

COMMUNICATIONS CANADA - CENTRAL REGION

SPECTRUM USAGE AND REQUIREMENTS

406 - 960 MHz

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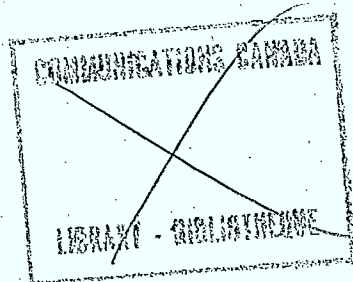


COMMUNICATIONS CANADA

Central Region

Spectrum Usage and Requirements

406 - 960 MHz



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Acknowledgement

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I thank all of you for your time, your ideas, and your essential assistance.

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### Introduction

This report explores the communications requirements for Central Region within the spectrum area of 406 MHz - 960 MHz. The recommendations are in support of these requirements.

Although the recommendations apply specifically to Central Region, many of the same considerations are applicable in other geographical areas of Canada. Where they are not applicable, we request a flexible national approach which will allow the necessary variations to be applied in Central Region. We believe the subject frequency band, due to pertinent propagation characteristics, can be molded to compensate for Regional differences.

## Conclusions

1. Demand for land mobile services in Central Region will continue to expand at rates over 20% compounded annually (see Appendix I.A., tables 1.b, 2.b, 3.b, and 4.b). Present methods of satisfying this demand will soon be inadequate (see section I.A.4.). We have reached a turning point, whereby a new direction is required.

Generally, the new direction is necessarily towards large integrated systems (see page 22, "New Approaches"). Specifically recommended are General Land Mobile Radio Systems (Public Mobile Telephone Systems), Restricted Common Carrier systems, and paging systems. These systems, when employing state-of-the-art techniques, are more efficient users of land mobile spectrum than most existing private systems.

While considering the types of systems referred to in the above paragraph, it should be realized that effective usage of individual frequencies increases with the total number of frequencies and users assigned to the particular system (see page 22, "New Approaches"). Considering also the practical limitations of modern radio equipment (i.e. at least 5 MHz spacing required between transmit and receive frequencies and preferably consecutively arranged transmit frequencies and consecutively arranged receive frequencies), block assignment of frequencies is mandatory.

Block assignments in existing land mobile bands would require the displacement of existing users. This is a difficult, if not impossible, process. 'Virgin' spectrum is required for the necessary block frequency assignments for integrated land mobile systems.

The advantages of assigning 'virgin' spectrum for the large integrated systems are apparent from the following predicted occurrence of events:

- a) Block assignments are allocated for the pertinent integrated systems.

- b) Initial users of the integrated systems will pay relatively higher costs (than would occur using available optional systems) for the advantages of practically nil waiting time, secure expansion possibilities and potentially greater flexibility.
- c) Presently existing land mobile spectrum will increase in congestion, and new users, along with existing users who are expanding their facilities, will opt for the large integrated systems.
- d) With many users, the cost per user of the integrated systems will drop, eventually becoming lower than private system costs in many areas.
- e) All new users, and all existing land mobile users whose equipment has been depreciated, will utilize the large integrated systems. Existing land mobile bands will become vacant, and available for reassignment to large integrated systems.
- f) The above (a) to (e) will occur to varying extent in various sizes of urban centers. The presently existing land mobile bands will exist as an alternative in rural areas for economically feasible private radio systems.

NOTE: Existing land mobile bands must be retained at this time to provide an alternative to the large integrated systems, thereby, encouraging the lowest possible usage prices in the integrated systems. Further, there will be no direct cost hardships introduced upon the land mobile user.

Given the inevitable trend towards large integrated systems, complications arise when attempting to foresee the composition and interrelations of these systems and their users. A basic ideology must be resolved, namely: Should there be one monopolistic integrated system, probably regulated,

to which all users must eventually go; or should a number of integrated systems be encouraged to develop?

Central Region believes competition, in the form of two or preferably more integrated systems, is desirable versus a regulated monopoly. This belief is based upon the certainty that the regulated monopoly, in this instance, would be the common carrier, a body whose structure is not conducive to continual implementation of developing techniques (new services, spectrum efficiency techniques, etc.). Additionally, competition is the optimum method of lowering user fees in this area.

The common carrier must make interconnection to the telephone network available to all integrated land mobile systems, and at a reasonable cost. This will ensure fair competition between the common carrier integrated systems and the privately financed integrated systems.

The amount of spectrum which should be set aside for the block allocations to integrated systems is difficult to determine. The allocation recommendations for 406 - 450 MHz (see page 10, Figure 1) make available three blocks of spectrum for large integrated land mobile systems, each block composed of 3 MHz for transmit and 3 MHz for receive frequencies. There is also one block of 1 MHz set aside for paging services. Of the three 3 MHz blocks, one is allocated to common carriers (public mobile telephone system), one is allocated to restricted common carriers, and one is reserved for future allocation. These allocations will accommodate requirements in Central Region until at least 1990, at which time the situation will be reevaluated. If required, additional blocks in 806 - 890 MHz may then be assigned to land mobile. (There may also at that time be available spectrum for block allocations within the presently existing land mobile bands).

*G.L.M.R.S.*  
To reiterate, large integrated land mobile systems (P.M.T.S., R.C.C.) and paging systems, which are efficient users of the frequency spectrum, must be encouraged.

2. Broadcasting services are essential to the people of Central Region. The type and variety of services, along with the economic base available to support these services, are major considerations in this area.

Central Region, until at least the year 1990, does not require UHF channels 70 - 83 (see section I.B.). It is, therefore, appropriate to reserve this portion of the spectrum (806 - 890 MHz), with a review in 1990 of needs and foreseeable possibilities.

3. Studio transmitter links (STL's) are currently operating in various land mobile and fixed bands. They are adversely affecting the optimum assignment of land mobile and fixed frequencies.

These one-way services are best combined with other one-way 'fixed' services. The ideal area for all STL's is within the UHF television band. The recommended spectrum is 794 - 800 MHz (UHF channels 67 and 68), which may be employed dependent upon the local allocated UHF channel. This spectrum is chosen as it is outside the shared (land mobile/television) channels proposed by the United States (Channels 14 - 20) and outside the reserved spectrum proposed by Central Region (806 - 890 MHz). It is also outside the spectrum in which satellite broadcasting is permitted (620 - 790 MHz).

4. Point-to-point services in the 890 - 960 MHz band are subject to unique requirements in Central Region, particularly in Alberta (see section I.C.). There are a large number of systems in urban areas. This requirement will continue.

Accordingly, Central Region recommends that there be no change in allocations for this spectrum.

Further, this band could be better utilized by the large variety of

users if only digital systems were allowed by 1990. This would enable implementation of a two frequency plan for the band. Subsequently, there would be sufficient spectrum available to encourage all point-to-point systems (of greater than six voice channel capacity) to migrate to this band. (This would aid in clearing the land mobile bands for previously described future block land mobile allocations).

'Grandfathering' of existing analogue fixed systems should begin as soon as possible.

