976 is shown in Table 2.3. Compared with the originally licensed categories of Table 2.1, this shows an increase of 9% in private systems, 5% increase in MTS with a 5% drop in GRS and no change in RCCMRS, indicating that business radio users are not turning to regulated common carriers to meet their private dispatch radio needs.

* each industrial category is given equal weighting

The survey revealed that several business and commercial licensees had discontinued the services. The main reasons given were:

GRS - noisy, skip interference, insufficient range, unreliable, and too much traffic (much of which is unnecessary). However there are some businesses and locations where interference may not be serious as in construction work in valleys, and there are also those emergency situations where any communication at all is valuable.

RCCMRS - Crowded and expensive

MTS - Too expensive, crowded, poor quality of service and lack of access in case of emergency. These criticisms follow along lines already reported in other sources. (1)

Private - Crowded and expensive

Twenty-eight percent of the respondents had made some change from the original system. Eight percent had changed to some other service category, and 4% had added a second or third service while keeping the original.

Almost 2/3 of the changes were in systems originally licensed as GRS. The major trend was from GRS to Private systems. Eight percent of the respondents had changed their private systems from the time it was originally licensed, and 6% of respondents had had some unspecified changes in their MTS service.

Among those who changed (see Table 2.4) 'Congestion' and 'Coverage Area Was Too Small' were given as the major reasons. 'Too much delay in reaching the other party' ranked third as a major reason for changing.

Table 2.3 Distribution of Service Categories*
by Provinces
(Present)

Category of Service	BC %	ALTA %	SASK %	MAN %	ONT %	QUE %	NB %	PEI %	NS %	NFLD %	TOTAL %
Paging	3	2	4	6	8	18	-	17	4	-	10
MTS	18	24	28	16	11	14	22	50	8	5	17
S/S	3	1	-	-	-	2	11	-	-	-	3
RCCMRS	11	10	11	10	7	1	44	33	10	-	10
GRS	5	5	6	-	9	8	-	-	3	32	7
Private	59	58	50	68	65	57	22	-	76	63	57

* % of systems in each category, not % of users, since all GRS and paging users in the sample are also private, RCCMRS or MTS licensees.

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Table 2.4 Reasons for Changing To Other Service

(A) Congestion - of those that change	Major reason	42%
	Minor reason	14%
	Not Applicable	44%
(B) Delay - in attracting operator's attention	Major reason	31%
	Minor reason	21%
	N/A	48%
(C) No Indication of Missed Calls	Major	16%
	Minor	25%
	N/A	58%
(D) Cost	Major	13%
	Minor	18%
	N/A	69%
(E) Interconnection Required	Major	11%
	Minor	8%
	N/A	81%
(F) Two-way Communication Needed	Major	6%
	Minor	5%
	N/A	88%
(G) Coverage Area Too Small	Major	36%
	Minor	15%
	N/A	49%

2.2.1.1.1 Growth Rate

The use of mobile radio has expanded greatly in the past 5 years with the number of new mobile licensees (not necessarily the number of mobile radios) coming into existence at an overall annual compound growth rate of 21%. Table 2.5 below shows the rate of growth by service category in the various periods.

Table 2.5 Annual Rate of Growth in Mobile Licensees

Period	Paging %	MTS %	RCCMRS %	Private %
Pre '60	-	-	-	6
'60 - '70	-	-	-	29
Pre '71	14	inconsistent		-
Post '71	34	37	5	6

It should be noted that the paging systems in Table 2.5 are only those which are operated in addition to some other form of licensed mobile service, and do not represent the more prevalent radio paging user who has no other form of licensed mobile radio.

2.2.1.2 Regional Characteristics

Reference to Tables 2.1, 2.2 and 2.3 will reveal the variations, on a provincial basis, of the distribution of original and present service categories and rates of implementation.

By 1976 (see Table 2.6) the individual distributions within six provinces were approximately the same as the national picture. In Saskatchewan however, slightly more licensees were using MTS than private systems. This differs from the national scene where private system users outnumber MTS users two to one.

Nova Scotia is similar to the central and western provinces. Although New Brunswick, Prince Edward Island and Newfoundland reported a higher than normal percentage of RCCMRS and a lower than normal share of private systems, the sample is too small to be reliable.

The use of supplementary GRS was prevalent among 4 to 6% of the respondents in 5 provinces, and 10% of them in Ontario but among virtually none in Manitoba, New Brunswick, Newfoundland and Prince Edward Island.

Table 2.2 indicates that British Columbia, the Prairie Provinces, Ontario, Quebec and Newfoundland were the first to adopt mobile radio. However in the last decade, 1965-1975, growth has been at approximately the same rate in all provinces except for a significant slowdown in Ontario. This may indicate some degree of market maturity being reached in Ontario.

2.2.1.3 Industry Differences

Question 12A, Appendix 3, shows graphically the distribution of originally licensed service categories by user industry classification, and questions 1 and 3 show the corresponding distributions for early 1976.

Question 12A indicates that, on a national basis in 1976, private systems were most prevalent in agriculture, communications, construction, fishing/trapping, forestry, transportation and utilities. MTS was assuming some importance, especially in Saskatchewan in construction. Fishing is a heavy user of GRS.

Finance, Insurance and Real Estate used mobile radio mainly in Ontario, predominantly MTS, with about 20% private and 5% RCCMRS.

Manufacturing and Personal Services were about equally divided between MTS and Private systems.

Trade and mines and oils are mainly split between MTS and private.

Table 2.6 Percentage of Services in Each Province

Category of Service	BC %	ALTA %	SASK %	MAN %	ONT %	QUE %	NB %	PEI %	NS %	NFLD %
MTS	21	27	48	23	24	28	17	66	23	25
GRS	4	4	6	-	10	6	-	-	6	-
RCCMRS	12	8	3	4	8	2	50	33	9	25
Private	63	61	43	72	58	64	33	-	62	50

From this (and other tables) it is not to be construed that, for example, P.E.I. (66% using MTS) has more users of the mobile telephone service than Ontario (with 24% of its users deploying MTS). This point is emphasized by the fact that Toronto and Montreal alone account, at present, for more than 40% of the total Canadian usage of land-mobiles.

Table 2.7 Aggregate of Business and Commercial Firms Surveyed

	1965	1970	1976
Number of Firms Surveyed	-	-	405
Total Employees	6,033	8,727	27,355 over 5,000* over 32,355
Number of Firms with Radio	81	160	405
Total Motor Vehicles	3,421	5,701	9,551
Motor Vehicles with Radios	1,861 500*	2,496 800*	5,826 5,000*
	<u>2,361</u>	<u>3,296</u>	<u>10,826</u>
Total Boats	55	44	120
Boats With Radio	30	44	227
Total Aircraft	18	34	39 **
Aircraft with Radio	18	34	17
Personal/portable 2 way radios	16 500*	96 1,000*	461 1,000*
	<u>516</u>	<u>1,096</u>	<u>1,461</u>
One-way paging receivers	15	94	291

* Reported by one major transportation company

** following trends in the U.S.A., (2) considerable growth in air-ground public radio telephone use in the business aviation community can be expected in the next 10 years. For air-ground communications a third dimension of space is introduced, which changes spectrum utilization procedures somewhat.

2.3 Uses of System

2.3.1 Total Picture

The major overall use, by far, for mobile radio is most suitably categorized as interworker communications (IWC) or information transfer such as reporting position location, emergency alert, worker-client or worker-worker communications. Less than one-quarter of the respondents described the purpose of their systems in terms that could be considered to be dispatch or command and control.

Tables for question 4 in Appendix 3 show the reported distribution of purposes.

Other purposes listed for 1% of the systems included antenna testing and adjustment, combined business and pleasure, remote broadcast pickup, and geophysical data transmission to and from sensing equipment.

2.3.2 Regional Characteristics

Generally the purpose reported in individual provinces are not significantly different from the national picture.

2.3.3 Industry Characteristics

Interworker communications dominates in Agriculture, Communications (except in B.C. where the split is about 50% interworker communications and 50% dispatch), Construction, Finance, Insurance, and Real Estate, Forestry, Manufacturing. Mines and Oils uses radio for everything from the location of deposits e.g. prospecting, drilling, communication with vehicles travelling along pipeline, to transportation of the finished product and uses radio mainly for interworker communication (except for Quebec and Nova Scotia where dispatch is by far the major purpose), IWC is also the main role in Personal Services, Trade, and Utilities where mobile radio is used for emergency dispatching of service trucks, and routine messages for maintenance of substations, transmission lines, construction of dams, etc.

Transportation dispatch messages are relatively short, frequent calls to and from mobiles which concern activities specifically related to work assignments of the operators of mobile units. Communications is between mobiles and a single fixed dispatch point, usually between a single mobile and his dispatcher. Occasionally a dispatcher may have to contact two or more mobile units and less frequently, his entire fleet. Rarely will any two mobile units of the same fleet need to communicate with each other.

Unlike the large fleet operator who may use a single private channel for radio dispatching purposes, the small fleet operator with limited funds and the ability to utilize only a part of the full load capacity of a radio channel may in some cases use RCCMRS instead of expensive high quality private systems. Due to familiarity with voices, types of messages and a constrained vocabulary these users of mobile radio for dispatch are much better equipped to use and accept service of degraded quality (e.g. access time) than other industries.

2.4 Size of Systems

2.4.1 Total Picture

Business and Commercial mobile radio systems range in size from one single base and mobile to several thousand mobiles. The largest reported in this survey has 5,000 mobile units and 1,000 portables. The average business and commercial operations excluding the above referenced system from the calculation, has 66 employees, 23 motor vehicles and 14 mobile radios, and at least one portable 2-way unit.

2.4.2 Regional Characteristics

On a regional basis there is no apparent trend toward a small or a large size in any province.

2.4.3 Industry Characteristics

The average number of mobile units per system varies sharply from industry to industry.

In descending order they rank:

Forestry - 19 mobiles

Transportation - 15 mobiles

Mines & Oils - 15 mobiles

Fishing/Trapping - 8 mobiles

Personal Services - 7 mobiles

Manufacturing - 5 mobiles

Construction - 5 mobiles

Communications - 4 mobiles

Agriculture - 4 mobiles

Trade - 3 mobiles

Utilities - 2 mobiles

Finance, Insurance and Real Estate - 1 mobile

The use of personal portables is on the increase. This is noticed particularly for construction (ease in communication both on a building site and from vehicles), forestry (use on both rough terrain and roads with a system of fixed and/or mobile repeaters), mines and oils, and transportation. Present use of often more than 7 portables per system contrasts strongly with the almost complete lack of use prior to 1965.

Paging receivers are in fairly common use in personal services. Limited use is noted in mines and oils, transportation, construction and forestry services (in Ontario and Quebec). These industries will in general utilize less than 4 paging receivers per system (for administrative use).

2.5 Technical Features

2.5.1 Frequency Bands In Use

2.5.1.1 Total Picture

The 'Frequency Used' table for question 6 (Appendix 3) shows the distribution of frequencies by provinces and industry. Approximately one-quarter of the respondents did not know what band they were operating in. Eight percent of the remainder reported that they use H.F., 24% use VHF low band, 62% use VHF high band and 5% use UHF.

2.5.1.2 Regional Characteristics

As with most of the questions, results from New Brunswick, Newfoundland and Prince Edward Island were inconclusive.

In Ontario, use of H.F. appears to be virtually nil, as is UHF in British Columbia, Manitoba and Nova Scotia. VHF high band dominates in all provinces and VHF low band is used in all provinces with a rather sporadic distribution by industries.

2.5.1.3 Industry Characteristics

Fishing is the only industry which reported a predominance of H.F. with the remainder in VHF low band. It is expected that maritime VHF communications will become a much more utilized band for commercial vessels due to the heavy traffic on low frequency marine channels.

Only Transportation, Forestry and Construction in Ontario, Manufacturing in Quebec, and Construction in Manitoba and Alberta have noticeable use of UHF. Even so these are minor compared to VHF in most cases.

2.5.2 Minutes of Air Time

2.5.2.1 Total Picture

The average number of minutes of 'air time' per hour used through the day, Monday to Friday, Saturday, Sundays, and statutory holidays is shown in Table 2.8 in the 'total' rows. As expected, air time is greater on Monday to Friday than at other times with usage fairly constant during the working day (7 am to 6 pm) at about 16 minutes in the hour. This rate is somewhat less than that for municipal, provincial and federal governments (about 22 minutes per hour). Traffic decreases on Saturdays and even more so on Sundays and statutory holidays, as expected from the commercial nature of the users' activities. During the working week the decline during traffic usage at 'night' (6 pm to 7 am) is not so marked as for other categories of user (see Sections 3.5.2.1 and 4.5.2.1) due to the requirement of several industrial categories (e.g. Transportation) to continue (or even increase) operations at night.

2.5.2.2 Regional Characteristics

Usage patterns are detailed in Table 2.8 by province. They seem to be very similar across the country, however with most usage in Ontario and Quebec, as was observed for municipal governments in these two provinces (Section 4.5.2.2).

2.5.2.3 Industry Characteristics

As noted from question 8, Appendix 3 (business and commercial), the industries with the greatest air traffic are Forestry, Manufacturing and Transportation. Forestry use of mobile radio tends to be limited to daylight whereas Transportation and to a lesser extent Manufacturing appear to be 'around-the-clock' operations. Lowest usage is in Agriculture, Fishing and Trapping (between 5 to 10 minutes in the hour, Monday to Friday).

Table 2.8 Average Number of Minutes Air Time Per Hour By Region

Province	Periods through the day						
	0-7	7-10	10-12	12-15	15-18	18-24	
BC	5	14	12	13	14	7	Mon. to Fri.
ALTA	15	16	15	16	17	11	
SASK	7	15	16	16	16	14	
MAN	10	15	17	17	16	11	
ONT	7	19	17	15	18	12	
QUE	7	20	21	20	21	14	
NB	-	25	18	12	19	5	
PEI	-	10	2	-	5	2	
NS	6	19	19	19	18	12	
NFLD	-	22	27	15	20	7	
TOT	10	16	16	15	16	9	
BC	9	6	6	7	6	3	Saturday
ALTA	14	18	18	13	14	16	
SASK	12	11	8	13	9	11	
MAN	15	14	10	12	10	10	
ONT	6	14	14	12	13	11	
QUE	8	12	16	16	13	9	
NB	-	19	17	8	15	-	
PEI	-	-	-	-	-	-	
NS	7	18	14	14	15	2	
NFLD	-	-	-	10	-	-	
TOT	10	14	13	7	12	7	
BC	12	6	4	4	7	4	Sunday
ALTA	7	11	12	10	13	13	
SASK	11	11	12	12	12	12	
MAN	12	8	7	5	5	5	
ONT	5	8	13	8	8	8	
QUE	9	13	20	17	17	9	
NB	-	-	-	-	-	-	
PEI	-	-	-	-	-	-	
NS	10	9	17	12	15	10	
NFLD	-	-	-	10	-	-	
TOT	8	8	11	8	9	8	

Table 2.8 Cont'd

Province	Period through the day						
	0-7	7-10	10-12	12-15	15-18	18-24	
BC	10	13	4	4	5	4	
ALTA	13	16	16	16	21	15	
SASK	10	12	13	10	11	9	
MAN	8	7	7	5	5	5	
ONT	5	7	13	7	8	8	Statutory Holidays
QUE	7	6	7	7	7	6	
NB	-	-	-	-	-	-	
PEI	-	-	-	-	-	-	
NS	8	16	15	11	11	8	
NFLD	-	-	-	10	-	-	
TOT	9	12	12	11	11	10	

2.5.3 Percentage Operations and Administration

2.5.3.1 Total Picture

The data tabulated for question 7 (see Tables in Appendix 3) show the distribution (by provinces and industries) of the estimated air time used for operations and administration respectively. On an overall national basis, less than 20% of the systems are used predominantly for administration, leaving 80% for operations. Table 2.9 shows the overall distribution.

Table 2.9 Distribution of Air Time Devoted To
Operations & Administration

Percentage Time Devoted to Service	Percentage of Systems	
0 - 20	14	} Operations
21 - 40	6	
41 - 60	7	
61 - 80	17	
81 - 100	56	} Administration
0 - 20	63	
21 - 40	11	
41 - 60	7	
61 - 80	9	
81 - 100	10	

2.5.3.2 Regional Characteristics

The use patterns reported by provinces are fairly consistent with the overall national average and do not warrant further comment.

2.5.3.3 Industry Characteristics

Fishing/trapping is the only industry showing a greater use of air time for administrative purposes than for operations.

2.5.4 Range

2.5.4.1 Total Picture

Table 2.10 shows the presently achieved and future required range of reliable mobile radio coverage among business and commercial users on a national basis. It is interesting to note that almost one-quarter of existing systems are capable of over 40 mile range.