Allocation Recommendations\*Refer also to Figure 1

406.0 - 410.0 MHz

- 406.0 - 406.1 MHz  
Primary Service - Mobile - Satellite
- 406.1 - 407.0 MHz  
Primary Service - Radio Astronomy
- 407.0 - 410.0 MHz  
Primary Service - Mobile <sup>\*(1)</sup> - Common Carrier - P.M.T.S. (TX 1)  
(Public Mobile Telephone)

410.0 - 420.0 MHz

- 410.0 - 413.0 MHz  
Primary Service - Mobile <sup>\*(1)</sup> - Restricted Common Carrier (TX 1)
- 413.0 - 414.0 MHz  
Primary Service - Mobile (Municipal/Safety Services)
- 414.0 - 415.0 MHz  
Primary Service - Fixed (Except Studio Transmitter Links)  
Secondary Service - Mobile
- 415.0 - 418.0 MHz  
Primary Service - Mobile <sup>\*(1)</sup> - Reserved (TX 1)
- 418.0 - 419.0 MHz  
Primary Service - Mobile (Municipal/Safety Services)
- 419.0 - 420.0 MHz  
Primary Service - Fixed (Except Studio Transmitter Links)  
Secondary Service - Mobile

420.0 - 450.0 MHz

- 420.0 - 423.0 MHz  
Primary Service - Mobile <sup>\*(1)</sup> - Common Carrier - P.M.T.S. (RX 1)  
(Public Mobile Telephone)
- 423.0 - 426.0 MHz  
Primary Service - Mobile <sup>\*(1)</sup> - Restricted Common Carrier (RX 1)
- 426.0 - 429.0 MHz  
Primary Service - Mobile <sup>\*(1)</sup> - Reserved (RX 1)

429.0 - 430.0 MHz  
Primary Service - Paging <sup>\*(2)</sup>

430.0 MHz - 450.0 MHz  
Primary Service - Radiolocation  
Secondary Service - Amateur

450.0 - 470.0 MHz

Primary Service - Mobile  
Secondary Service - Fixed <sup>\*(3)</sup> (Except Studio Transmitter Links)

470.0 - 608.0 MHz

No change.

608.0 - 614.0 MHz

No change.

614.0 - 806.0 MHz

Primary Service - No change.

788.0 - 800.0 MHz  
Secondary Service - Studio Transmitter Links <sup>\*(4)</sup>

806.0 - 890.0 MHz

Primary Service - None - Reserve until 1990 <sup>\*(5)</sup>

890.0 - 960.0 MHz

No change. <sup>\*(6)</sup>

<sup>\*(1)</sup> - Systems approved for use in this spectrum must employ the following spectrum conservation techniques:

- a) Automatic frequency scanning;
- b) sub-audio operated squelch;
- c) digital transmission;

NOTE: i) The 'reserved' land mobile spectrum should be allocated to R.C.C. or common carrier as may be appropriate at a later date.

- ii) Interconnection to the telephone network must be supplied at a reasonable cost by the common carrier upon request.
- iii) Equipment parameters should be specified to incorporate state-of-the-art techniques. Spectrum conservation techniques should be employed (see page 21, "Technological Advances").

\*(2) - Systems approved for use in this spectrum must employ the following conservation techniques:

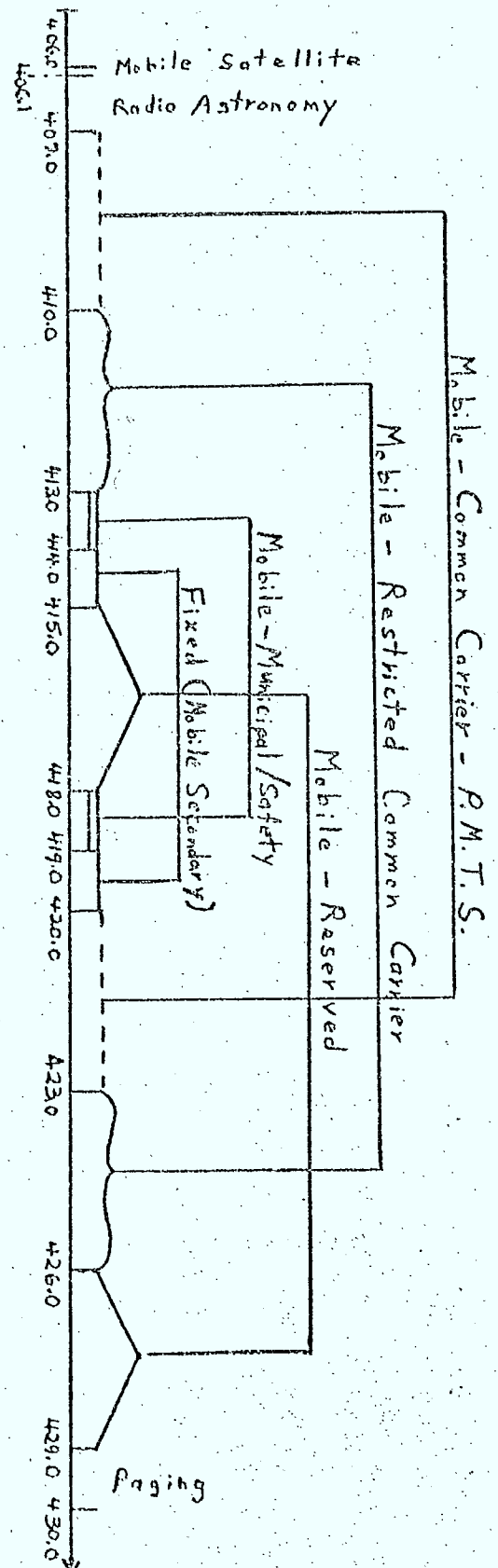
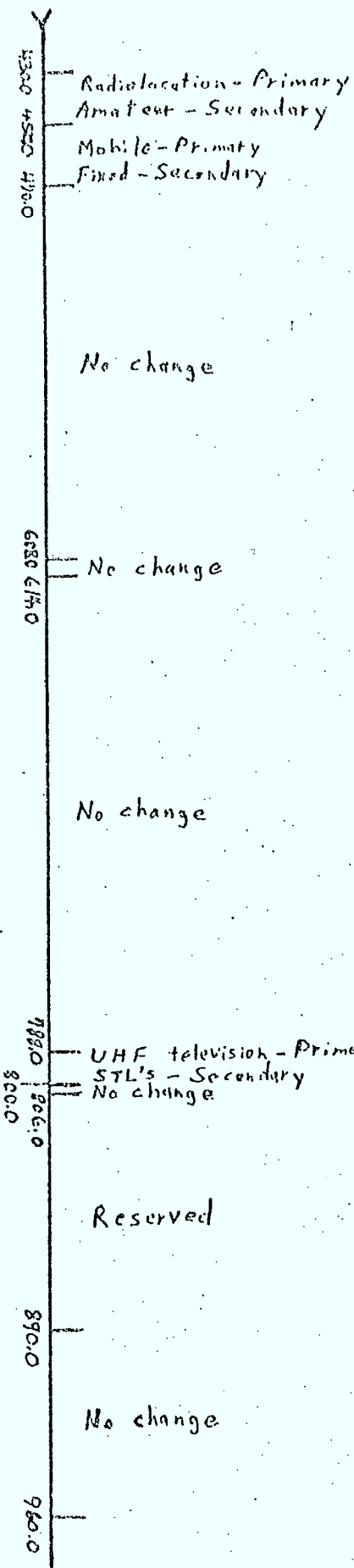
- a) one-way only;
- b) tone only; .....see Attachment B
- c) digital transmission; ...see Attachment B
- d) automatic frequency scanning.

\*(3) - Only fixed services with 6 voice channels or less and a maximum 56 KHz bandwidth allowed. All other point-to-point must use 890 - 960 MHz band.

\*(4) - Either 788.0 - 794.0 MHz (UHF Channel 67) or 794.0 - 800.0 MHz (UHF Channel 68) will be used in an area, dependent upon the local allocated UHF channel.

\*(5) - At 1990, this spectrum will be allocated according to conditions existing or foreseeable at that time.

\*(6) - By 1990, all systems should be digital transmission with a two frequency assignment plan.



Other Pertinent Recommendations

1. The military should be formally requested to review their requirements in the 216 - 375 MHz band.
2. The fee structure for radio licences should be reevaluated with the establishment of:
  - a) a selective increase in fees to promote, where practical, use of services alternate to radio systems;
  - b) a fee structure related to amount of spectrum used. (This could be based upon a nominal quantity, possibly the spectrum used by one-way tone-only digital paging).



### Analysis Approach - Explanation

The spectrum of 406-960 MHz is subdivided into three sub-spectrums.

These sub-spectrums are:

- A. 406-470 MHz and 608-614 MHz.
- B. 470-890 MHz (excluding 608-614 MHz).
- C. 890-960 MHz.

Analysis of the three sub-spectrums proceeds in four general stages.

These four stages are:

- I. Past usage trends and subsequent future trends.
- II. Technical developments, new services, and cost considerations.
- III. Social and economic considerations.
- IV. Other considerations.

The format of the analysis in point form is:

	<u>PAGE</u>
I.A .....	13
I.B .....	15
I.C .....	16
II.A .....	18
II.B .....	24
II.C .....	25
III. ....	27
IV. ....	35

## STAGE I

### Past Usage and Subsequent Future Usage Trends

#### I.A. 406-470 MHz and 608-614 MHz

This sub-spectrum is further subdivided into smaller frequency bands as indicated in succeeding paragraphs. Each of these bands is analyzed on a "worst case" basis under the following assumptions and criteria:

- a) assuming past and present trends will continue;
- b) assuming no increase in efficiency of spectrum utilization due to technological developments or new approaches;
- c) accounting for demand pressures from other areas of the spectrum;
- d) assuming no increase in existing frequency sharing levels (see Appendix I.A.5).

NOTE: Neglected is consideration of new services which may increase demands.

Additionally, this sub-spectrum is studied only in the "higher density" geographical areas of Central Region. This confines the study in some bands to within approximately seventy miles of the centers of Winnipeg, Edmonton, Calgary, and Regina.

#### I.A.1. 406-410 MHz

There are no assignments in this band in Central Region. As no trends exist, this band will not be studied further until Stage IV of this report.

#### I.A.2. 410-420 MHz

This band is currently being reserved in Central Region for municipal

safety services and other as yet undetermined services. The small number of assignments existing are not indicative of any trends. This band will not be studied further until Stage IV of this report.

I.A.3. 420-450 MHz

With the exception of 430 MHz and 450 MHz assignments at Churchill, Manitoba, this band is used in Central Region for amateurs only. Usage trends here are difficult if not impossible to determine. This band is, therefore, not studied further. It will be treated arbitrarily in the recommendations of this report.

NOTE: High power radars are employed by the United States in this band.

I.A.4. 450-470 MHz

This band is studied in areas within seventy miles of the centers of Winnipeg, Edmonton, Calgary, and Regina. Potential demand pressures on this band may originate in the bands of 30-50 MHz; 138-144 MHz; 144-150.8 MHz; and 150.8-174 MHz. Given the "worst case" criteria referred to earlier, each of the "demand pressure" bands may increase demand upon the 450-470 MHz band in the manner indicated in Appendix I.A. Each area studied would exhaust (consume) available frequencies in the 450-470 MHz band as follows:

<u>Area</u>	<u>Year of Consumption</u>
Winnipeg	1983
Edmonton	1980
Calgary	1980
Regina	>1990

It should be remembered that there exist a certain number of wideband point-to-point systems (including studio transmitter links) in various

of these bands. These systems further reduce the total number of frequencies available in any area, to an extent which will be determined in a later investigation.

NOTE: i) In Appendix I.A., the 1966-1975 assigned frequencies are obtained from a report entitled "Rate of Channel 'consumption'", issued by V. Sahay of DTS-S, Ottawa on May 20, 1976. The subject report is based upon the domestic frequency list (DFL) data base, but also accounts for frequencies unassignable due to FCC and <sup>RAC</sup>IRAQ assignments.

ii) The 'sharing levels' in Appendix I.A.5. are derived from the Central Region VHF/UHF data base, which is current and accurate.

I.A.5. 608-614 MHz

There are no assignments in this band in Central Region. As no trends exist, this band will not be studied further. It will be treated arbitrarily in the recommendations of this report.

I.B. 470-890 MHz (excluding 608-614 MHz)

This sub-spectrum is currently allocated in Central Region exclusively to UHF television broadcasting.

Current and previous assignment percentages and similar historical data do not relate simply to future needs or developments in this area. A more subjective analysis is required.

The analysis is based on a fundamental premise. Within the next twelve years (1990), the following services will be the maximum required in the cities of Central Region:

- 1 CBC English service
- 1 CBC French service
- 1 CTV English service
- 1 Independent service
- 1 Educational service
- 1 Unforseen service

The above premise has been applied to all cities with a population of 10,000 or greater in Alberta, Saskatchewan, and Manitoba (the Northwest Territories is assumed to be adaptable to decisions which have been based upon the Prairie Provinces). Appendix I.B., Table 1, demonstrates that all services can be supplied without utilization of UHF channels 70 to 83.

It is interesting to realize that 10 of the cities studied have consumed their VHF allocations, while 5 more cities have only one unused VHF allocation. UHF will be required for future expansions.

- NOTE:
- i) Existing programs and data incorporated by Ottawa have been utilized in this study.
  - ii) Existing full-power broadcast services which have been authorized as of December, 1976, are included for completeness in Appendix I.B., Table 2.

I.C. 890-960 MHz

This sub-spectrum is currently utilized in Central Region by fixed point-to-point systems and studio-transmitter links (STL's). The development of usage in this spectrum is studied to determine whether the spectrum is insufficient for present services, or conversely whether sharing arrangements with new services are feasible.

Appendix I.C., Table 1, shows the present distribution of frequency

assignments (not hops) among the various users in each province. Many of the systems in Alberta are situated in or near the large metropolitan centers (Calgary and Edmonton), while in the other provinces (and Northwest Territories) the systems are located in more remote areas (around smaller population centers).