Table 2.10 Coverage Range of Business and Commercial Mobile Radio System

Range in Miles	under 10	11-15	16-20	21-25	26-30	31-35	36-40	over 40
Achieved in '76	17 %	7 %	17 %	11 %	12 %	4 %	8 %	24 %
Req'd by end of '80	8 %	4 %	7 %	5 %	13 %	1 %	7 %	54 %
Req'd by end of '85	8 %	4 %	6 %	5 %	9 %	4 %	7 %	55 %

Furthermore, approximately another one-quarter of present users expect that their present coverage will be inadequate by 1980 and the net effect of the changing requirements will result in over half of the existing systems requiring over 40 mile range. Based on current user predictions, they expect their needs to generally stabilize so that required coverage by 1985 is essentially the same as for 1980. 15% indicate a need for omni - directional coverage while the remaining 85% indicate that the extended coverage will be required in particular directions including:

- (a) Along highways (transport and auto recovery services)
- (b) In directions of mountains
- (c) Towards the north
- (d) Inter-city MTS in rural areas
- (e) From shore to rigs in water

Another expressed need was for base to base communication between several bases located within a 100 mile radius along with 25 mile base-to-mobile range.

2.5.4.2 Regional Characteristics

Within a given province, excluding the three Maritimes where the returns were inadequate, the present ranges of coverage appear to be distributed in a relatively random manner, with no distinct pattern emerging in any one province.

2.5.4.3 Industry Characteristics

Within the 12 industry classifications the existing ranges in Transportation tend to cluster toward the shorter distances (see Tables for question 9 in Appendix 3). Forecast needs of transportation for 1980 and 1985, however are distributed more or less uniformly in the different range intervals with a slightly higher percent in the 'over 40 miles' class.

Forestry, on the other hand shows a distinct leaning (about 60% of systems) to 'over 40 miles' in both the present achievable and future required coverage.

All other industries tend to show only randomly distributed ranges from 'under 10' to 'over 40 miles' in both the existing and future categories, or else the sample size was too small to reveal a distinguishable trend.

2.5.5 Adequacy of System

2.5.5.1 Total Picture

On a national scale, although many users indicate a fairly high degree of satisfaction with existing systems, there is a very significant group of users who consider that their requirements are not being fully met. On an overall basis 12% complained of insufficient range and over half of these volunteered an explanation. Over one-half of the complaints concerned private systems, over one-quarter were about MTS and the remainder concerned RCCMRS except for one lone GRS user. Detailed comments are tabulated for question 11A in Appendix 3

Most users, on a national basis, do not have any difficulty in getting the operator's attention when called. However as with range, a significantly sized group representing about 22% of users does have difficulty. In those cases where an explanation was volunteered, half of the complaints concerned MTS, generally because of busy channels, although slowness on the operator's part was cited in several cases. Approximately one-quarter concerned private systems and the remainder, except for one GRS, concerned RCCMRS. Detailed comments are tabulated for question 11B in Appendix 3.

Similarly, although many users are satisfied with the degree of privacy afforded by conventional mobile radios, about 28% consider that the service falls short, in terms of privacy, of meeting their requirements. No explanations were offered.

Almost 90% of users do not employ mobile radio for non-voice purposes. Of the 10% who do, 88% find that their requirements are being met and only 2% (2 respondents) say they are not. No explanatory comments were offered.

Nine other comments were offered and these are tabulated under question 11E in Appendix 3. Five of them relate to crowded conditions on MTS channels, one concerns missed calls on MTS and three relate to private systems, including the comment that private equipment is too expensive.

2.5.5.2 Regional Characteristics

There do not appear to be any areas of dissatisfaction that can be identified as predominant in any region or regions, except that more problems seem to exist with range in the construction and agricultural industries in Saskatchewan and agriculture in Manitoba.

2.5.5.3 Industry Characteristics

Generally speaking, the proportion of dissatisfied users is about the same in most industries except for fishing/trapping which has about 50% dissatisfied with range and about 70% dissatisfied with lack of privacy and inability to get the operators' attention. Manufacturing indicates about 50% dissatisfaction with lack of privacy.

For the forestry industry, mountainous terrain is a limiting factor in the direct coverage obtained from low power VHF equipment. The areas served by these networks are large, resulting in relatively long transmission paths. Radio communication, mainly for fire prevention, between field units is often as important as communication with the district office and presents extra difficulties. Higher maintenance standards are required in this industry. Trees cause significant scattering of VHF radio waves and the trunks seem to be the significant scatterers. (3) Deep nulls in the received signal occur as a vehicle moves along a forest trail. Significant range degradation occurs when VHF radio sets are used in forests relative to the ranges achieved in open areas.

2.5.6 Facilities Provided

2.5.6.1 Total Picture

On a national basis, 'voice only' capability is provided in 93% of the systems reported. Only 4% report having 'voice plus data' facilities and the few remaining indicated having some other facility such as:

- Telemetering of water levels
- Beep of pagers
- Transmission of short tone to trigger apparatus at regular intervals (geophysical operations).

2.5.7 Paging

About 10% of licensees have, in addition to their conventional two-way land mobile system(s), a one-way paging service. As was stated in Section 2.2.1.1 this is most frequently accomplished through a separate privately owned transmitter, a telephone company or an independent paging service, with very few employing their two-way base station for paging.

2.6 Future Needs

2.6.1 Technical Facilities for Incorporation

2.6.1.1 Total Picture

Table 2.11 shows, by percent of users, the expressed intentions regarding present and future applications of various non-voice facilities.

Table 2.11 Intentions Regarding Present and Future Facilities

Question	18A %	18B %	18C %	18D %	18E %	18F %	18G %	18H %	18I %	18J %	18K %
In system	2	3	6	1	-	1	-	5	4	-	1
Not	98	97	94	99	100	99	100	95	96	100	99
<u>Info.</u>	-	-	-	-	-	-	-	-	-	-	-
No Info.	100	100	100	100	100	100	100	100	100	100	100
Def. Not	49	48	59	45	44	45	46	30	34	39	38
Unlikely	41	35	27	39	43	39	37	27	41	32	32
Undecided	7	8	8	5	4	5	9	10	8	8	10
Likely	2	7	5	5	8	5	6	24	12	11	14
<u>Definitely</u>	2	2	1	6	1	6	2	8	4	9	5
5 Years	50	83	81	70	68	70	55	76	74	74	65
<u>Later</u>	50	17	19	30	32	30	45	24	26	26	35

Except for computer-assisted dispatch (CAD, (E)), computer input from vehicle (CIV, (F)), computer retrieval from vehicle (CRV, (G)), and slow scan television (D) which have even less usage, a small group of users, from 1 to 6% are already using the facilities listed. Some 4% to 11% appear to be about to add one or more of these facilities. Half to three-quarters of them will do it in the next 5 years, i.e. by 1981.

There is a strong indication that individual selective signalling will be added by about 24% in the next 5 years and by another 8% after that. About 12% and 4% respectively will adopt selected group signalling in the same period.

About 20% of the users are seriously considering automatic vehicle identification and automatic vehicle location with almost 10% definitely planning the former. Two thirds to three quarters of these expect to incorporate them within the next five years. The written comments indicated that lower cost would either result in the use of more or a better grade of equipment.

The table for question 18 is shown by provinces and industries in Appendix 3.

2.6.1.2 Regional Characteristics

The provinces with the greatest use of the facilities mentioned in Appendix 1 are Ontario, Alberta, Quebec, and British Columbia. Of these Alberta, Quebec, and Ontario have some present use of all of the facilities 'available', whereas British Columbia appears to concentrate on facsimile, teletype, and individual and group signalling. Details of probability of incorporation, time of incorporation etc. are given in Appendix 3.

2.6.1.3 Industry Characteristics

The most progressive industries, in terms of their use of the facilities mentioned are transportation, mines and oils, and personal services. Of these, transportation and personal services avail themselves, at least some extent, of most of the facilities, whereas mines and oils makes more use of facsimile, teletype, and data terminal, e.g. the use by truckers of teleprinters for bills of lading.

Less work has been done on user applications in other industries. Perhaps the feeling is that there is little of interest in these areas, since the user with a small amount of system planning sets up one or more base stations and installs mobile units in trucks and cars just as everyone else has done for many years.

Agriculture expects some implementation of many of the innovations mentioned, especially individual selective signalling (ISS) and automatic vehicle location (AVL). Communications and construction intend to use individual selective signalling, AVL and automatic vehicle identification (AVI), plus group signalling for construction.

Forestry, as well as Finance, Insurance and Real Estate are keen on the installation of individual and group signalling and AVI. In addition forestry shows an interest in CAD and CIV. Both manufacturing and personal services are intent on individual selective signalling, AVI and AVL. As well as these facilities (ISS, AVI, AVL), mines and oils anticipates use of CAD and CIV. Trade industries are keen on computer retrieval from vehicles (CRV), AVI and AVL whilst transportation will install AVI, AVL, individual selective signalling and computer assisted dispatch. Utilities industries expressed interest in the use of facsimile and teletype equipment.

2.6.2 Equipment Costs

2.6.2.1 Total Picture

Question 19 attempted to find the cost level of various facilities at which the user would consider it not worth having. This question was not well answered, indicating that the users do not really have a knowledge of or 'feel' for appropriate costs.

Question 20 however drew a definite response, (as shown in Table 2.12) with over one-third of the users indicating that lower equipment costs would increase the number of mobiles they would use and would affect the introduction of the facilities referenced in Section 2.6.1. The table on question 20 in Appendix 3 shows the distribution of responses by provinces and by industries.

2.6.2.2 Regional Characteristics

Some provinces show a greater sensitivity to the cost of basic mobiles than they do to the cost of additional facilities. Manitoba users profess to be the least sensitive to prices whereas British Columbia and Nova Scotia users show the greatest sensitivity.

2.6.2.3 Industry Characteristics

Table 2.13 shows the price sensitivity by industry. Two-thirds of the users in Agriculture and half of those in Construction indicated that they would use more mobile radios if the price were lower. In Finance, Insurance and Real Estate as well as Communications, Forestry and Transportation only about 23 to 30% of the users indicated sensitivity to the price of mobile radios. In the other industries a higher proportion, in the 33 to 43% range showed price sensitivity.

As in the national and regional case, fewer users indicated that price would affect their use of additional facilities. A high proportion of Communications, Agriculture and Forestry said that it would, while Finance, Insurance and Real Estate, Manufacturing, Trade and Utilities showed little or no sensitivity to price while other industries except Fishing show about the same trends as the overall national average. In Fishing only one user who responded to the question on the price of additional facilities, indicated that price would affect their use.

Table 2.12 Effect of Lower Prices by Provinces and Nationally

	B.C.		ALTA.		SASK.		MAN.		ONT.		QUE.		N.S.		TOTAL	
	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no
	%		%		%		%		%		%		%		%	
Affect quantity of mobiles	44	56	25	75	27	73	14	86	26	74	23	77	37	63	36	64
Affect introduction of facilities	34	66	14	86	29	71	15	85	8	92	6	94	26	74	32	68

Table 2.13 Effect of Lower Prices by Industries (% of users)

*Industry No.	1		2		3		4		5		6		7		8		9		10		11		12	
	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no
Affect Mobiles	67	33	37	63	53	47	30	70	33	67	30	70	40	60	37	63	40	60	43	57	23	77	0	100
Affect Facilities	50	50	63	37	43	57	10	90	100	0	60	40	0	100	27	73	37	63	0	100	30	70	0	100

* Industries are identified as follows:

- | | |
|---------------------------------------|----------------------|
| 1. Agriculture | 7. Manufacturing |
| 2. Communications | 8. Mines and Oils |
| 3. Construction | 9. Personal Services |
| 4. Finance, Insurance and Real Estate | 10. Trade |
| 5. Fishing and Trapping | 11. Transportation |
| 6. Forestry | 12. Utilities |

2.6.3 Other Forms of Mobile Radio

2.6.3.1 Total Picture

Two-thirds of users do not plan to add other forms of mobile radio. However, 21% indicated that they do have such plans for implementation within the next 5 years while another 7% expect to do so later. The distribution of these plans by provinces and industries is shown for question 21 in Appendix 3.

The written comments indicate a variety of intentions such as:

- Add radio paging to private system
- Add GRS in addition to private system
- Add MTS in addition to private system
- Replace MTS with private system
- Add slow scan television
- Add automatic vehicle location
- Add a direct dial with private channel (from a current MTS user).

2.6.3.2 Regional Characteristics

On a provincial basis, Nova Scotia, Saskatchewan and Manitoba have the greatest proportion of users who seem likely to add other forms of mobile service. Ontario shows the least likelihood. Although the other three Maritime Provinces showed no such intentions, returns from them were too low to justify drawing a general conclusion.

Table 2.14 Probably Add Another Form of Mobile Radio
(by provinces)

Prov.		BC %	ALTA %	SASK %	MAN %	ONT %	QUE %	NB %	PEI %	NS %	NFLD %	TOTAL %
In next 5 years	yes	16	23	23	13	7	17	0	0	26	0	21
	no	84	77	77	87	93	83	100	100	74	100	79
Later	yes	4	0	6	4	8	0	0	-	8	0	7
	no	96	100	94	96	92	100	100	-	92	100	93

2.6.3.3 Industry Characteristics

Agriculture, Finance, Insurance and Real Estate and Communications show the greatest probability of adding other forms of mobile service in the next 5 years, while Manufacturing, Personal Services and Transportation seem more likely to make such additions later than the next 5 years.

2.6.4 D.O.C. Policy

2.6.4.1 Total Picture

On an overall basis, 15% of users have expressed a need for D.O.C. policy change. This has been reinforced through personal interviews, especially from associations or user organizations operating in two or more administrative regions of the D.O.C.

Areas of Complaint included:

- Inconsistency in the application of requirements from region to region affecting antenna gain and directivity on point-to-point circuits.
- Inability to get a list of users on adjacent channels in a given area in order to enable system frequency planning and interference prediction.

2.6.4.2 Regional Characteristics

The distribution, by provinces, of desires for policy change is shown in Table 2.15.

Table 2.15 Need For D.O.C. Policy Change

Province	BC	ALTA	SASK	MAN	ONT	QUE	NB	PEI	NS	NFLD	TOTAL
	%	%	%	%	%	%	%	%	%	%	%
yes	22	14	16	11	4	6	0	0	7	0	15
no	78	86	84	89	96	94	100	100	93	100	85

The greatest desire for change comes from the Pacific Region, (British Columbia), followed by users from Central Region (the prairie provinces) with a relatively low level from Ontario, Quebec and the Maritimes.

2.6.4.3 Industry Characteristics

All respondents in Finance, Insurance and Real Estate and Utilities and all except one respondent in Forestry and one in Fishing/Trapping saw no need for D.O.C. policy change. Between 10% and 30% of other industries expressed a desire for policy change.

2.6.5 Emergency Channel

2.6.5.1 Total Picture

On an overall basis 85% of users would favour the mandatory establishment of a land mobile emergency channel which would be continuously monitored, provided that it is technically feasible. The distribution of responses to question 23 is shown in tabular form in Appendix 3.

2.6.5.2 Regional Characteristics

Within the provinces, as shown in Table 2.16, support for an emergency channel is high except in Newfoundland. Except for Nova Scotia the few returns received from the maritime province do not constitute a good enough sample to support a conclusion on the basis of their responses alone. However the consistency of support from the other provinces suggests that the maritime users would be equally enthusiastic.

Table 2.16 Establishment of an Emergency Channel

Province	BC	ALTA	SASK	MAN	ONT	QUE	NB	PEI	NS	NFLD	TOTAL
	%	%	%	%	%	%	%	%	%	%	%
Favour Emergency Channel	87	87	87	82	65	76	83	100	71	40	85
Do Not Favour Emergency Channel	13	13	13	18	35	24	17	-	29	60	15

2.6.5.3 Industry Characteristics

Support for establishment of an emergency channel is generally strong in all industrial sectors and is unanimous in the case of Utilities and Fishing/Trapping.

2.6.6 Telephone Interconnection

2.6.6.1 Total Picture

The responses to question 24 on telephone interconnection are presented in tabular form by provinces and industries in Appendix 3. Table 2.17 below summarizes them by provinces. A full two-thirds of licensees now affirm that access to the public telephone network would be of value. This represents a significant shift from what was thought to be the level of demand for interconnection of mobile radio, 3 or 4 years ago.