In Table 2 of Appendix I.C., is listed the breakdown of bandwidth utilized for each respective assigned frequency. Most of the assigned frequencies with bandwidths less than 2000 KHz (24 channels or less) are located in Alberta. (This is verified by Table 1 of Appendix I.C., which shows the high percentage of total frequency assignments in Alberta employed for pipeline communications with typical utilization of 24 or fewer voice channel systems).

The major urban areas in Central Region, with the exception of those in Alberta, are minor users of this sub-spectrum, and there is no trend which indicates a future deviation from this situation.

The Alberta situation is currently being explored from the aspect of alternatives to this sub-spectrum for providing communications requirements, particularly for the major urban areas. A report will be completed within the next few months. \*

## STAGE II

### Technical, Service, and Equipment Cost Considerations

This stage of analysis explores the above considerations, which STAGE I assumed constant. The pertinent factors may be generally classified into two groups: a) those factors which increase demand for frequencies; b) those factors which decrease demand for frequencies.

a) Demand Increase Factors:

- i) New services.
- ii) Equipment cost considerations (i.e., new technology causing existing services to be available at lower costs.)

b) Demand Decrease Factors:

- i) Deleted services (due to movement to other spectrum areas).
- ii) Alternate services (i.e., non-radio).
- iii) Spectrum efficiency increase due to:
  - $\alpha$ ) Technological advances.
  - $\beta$ ) New approaches (such as time sharing one or more frequencies, multiple low power assignments, combination of services in one communications media).

Various possible effects of these factors upon developments in Stage I are examined. The applicable time spread is to 1990.

#### II.A. 406-470 MHz and 608-614 MHz

For bands 1 (406-410 MHz), 2 (410-420 MHz), 3 (420-450 MHz), and 5 (608-614 MHz), referral is made to Stage I.

#### II.A.4. 450-470 MHz

##### a) Demand Increase Factors

###### i) New Services

Various services may exhibit a higher growth rate in the future than their current average in each pertinent band (bands listed in I.A.4). Other services are in their infancy and will expand to varying degrees.

Modest demands may be expected from railroad communications<sup>(1)</sup>, transit systems<sup>(2)</sup>, automatic vehicle location systems<sup>(3)</sup>, rural radio telephone systems<sup>(4)</sup>, energy transmission systems<sup>(5)</sup>, alarm monitoring systems<sup>(5)</sup>, and telemedicine<sup>(6,7,8)</sup>. Meteor burst communications<sup>(9,5,10)</sup>, which utilizes 10-100 MHz frequencies, will replace HF communications in many areas, with eventual effects in 450-470 MHz.

High demands may originate from dissatisfied General Radio Service (GRS) users<sup>(11,12)</sup>. A one percent movement from GRS to (say) the 30-50 MHz band would necessitate over 800 additional frequencies in this band in Central Region. This demand is eventually reflected in the 450-470 MHz band.

More frequencies will be required for studio transmitter links (STL's) in 450-470 MHz if the CRTC "suggests" that all AM radio stations also offer an FM service.

There is also the general trend that labour intensive services are increasing in cost and will, therefore, be replaced where applicable by communications systems<sup>(13)</sup>.

###### ii) Equipment Cost Considerations

The greatest demand pressures for frequencies will probably originate with equipment cost reductions.

Microprocessor modules, which have been used in radio equipment only one or two years, will accelerate in usage and will drop from a current \$50.00 price range to \$5.00 within the next two years<sup>(14,15)</sup>. Services supplied by pagers<sup>(16)</sup>, and portable telephones<sup>(17,18,19)</sup>, as well as by mobile radios, will be available to major portions of the consumer market. These demands could not possibly be accommodated with existing approaches.

b) Demand Decrease Factors

i) Deleted Services

Of the existing services in 450-470 MHz and related bands, there is not seen at this time a drop in demand. There is only a possibility of movement of services to other spectrum areas.

As the frequencies of concern are appropriate for land-mobile operations, the logical course is to discourage point-to-point systems in these bands. The fixed services can be accommodated at higher frequencies. This action should apply particularly to wideband (greater than 6 voice channel) systems.

ii) Alternate Services

Counteracting demand for more spectrum are options such as radiating cable for automatic vehicle location systems and road and rail transportation<sup>(20,21)</sup>. Also, time division multiplexed (TDM) coaxial cable is available for rural communications<sup>(22)</sup>. Certainly cable can cost-effectively substitute for backbone radio on pipeline systems<sup>(23)</sup>.

Some of the alternatives are cost-effective and some are not. Many more alternatives would be feasible should the spectrum be assigned a monetary value (more than the token value assigned today). This approach should be applied where possible<sup>(24)</sup>.

II.A.4.b. iii) Spectrum Efficiency

The major decrease in demand for frequencies should definitely originate in this area.

c) Technological Advances

Spectrum may be conserved in many ways, but normally with some economic penalties. There are some major impact possibilities which are current state-of-the-art.

Single sideband transmission would allow 12.5 KHz channel spacings, and thereby double the existing number of available frequencies<sup>(25,26,27,28)</sup>. Some countries, such as England, are studying 6.25 KHz channel spacing (below 100 MHz), although there is a trade-off with intermodulation levels<sup>(29)</sup>.

Where FM radio is employed, its characteristics should be employed to allow closer frequency spacing. VHF radios exist which can be co-located with a 5%-7% frequency spacing<sup>(30)</sup>.

Various types of tone signalling reduce interference and allow closer spacing of assigned frequencies<sup>(31)</sup>.

Utilizing two antennae on mobiles with proper combining circuits is an extension of a technique common in microwave systems. Measurements show, for example, that a mobile system with a reliability of 88% will increase its reliability to 99% with this technique<sup>(32-36)</sup>. This obviously would allow lower effective radiated powers (ERP) and a closer spacing of frequency assignments.

Null steering antennae is a more expensive technique, but one which can also be applied to advantage in some cases<sup>(37,38)</sup>.

New techniques

Finally, use of digital transmission versus analog transmission has great potential. Digital transmission allows savings in time and a greater reliability<sup>(39-46)</sup>. As data becomes more important in mobile communications (even to the extent of a nil requirement for voice communications), the fivefold spectrum advantage of transmitting this type of information over a digital versus analog system further substantiates the case for digital transmission<sup>(47,48)</sup>.

Although there are some initial economic penalties, the long term implications in conservation of frequency spectrum contribute to the attractiveness of the above technological possibilities.

#### II.A.4.b. iii.<sup>B</sup>) New Approaches

The greatest opportunity for satisfying increasing demand lies with new approaches.

One approach which is used to some degree today is assignment of one frequency to more than one user in one area. Time sharing of the assignment is then required<sup>(49)</sup>. The level of sharing in Central Region is shown in Appendix I.A.5. Certainly this level will and should be increased. But this in itself is not the final solution, as it does not allow 100% useage (which is the ideal) of a frequency while maintaining satisfactory (to the user) service.

Another possibility is sharing of frequencies between different services on a coordinated basis. Sharing of land-mobile and UHF television is an example<sup>(50)</sup>. This allows a greater reuse of frequencies, but is accompanied by administrative complications. Situations may exist which warrant implementation of this technique.