Table 2.17 Desire for Telephone Interconnection by Provinces

Province	BC %	ALTA %	SASK %	MAN %	ONT %	QUE %	NB %	PEI %	NS %	NFLD %	TOTAL %
Interconnection Not Desired	28	53	40	44	48	35	25	0	28	33	34
Interconnection Desired	72	47	60	56	52	65	75	100	72	67	66
For all mobiles*	42	53	24	33	40	23	0	100	34	50	41
Selected mobiles*	45	39	52	42	50	54	100	0	44	0	59
All portables*	10	0	0	8	0	0	0	0	11	50	16
Selected portables*	3	8	24	17	10	23	0	0	11	0	84
In local calling area*	88	70	64	73	64	72	100	100	55	100	70
In other calling Areas*	50	39	17	36	33	35	0	100	45	100	34

* % of those who want interconnection.

The trend is consistent however with comments made publicly by F C C personnel earlier this year. Although the U.S. does not have any statistics, some mobile radio people have suggested that as much as 85% of U.S. mobile systems may already be interconnected.

2.6.6.2 Regional Characteristics

Alberta is the only province that showed a minority desiring interconnection. As in the case of other parameters, the samples from New Brunswick, Prince Edward Island and Newfoundland are too small to support a conclusion by themselves, but appear to be consistent with the trend in the other provinces.

Saskatchewan and Quebec users show the least but nevertheless significant interest in having telephone network access available to all mobiles. Generally more users want it for only selected mobiles. Only in British Columbia, Manitoba and Nova Scotia is there significant demonstrated interest in having all portables in a given system interconnected.

Most users want interconnection for the local calling area with the exception of Saskatchewan where 1/3 to 1/2 of them also want network access outside the local calling area.

2.6.6.3 Industry Characteristics

From the question 24 tables in Appendix 3, it is apparent that Construction and Finance, Insurance and Real Estate are almost unanimous in their desire for interconnection. Only a few Transportation and Fishing/Trapping users exhibit any demand for interconnection. The remaining industries exhibit a demand for interconnection in a reasonably consistent manner.

The number of users wanting interconnection of only selected mobiles tend to equal or exceed those wanting interconnection of all mobiles except in the utilities industry. The latter shows the interconnection of all mobiles as its overwhelming requirement.

Finance, Insurance and Real Estate and Communications show a greater number of users wanting other calling area access. The remaining industries, although predominantly wanting local network access appear to have a substantial desire to access the toll network as well.

Reticence is seen in some companies since firms do not want their vehicle drivers to be able to get into the commercial telephone systems on a local or long distance basis for personal calls.

2.6.7 Satellite Communications

2.6.7.1 Total Picture

At this point in time, most users do not envisage any benefit in satellite communications to link distant base stations. However, in every province and virtually every industry there is a small segment of about 15 to 25% of the users who say this would be beneficial.

It may well be that as satellite communications continues to develop, major terrestrial mobile systems will find increasing value in tying in to satellite channels.

This is because of the large spectrum channel capacity that exists through use of communications satellites. Narrow beamwidth ground antennas allow close angular spacing of satellites using the same frequency allocations without communications interference. Coexistence with surface communications is possible.

2.7 Non-Users

2.7.1 Knowledge of Mobile Radio

55% of the respondents in this 'non-user' category have at least some knowledge about such aspects of mobile radio as uses, availability, methods of operating etc. The extent of this knowledge was rated by the non-users as either mid-way between considerable and scant, or scant. Very few 'non-users' as anticipated, professed extensive knowledge of the field. As shown in Table 2.17 the largest number of non-users obtained its information from discussion with users. The next most important sources of information were 'other' (see below), followed by 'reading', and observing current users. Salesmen's visits, television and formal education accounted for only 16% of this knowledge.

Table 2.17 Sources of Knowledge Regarding Mobile Radio

Source	% Distribution
Reading	19
Salesman's Visit	10
Discussion with Users	27
Observing Current Users	18
Viewing TV	3
Formal Education (e.g. Armed Forces)	3
Other	21

'Other' sources of information were: (predominantly) present or past personal licensing of the person answering the questionnaire e.g. ship-to-shore on yachts, aircraft radio telephone licence; former business use of mobile radio; and self-education.

2.7.2 Applicability of Mobile Radio

Somewhat suprisingly, 55% of the respondents considered that mobile radio will, in future, be applicable to their business. Due to D.O.C. licensing methods these business 'non-users' (see Appendix 2 for sampling methodology) of mobile radio may in fact be using paging systems or GRS. In fact, amongst those who consider mobile radio to be applicable, 59% (of those that answered question 7) declared that they were now using some form of mobile radio. Of these, 70% use GRS and the rest paging receivers.

2.7.3 Technical Features of System

The distribution of number of mobile radios (in-vehicle & portables) is shown in Table 2.18. It is evident that most systems are either very small (1 radio)

Table 2.18 Distribution of Number of Mobile Radios

Number	% Distribution
1	31
2	15
3	15
more than 3	38

or tending to 'moderate' in size (greater than 3 radios). These distributions are reinforced by the general size statistics for the non-user industries surveyed. Shown below in Tables 2.19 and 2.20 are variations in number of employees and number of vehicles for the firms sampled.

Table 2.19 Distribution of Firms by Number of Employees

Number	% Distribution
1 - 5	40
5 - 10	20
10 - 15	-
Greater than 15	40

Table 2.20 Distribution of Non-User Firms by Number of Vehicles

Number	% Distribution
1 - 5	60
5 - 10	20
10 - 15	-
Greater than 15	20

The 'non-user' firms sampled tend to be either very small or moderate in size (greater than 15 employees). Summarising, most 'non-user' firms have less than 10 employees, deploy 5 or less vehicles and operate one (or possibly several) mobile radios. These companies are in the early stages of development (as suggested by the above results) and use paging or especially GRS because of the small initial outlay on the part of the company (as compared with private systems) and the speed with which they can be installed. This developmental nature is further emphasized by the low range requirements of these companies compared with business users of private systems (Section 2.5.4.1). Ranges in excess of 20 miles are not as commonplace (reasonable result for GRS and paging) for 'non-users', Table 2.20, as for business users.

Table 2.20 Distribution of 'Non-Users'
(using GRS & paging) by Range of Operation

Range in Miles	% Distribution
0 - 10	8
11 - 20	46
21 - 30	23
Greater than 30	23

Nearly one-third of the paging systems in use employed their own transmitter whilst, for 30% of the paging users, the service was rented from a telephone company. The remaining 40% rented their service from other sources.

2.7.4 Adequacy of System

62% of the 'unlicensed' users sampled considered their systems to be adequate. Complaints about paging involved criticism of the one-way nature of the service, two-way communication being preferred. GRS was accused of congestion and 'lack of courtesy' amongst users.

2.7.5 Change to System

Of considerable interest is the fact that many users of GRS or paging systems strongly contemplate changes in their system. The distribution of likelihood that additions to, or conversions from the system will occur is displayed in Table 2.21. These intended changes will be made either within the year or the next 5 years. These changes consist of moves from GRS to private, improvements in GRS service and moves to MTS (see Table 2.22 for intended categories of service).

Table 2.21 Likelihood of Changes

Likelihood	% Distribution
Definitely not	14
Unlikely	14
Likely	29
Definitely	43

The number of in-vehicle radios expected is shown in Table 2.23.

Table 2.22 Intended Category of Service

Category	% Distribution
GRS	40
MTS	20
S/S	-
Private	40

Table 2.23 Number of Mobile Radios in Vehicles

Number	% Distribution
1	40
2	-
3	40
Greater than 3	20

Table 2.23 would tend to suggest that the introduction of in-vehicle radio in the next year or 4 years following, will be (initially) on a tentative basis. That is, in accord with the developmental nature of many of the companies involved, only a small fraction of their fleet will be equipped, further expansion (in the new service category chosen) awaiting confirmation of the benefits to be accrued and expansion of the company. Personal portables are also to be included in small numbers.

Table 2.24 reinforces this suggestion in that most systems will use just one base station. No systems are intended for use with more than 3 base stations.

Table 2.24 Distribution of Systems By
Number of Base Stations Intended

Number	% Distribution
1	64
2	18
3	18
Greater than 3	--

An increment in range is anticipated in the new system compared with GRS and paging as evidenced by the desire for increased range of operation (Table 2.25).

Table 2.25 Intended Range of Operation

Range in Miles	% Distribution
1 - 10	--
11 - 20	16
21 - 30	33
Greater than 30	50

As might be expected for very small businesses these new systems will be used for dispatch purposes almost entirely. This is due to the more obvious benefits visible from efficient utilization of limited personnel. To this same end, no special features (as opposed to two-way voice communication) were desired by respondents.

2.7.6 Reasons for Not Using Mobile Radio

80% of all respondents have seriously given thought to the installation of a mobile radio system. Of these 80%, reasons why a radio system is not yet included in their company are:

1. Evaluation of the benefits to be gained is still in progress.
2. Cost is a major factor, particularly for the outlay necessary for private systems. These expenses, incurred by small companies, are not balanced by efficiency gains (e.g. for limited seasonal use).
3. Companies have just started out and have not yet had time to carry out installation.
4. Insufficient knowledge of available systems and services is widespread.

5. Inadequacies viz 'dead' zones, interference, limited range are known from radio users.

The respondents who considered cost to be a factor against the use of mobile radio were (almost unanimously) unable to decide upon an installation cost or monthly rental per station at which they would be willing to obtain a mobile radio system. The very few who suggested a price mentioned \$100.00 as a reasonable installation cost or \$30.00 monthly rental.

The probability of 'non-users' subscribing to a pocket or purse sized portable radio telephone is shown in Table 2.26. It noticed that over half the respondents considered radio-telephone use likely (if the cost were comparable to that of a conventional business telephone).

Table 2.26 Distribution of Respondents by
Probability of Radio Telephone Use

Probability	% Distribution
Def. not	13
Unlikely	30
Probable	30
Definite	26

2.7.7 General Comments by Non-Users

Many 'non-users' considered that great improvements have occurred in the mobile radio field in recent years. When expansion of a company to a certain size occurs, use of radio is anticipated. This is because present costs are prohibitive for firms just starting out.

Respondents felt that mobile radio was very useful and worthwhile but have not been able to come into contact with anyone who could advise in the purchase of suitable units. They felt that salesmen would naturally promote their own products which might easily not be to the customer's best advantage. Along this line, more knowledge (technical and legal) was sought after.

Respondents felt that radios can help prevent traffic accidents, report accidents and breakdowns especially when out of reach of a telephone.

Non-users were aware of the privacy problem ('stealing' of business calls) even on 'private' systems which they considered too expensive.

Technical complaints concerned lack of range, considering the necessity for future range of 30 miles and more, and the cost of the equipment. Respondents were also aware of problems of congestion especially at peak periods during the business day. One respondent discontinued his system in favour of the land-line telephone network. Another was worried about misuse of the radio and increased 'laziness' of his drivers upon installation.

2.8 Conclusion

The business and commercial sector, which comprises the largest number of land mobile radio licensees, has experienced explosive growth in the 70's. A significant number of users are already operating a second type of service such as paging, GRS, ship-to-shore or MTS in addition to their normal private two-way system. This trend appears likely to increase.

The recent heightened interest in C.B. in the U.S.A. appears to be spilling over into Canada. Historically many users have found both GRS and MTS unsatisfactory because of congested traffic and interference and have turned to private systems. This trend will probably accelerate.

Long distances, in excess of 40 miles radius are being achieved now by most systems, and more users are forecasting the need for greater distances in the next 5 years. This may well suggest the need for some other form of regional or nationwide service embodying the traditional fast access features of private dispatch, but having roaming characteristics more like MTS with emphasis on most main roads as well as into the more sparsely populated regions.

It appears that lower equipment costs could trigger an increase in the number of mobile radios within existing systems as well as stimulate demand for new systems.

The thirst for greater sophistication in equipment is quite evident and during the next five years or decade automatic vehicle identification and location is likely to become a great deal more commonplace. Other facilities such as in-car teletype, facsimile, slow scan television, computer access, will come into increasing use along with voice plus data. It seems unlikely however, that voice will cease to be the main medium of communications. There will probably, however, be increased demand for privacy or voice security, as businesses have greater need to transmit competitive information by mobile radio.

It does not appear that lower cost will be a major factor in stimulating the adoption of these new facilities.

The users are generally satisfied with D.O.C. policies but a small percentage would like to see some changes especially in the matters of E R P restrictions in remote areas and uniformity of policy between regions.

Demand for interconnection to the telephone network has reached major proportions with an apparent need to access both local exchanges and the toll network both from mobile radios and from a restricted group of portables.

Awareness of satellite communications possibilities seems to be strong with a fairly significant number of users sharing the opinion that it would benefit them if their geographically separated base stations could be linked through satellite service especially in the north or in areas where mountain ranges intervene.

Non-use of mobile radio in the business sector may be attributed to several causes. Chief amongst these is the cost/benefits aspect. Most of the non-user companies sampled are in the early 'developmental' stage and have either not had sufficient time to adequately evaluate their radio needs or have insufficient funding to warrant the increase in efficiency of a limited number of personnel.

Insufficient knowledge of available services and systems was another major reason. Most knowledge came from discussion with radio users rather than salesmen, formal education, television, etc. These companies would appreciate more personal advice from sources (D.O.C.?) other than mobile radio manufacturers' salesmen who were considered to be more interested in 'pushing their products' than in giving the company the 'best' advice.

The D.O.C. could form more information offices for members of the public, citizen's groups and D.O.C. licensees who seek information and assistance - a means by which the public can rapidly secure the right information from the right person within the D.O.C. More special sessions should also be held in district offices to greater familiarise both users and non-users with the mobile radio field and to allow open planning, with community participation.

Non-users are also aware of technical inadequacies in many systems, such as dead zones, interference, limitations in range, lack of privacy etc.

55% of these business non-users consider that mobile radio will be applicable in the near future (less than 5 years) upon expansion of their firm. Most will move to private and GRS, with some intent for MTS. Introduction of services will be on a tentative basis with 3 or less in-vehicle radios, one portable, and one base station. Ranges over 30 miles will often be required. These systems, featuring two-way voice communication only, will be used predominantly for dispatch.

CHAPTER 3

FEDERAL AND PROVINCIAL USERS

3.1 Introduction

This chapter summarizes the research carried out onto user characteristics and needs in federal and provincial departments through the country. In accordance with the objectives of the study (detailed in Appendix 2) topics discussed are the present status of mobile radio systems in use, their functions and historical development. Other characteristics such as size, technical features etc. are also dealt with. A section on future needs of this group of radio users is then included. Finally conclusions and recommendations are made on the basis of the preceding sections.

As in Chapter 2, because of the large quantity of information available from the study, discussion of each user characteristic is carried out at three levels. This, hopefully, allows the data to be assimilated more readily. Initially the total picture, that is for all federal and provincial government agencies combined is discussed. This overview is then broken down into its constituent parts: namely separation of federal from provincial, and then by departmental grouping. These groupings are chosen to maintain a sufficiently large size in each category and to prevent the number of departmental categories from becoming intractably large. These categories are:

1. Transportation: encompassing such activities as construction and maintenance of highways, public works, maintenance of vehicles, inter-department communication, control of vehicles in transportation services etc.
2. Natural Resources: including energy, minerals, mines, forestry, environment, fisheries and other marine communication.
3. Human Resources: such as education, health and welfare, recreation, etc.
4. Services and Urban Affairs: consisting of remaining departments such as administrative services, municipal, regional and international development programs, consumer affairs, public utilities, etc.

The results discussed in this chapter are based, to a large extent, upon the results of the survey, given in Appendix 3.

Discussion of federal and provincial law enforcement and public safety organisations is carried out in Chapter 4.

3.2 Present Status and Historical Development

3.2.1 Category of Service Used

3.2.1.1 Total Picture

The distribution of service category (see Appendix 1 for definitions) for all government (combined federal and provincial) is shown in the fourth column of Table 3.1. From this table, it is seen that 'private' systems are most prevalent (with 68% of all radio systems in the 'private' service category). This is as expected for basically large systems (see Section 3.4) with often 'adequate' funding (Section 3.5.4). 'Private' systems are followed in popularity by mobile telephone service (MTS), paging and ship to shore, in that order. These percentage distributions have been confirmed by a second request for similar information (question 3A, Appendix 3).

Table 3.1 Present Distribution of Systems by Service Category

Category of Service	Provincial %	Federal %	Total %
Paging	10	2	9
MTS	20	23	21
S/S	3	1	2
Total Private (includes GRS and RCCMRS)	66	74	68

The distribution of systems for all agencies when operation first began is shown in Table 3.2 (column 4) where it is seen that 'private' systems had a still larger share (79%) of the total than at present. Paging and MTS systems have taken over some of the functions initially handled by 'private' systems or have been introduced to cope with new agency requirements as the department develops. Of all the

Table 3.2 Initial distribution of Systems by Service Category

Category of Service	Provincial %	Federal %	Total %
Paging	-	-	-
MTS	14	33	17
S/S	5	-	5
GRS	5	25	9
RCCMRS	38	-	28
Private	38	42	42
Total		67	79
private			

'private' systems, restricted common carrier (RCCMRS) and especially general radio services (GRS) were less popular than (true) private systems. To gain some insight into this historical development the services used by departments in 1965 and 1970 were requested, and shown in columns 4 of Tables 3.3 and 3.4 respectively.

Table 3.3 Distribution of Systems by Service Category in 1965

Category of Service	Provincial %	Federal %	Total %
Paging	-	-	-
MTS	13	-	13
S/S	-	-	-
GRS	-	17	5
RCCMRS	25	-	18
Private	63	83	65
Total		100	88
Private		100	88

No trend towards more paging and MTS is detected over this 5 year period and it is concluded that a large number of radio

Table 3.4 Distribution of Systems by Service Category in 1970

Category of Service	Provincial %	Federal %	Total %
Paging	-	-	-
MTS	8	13	13
S/S	-	-	-
GRS	8	13	13
RCCMRS	46	-	29
Private	38	74	46
Total		87	88
Private		87	88

systems started after 1970, and that prior to 1970, departmental systems were fairly stable with mostly 'private' systems, some MTS and little or no paging. These hypotheses are supported by the distribution of years in which operation started (column 4 of Table 3.5) which shows that 45% of all systems in use

Table 3.5 Distribution of First Year of Licence

Year	Provincial %	Federal %	Total %
'50 or before	7	10	9
'51 - '55	7	-	2
'56 - '60	-	10	2
'61 - '65	11	33	22
'65 - '70	27	-	19
'71 - '75	48	48	45

started after 1970, and supports the claim that the trend towards MTS and paging (in the 'developmental stage' of a department's history) has started in the last 5 years. From Tables 3.2 to 3.4 it is also noticed that a move towards RCCMRS occurred before 1970 but has eased off since, and an initial trend towards GRS seems to have reversed itself in the 1970's.

The reason for branching out from private systems appears to be a general desire for more flexibility, that is the ability to transfer information to its destination by a variety of means, and with varying reliability. Growth rates of government radio systems in use are seen from Table 3.5 to be quite erratic, being a complex function of federal and provincial funding to the communications divisions of each department, which in turn depends (to an extent) upon public favour towards a certain department etc.

3.2.1.2 Federal and Provincial Categories

In this section, differences between federal and provincial agencies that cause deviations from the general conclusions reached in the preceding section are discussed. The present distributions of systems by service category are shown for provincial and federal departments in columns 2 and 3 of Table 3.1. This sharing of services is seen to be similar for both groups (and as described in Section 3.2.1.1). More paging is evidenced at the provincial level than at the federal. In this table (as in all tables) each of the 4 categories of department namely Transportation, Natural Resources, Human Resources, and Services and Urban Affairs, are given equal weighting in reaching the total percentage figures.

When operations first started (Table 3.2) federal departments used more MTS and GRS than provincial agencies which dedicated themselves to RCCMRS and private systems. Since the inception of these systems of mobile radio the differences have largely disappeared. Between 1965 and 1970 both federal and provincial government departments were very 'private' orientated (stable systems). Provincial departments again were involved with private, RCCMRS, and some MTS whereas federal institutions used private and GRS with a swing to MTS at the end of the period. This federal growth of MTS has continued to the present day, as it has for the provinces. The lack of use of RCCMRS in federal agencies initially and during the period 1965 to 1970 can be attributed more to policy decisions rather than the inability of this service to meet some of the requirements of federal agencies. This is considered likely due to the considerable popularity of restricted common carrier mobile radio systems at the provincial level.

3.2.1.3 Departmental Categories

Agencies classified under 'Human Resources' tend to use more paging equipment than the norm (question 1A, Appendix 3). This is due to the nature of their operations which do not require long, involved information transmission but rather, brief one-way signalling that contact with the office should be made. For example welfare officers would not require as much dispatching information as personnel involved in vehicle or highway maintenance. The probable small percentage of budget allocated for mobile communications would preclude expensive private systems. Similar comments may be made about the considerable use of MTS made by 'Services and Urban Affairs'. As expected, 'Transportation' and 'Natural Resources' use private systems due to their size (Section 3.4) and the importance attributed to this section of their operations. These four departmental categories started mainly on 'private' systems except for Services and Urban Affairs which got its start largely with MTS. This may be attributed in part to the year mobile radio operation started for these four categories (question 7A, Appendix 3). Services and Urban Affairs commenced radio operations at a later date (generally after 1966) than the other departments and thus could avail itself from the onset of 'newer' services such as MTS. For example a considerable proportion (10%) of Transportation Departments commenced mobile radio communications before 1950 using private radio equipment.

3.3 Uses of System

3.3.1 Total Picture

The uses to which the radio systems of federal and provincial agencies are put are examined in Table 3.6

Table 3.6 Distribution of Uses of Mobile Radio Systems

Use	Provincial %	Federal %	Total %
Dispatch	24	22	25
IWC	63	78	62
Educ Aids	-	-	-
AHC	7	-	7
Training	7	-	7

'Dispatch' is the function of informing mobile personnel where to proceed for the performance of their delegated tasks; e.g. for Transportation-to provide communications between dispatching and maintenance yards with mobile units in operation, to

-maintain public highways etc. Also dispatching for snow removal, landslides, road blocks, and similar emergency situations is affected.

Inter-worker communication (IWC) consists of all information transfer other than dispatch, for example position location, worker-worker and worker-public communication.

Educational Aids involves such purposes as transmission of recorded lessons (e.g. dictation of shorthand classes); Training consists of instructing technicians in the installation, operation and servicing of radio systems etc, and After-Hours Communication (AHC) involves any unscheduled use of the mobile units in other than regular hours.

As expected inter-worker communication and (to a lesser extent) dispatch far exceed the other categories of use (column 4). Thus to appreciably reduce spectrum congestion, any methods by which inter-worker communication could be reduced to the minimum, would be of paramount importance. This might involve increased urging to operators to keep conversations terse, number coding of frequently used messages (cf. 10 - system used by many police forces in North America), digital status messages etc.

3.3.2 Federal and Provincial Categories

As expected most regional and provincial educational and other training programs are handled by provincial agencies. Both provincial and federal institutions have IWC as the dominant use of the their systems.

3.3.3 Departmental Categories

Both Transportation and Natural Resources have IWC in prevalent use (question 2, Appendix 3), whereas Services and Urban Affairs makes great use of mobile radio for dispatch purposes. This may be appreciated in the light of the fact that this category (SUA) is greatly involved with the delivery of supplies inter-departmentally and also to other government agencies, as required. The prevalence of IWC in Transportation and Natural Resources seems reasonable from such activities as marine communication (Natural Resources) which uses radio for (a) messages of immediate urgency, (b) messages concerning the safety of a ship or person, or regarding navigation dangers, (c) ship-to-ship (for port operations and navigation etc), and (d) ship-shore (for port operations and operational messages). Human Resources, by definition, makes some use of radio for education and training purposes.

3.4 Size of System

3.4.1 Total Picture

The distribution of system size in terms of the total number of radios in use is illustrated in Table 3.7

Table 3.7 Distribution of System Size By Number of Radios

No. of Radios	Provincial %	Federal %	Total %
5 or less	32	-	28
6 - 20	7	33	20
21 - 100	40	50	36
101 - 500	8	-	4
501 - 1000	8	-	4
1001 - 2000	0	17	4
2001 - 5000	3	-	3
5001 - 10000	0	-	-

It is seen that the largest percentage (36%) of all systems have between 21 and 100 radios, and may be classed of moderate size (over the range encountered). Average system size is calculated as 89 radios per system. Less than 20% of all systems are larger than this whereas 48% of all department systems have 20 mobile radio units or less. For these mobile radio networks the number of base stations required will depend upon the technical sophistication of the system and the use to which it is put. For example with increasing departmental expansion the number of mobile units will rise but the proportionate rise in number of base stations may be restrained by the use of more advanced base station technology and techniques of operation. The variation in number of base stations required is shown in Table 3.8

Table 3.8 Variation in Number of Base Stations per System

No. Stations	Provincial %	Federal %	Total %
1	50	6	44
2 - 4	4	28	14
5 - 7	17	50	22
Greater than 7	29	17	14

In accordance with the fact that half of all departmental systems use 20 mobile units or less, nearly half (44%) of the radio systems require only one base station. Departments

using over 500 mobile radios in general require 7 or more base stations, whereas moderately sized (20-500 radios) systems tend to use between 5 and 7 stations.

The distribution of the quantity of radio repeaters in service is detailed in Table 3.9 where it is seen that the majority of systems use twenty radio repeater stations or more. From this we conclude that even departments with a small number of radios (less than 20) may still require ranges of operation comparable to those of some of the larger systems (see below, this section).

Table 3.9 Distribution of Number of Radio Repeaters

No. Repeaters	Provincial %	Federal %	Total %
1	22	50	29
2 - 10	11	25	13
11 - 20	-	-	-
Greater than 20	67	25	58

Other departments whether large or small, use just one repeater and their range of operation (and region over which they contribute to spectrum congestion) will be quite restricted.

In each system, the number of radio-equipped vehicles in departmental service is seen to be either 'small' (1-10 vehicles) or 'large' (greater than 30). The distributions (Table 3.10) are in general agreement with the variation in number of radios used in these systems (Table 3.7) and lend support to the validity of the data. For example 48% of government systems have 20 radios or less, in comparison with 53% of systems with 20 radio-equipped vehicles or less. Differences between these statistics are due to the addition

Table 3.10 Distribution of Number of Radio-Equipped Vehicles

Number	Provincial %	Federal %	Total %
1 - 10	53	17	49
11 - 20	-	33	4
21 - 30	9	-	4
Greater than 30	39	50	43

and distribution of personal portables in use (varying somewhat from that for 'fixed' mobile equipment). This distribution is given below in Table 3.11.

Table 3.11 Distribution of Number of Personal Portable Radios

Number	Provincial %	Federal %	Total %
1	-	-	-
2 - 10	48	28	48
11 - 20	31	11	18
Greater than 20	21	61	34

These portables will increase the number of radios per system throughout the range but particularly in the range of 20 radios or less. This is because a large proportion (66%) of mobile systems use less than 20 portable radios.

The range used by government agencies is a critical parameter in the search for new methods to alleviate interference, delays, etc. Range will become more and more a critical issue in frequency allocation policy and system type decisions. The distribution of coverage actually used by these departments is detailed in Table 3.12

Table 3.12 Range Used in Miles

Range	Provincial %	Federal %	Total %
10 or less	-	17	8
11 - 15	23	-	12
16 - 20	25	-	8
21 - 25	13	17	7
26 - 30	-	17	8
31 - 35	25	11	30
36 - 40	-	-	-
Greater than 40	15	39	26

It is seen that over half the systems (56%) operate at ranges which at times exceed 30 miles (greater than city wide if there located) and one quarter of the departments operate at over 40 miles maximum range. Very few systems (8%) operate with smaller than city-wide coverage (less than 10 miles). Ranges will depend upon the function of the individual department and will not in all cases correlate directly with system size.

Most of these systems operate on between 2 and 5 frequency channels as evidenced from the distributions of Table 3.13.

Table 3.13 Distribution by Number of Radio Channels

Number	Provincial %	Federal %	Total %
1	13	-	5
2	38	11	38
3 - 5	38	72	44
6 - 8	6	-	4
Greater than 8	6	17	8

Thus a typical system might operate between 20 and 100 radio units, require one base station (or less likely up to 7 depending upon system function), and employ just one repeater station. The number of radio-equipped vehicles is either less than 10 or considerably larger than 30 and number of portables either between 2 and 10 or greater than 20. These mobile radios operate on usually 4 channels and system coverage is very often 30 miles or more.

The development of mobile radio to these present characteristics is illuminated somewhat by the following tables. Average numbers of radio-equipped vehicles are shown below in Table 3.14 for start of operation, 1965 and 1970.

Table 3.14 Average Number of Radio-Equipped Vehicles per System

Time	Provincial	Federal	Total
Start	24	9	7
1965	34	15	14
1970	92	26	41

The average number at the start is one-half the figure for 1965 and one-sixth that for 1970. This suggests that systems licensed before 1965 started out with a very few vehicles increasing in number by an order of magnitude to the present day. Departments with systems licensed after 1970 (45%) also appear to have started with just a few vehicles due to the tentative, slow introduction of this unproven new facility in the government agency (Human Resources and Services and Urban Affairs). Accurate estimates by departments without much previous experience in this area of the amount of mobile equipment needed are difficult to make even with advice from departments with long standing in mobile radio.

The average numbers of personal portables for these three times are shown in Table 3.15 below, where it is seen that the ratio of personal portables to radio-equipped vehicles

has increased from 1 to 1 towards 2 to 1 between 1965 and 1970. This trend towards portables is still in effect, due to their greater adaptability (multi-purpose use).

Table 3.15 Average Number of Portable Radios per System

Time	Provincial	Federal	Total
Start	20	11	15
1965	18	21	18
1970	69	33	53

3.4.2 Federal and Provincial Categories

From Table 3.7 it is observed that while both federal and provincial agencies have systems with mostly between 20 and 100 radios, many more provincial departments (32% compared with less than 1% for federal) have very small systems with five radios or less. This may be attributed to the generally larger and wide-ranging nature of federal (as compared to provincial) departments. These findings are endorsed by the distribution of base stations (Table 3.8) - provincial departments tend to communications networks that are either large (greater than 5 base stations) or very small (50% with only one station). Federal organisations, on the other hand, tend to systems with 5 to 7 base stations. Provincial departments also have either a large (greater than 30) number of radio-equipped vehicles or a small number (less than 10). Federal departments tend to a larger number of equipped vehicles and portable radios (Tables 3.10 and 3.11), and also frequency channels (Table 3.13).

Federal departments have considerably fewer systems with 10 or more repeaters compared with those at the provincial level, with however considerably more demand for range in excess of 40 miles, indicating considerable difference in equipment details between provincial and federal departments. This is hinted at by the low percentage of RCCMRS use in federal agencies. Technical differences between these agencies is discussed further in Section 3.5.1.2.

The distribution of range (Table 3.12) indicates that a fair proportion of federal systems is for intra-city (centre) only (less than 10 miles) whereas for provincial agencies coverage in the order of twenty miles from the base station is required. These regional systems have mostly till now operated as separate entities. In some cases, there is a desire for an overall (province-wide) radio system tying all these other systems together, while in others (depending upon departmental category) there seems to be very little need.

3.4.3 Departmental Categories

As expected, Transportation departments have the largest size in terms of number of radios in use, with systems with up to 2000 radios (question 1B, Appendix 3). Although smaller in general, some Natural Resources departments, such as forestry, are also of this magnitude. Human Resources and Services and Urban Affairs have usually less than 100 radios per system. In accordance with these sizes, Transportation agencies have many systems with over 7 base stations, National Resources have many with either 5 to 7 (e.g. forestry) or just one (e.g. environment), while Human Resources and Services and Urban Affairs have generally less than 5 base stations per system.

Transportation and Natural Resources departments have three-quarters of their systems with 20 or more repeaters (for example to adequately cover the rugged terrain found in forestry protection work), whereas other departmental categories use just one or between 2 and 10 radio repeaters. Continuing with this general trend, Transportation systems are endowed with more than 30 radio-equipped vehicles, for the most part, while Natural Resources has either a large number (greater than 30) or a small number (between one and 10). Human Resources and Services and Urban Affairs systems have less than 10 vehicles apiece, except for agencies dealing in delivery of supplies etc. Due to their versatility, especially over rough ground, the ratio of portables to radio-equipped vehicles is on the increase. At present Transportation and Natural Resources have either between two and 10 or considerably over twenty and the other departments, because of their recent development have been able to make immediate good use of this facility. The use of portables is expected to increase in all sectors, both of general and 'special purpose' (e.g. as worn by firefighters). This increase would be accelerated rapidly by the advent of in-vehicle radio units with capability for effective operation as an automatic repeater.

Due to the often unplanned, wide-ranging nature of their activities, Transportation and Natural Resources frequently require ranges of over 40 miles. Human Resources and Services and Urban Affairs, on the other hand, usually travel within an urban region and have smaller range requirements.

Modern private systems have usually multi-channel capability and this facility is used in all categories. The largest systems in Transportation use over 8 channels but in general (for all departments) 3 to 5 channels are employed.

From questions 7C and D, Appendix 3, it is seen that Transportation and Natural Resources used more vehicles at their start

of operation, 1965, and 1970 than the other departments, as anticipated. Similar comments hold for the number of personal portable two-way radios at these three times. For greater detail of distributions the reader is referred to the Appendix.