Certainly time sharing of many frequencies by many users provides the optimum use of assigned frequencies. Systems approaching this concept are restricted common carrier systems (16,53) paging systems (51,52,54,55), and general land mobile radio service (GLMRS) systems (17,18,19). These types of systems must be encouraged, and within the systems must be encouraged the adoption of optimum techniques (computer or microprocessor controlled frequency selection, digital techniques, etc.). This will be the only way to meet the forecast demand (see Appendix I.A.) for frequencies (i.e., services) in 1990.

Development of the above systems should proceed recognizing that the final arrangement will consist of small zone (or cellular) systems (56,57,58). These systems, more than any other concept, approach 100% useage of assigned fréquences. Although they are not viable at this time in most areas (59), they will be mandatory in many areas by the end of the century. Systems incorporated in the next 25 years should not be allowed to conflict with this general principle, or in any way complicate its eventual implementation.

II.B. 470-890 MHz (Excluding 608-614 MHz)

a) Demand Increase Factors

An increase in demand in Central Region by the year 1990 would only result should a political decision be made to subsidize services over and above the six services referred to in Stage I of this report.

b) Demand Decrease Factors

i) Alternate Services

Cable television is competing successfully with off-air broadcasting in many areas. Where cable is available in Central Region, penetration levels of 70% and higher are common. In many towns, (e.g., Wainwright, Alberta) a cable television head-end provides all or most of television services. The wired-city concept will contribute to this trend<sup>(60,61)</sup>. Although the wired-city idea is approaching slowly in some areas<sup>(62)</sup>, it is nevertheless becoming a reality in towns such as Portage la Prairie, Manitoba, where two-way cable and amplifiers, plus switching are available.

Additionally, direct satellite television broadcasting may have a large impact. One hundred percent penetration is achieved and cost-effectively<sup>(63,66)</sup>.

ii) Spectrum Efficiency Increase

Initiated recently are attempts at upgrading UHF television receivers<sup>(64)</sup>. The objective is to reduce or eliminate as many of the UHF "taboos" as possible<sup>(65)</sup>. Success in this area could increase the effective number of available UHF assignments.

## II.C. 890-960 MHz

### a) Demand Increase Factors

Demand may increase as point-to-point systems move into this sub-spectrum from lower frequencies (due to congestion in lower frequencies) and from higher frequencies (due to higher equipment costs at higher frequencies).

Also, particularly in Alberta, demand may rise with the implementation of more stringent pollution control regulations for pipelines.

### b) Demand Decrease Factors

#### i) Deleted Services

A decrease in demand may occur only in Alberta, and would result from the exhaustion of oil and natural gas reserves.

#### ii) Alternate Services

Should wire line links become less expensive than radio, studio transmitter links (STL's) would move away from radio. This could be encouraged through licence fee structures. The use of satellite, probably around 12 GHz frequencies, could substitute for, in particular, long-haul low capacity systems.

#### iii) Spectrum Efficiency Increase

##### α) Technological Advances

New technology has made possible the re-use of frequencies on some adjacent hops of point-to-point systems<sup>(67)</sup>. This has the potential of effectively increasing the spectrum available.

Digital radio systems use spectrum more efficiently than

analogue systems, and should accordingly be encouraged.

B) New Approaches

Some decrease in demand would originate with an allowance for sharing of systems among utilities.

### STAGE III

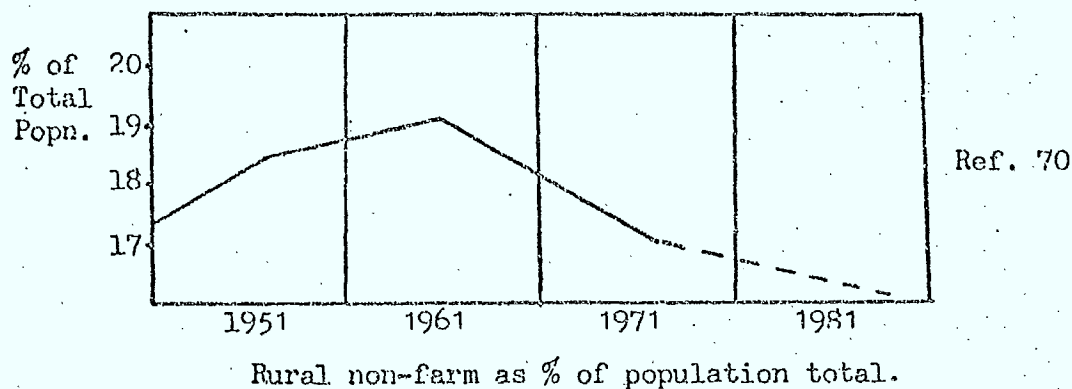
#### Population

To assess spectrum requirement in the band 406-960 MHz we must first know the Canadian population size and where it will be distributed throughout the forecast period. Two possibilities exist:

- 1) That urbanization will continue till 90% plus of the population is urbanized.
- 2) Urbanization will peak at approximately 75-80% and an ex-urbanization move will occur.

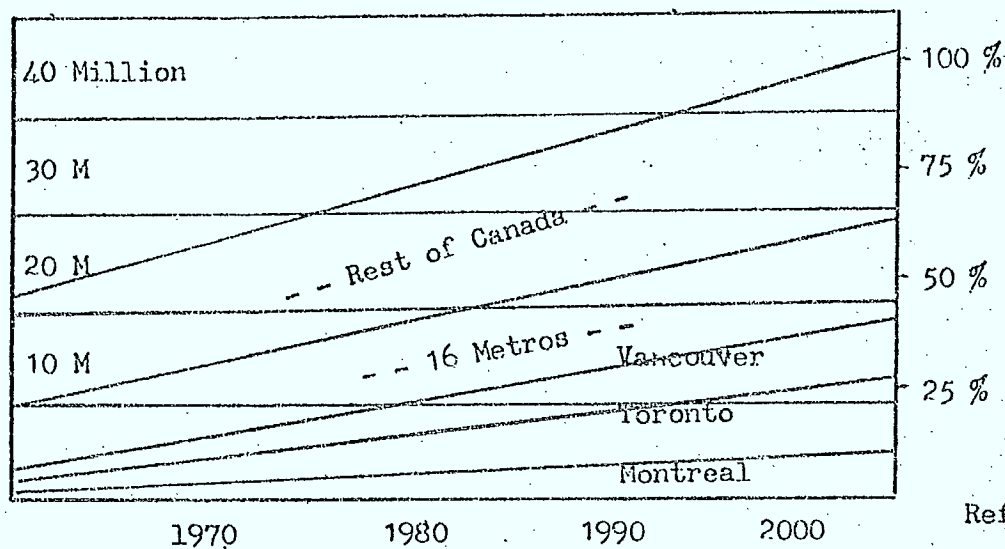
If we consider probabilities, urbanization of 75% has already been surpassed in Ontario and Quebec (82.4% and 80.6% respectively in 1971), while British Columbia had reached 75.7% and Alberta 73.5% by this same period.<sup>68</sup> None of these provinces show any sign of letup in the urbanization process. When we consider that Australia reached an urban population of 88.5% in 1970,<sup>69</sup> it is apparent that population density can rise considerably higher in Canada before it becomes a controlling factor in any ex-urbanization process. Thus, though two possibilities for population distribution are possible, it would appear that 90% plus urbanization is a distinct probability. The ex-urbanization or rural non-farm population may at most provide up-to 10% of the total population with the majority clustered around the larger urban areas within commuting distance of their place of employment. Though some communications demand as a substitute for transportation may be required, it is not

likely to be a significant factor in the Central Region area.