3.5. Technical Features

To investigate whether government agencies have made use of their potential to introduce more sophisticated communications networks than the individual business users of Chapter 2, a number of technical features of their government systems are discussed below. These topics help throw some light on the hypothesis made (Section 3.4.2) that the technical aspects of federal and provincial radio systems differ considerably.

3.5.1 Frequency Band Used

3.5.1.1 Total Picture

The distribution of radio systems by frequency band used is given in Table 3.16.

Table 3.16 Distribution of Radio System by Frequency Band in Use

Frequency	Provincial %	Federal %	Total %
HF	8	7	10
LB VHF	21	15	25
HB VHF	71	72	61
UHF	-	7	3

Very little swing towards UHF from the popular high band VHF channels is evidenced from this table. This may be understood on the basis of user satisfaction (Section 3.5.4) where nearly 70% of the respondents considered their system adequate. Very few complaints about congestion in the VHF bands were made, the main criticism about 'private' systems was the amount of atmospheric interference, particularly in Northern communications. To a large extent the HF band has now been abandoned. This shift away from lower frequencies is illustrated in Table 3.17 for the start of operation, 1965 and 1970.

Table 3.17 Distribution of Systems by Frequency at Start, 1965 and 1970

Frequency	Provincial %			Federal %			Total %		
HF	13	33	33	50	50	50	25	50	50
LB VHF	25	33	-	17	17	12	23	6	5
HB VHF	63	33	67	33	33	38	53	44	45
UHF	-	-	-	-	-	-	-	-	-
	Start	'65	'70	Start	'65	'70	Start	'65	'70

From the 'total' columns it is seen that the great increase in high band VHF has occurred largely since 1970, departments starting their systems since 1970 going directly into this band (seen from the higher percentage of high band users in the 'start' column). What little use of UHF there is has been implemented since 1970.

3.5.1.2 Federal and Provincial Categories

From Table 3.16 it is seen that the distributions for federal and provincial agencies are very similar, with however most UHF systems deployed by federal departments. The static picture described in the section above during the period 1965 to 1970 holds true for federal systems (Table 3.17). Provincial agencies with systems introduced before 1965 seem to have responded more quickly to the advantages to be had from VHF radio, installing these new systems before 1970 in many cases. This faster response to technical innovation may have been due, in part, to the smaller size (Section 3.4.2) of provincial departments (in terms of radio), thus involving lower costs in change of equipment.

Initially more provincial than federal departments started out on high band VHF equipment. This is due to the fact that provincial departments developed their communications networks rather later than federal agencies 25% before 1965 compared with 53% for federal (Table 3.5, Section 3.2.1.1). This faster response, as also evidenced between 1965 and 1970, appears to be due more to factors such as size, year operation started etc. rather than any greater awareness on the part of the provinces with regards to technical improvement of their systems.

3.5.1.3 Departmental Categories

All agencies tend to follow the general frequency distributions outlined above, though marine communication (among the first users of mobile radio) still uses low frequency equipment which will carry over longer distances than FM VHF equipment. Fading in this HF band could be countered by error correcting codes and frequency diversity techniques. 'Pioneer' work in the UHF band has been carried out entirely in Transportation and Natural Resources departments (for those departments sampled), with satisfaction expressed regarding most technical aspects except range. Insufficient response to question 7G, Appendix 3 prevents 'reliable' breakdown of the historical development of this frequency usage.

3.5.2 Minutes of Air Time

3.5.2.1 Total Picture

The average number of minutes of 'air time' per hour used through the day, Monday to Friday, Saturday, Sundays, and statutory holidays is shown in Table 3.18.

Table 3.18 Average Number of Minutes Air Time Per Hour

	Periods through the day						
	0-7	7-10	10-12	12-15	15-18	18-24	
Provincial	3	24	22	18	17	8	Mon. to Fri.
Federal	8	27	17	17	30	6	
Total	5	22	20	16	19	9	
Provincial	5	7	6	5	6	6	Saturday
Federal	5	8	5	6	8	5	
Total	4	7	6	6	7	5	
Provincial	4	6	5	5	6	6	Sunday
Federal	8	6	3	6	6	5	
Total	5	6	4	5	6	5	
Provincial	7	8	6	5	7	10	Statutory Holidays
Federal	3	3	3	3	3	3	
Total	6	7	6	5	6	8	

As expected, air time used is greater on Monday to Friday than at other times, with the usual morning and afternoon peaks of 22 minutes per hour and 19 minutes per hour between 7 and 10 a.m. and 3 and 6 p.m. respectively. At other times the level of usage is relatively constant at about 5 minutes per hour, no appreciable difference being noted between traffic on Saturday, Sunday and statutory holidays. This decrease from weekly rates could be utilized by reassignment of channels (at weekends and statutory holidays) for various essential services such as emergency repair of highways, continuous supervision of natural resources etc. as well as public safety organisations such as police, fire and ambulance. This important class of users could utilise channels vacated by business and government agencies at weekends, relieving present and future congestion. Transfer of communications requirements to the weekend and the night period from 6 p.m. to 7 a.m. whenever possible would also help the situation.

3.5.2.2 Federal and Provincial Categories

Usage patterns are very similar for both federal and provincial with a rather higher rate for federal institutions between 3 and 6 p.m. on weekdays. Provincial departments appear to communicate more on statutory holidays (Table 3.18). This is due to the higher use of provincial facilities e.g. parks and highways during the holiday period by the general public (see Section 3.5.2.3).

3.5.2.3 Departmental Categories

Transportation and Services and Urban Affairs have the highest levels of usage with morning and afternoon peaks of 30 and 21 minutes for Transportation and 41 and 33 minutes for Services and Urban Affairs (Mon. - Fri.). This large amount of information transfer is due to the commuter and 'business' orientation of these departments, as shown by the morning and afternoon radio traffic peaks. These maxima are not present in Natural and Human Resource Departments. During weekends and particularly on statutory holidays National Resource usage is high (in parks and other provincial facilities), being above 10 minutes in the hour at times (see question 6, Appendix 3 for more detailed results). Some seasonal loading was mentioned in the replies received, especially for Transportation and Natural Resources.

3.5.3 Time Spent on Operations, Administration and Public Service

3.5.3.1 Total Picture

The distribution of air-time devoted to operations (see definitions, Appendix 1) is laid out in Table 3.19.

Table 3.19 Distribution of Air Time Dedicated to Operations

% of Air Time	Provincial %	Federal %	Total %
0-20	-	11	4
21-40	13	-	8
41-60	22	-	17
61-80	17	28	23
81-100	48	61	46

As expected from the definition for operations this function takes up a large percentage of air time. Nearly half the systems spend over 80% of their air time on operations. The distribution of air time used for administrative purposes (see definitions, Appendix 1) is given in Table 3.20 where, in accord with the findings above, three-quarters of all department radio systems spend less than 40% of their radio time on this function.

Table 3.20 Distribution of Air Time Dedicated to Administration

% of Air Time	Provincial %	Federal %	Total %
0-20	42	17	25
21-40	29	67	41
41-60	29	-	27
61-80	-	-	-
81-100	-	17	8

The distribution of air time devoted to public service (see definitions, Appendix 1) is described by Table 3.21 below, with anticipated weighting towards little or no public service

Table 3.21 Distribution of Air Time Dedicated to Public Service

% of Air Time	Provincial %	Federal %	Total %
0-20	50	50	58
21-40	33	50	33
41-60	17	-	8
61-80	-	-	-
81-100	-	-	-

by the majority of government departments.

3.5.3.2 Federal and Provincial Categories

Federal agencies lean more towards operational aspects than do provincial departments (Tables 3.19 and 3.20). This may be caused, to an extent, by the more service conscious attitude of provincial agencies towards detailed public needs particularly in their vicinity, as compared to the (of necessity) more remote, all-encompassing nature of federal departments. This view is supported by the fact that some provincial departments spend up to 60% of air time for public service whereas no federal institutions use more than 40% of their air time on this function.

3.5.3.3 Departmental Categories

By their nature Transportation and Natural Resource departments were expected to spend more time on operations than other departments. This is borne out by the detailed distributions of question 5, Appendix 3. For example 55% of Transportation and 66% of Natural Resource departments spent over 80% of their time on operations compared with 33% for Human Resources and Services and Urban Affairs. It is also noted that Services and Urban Affairs departments may spend up to 60% of air time on public service, expectedly more so than for the other groupings, since not many people look to Transportation and Natural Resource agencies for their communications needs except in an emergency.

3.5.4 Adequacy of System

A large proportion (68%) of the respondents considered their system to be adequate. Complaints that were received are discussed briefly below in terms of the service category used. The reader is referred to Chapter 2 for more detailed discussion.

3.5.4.1 Private Service

Most complaints about this service came from Transportation and Natural Resource departments at the provincial level, due to the stringent demands placed upon a communication system for use in these fields. The largest percentage of 'technical' grievances was concerned with poor radio communication due to atmospherics etc, particularly in Northern regions. Insufficient provincial funding was also cited as a reason for inefficient radio communication (lack of base station facilities etc.) and hence poor service to the public.

3.5.4.2 General Radio Service

As for business and commercial users, many complaints about local interference (e.g. other users and television) were made. In addition to the crowding problems, there are difficulties in propagation at ~27MHz. Because of reflections from the ionosphere, long distance interference (e.g. from the U.S.) occurs frequently on the GRS band, with the result that communication frequently cannot be conducted when desired, and may be interrupted without warning. The reader is referred to Section 2.5.5 for further discussions on GRS failings. GRS use was mostly found in Transportation agencies.

3.5.4.3 Restricted Common Carrier Mobile Radio Service

This service, used predominantly in Natural Resource departments, is subject to similar criticism as private systems regarding poor radio communication due to atmospheric disturbance, low coverage (due to an inadequate relay system etc.) etc.

3.5.4.4 Mobile Telephone Service

Natural Resource departments consider MTS to be inadequate (poor coverage) especially in the isolated areas in which they must often operate. As in Chapter 2 the delay (or near impossibility) of accessing a channel is deemed a major reason for disfavour with this service. Unfortunately none of the respondents made mention of the average maximum waiting time they would be prepared to wait to access a channel.

3.5.4.5 Conclusions

In spite of the fact that these departments are undergoing continued expansion (in number of radios and area of coverage), conversion and improvement, a considerable degree of satisfaction exists, except in Transportation and Natural Resources. The trend appears to be towards integral regional systems with no need for contact between regional offices except via the central office. Little demand is seen for talk to the mobile unit itself from the central headquarters, but only from the district office.

As opposed to the business and commercial sector, no complaints were received concerning eavesdropping, shortage of channels (except MTS) or about equipment maintenance. No feeling was expressed towards greater use of mobile radio by the general public for example for survival radio, park radio telephones etc., or for interconnection with land telephone lines.

3.5.5 Facilities Provided

3.5.5.1 Total Picture

The only facility provided by nearly all the departments was standard voice transmission. Only in Natural Resources was any other type of transmission supplied. This department uses telemetry and remote control of equipment for recording weather parameters in remote locations.

The distribution of type of signalling used is shown in Table 3.22.

Table 3.22 Distribution of Type of Signalling

Type	Provincial %	Federal %	Total %
Voice	76	55	73
Individual Selective Call	18	45	25
Group Call	6	-	2
Other	-	-	-

The majority (73%) of systems employ just voice signalling. No desire for other types was expressed by respondents who just had this one signalling method. Little or no use of group call signalling was found. This lack of desire for individual selective and group calling may be understood from user satisfaction with their system in that little congestion of radio traffic was noted.

3.5.5.2 Federal and Provincial Categories

Federal agencies are seen to use more selective (individual and group) calling than provincial agencies. This is probably due somewhat to the considerably larger funding available to federal agencies for sophisticated equipment, and detailed aspects of operational behaviour (such as type of personnel to be contacted, their function etc.).

3.5.5.3 Departmental Categories

More use of selective calling is made by Transportation, Human Resources, and Services and Urban Affairs than by Natural Resources. Services and Urban Affairs systems, developed later than Transportation and Natural Resources, has had the chance to develop a group call facility (see question 3J, Appendix 3).

3.6 Future Needs

3.6.1 Future Incorporation of Technical Facilities

3.6.1.1 Total Picture

In the questionnaire a number of facilities were listed and described (see Appendix 1) that are technically feasible at present. Of these facilities, it was found that those in present use are facsimile, teletype (hard copy), use of data terminals, individual selective signalling and selected group signalling. Percentages of departments with these facilities are shown in Table 3.23. Facsimile and teletype are seen to be more popular than data terminals, while individual selective calling is considerably more in favour than group call, in agreement with the results of the last section. It is of significance that none of the departments without a facility had any information upon its benefits, cost etc. with which to reach an informed decision as to its incorporation. In general these departments considered it unlikely that the features would be added, but were reluctant to commit themselves to a time frame concerning this decision. Of those departments that expected the facilities, active use was anticipated in the next 5 years rather than later. The features most likely to be incorporated were individual selective signalling, group signalling, automatic vehicle identification (AVI), and automatic vehicle location (AVL).

3.6.1.2 Federal and Provincial Categories

Of these facilities in use now, federal departments make more use of facsimile, individual and group calling, and less use of teletype and data terminals than provincial departments (Table 3.23). For future needs provincial institutions are keener on teletype, slow scan television and group calling, but less in favour of data terminal, computer assisted dispatch (CAD), computer input from vehicle (CIV), computer retrieval from vehicle (CRV), and automatic vehicle location (AVL) than federal departments.

3.6.1.3 Departmental Categories

Transportation and Human Resources departments make some use of facsimile (as compared to none for Natural Resources and Services and Urban Affairs). Teletype is employed by Transportation and Natural Resources. Human Resources is the only department to avail itself of data terminal facilities, whilst Services and Urban Affairs and Transportation were the only departments to avail themselves of selective calling. No clear group policy is evident from the above results (Sections 3.6.1.1 to 3.6.1.3). This is supported by the results for

Table 3.23 Incorporation of Technical Facilities

	FACSIMILE			TELETYPE			DATA TERMINAL		
	Prov %	Fed %	Tot %	Prov %	Fed %	Tot %	Prov %	Fed %	Tot %
In System Now	-	33	18	17	10	13	8	-	8
Not in System	100	66	82	83	90	87	92	100	92
Info. on Facility	-	-	-	-	-	-	-	-	-
No info.	100	-	100	100	-	100	100	-	100
Incorporation ?									
Def. not	50	25	29	-	25	8	25	25	17
Unlikely	46	75	67	75	75	83	75	50	75
Undecided	4	-	4	-	-	-	-	-	-
Likely	-	-	-	25	-	8	-	25	8
Incorporation ?									
Next 5 years	-	-	-	100	-	100	-	100	100
Later	-	-	-	-	-	-	100	-	-

Table 3.23 cont'd

	SLOW SCAN TV			CAD (E)			CIV (F)		
	Prov %	Fed %	Tot %	Prov %	Fed %	Tot %	Prov %	Fed %	Tot %
In System Now	-	-	-	-	-	-	-	-	-
Not in System	100	100	100	100	100	100	100	100	100
Info. on Facility	-	-	-	-	-	-	-	-	-
No info.	100	-	100	100	-	100	100	100	100
Incorporation ?									
Def. not	25	58	27	25	58	27	25	58	27
Unlikely	68	42	66	75	17	65	75	17	65
Undecided	3	-	3	-	-	-	-	-	-
Likely	3	-	3	-	25	8	-	25	8
Incorporation ?									
Next 5 years	100	-	100	-	100	100	-	100	100
Later	-	-	-	-	-	-	-	-	-

Table 3.23 cont'd

	CRV (G)			INDIV. SIGNAL			GROUP CALL		
	Prov %	Fed %	Tot %	Prov %	Fed %	Tot %	Prov %	Fed %	Tot %
In System Now	-	-	-	25	58	23	-	25	9
Not in System	100	100	100	75	42	77	100	75	91
Info. on Facility	-	-	-	-	-	-	-	-	-
No info.	100	100	100	100	-	100	100	-	100
Incorporation ?									
Def. not	25	58	27	-	50	8	-	42	17
Unlikely	75	17	65	83	-	67	28	17	29
Undecided	-	-	-	17	50	25	39	17	38
Likely	-	25	8	-	-	-	33	25	17
Incorporation ?									
Next 5 years	-	100	100	-	-	-	100	100	100
Later	-	-	-	-	-	-	-	-	-

Table 3.23 cont'd

	AVI (J)			AVL (K)		
	Prov %	Fed %	Tot %	Prov %	Fed %	Tot %
In System Now	-	-	-	-	-	-
Not in System	100	100	100	100	100	100
Info. on Facility	-	-	-	-	-	-
No info.	100	-	100	100	100	100
Incorporation ?						
Def. not	13	58	23	25	50	23
Unlikely	71	-	57	63	-	55
Undecided	17	17	14	13	33	17
Likely	-	25	6	-	17	7
Incorporation ?						
Next 5 years	-	100	100	-	100	100
Later	-	-	-	-	-	-

probability of incorporation. For example facsimile is considered very unlikely for use in the Transportation business (question 9A, Appendix 3) however this facility has been chosen for use by this department in the past. This lack of direction is further emphasized by the lack of information in most departments on these facilities. A need for these facilities, especially data transmission, has been identified from the results (detailed in Appendix 3) but this need has not been well-identified by the potential user (that is not channeled into a specific direction). For example Natural Resources could use facsimile to transmit maps from base to mobile. However this would take a long time for a high quality copy, and some study is required before a decision as to a facility's suitability for a specific purpose can be made.