As the foregoing chart indicates, the ex-urbanization process is not as probable as the 90% plus urbanization process. However, though it represents a percentage decrease, this will still mean a rise in real numbers supplying a steady demand on the 450-470 MHz land mobile section of the spectrum.

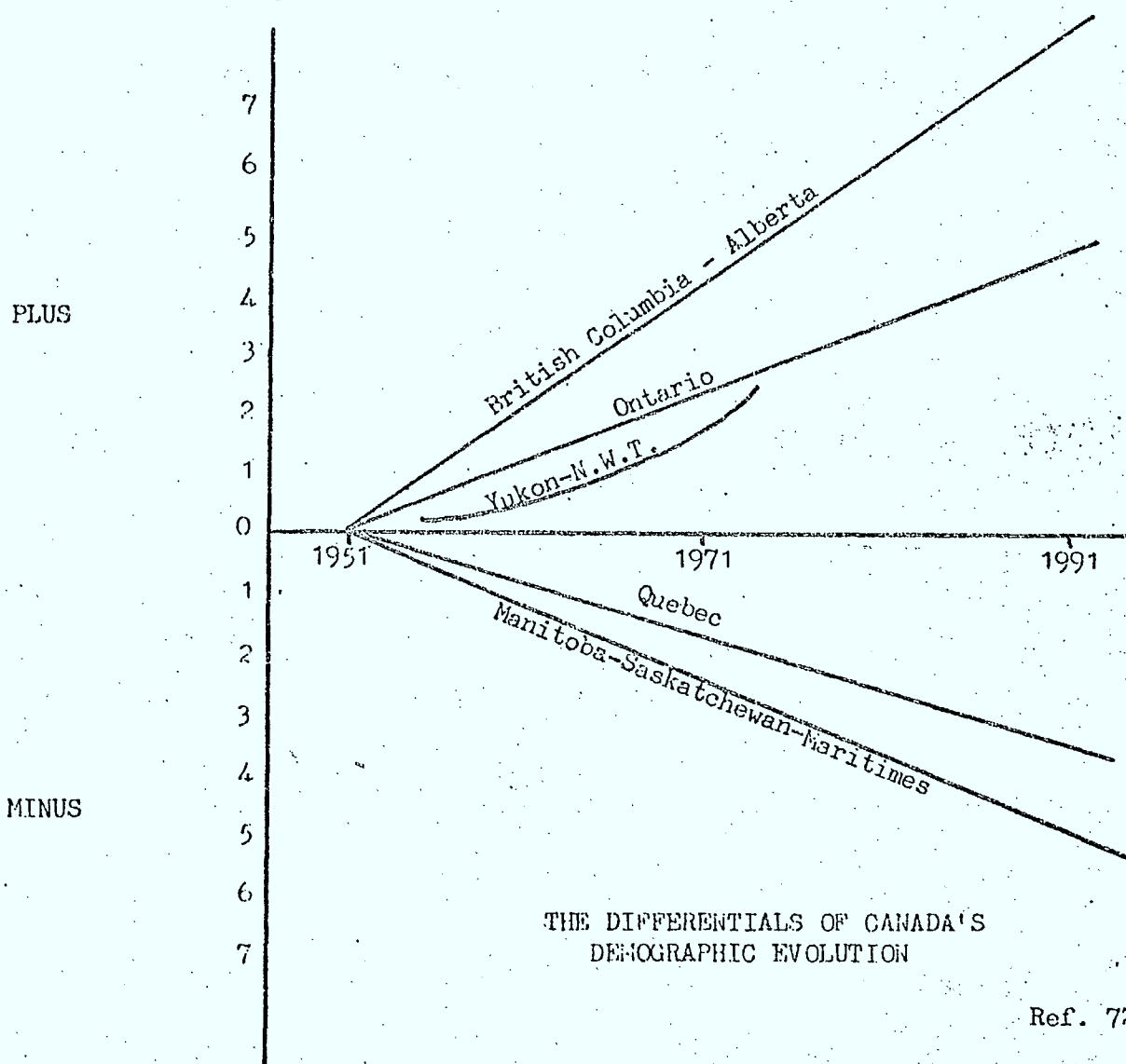
The 1971 population projections for the year 2000 indicates that Canada will consist of 19 metropolitan areas. Montreal, Toronto, and Vancouver will be considerably larger than the remaining 16 metro areas. Central Region will probably have 3 major metro's, namely Edmonton, Calgary, and Winnipeg, with three minor metro's, these being Regina, Saskatoon, and Brandon. This is illustrated by the following chart:



Ref. 71

Projected size of Metropolitan areas to 2000.

Predicted overall Canadian population distribution is expected to take the following long-range pattern.