From the questionnaire, very few needs other than those mentioned above were put forward. For example no push was evidenced for digital communication (due to lack of complaints about privacy, spectrum congestion etc.) present voice transmission techniques being seen as adequate for some time to come. No need was seen for cellular systems (to alleviate congestion) or any other recent sophisticated communication techniques. Nor were other more detailed suggestions put forward. For example no mention was made by Transportation departments for some highway communication scheme for general public use. This is possibly due to practical problems such as funding, manning of bases, maintenance of repeaters, getting the radios into vehicles etc.

3.6.2 Equipment Costs

Response for information as to purchase cost or monthly rental at which the facilities enumerated above would cease to be worth having was very poorly answered. This is due to the lack of information respondents had as to the usefulness of the facilities offered, complexities of departmental budgeting etc. The very few replies that were obtained showed no general pattern as to what a reasonable price might be.

3.6.3 Departmental Sharing and Control

Response to the delicate issue of departmental sharing and control was, somewhat understandably, rather poor. Of the answered questions, 40% shared their system, federal and provincial departments showing no difference. Federal departments of Natural Resources and Services and Urban Affairs 'admitted' to sharing their system, in the case of Natural Resources with provincial Transportation agencies (Transportation originating the system) and for Services and Urban Affairs, undisclosed. Provincial Transportation and Natural Resources

organisations shared their systems, often, in the case of both departments, with police forces who monitor their frequencies (Transportation originating). Some provincial Natural Resources departments were also found to share their facilities with Services and Urban Affairs (NR originating), and with regional municipalities (these municipalities starting the system). Another Natural Resources provincial department shared its equipment with any other department which required this facility (link to the system being by telephone line). This system was originated and coordinated by a telephone company. A provincial NR department shared its facility with a territorial government.

The provincial NR department sharing with SUA (discussed above) was subject to guidelines by this latter agency. A provincial HR department was 'controlled' by the Transportation department of that province.

These findings agree with previous patterns. Transportation and, to a lesser extent, Natural Resources departments initiated their systems early on and have developed into large, fairly sophisticated systems. Other departments entering into mobile communications may often avail themselves of this established service particularly if their needs are small and funding low. Although some federal/provincial sharing is seen, these agencies will often operate separate systems in the same area. It should be feasible to combine more systems, especially those that now have their mobile units of each agency monitoring the other's transmissions for coordination. However each department would have to receive their own transmissions on a priority channel.

3.6.4 Department of Communications Policy

Satisfaction in federal communications policy was in general expressed, with 100% satisfaction from federal agencies. 83% of all provincial governments considered change in regulations unnecessary. These figures may be overly complimentary due to the hesitation of many (provincial) departments to enter into debate into such topical matters. Knowledge of D.O.C. objectives and jurisdiction is also considered meagre in the light of the small amount of constructive suggestions and criticism obtained. The few suggestions that were received complained largely about GRS, with regards to border policy with the U.S.A. (no greater details given) and active urging to restrict the use of illegal high power GRS transmitters. One government employee however expressed the wish to talk to other GRS stations 'regardless of location', and also double the power of GRS units (amplitude modulation and single side band) to get better coverage in isolated areas.

A Human Resources department suggested 'elimination' of regulations for transmissions for learning laboratories (dictation and language for example).

This lack of response is also probably due to the personnel answering the questionnaire being unaware of their department's overall policies and how they interact with D.O.C. regulations. For example communications division personnel of government departments might well be unaware that environmental protection policies viz antennas, and other communications facilities in wilderness areas and other areas of special value were contemplated (if indeed they are) by Natural Resources departments. Or that for example a national weather warning system to drivers, hikers etc. was envisaged by Transportation (hypothetical). Any extensive application of conventional radio communication methods for use by the public on highways would further complicate spectrum utilization and interference problems, but the potential value of electronic communication methods on highways is very great.

3.6.5 Emergency Channel

Question 17, Appendix 3 shows that 78% of all departments questioned were in favour of the establishment of an emergency channel, distributed evenly between federal and provincial respondents. The reader is referred to the questionnaire, Appendix 1 for a further description of this 'offered' feature. Services and Urban Affairs understandably are not overly enthusiastic about this development, their operations being largely city-based. Natural and Human Resources, on the other hand are overwhelmingly enthusiastic about this emergency channel. Somewhat surprisingly 40% of the Transportation departments questioned were not in favour of this service. This may be due to the fear that emergency service would remove them from their primary function.

3.6.6 Satellite Communications

For geographically separated mobile radio systems, 55% of the departments did not envisage any benefits to be gained through linking of these systems by means of an earth satellite communications facility. 45% of respondents considered this system beneficial and no government organizations had this facility already in use. Federal departments considered this service somewhat more useful than did provincial agencies, in spite of the ability of satellites to assist in province-wide communication as well as in nation-wide coverage. As anticipated, Natural Resource departments were most in favour of coordination of their large systems on a province-wide basis. They considered that the facility would reduce atmospheric disturbances rendering their information transmission more reliable. Large geographic distances to be carried in the north, coupled with low population densities, create communications systems design problems not normally encountered in more populated areas. Thus as systems are enlarged to cover entire provinces, use of satellites is widely envisaged as an

aid to communication. Transportation departments considered that this facility would lead to 'more efficient communications' but were not specific other than mentioning that earth satellites could replace some or all of a large number of base and repeater stations. Services and Urban Affairs, by their very nature not concerned with entire coverage of the province or precise 'immediate' coordination, were not in favour of the suggestion.

3.7 Conclusions

A summary of the results discussed in this chapter is given below.

1. 'Private' systems (including GRS and RCCMRS) are most prevalent in federal and provincial departments, followed by MTS, paging and finally ship-to-shore. Initially these 'private' mobile radio systems had a larger hold on the service 'market', however paging and MTS systems have taken over some of these functions in recent (last 5) years. Of these 'private' systems, RCCMRS and GRS were and still are less popular than true private systems. It may thus be most profitable to focus attention upon the problems of private users in this sector..
2. A large proportion of these radio systems started out after 1970 and, prior to 1970, departmental radio systems were fairly stable (no change in service). An initial trend towards GRS seems to have reversed itself in the 70's, and a move towards RCCMRS occurred before 1970 but has eased off since.
3. Inter-worker communication and then dispatch far exceed any other categories of use.
4. Mobile systems in general operate between 20 and 100 radios (average of 89 radios per system), or sometimes with less than 20 units. These small systems use just one base station, whereas the moderately sized systems use between 5 and 7. Systems use either one repeater station or (the majority) twenty or more radio repeaters. 66% of these departments deploy less than 20 personal portable radios. Over half the systems operate at ranges which at times exceed 30 miles and one-quarter of the departments operate at over 40 miles maximum range. Very few communications networks require less than 10 miles range. Nearly all (except the few very large systems) use between 2 and 5 frequency channels.

5. An increase in the use of personal portables is envisaged, especially if a satisfactory automatic in-vehicle repeater radio were developed.
6. Very little swing towards the UHF band is noticed, due to the considered adequacy of presently popular high band VHF systems. The HF band has all but been abandoned in favour of VHF.
7. Air time is expectedly greater on Monday to Fridays with morning and afternoon peaks of 22 and 19 minutes in the hour between 7 and 10 a.m. and between 3 and 6 p.m., respectively. At other times (weekends and statutory holidays) the level of usage is relatively constant at approximately 5 minutes per hour. Reallocation of federal and provincial frequency channels to essential services e.g. police at weekends could alleviate congestion in these services.
8. This air time is spent largely upon 'operations', some on 'administration' and the very small remainder on 'public service'.
9. In general a high degree (68%) of satisfaction was felt in the radio equipment presently in use. Private systems were criticised on account of poor communications service in remote Northern regions and insufficient provincial funding for these sophisticated systems. Complaints concerning GRS followed exactly the type detailed in Chapter 2 whilst RCCMRS suffered from similar complaints as for private systems. The 'usual' complaints about MTS were voiced, namely poor coverage, especially in rural areas, and delay in accessing a channel.
10. The only type of information transfer in general use is voice transmission, very little telemetry, remote control etc. being found. The majority of systems also used voice signalling, no strong future need for other types being expressed.
11. The only facilities in present use are facsimile, teletype, data terminal, individual selective and selected group signalling. Departments in which these and other facilities were not implemented had no information on these topics and considered it unlikely that these facilities would be introduced, except possibly for individual selective and selected group signalling, automatic vehicle identification and location.
12. 40% of the departments that answered this question shared their system with another agency. Although some federal-provincial sharing is seen, these departments will often operate separate systems in the same area.

13. As in 12 above many departments declined to answer enquiries concerning user satisfaction with D.O.C. policy. Of those that replied, satisfaction was, in general, expressed. In addition knowledge of D.O.C. activities in depth is considered small in the light of the low response.
14. 78% of the departments questionned were in favour of the establishment of an emergency channel.
15. Departments appeared split as to the benefits of earth satellite communications. No satellite systems were in use in the departments sampled.

CHAPTER 4

MUNICIPAL USERS

4.1 Introduction

This chapter describes user characteristics and needs in municipal departments through the country. Following the objectives of the study (described in Appendix 2) subjects dealt with are the present status of mobile radio systems in use, their functions and historical development. Other characteristics such as size, technical features etc. are also discussed. A section on future needs of this group of radio users is then included and finally conclusions and recommendations are made on the basis of the preceding sections.

As before, these topics are discussed at three levels, total, regional, and departmental. To maintain a sufficient sample in each category, the geographical regions chosen were B.C., Prairies (Alberta, Saskatchewan and Manitoba), Ontario, Quebec, and the Maritimes (New Brunswick, Prince Edward Island, Nova Scotia, and Newfoundland and Labrador). Municipal categories chosen are those in general use e.g. police, fire, parks, engineering, transit, roads and public works, and utilities. The results discussed in this chapter are based, to a degree, upon the results of the survey, given in Appendix 3.

4.2 Present Status and Historical Development

4.2.1 Category of Service Used

92% of the municipal agencies sampled (192 departments) have mobile radio systems. This high percentage justifies, to an extent, the method of sampling chosen in this category (see Appendix 2). The distribution of service category for all municipal agencies (and all geographical regions combined) is shown in Table 4.1. From this table it is seen that private systems are, by far, in the majority. As for federal and provincial departments, this is as expected for publicly-owned systems. Private systems are followed in popularity by GRS, RCCMRS, paging systems and ship-to-shore, in that order. Similarities in this order with that for federal and provincial users are again noted.

Table 4.1 Present Distribution of Systems by Service Category

Category of Service	% of Systems
Private	79
Paging	2
RCCMRS	9
GRS	10
S/S	-

The distribution of systems by service category for all agencies when operation first began is shown in Table 4.2, where it is seen that approximately the same number of private systems are in use now as when the systems were first set up.

Table 4.2 Initial Distribution of Systems by Service Category

Category of Service	% of Systems
Private	75
Paging	5
RCCMRS	8
GRS	11
S/S	-
MTS	1

The remainder of the picture is also very stable with a small drop in number of paging receivers in use since their initiation. This conclusion regarding the stability of municipal

systems (in terms of service category) is reinforced by results describing detailed information on changes in types of service, number of mobile radios etc. Although 60% of those that responded declared that changes had been made, these changes, for the most part, were in numbers of mobile units, portables, repeater stations etc., rather than change in service category. A detailed list of types of changes encountered is included below:

1. growth and expansion, in terms of mobile vehicles, range (more repeaters), etc., e.g. expansion of 'dial-a-bus' service, as the population and city limits increase. This is noted for all department types.
2. portable radios added, especially by fire departments for inspection and fire control (especially as high-rise density increases), by police to improve reliability and decrease 'down-time'.
3. regional government amalgamation, merging of bus companies etc.
4. conversely, separation of departments previously sharing a system (for example the old system to the fire department, the new to police), obsolescence of old systems etc.
5. changes to relieve congestion (e.g. from GRS to VHF private systems).
6. addition of paging receivers.

The distribution of years in which operation started (Table 4.3) shows a slow increase from the earliest systems (1946-

Table 4.3 Distribution of Years in which Operation Started

Year Started	%
1946 - 50	11
51 - 55	10
56 - 60	19
61 - 65	16
66 - 70	19
71 - 75	26

1950) to the 'boom' in the last 5 years. A number of systems have thus had considerable time for expansion and development of new equipment, services offered etc. Recent increases, as mentioned in the introductory chapter, may be attributed to more awareness of the advantages to be gained by use of mobile radio, these advantages being disseminated by television, the press etc.

This slow increase (till recently) tends to confirm the stable situation put forward above. Large increases in attractiveness of mobile radio in the past and, on account of this, change in favour towards one or more service, would have caused an upsurge in the number of licences issued in that period.

4.3 Uses of System

The uses to which the radio systems of municipal departments are put were examined, and showed an upsurge (compared to federal and provincial users) in the function of 'dispatch'. This is reasonable for the type of services encountered in some departments (fire, police, transit). Other departments show a predominance of inter-worker communication followed by dispatch.

Dispatch may involve assignment of crews to various locations both for regular duties and emergencies (engineering, parks, roads and public works, police, fire), mobile radio being seen as essential for a speedy response to calls, e.g. for 'dial-a-bus' service. Inter-worker communication adds flexibility to operations, for example change in work assignments (engineering, roads and public works, public utilities etc.) and administration. It also adds quite a measure of security for police, parks officials etc. out on solo patrol. Radio is also used for interdepartmental communication, for example between police, ambulance and fire departments, municipal to provincial police etc.

4.4 Size of System

The distribution of number of radio systems operated by each department is shown below in Table 4.5, where it is seen that most utilize just one system. This is to be expected from

Table 4.5 Distribution of Number of Radio Systems Operated by Each Department

Number of Systems	%
1	79
2	13
3	7
Greater than 3	1

efficiency considerations for the moderate and small-sized municipalities that made up the largest portion of the sample. This is illustrated by Tables 4.6 and 4.7 which describes the area served by departments and the population of this municipal area. It is seen that 84% of the departments serve an area less than 100 square miles and 73% serve a population of less than one hundred thousand. Very few departments

Table 4.6 Distribution of Area Served by Departments

Area in Square Miles	%
Less than 1	1
1 - 5	12
5 - 15	22
15 - 30	13
30 - 100	36
101 - 300	16

operate over 3 systems except those with populations over one million.

Table 4.7 Distribution by Population of Area Served by Departments

Population	%
Less than 2000	-
2001 - 5000	2
5001 - 10,000	21
10,001 - 25,000	21
25,001 - 100,000	29
100,001 - 250,000	14
250,001 - 1 million	11
Greater than 1 million	1

For these systems the number of base stations will depend upon the year operation started, technical sophistication, and use to which the system is put. The variation in number of base stations required is shown in Table 4.8.

Table 4.8 Variation in Number of Base Stations per System

No. Stations	%
1	65
2	20
3	5
Greater than 3	9

In accordance with the moderate population (affecting number of requests for assistance etc.) and area (range required approximately 10 miles) of most municipalities, in general only one or possibly two base stations are used per system. Only cities in excess of 250,000 inhabitants and area 100 square miles make use of more than 3 base stations. The distribution of the quantity of radio repeaters in service is detailed in Table 4.9 where it is seen that the majority of departments with repeaters in use require just one, in agreement with the above discussion. The largest systems use considerably more than 4 repeaters per system, for areas in

Table 4.9 Distribution of Number of Radio Repeaters Used

No.	%
1	62
2	19
3	6
Greater than 4	13

excess of 100 square miles.

In each system, following the theme of moderate size, nearly half the municipalities have systems with less than 10 radio-equipped vehicles. This distribution, summed over all departmental categories and geographical regions belies the considerable differences found in individual departments. For

Table 4.10 Distribution of Number of Radio-Equipped Vehicles

Number	%
1 - 10	47
11 - 20	18
21 - 30	10
31 - 50	11
51 - 70	6
Greater than 70	8

example more than 10 radio-equipped vehicles are often in use in moderately sized police forces (see Appendix 3) whereas engineering, parks and transit, utilities, roads and public works bring this figure down.