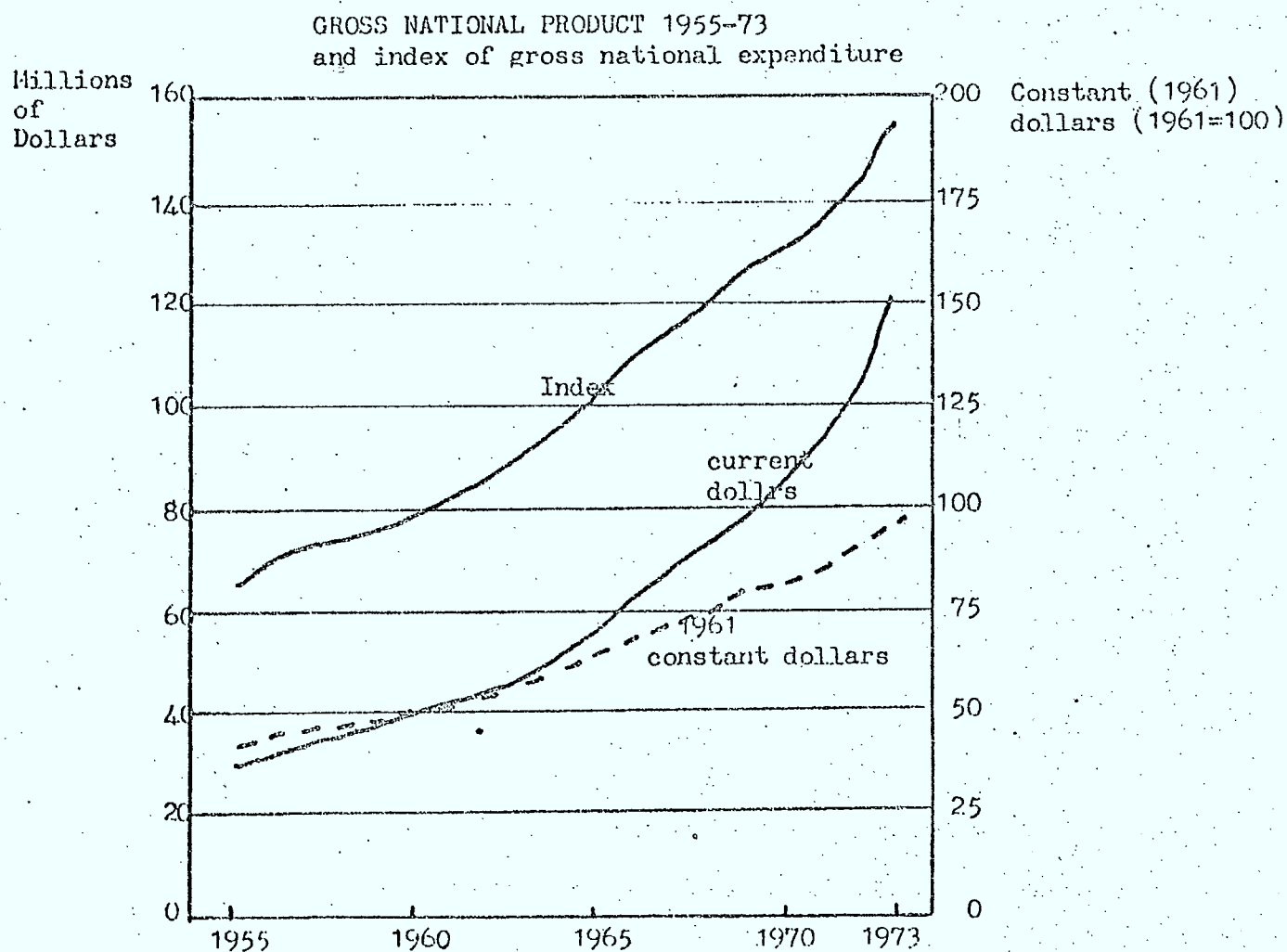


In essence, Saskatchewan and Manitoba will decrease as a percentage in overall population as will Quebec and the Maritimes. However, we must keep in mind that real numbers will slowly increase. The long-range concern for population and subsequent communication requirement for Central Region then will rest primarily in Alberta with Winnipeg also a

large centre. Pressure will be applied to the 890-960 MHz point-to-point sector and as well to the 450-470 MHz land mobile sector of the spectrum.

### Economic Trends

As the attached chart indicates, the Canadian GNP has shown a steady increase.



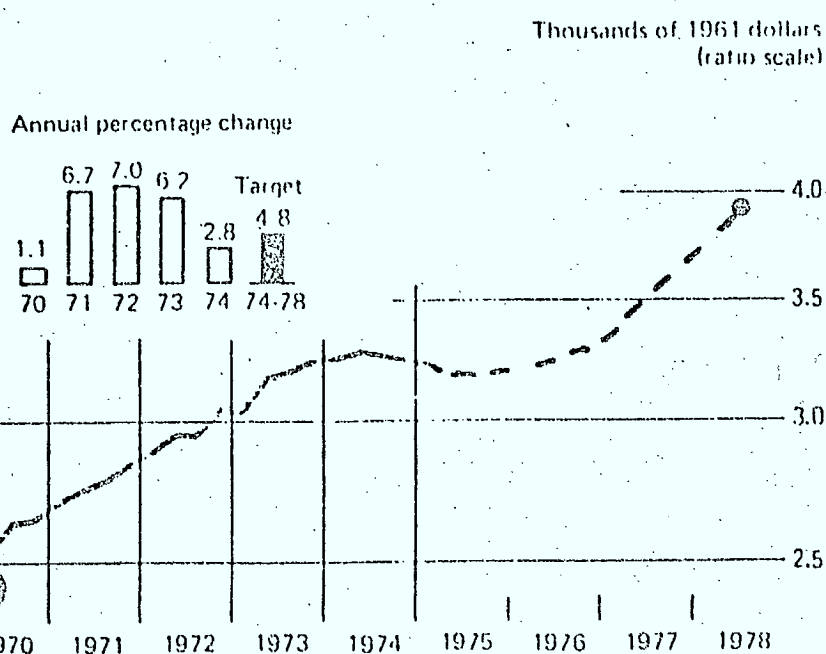
Ref. 73

Though inflation has exaggerated the curve over the latter years, the GNP based on stable 1961 dollars shows a steady rise. GNP predictions are extremely risky but if we assume a straight extrapolation with a built-in 10% inflationary factor, the economy will still be strong in 25 years. Canada has the labour force and the resources to ensure such a probability. This then implies a steadily increasing demand on the 450-470 MHz land mobile and 890-960 point-to-point sections of the radio spectrum.

### Disposable Incomes

Previous increases in disposable income has slowed considerably and even shown a decrease over the past two years. This is indicated by the following chart:

### real disposable income per capita



Gains in real disposable income per capita were substantially lower in 1974 than in the previous three years, on account of the general slowdown in economic activity and the rapid increases in prices.

The indicator for real disposable income per capita calls for an average annual rate of growth of 4.8 per cent over the 1974-78 period. The conjunction of cyclical recovery and favourable fiscal policy to keep the economy on its upward trend is a prerequisite to the attainment of this target.

Ref. 74

Correspondingly, the amount of money available for items affecting communications should have been less. Sales of GRS Radios, however, have soared dramatically over the last year, apparently in contradiction to the amount of money people have to spend on this type of commodity. As the long-range (1978) forecast is for a rise in disposable income, we should expect an increased requirement in communications spending particularly in areas relating to recreational activity. This will primarily affect the land mobile 450-470 MHz portion of the spectrum.

#### Leisure Time

Leisure time is increasing constantly and this trend is likely to continue. As automation increases we can expect to see the 37 hour work week shrink to 35 and ultimately to a 4 or even 3 day work week by the year 2000. This additional leisure time will be filled by entertainment and recreational sport. Some of this entertainment will undoubtedly entail expanded media facilities (Video/Audio) and some spectrum space will have to be allotted to communication requirements for transportation systems and associated recreational activity. Probability is high that this will also place additional pressure on the land mobile portions of the spectrum.

## Northern Development

Northern development has in the past years been primarily resource-based and will in all probability remain so in the foreseeable future. It is unlikely that large metropolitan areas will develop to a point where they will become a communications problem from a spectrum useage point-of-view. What is probable, however, is the requirement for spectrum space for communications control and servicing for such development as gas and oil exploration and delivery systems of Northern resources to Southern markets.

STAGE IV

Other Considerations

IV.A. 406-470 MHz

IV.A.1. 406-410 MHz

Refer to IV.A.2. for discussion.

IV.A.2 410-420 MHz

Recommendations regarding use of this band have previously been forwarded to Ottawa (a copy of the memorandum is included as Attachment A). Summarily, the recommendation states or implies:

a) 414-415 and 419-420

Primary Service : Fixed  
Secondary Service: Mobile

b) 413-414 and 418-419

i) Centres with population of 200,000 or more:

Primary Service : Municipal Safety  
Secondary Service: Municipal Public Transportation  
Systems

ii) Centres with population between 75,000 and 200,000:

Primary Service : All Municipal Services  
Secondary Service: Fixed Services

iii) Low populated areas:

Primary Service : Municipal and Fixed Services

c) 410-413 and 415-418

Common carrier (CTCA) for public land mobile telephone requirements.