The distribution of personal portable radios is given below in Table 4.11 where it is clear that in-vehicle mobile radios are still more prevalent than the versatile portable. Increase

Table 4.11 Distribution of Number of Personal Portable Radios

Number	%
1 - 5	76
6 - 10	12
11 - 15	4
16 - 20	4
21 - 40	2
Greater than 40	2

in the number of portables is however expected in future bringing these distributions in line and perhaps putting a portable unit in each radio-equipped vehicle.

Range used by municipal agencies is, as in previous chapters, of considerable importance. Detailed below in Table 4.12 is the distribution of coverage actually used by these departments. Also shown is the area of coverage due to this expressed range, based upon a circular pattern.

Table 4.12 Range Used in Miles and 'Theoretical' Area of Coverage

Range	%	' Area 'of Coverage sq. miles
1 - 5	25	3 - 80
6 - 10	23	80 ⁺ - 300
11 - 15	26	300 ⁺ - 700
16 - 20	8	700 ⁺ - 1250
21 - 40	12	1250 ⁺ - 5000
Greater than 40	6	Greater than 5000

As anticipated for moderately-sized municipalities, ranges of below 15 miles constitute three-quarters of all replies. From comparison of the theoretical area of coverage, Table 4.12 and actual area served by the departments, (modelled statistically as circular in shape) it would appear that the range capability of the mobile radio systems tends to exceed the defined area of coverage of that department.

Most of these systems operate on just one or possibly two channels. Less than 12% of the municipal departments make use of 3 or more channels, as noted from the percentages of Table 4.13.

Table 4.13 Distribution by Number of Radio Channels

Number	%
1	66
2	23
3	4
4	3
5	1
Greater than 5	3

Thus a typical system might operate one or possibly two base stations, employ one automatic repeater station, operate 10 radio-equipped vehicles and 5 portable radios. These mobile radios operate on one channel at a range of 15 miles or less.

The development of mobile radio to these present proportions is shown, to an extent, by the following tables showing average numbers of mobile radios in use for the start of operation, 1965 and 1970. From Table 4.14 we obtain corroboration of

Table 4.14 Average Number of Mobile Radios at Start, 1965, and 1970

	Average No.
Start	37
1965	52
1970	92

Section 4.2.1 that over half the systems started operation before 1965. This is probable from the increase in average number of mobile radios from the start, 1965 and 1970. These average figures are considerably different from 'typical' figures due to the larger municipalities having a large number of radio-equipped vehicles. The average numbers of personal two-way portables for these three times are shown in Table 4.15.

Table 4.15 Average Number of Portables at Start, 1965, and 1970

	Average No.
Start	10
1965	5
1970	15

It is seen that many departments introduced personal portables at a later time than radio-equipped cars, that is after 1965 and before 1970. The ratio of vehicular mobile units to personal portables has dropped from 10 to 1 in 1965 to 6 to 1 in 1970 and is expected to have fallen further since then.

4.5 Technical Features

For comparison of communications facilities of municipal and other users, municipal agencies were asked for information concerning certain technical features of their systems.

4.5.1 Frequency Band Used

The distribution of radio systems by frequency band used is given in Table 4.16.

Table 4.16 Distribution of Radio System by Frequency Band in Use

Frequency	%
HF	-
LB VHF	3
HB VHF	90
UHF	7

An overwhelmingly large sector is in occupation of high band VHF channels. As for federal and provincial users the HF bands have been left in favour of the greater reliability of the higher frequencies. Similarly little use of the UHF band is seen, at present. This shift away from the lower frequencies is illustrated in question 9H, Appendix 3 with UHF systems originating in the last 5 years.

4.5.2 Minutes of Air Time

4.5.2.1 Total Picture

Certain land mobile services such as police and fire may show fairly low occupancy on a particular frequency, except during emergencies (which may last from a few minutes to a few days) at which times traffic density becomes very high and may even approach saturation.

The average number of minutes of 'air time' per hour used through the day, Monday to Friday, Saturday, Sundays, and statutory holidays is shown in Table 4.17, for services other than police and fire.

Table 4.17 Average Number of Minutes Air Time Per Hour

Departments	Periods through the day						
	0-7	7-10	10-12	12-15	15-18	18-24	
Engineer	9	24	26	22	22	15	Mon. to Fri.
Parks	5	17	20	21	15	14	
Transit	13	32	23	35	31	28	
Utilities	5	21	22	23	20	9	
Roads & Public Works	17	17	17	17	16	11	
Total	10	22	22	24	21	15	
Engineer	9	10	10	11	13	12	Saturday
Parks	-	5	10	4	7	4	
Transit	10	19	14	28	20	24	
Utilities	4	10	9	9	10	7	
Roads & Public Works	15	14	9	9	9	11	
Total	10	12	10	12	12	12	
Engineer	8	7	5	5	6	9	Sunday
Parks	-	5	5	3	5	4	
Transit	6	8	7	8	7	10	
Utilities	4	7	5	6	7	5	
Roads & Public Works	3	9	9	9	9	10	
Total	5	7	6	6	7	8	

Table 4.17 Cont'd

Departments	Periods through the day					
	0-7	7-10	10-12	12-15	15-18	18-24
Engineer	8	9	6	6	7	10
Parks	1	5	7	4	5	4
Transit	5	8	7	8	7	10
Utilities	4	7	5	6	7	5
Roads & Public Works	11	10	10	10	10	11
Total	6	8	7	7	7	8

Statutory
Holidays

As expected, air time is greater on Monday to Friday than at other times with daily usage fairly constant at about 22 minutes in the hour except for lower rates before 7 am and after 6 pm. This constant rate contrasts with morning and afternoon peaks of 22 minutes and 19 minutes respectively for federal and provincial users. Usage in municipal government between 6 pm and 7 am is considerably higher than for federal and provincial governments. This may be expected from the more essential service nature of many municipal departments. This higher level of usage is also noted on Saturdays with average usage times of about 12 minutes per hour. Sundays and statutory holidays show similar patterns of traffic with usage around 7 minutes in the hour for all government levels. This decrease in radio air time could be utilized by public safety organizations with greater needs at weekends and at night (CF business users during the day, tv UHF channels at night).

4.5.2.2 Regional Variation

Usage patterns are detailed in Table 4.18 below (by regions across the country). They seem to be very similar for all regions except that: usage on Mondays to Fridays in the 'West' appears to be less than for other regions; and Ontario and Quebec appear to have a higher rate of air time per hour than the other regions.

Table 4.18 Average Air Time Per Hour By Regions

Region	Periods through the day						
	0-7	7-10	10-12	12-15	15-18	18-24	
BC	4	24	22	24	23	6	
WEST (Alta, Sask Man)	15	18	15	18	19	16	
ONT	11	25	24	28	23	19	
QUE	11	19	27	27	18	12	Mon to Fri.
EAST (NB, PEI; NS, NFLD)	15	29	30	28	29	28	
BC	3	5	5	5	5	6	
WEST	7	11	12	11	9	13	
ONT	12	17	12	13	15	11	Saturday
QUE	16	7	7	7	7	11	
EAST	15	10	10	38	28	33	
BC	2	3	2	2	4	4	
WEST	6	9	6	6	7	10	
ONT	10	8	8	7	8	8	Sunday
QUE	11	8	7	8	8	12	
EAST	-	5	5	5	5	-	
BC	2	5	3	3	5	5	
WEST	7	10	8	9	9	11	
ONT	7	9	7	7	8	8	Statutory Holiday
QUE	7	7	7	7	7	8	
EAST	-	5	5	5	5	5	

4.5.2.3 Departmental Variation

During the week transit departments followed by engineering appear to have the most usage (with peaks of 35 and 26 minutes respectively). Utilities, parks, roads and public works then follow (in that order). This order (see question 8, Appendix 3) is maintained at weekends and on statutory holidays except for an increase in usage by roads and public works relative to the other departments. Utilities shows very little usage before 7 am during the week, a build-up to 'maximum' between 10 am and 3 pm and then a slow decline until midnight, in keeping with previous results. (4) In contrast, from this reference police usage remains relatively constant except for a decrease between 3 and 6 am.

4.5.3 Time Spent on Operations, Administration and Public Service

The distribution of systems by percentage air-time devoted to operations is laid out in Table 4.19.

Table 4.19 Distribution of Air Time Dedicated to Operations

% of Air Time	% Distribution
0 - 20	6
21 - 40	4
41 - 60	14
61 - 80	22
81 - 100	54

As expected this function takes up a large percentage of air time. Over half the systems spend over 80% of their air time on operations. The distribution of air time used for administrative purposes is given in Table 4.20, where, in accord with the findings above nearly three-quarters of all municipal radio systems spend less than 20% of their

Table 4.20 Distribution of Air Time Dedicated to Administration

% of Air Time	% Distribution
0 - 20	72
21 - 40	13
41 - 60	10
61 - 80	—
81 - 100	5

'radio time' on this function. The distribution of air time devoted to public service is described by Table 4.21 below,

Table 4.21 Distribution of Air Time Dedicated to Public Service

% of Air Time	% Distribution
0 - 20	62
21 - 40	9
41 - 60	5
61 - 80	3
81 - 100	20

with anticipated weighting towards little or no public service by the majority of the municipal departments, with however 20% of those sampled spending over 80% of their time on this function (e.g. police, fire).

4.5.4 Adequacy of System

A large proportion (83%) of the systems was considered adequate by the department concerned. Complaints that were received are discussed below in terms of the municipal departments originating the criticism.

4.5.4.1 Police (Municipal, Provincial and Federal sampled)

Police were among the first to develop land mobile radio in cars and because of this long period in the field and great importance of their role, are very eloquent in their criticism of present systems and demand for more sophisticated techniques. Their major complaints are :

1. desire for additional channels. For example simplex operation on only 2 VHF low band frequencies causes congestion

and mutual interference. When skip conditions are prevalent additional interference is experienced from outside the area.

2. Increase in power. Due to the necessity for good coverage, police forces utilise a larger number of repeaters per system than any other user. In spite of this, great concern was expressed over the poor quality of base-vehicle communication, especially with fast-moving police cars travelling along crowded highways. Suggestions for greater power output of transmitters and more repeaters were made.
3. the availability of two-way radio with the police officer (personal portable) with in-car repeaters would significantly increase what that officer can accomplish.
4. Inter-system communications for police forces with overlapping jurisdictions could be improved greatly.
5. Lack of privacy due to high quality (plus auto-scan) receivers being available to the general public. Automatic channel switching would eliminate part of the problem, but scrambling and digital communications are seen as the main solutions. Even some frequency scrambling techniques however are readily vulnerable to 'attack' by the determined criminal element. (5)

4.5.4.2 Fire

Complaints from fire departments were mainly concerned with interference, congestion and the need for an emergency frequency, kept clear at other times, and monitored by other public safety organisations in their own and adjoining municipalities.

4.5.4.3 Other Departments

Engineering, public works, public utilities and transit companies complained about skip interference, congestion of channels, and the need for better mobile units. Complaints were received from public works departments concerning the lack of automatic vehicle identification (AVI).

4.5.5 Facilities Provided

The distribution of type of signalling used is shown in Table 4.22 and shows that the majority of systems still use (entirely) voice signalling. Some individual and group signalling is employed, particularly by police departments while less than one per cent used paging to signal intent to communicate, probably due to lack of coverage and its inherent one-way nature.

Table 4.22 Distribution by Signalling Technique

Type of Signalling	%
Voice	81
Individual Selective	10
Group Selective	9
Paging	-

Greater use of individual and group selective signalling is expected because the number of separate police forces, for example, is on the decrease but the size of each reformed department will naturally tend to increase, causing further problems of congestion and voice queuing for messages. The same is true for other municipal departments following the trend towards amalgamation of municipalities. This use would of course be accelerated by reductions in cost and availability of equipment compatible with that in service.

4.6 Future Needs

4.6.1 Future Incorporation of Technical Facilities

Of the facilities suggested in the questionnaire (see Appendix 1), all but slow scan television, and automatic vehicle location (AVL) were found to be in use somewhere. This contrasts strongly with federal and provincial agencies. The facilities most in use by municipal departments were individual selective signalling, then group signalling and data terminal, and finally an even distribution of the other facilities. Percentages of departments with these facilities are shown in Table 4.23. This hierarchy of favouritism discussed above is understandable in view of the developing unwieldiness of regional municipal departments in terms of size of mobile fleet, and in the light of the somewhat prohibitive costs. For example AVL, in the minds of many departments, is limited from widespread use by economics. Future users of this facility might include law enforcement agencies, emergency vehicles, city government vehicles, city utilities, urban mass transit vehicles (bus, 'dial-a-ride' etc.) etc. The application of AVL must address various operational methodologies including (a) fixed route (e.g. buses) (b) random route (e.g. police) (c) free agent (police on patrol) (d) critical time schedule vehicles (school bus for example) (e) emergency vehicles (f) vehicles operating through a small fraction of the day, or a large fraction, etc. That is, AVL systems would have to be developed preferably with variable location accuracy, minimum impact on existing radios, multiple mode of operation, application to cities of any size and low initial and operating costs! (6) Practically none of the city departments without a facility had any information on its benefits, cost etc.

Table 4.23 Incorporation of Technical Facilities

	Facsimile %	Teletype %	Data Terminal %	Slow Scan TV %	CAD(E) %	CIV(F) %
In System Now	1	2	8	-	1	1
Not in System	99	98	92	100	99	99
Info. on Facility	1	-	-	-	-	-
No infor.	99	100	100	100	100	100
Incorporation ?						
Def. not	47	49	36	43	35	34
Unlikely	42	35	42	45	44	47
Undecided	5	10	9	7	6	6
Likely	5	5	12	6	14	12
Definite	1	1	1	-	1	1
Incorporation ?						
Next 5 years	62	57	72	49	58	57
Later	38	43	28	51	42	43

Table 4.23 cont'd

	CRV(G) %	Ind. Sel. Sig. %	Group Sig. %	AVI(J) %	AVL(K) %
In System Now	1	9	8	1	-
Not in System	99	91	92	99	100
Info. on Facility	-	-	-	-	-
No info.	100	100	100	100	100
Incorporation ?					
Def. not	37	24	26	28	30
Unlikely	43	36	40	43	39
Undecided	6	15	15	12	14
Likely	14	21	18	16	16
Definite	1	2	2	2	1
Incorporation ?					
Next 5 years	55	70	62	60	52
Later	45	30	38	40	48

In agreement with the foregoing discussion individual selective and selected group signalling were considered to be the most likely to be added to existing systems, probably with the next 5 years. Following these, AVI, AVL, computer-aided dispatch, CRV, CIV and data terminal were considered (in the order presented) to be of likely incorporation with slight emphasis upon incorporation within the next 5 years. Little future use of facsimile, teletype and slow scan television is anticipated.

4.6.1.1 Police Needs

Police needs and future facility requirements received special attention due to their importance and the large number of mobile units and base transmitters in operation. Future needs are enumerated below, in line with previous surveys. (7)

1. Computer-aided dispatch, namely the automatic routing of message traffic, automatic frequency assignment, push-button initiated generation of messages, error rejection, dispatcher display system, back-up computer, supervisor override etc., was considered very desirable in large urban areas (e.g. not by RCMP with an often 'rural' role).
2. High speed access to information (e.g. CPIC computer system). Land line communication to regional police forces takes a lot of narrative traffic off the air.
3. Some mobile data device use e.g. facsimile, teletype, etc. is envisaged, however these facilities would increase radio congestion considerably.
4. Separate tactical (working) and administrative channels would be preferable.
5. 911 emergency number ~ public demand not very vocal, system fraught with practical difficulties.
6. Full-text digital communication is eventually seen as a large part of the answer to security problems, reduction in channel utilization, improved response time etc.
7. Automatic vehicle location can improve police operations by significantly reducing response time, by permitting dynamic redeployment of forces.

4.6.1.2 Medical Needs

There is a need for more flexible and expanded radio capabilities to meet emergency medical services (EMS) communications requirements. (8,9) They must provide for the intercommunication of law enforcement agencies, ambulances, ambulance dispatchers, emergency receiving facilities and other health care institutions and medical practitioners. Two-way voice communication is needed between the various elements of the EMS, sometimes over large geographic areas with a very sparse population located in relatively few population centres in the Canadian north. This mobile radio system would lessen reporting time of accidents, coordinate activities of ambulances responding to a call for help, lessen their response time, and allow ambulance operators to seek assistance from doctors and other personnel. In an EMS system there are three types of communication sub-systems (a) hospital administration (b) command/control and dispatch (c) talk from a doctor and telemetry - the transmission of critical function data from sensors on the patient to a remotely located doctor. Because of the danger of interference causing errors in diagnosis, channel allocation must receive special attention. Telemetry must be maintained 100% of the time while still permitting the driver to maintain continuous command/control communications. Access to the EMS system should be provided for the general public, CB and amateur radio users.

Mobile radio could be further used for delivery of primary health care to remote areas using voice, slow scan video and long-range biomedical telemetry. Use of telemetry is on the increase. Unlicensed, with ranges of 100-200 feet telemetry can be used for hospital intensive care, sensors for athletes' performance etc. Larger range telemetry can be used for tracking the pattern of living of animals, e.g. for bird migration, cattle for location and information on their energy use etc.

More social consciousness is needed in the medical use of mobile radio. The development of non-vocal communications devices should be encouraged for the handicapped and deaf. Also special communications devices for high level spinal injuries etc. (e.g. if person can only move eyes, mouth etc). Mobile radio could also be used to keep the aged out of institutions, leaving these homes for chronic patients only. For the aged at home, a great anxiety is not having help at hand. If the person wears a transmitter he could alert a neighbour or a central location in case of a fall or other accident.

4.6.2 Equipment Costs

The response for information as to purchase cost or monthly rental at which the facilities enumerated above (section 4.6.1) would cease to be worth having is laid out in Table 4.24. It is seen that almost all municipal departments want to purchase these facilities outright, due to their spending power and long-term savings to be made.

Costs per mobile for these facilities tend to vary considerably from one respondent to another, however in general \$3000.00 is considered the maximum cost per mobile. Costs of 'Add-On' to base stations are seen to vary even more than costs per mobile. The departments most able to quote desired figures were police, fire and transit authorities.

Table 4.24 Response to Cost of Facility (Individual Responses)

Facility	No. of Vehicles	Cost per Mobile \$	Cost of 'Add-On' to Base Station \$	Purchase	Monthly Rental
Facsimile	10	3000	5000	P	
	20	3000	5000	P	
Teletype (hard copy)	25/35	500	3000	P	
	10	3000	5000	P	
	20	3000	5000	P	
Data Terminal	5 (dispatch to mobile)	260	-	P	
	50 (mobile to dispatcher)	150	500	P	
	176	3000	528,000	P	
	65	3000	10,000	P	
	20	3000	5000	P	
	13	1500	4000	P	
	84 (mobile to Dispatcher)	3000	20,000	P	
	20	3000	5000	P	
Computer Assisted Dispatch	3	800	4000	P	
	25/35	500	3000	P	
	18	800	380	P	
	176	3000	528,000	P	
	65	10,000	1.8 million(3 facility pack- age)	P	
	84	3000	20,000	P	
	20	3000	5000	P	
	13	1500	4000	P	

Table 4.24 Cont'd

Facility	No. of Vehicles	Cost per Mobile \$	Cost of 'Add-On' Purchase to Base Station \$	Monthly Rental
Computer Input from Vehicle	3	800	4000	P
	65	10,000	1.8 million	P
	65	3000	10,000	P
	84	3000	20,000	P
	20	3000	5000	P
Computer Retrieval from vehicle	3	800	4000	P
	18	800	-	P
	176	3000	528,000	P
	65	10,000	1.8 million	P
	65	3000	10,000	P
Individual Selective Signalling	13	1500	4000	P
	45	300	800	P
	3/4	500	500	P
	18	800	-	P
	84	3000	20,000	P
Selected Group Signalling	6	1000	1500	P
	45	300	800	P
	84	3000	20,000	P

Table 4.24 Cont'd

Facility	No. of Vehicles	Cost per Mobile	Cost of 'Add-On' to Base Station	Purchase Monthly Rental
		\$	\$	
Automatic Vehicle Identification	70	10-15	200	P
	45	300	800	P
	176	3000	528,000	P
	65	3000	10,000	P
	84	3000	20,000	P
	13	1500	4000	P
	19	200	1500	P
	6	500	1000	P
	200	3000	20,000	P
Automatic Vehicle Location	50			20/mo. extra
	45	300	800	P
	176	500	88,000	P
	79	3000	1 million	
	13	4000	*	P
			*cost not warranted for dial-a-bus alone	
	84	3000	20,000	P
	19	200	1500	P
	9	200	-	P
	6	500	1000	P

4.6.3 Departmental Sharing and Guidelines

41% of the departments questionned shared their radio facility with at least one other department. Police systems were initiated by either themselves or a neighbouring (previously established) police system. Police radio networks were also established; in some instances, by fire departments, private companies, roads and public works departments and in one instance by a university. Fire departments were started into mobile radio by (other than themselves) police and public work agencies.

Emergency departments, if helped to start from outside, used systems first operated by either fire departments, utilities, public works, and parks departments. Public works started out on fire department and police systems while utilities and parks developed their own systems (for the respondents who answered). Detailed response to this question was poor and from the rather meagre number of respondents no clear pattern develops as to which department leads in the development of systems for other agencies. It would appear however that, as expected, police and fire systems are not shared by the other departments, which are not so public safety orientated. In addition, systems in a municipality were usually (97%) started in that same city, and two-thirds of the departmental systems were first started by that same department.

The only guidelines and directives noted from a provincial agency aimed towards municipalities were from 'Transportation' departments. These restrictions were 'regulations on heights of towers at some locations in the city', and 'slow processing of applications'. Federal D.O.C. restrictions and suggestions for change are enumerated in the next section.

4.6.4 Department of Communication Policy

Complaints regarding D.O.C. policy were numerous in this user category and are enumerated below.

4.6.4.1 Frequency Allocation

1. In the opinion of some departments the D.O.C. should take more care in monitoring all new frequencies before issuing that channel to a department. A fire department was issued frequencies in 1971 which interfered with a large city police system in the United States and considerable cost was incurred by the fire department in changing those frequencies. Departments felt that the D.O.C. should take some responsibility in changes required to equipment if the assigned frequency is found to be unsuitable. More mobile laboratories and other methods for the characterization and measurement of man-made electromagnetic 'noise' in the urban, suburban, and rural environment could be used for this purpose.

2. Fire-fighting agencies also complained that no frequency allocation was available in the 'fire-band' range. A suggestion was put forward that a study should be undertaken by the D.O.C. to have the fire band' range cleared of all non-fire equipment so that when a county mutual aid repeater system or other fire department needs a frequency allocation, it would be more readily available. D.O.C. in one case first proposed a frequency completely outside the fire-band range, which was totally unacceptable

to the fire department. The department in question has been attempting for a year to have frequencies allocated so that radio communications are maintained over county boundary lines. D.O.C. have proposed two frequency pairs in the fire-band range by splitting existing frequency channels and the pairs proposed have gone for coordination in Ottawa and Washington.

3. Police departments also complained about the difficulty in obtaining extra frequencies, both in high band and low band VHF.
4. Some agencies would consider it a courtesy if D.O.C. could inform them when the frequency used by that department is to be allocated to and shared by another department. The number of mobile units on many of these shared frequencies was considered excessive.
5. Electrical Utilities requested that they be classified as 'essential services' to assist in allocation of more (needed) frequencies. Emergency services should be exempt from frequency sharing.
6. Police departments suggested that when 2 adjacent channels are coordinated for use, the interstitial frequency should be coordinated automatically (for that department) for such use as tone control, alarms, surveillance devices etc. Low power one-way non-voice biomedical telemetry operations of the low-power user such as at airports, stadia, racetracks, office buildings, construction sites, shipyards, farms etc. could be permitted on off-set frequencies.
7. Transit departments considered the local D.O.C. office very restrictive in allocation of channels. 'There are 4 duplex channels approved nation-wide for use by transit authorities.' One department had difficulty in obtaining use of two of them. This department was unsure whether 'uncooperative' attitudes are D.O.C. policy or just local interpretation.
8. Public works departments had considerable trouble, in some instances, in getting frequency assignments for repeater operation. In some cases tenders for equipment went out on the basis of VHF frequencies. D.O.C. is urging use of UHF frequencies and consequently the department had to retender, at considerable extra cost and delay, since very few suppliers make equipment in the new 410 - 420 MHz band. This restricts bidding and may result in overpricing. D.O.C. and municipal departments should be in closer contact, keeping each other aware of market conditions, frequency allocation policy etc., before making decisions of this nature.
9. Some departments requested that their GRS systems be allocated other frequencies than are now available.

4.6.4.2 Privacy

Great concern was expressed with regards to the security of systems. The D.O.C. was urged to prohibit the sale of receivers capable of monitoring messages in fire and police frequencies. For example fire departments are experiencing road traffic problems at the scene of a fire due to persons responding to the location on paging and group call. The sale of receiver crystals for these VHF and UHF emergency service bands should not be permitted through commercial outlets, to avoid panic during emergency situations, crowd and traffic control etc. Concern regarding the sale of 'scanners' was expressed by the police.

4.6.4.3 Miscellaneous

1. Interference from other local antennas e.g. t.v., was cited as a source for major irritation.
2. The coordination corridor at the U.S. border should be widened (directional antennas would help).
3. Equipment specification minima should be upgraded as technology changes - possibly every five years, and lightweight programmable test sets should be available for testing all aspects of a mobile communication system.

4.6.5 Emergency Channel

71% of respondents were in favour of the setting up of an emergency channel.

4.7 Conclusions

A summary of the results discussed in this chapter is given below.

1. Private systems are most prevalent in municipal departments, followed in popularity by GRS, RCCMRS, paging systems and ship-to-shore, in that order. When the systems were first started the distributions were very similar, indicating a stable situation.
2. A large proportion of these radio systems started prior to 1965 with a steady increase in number of licences issued until the last 5 year period when a sudden surge occurred.
3. Dispatch and inter-worker communication form a large part of the functions of these departments.
4. Departments in general operate just one system serving an area less than 100 square miles and a population of less than one hundred thousand. Very few departments

had over 3 systems except those with population over one million.

5. In general only one or possibly two base stations are used per system, and just one repeater station. Larger systems use considerably more than 4 repeaters per system for areas in excess of 100 square miles. Nearly half the municipalities have systems with less than 10 radio-equipped vehicles, though some departments may vary considerably from this typical figure.
6. In-vehicle mobile radios are still more prevalent than portables but the ratio has been decreasing since 1965.
7. Ranges of below 15 miles constitute three-quarters of all replies. It appears that often the range capability of the mobile radio systems tends to exceed the defined area of coverage of that department.
8. Most of these systems operate on just one or possibly two channels. Less than 12% make use of 3 or more.
9. An overwhelmingly large sector of municipal users occupies the high band VHF channel, having abandoned HF. UHF systems have developed over the last 5 years to their present 7% of the 'market'.
10. Most of the departments spend a great deal of their time on operations, rather than administration. 'Public Service' is carried out only by public safety organisations.
11. Satisfaction was expressed by 83% of the sample regarding system satisfaction. The majority of complaints, detailed in Section 4.5.4, were from police departments.
12. Many systems still use voice signalling and some (19%) individual and group calling is employed, particularly by police forces. This use is expected to increase.
13. Facilities most in use were individual selective signalling, and data terminal, and finally an even distribution of the other facilities.
14. Individual selective and selected group signalling were considered to be the most likely to be added to existing systems, probably within the next 5 years. Following these, AVI, AVL, CAD, CRV, CIV (see Appendix 1 for definitions) and data terminal were considered (in the order presented) to be of likely incorporation.

15. Police departments declared needs for computer-aided dispatch, high speed access to information, and full-text digital communication.
16. 41% of the departments questionned shared their facility with another agency. The only guidelines these departments were subject to were from provincial 'Transportation' departments and the federal D.O.C.
17. Complaints regarding D.O.C. policy were numerous and consisted of criticism concerning (a) frequency allocation policy (b) security against eavesdropping (c) interference (d) coordination policy (e) and equipment standards.
18. 71% of the respondents were in favour of the setting up of an emergency channel.

Many departments would appreciate a lead by the D.O.C. in the development of AVI and AVL systems. Initially this might involve computer simulations of system responses, giving information such as the maximum number of vehicles that could be handled, number of channels needed, energy saving in comparison to a system without AVI or AVL, degree of control sophistication needed etc. In a somewhat similar vein the D.O.C. could investigate the improvements in service to mobile stations and the more effective use of equipment at a base station by the use of mini-computer control (not necessarily with AVI and AVL).

Small non-users (and users), to obtain the advantages of a large system such as wide coverage, 'private' service, low delay etc. should cooperate in large groups (with D.O.C. assistance?) for the purposes of system design and licensing. In spite of the practical difficulties, this scheme could enable more 'non-users' to obtain the benefit of radio communication (e.g. by the use of community repeaters).

CHAPTER 5

CONCLUSIONS

The present and future needs of mobile radio users in Canada have been examined. Methods used for this purpose consist of literature searches, personal interviews with both individual users and user groups, and a questionnaire-type survey carried out across the country.

Explosive growth in the 70's has been seen in all three categories of users. The business and commercial sector, which comprises the largest number of land mobile licensees, has experienced the highest growth rates. In this sector a significant number of users are already operating a second type of service, such as paging, GRS, ship-to-shore or MTS, in addition to their normal private two-way system. This trend appears likely to increase. In municipal, provincial and federal government departments, private systems predominate with few secondary services in employ.

The recent heightened interest in C.B. in the U.S.A. appears to be spilling over into Canada, for private pleasure purposes. Historically however many business users have found both GRS and MTS unsatisfactory because of congested traffic and interference, and have turned to private systems. Government users have never introduced GRS in large quantities. C.B. has shown the potential rapid growth of any of the categories of service. For example a large common carrier system could arise if MTS became a standard option on automobiles (GRS also possible here).

Long distances, in excess of 40 miles radius are now being achieved by many systems and more users are forecasting the need for greater distances in the next 5 years. This may well suggest the need for some other form of regional or nation-wide service embodying the traditional fast access features of private dispatch, but having roaming capability more like MTS with emphasis on most main roads as well as into the more sparsely populated regions.

It appears, in all sectors, that lower equipment costs could trigger an increase in the number of mobile radios within existing systems as well as stimulate demand for new systems. The D.O.C. could invent possible scenarios using these new systems to determine the relative savings potential and time necessary to implement the new system. As prices lower, not only will demand for services increase, but usage patterns and service requirements could shift as previous non-users of all types begin using these services.

The thirst for greater sophistication in equipment is quite evident and during the next 5 years several facilities will become considerably more commonplace. In the business sector, automatic vehicle identification and location is expected to gain a fair degree of popularity. Other facilities such as in-car teletype, facsimile, slow scan television and computer access will come into increasing use along with voice plus data. Due to the reluctance of the major suppliers to enter into cooperative ventures with their competitors, the D.O.C. should take the lead in the development of facilities such as automatic vehicle identification, use of cellular systems, dynamic channel reassignment, variable range control, pre-arranged communications paths etc.

For federal and provincial users the facilities in present use are facsimile, teletype, data terminal, individual selective and selected group signalling. The only other facilities likely to be incorporated is automatic vehicle identification. Municipal governments are using individual selective, selected group signalling, and data terminal and expect these to become more popular.

It seems unlikely, however, that voice will cease to be the main medium of communication. There will be increased demand for privacy or voice security especially in the business sector as firms develop greater need to transmit competitive information. Privacy was also considered a major problem by municipal public safety agencies, (but not by any federal or provincial departments).

Business and federal and provincial government users are generally satisfied with D.O.C. policies but a small percentage of business users would like to see some changes especially in the matter of ERP restrictions in remote areas.

Business users of mobile radio suffer from a lack of organizational ability (inherent to a group of highly parochial industries) in terms of collectively expressing their present and future radio needs. Because of the difficulty in achieving coordination between users who have little or no understanding of each others' activities, resolution of such problems as interference become more complicated. Business radio associations in Canada could be encouraged, to somewhat alleviate these problems.

Municipal departments expressed a fair amount of dissatisfaction with D.O.C. policy. Their complaints concerned lack of cooperation between the D.O.C. and their department concerning frequency allocation, security against eavesdropping, and changes in coordination policy and equipment standards. Detailed knowledge of D.O.C. activities and of policy were not, in general, visible in the areas sampled.

Demand for interconnection to the telephone network has reached major proportions amongst business users with an apparent need to access both local exchanges and the toll network both from mobile radios and from a restricted group of portables.

Awareness of satellite communications possibilities seems to be strong with a fairly significant number of users sharing the opinion that it would benefit them if their geographically separated base stations could be linked through geo-stationary satellite service especially in the north or in areas where mountain ranges intervene.

Further research in the mobile field could involve detailed studies to size up the future potential for personal communications and determine how these future needs can best be accommodated. Other profitable areas for increased study would be the use of microwave frequencies for mobile communication (10) and the utilization of digital techniques in mobile radio (digital techniques have, of course, been used for many years in various special mobile applications such as telemetry and selective calling). If the D.O.C. is considering licensing different forms of modulation, compatibility of systems and possible changes in various licensing parameters will be of prime consideration.

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A STUDY OF USER NEEDS IN MOBILE RADIO

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