There has been discussion to the effect that it may be preferable to move the 410-413 slot from (c) downwards into the 406-410 MHz band. This would provide a separation of transmit/receive frequencies for the mobile telephone systems.



Appendix I.A.

I.A.1. WINNIPEG

TABLE 1.a

Past Progression of Assigned Frequencies

<u>Year</u>	<u>30-50 MHz</u>		<u>138-144 MHz</u>		<u>148-150.8 MHz</u>		<u>150.8-174 MHz</u>		<u>450-470 MHz</u>	
	<u>1*</u>	<u>2**</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>
1966	1	0	3	0	3	0	145	19	17	0
1967	3	300	3	0	4	33	177	22	18	6
1968	3	0	8	267	8	100	191	8	19	6
1969	6	100	8	0	9	13	212	11	24	26
1970	10	67	8	0	15	67	227	7	27	13
1971	11	10	10	25	19	27	250	10	33	22
1972	15	36	10	0	24	26	276	10	45	36
1973	19	27	11	10	30	25	319	16	58	29
1974	31	63	13	18	38	27	357	12	76	31
1975	36	16	16	19	47	24	400	12	85	12

\* Frequencies Assigned (including all previous assignments).

\*\* Growth from Previous Year (%)

TABLE 1.b

<u>Band</u>	<u>Compounded Annual Growth</u>		<u>Standard Deviation</u>
	<u>1963-1973</u>	<u>1970-1975</u>	<u>1970-1975</u>
30-50 MHz	52%	29%	20.8%
138-144 MHz	20%	15%	9.7%
148-150.8 MHz	39%	26%	1.3%
150.8-174 MHz	12%	12%	2.5%
450-470 MHz	19%	26%	9.3%

TABLE 1.c

\*Predicted Future Progression of Assigned Frequencies

<u>Year</u>	<u>30-50 MHz</u> (1000 Avail)	<u>138-144 MHz</u> (200 Avail)	<u>148-150.8 MHz</u> (88 Available)	<u>150.8-174 MHz</u> (691 Available)	<u>450-470 MHz</u> (800 Avail)
1977	.	.	75	.	.
1978	.	.	94	.	.
1979	.	.	118	629	.
1980	.	.	149	705	270
1981	.	.	188	790	340
1982	.	.	237	884	429
1983	.	.	299	990	540
1984	.	.	376	1,109	680
1985	.	.	474	1,242	857
1986	.	.	597	1,391	1,080
1987	.	.	753	1,558	1,361
1988	986	.	948	1,745	1,715
1989	1,272	.	1,195	1,955	2,161
1990	1,641	.	1,505	2,189	2,723

\* i) Using 1970-1975 growth rates (See Table 1.b)

ii) Assuming unlimited available frequencies

NOTE: Figures are reproduced only as they approach the actual number of frequencies available in each band.

TABLE 1.d

Predicted Number of Assigned Frequencies in 450-470 MHz with  
Additional Load from Excessive Requirements in Other Bands

<u>Year</u>	
1980	345
1981	539
1982	771
1983	1,050
1984	1,386
1985	1,794
1986	2,289
1987	2,893
1988	3,629
1989	4,804
1990	6,279

←--- Available Frequencies (800) Exceeded in 1983.

I.A.2. EDMONTON

TABLE 2.a

Past Progression of Assigned Frequencies

<u>Year</u>	<u>30-50 MHz</u>		<u>138-144 MHz</u>		<u>148-150.8 MHz</u>		<u>150.8-174 MHz</u>		<u>450-470 MHz</u>	
	<u>1*</u>	<u>2**</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>
1966	4	0	2	100	3	0	157	30	13	117
1967	6	50	2	0	4	33	191	22	17	31
1968	10	67	10	400	7	75	222	16	21	24
1969	11	10	11	10	7	0	240	8	26	24
1970	12	9	14	27	8	14	281	17	35	35
1971	18	50	18	29	8	0	321	14	67	91
1972	21	17	26	44	10	25	369	15	91	36
1973	32	52	26	0	33	230	420	14	118	30
1974	42	31	29	12	37	12	466	11	143	21
1975	62	48	46	59	40	8	492	6	161	13

\* Frequencies Assigned (including all previous assignments)

\*\* Growth from Previous Year (%)

TABLE 2.b

<u>Band</u>	<u>Compounded Annual Growth</u>		<u>Standard Deviation</u>
	<u>1963-1973</u>	<u>1970-1975</u>	<u>1970-1975</u>
30-50 MHz	35%	39%	15.2%
138-144 MHz	44%	27%	23.8%
148-150.8 MHz	41%	38%	100.1%
150.8-174 MHz	15%	12%	3.7%
450-470 MHz	37%	36%	30.9%

TABLE 2.c

\*Predicted Future Progression of Assigned Frequencies

<u>Year</u>	<u>30-50 MHz</u> (1000 Avail)	<u>138-144 MHz</u> (200 Avail)	<u>148-150.8 MHz</u> (88 Available)	<u>150.8-174 MHz</u> (691 Available)	<u>450-470 MHz</u> (800 Avail)
1977	.	.	76	.	.
1978	.	.	105	691	405
1979	.	.	145	774	551
1980	.	.	200	867	749
1981	.	193	277	971	1,019
1982	.	245	381	1,088	1,385
1983	864	311	526	1,218	1,884
1984	1,201	395	726	1,364	2,563
1985	1,669	502	1,002	1,528	3,485
1986	2,320	638	1,383	1,711	4,740
1987	3,225	810	1,908	1,917	6,446
1988	4,483	1,029	2,633	2,147	8,767
1989	6,232	1,306	3,634	2,404	11,922
1990	8,662	1,659	5,015	2,693	16,215

- \* i) Using 1970-1975 growth rates (See Table 2.b).
- ii) Assuming unlimited available frequencies

NOTE: Figures are reproduced only as they approach the actual number of frequencies available in each band.

TABLE 2.d

Predicted Number of Assigned Frequencies in 450-470 MHz with  
Additional Load from Excessive Requirements in Other Bands

1975	161	
1976	219	
1977	298	
1978	422	
1979	611	
1980	957	←--- Available Frequencies (800) Exceeded in 1980.
1981	1,408	
1982	2,040	
1983	2,880	
1984	4,190	
1985	6,127	
1986	8,733	
1987	12,247	
1988	17,000	
1989	23,439	
1990	32,185	

I.A.3. CALGARY

TABLE 3.a

Past Progression of Assigned Frequencies

Year	30-50 MHz		138-144 MHz		148-150.8 MHz		150.8-174 MHz		450-470 MHz	
	<u>1*</u>	<u>2**</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>
1966	4	100	2	0	8	14	144	21	2	-
1967	5	25	2	0	9	13	177	23	2	0
1968	8	60	9	350	11	22	212	20	7	250
1969	10	25	9	0	11	0	225	6	11	57
1970	14	40	9	0	11	0	255	13	14	27
1971	19	36	11	22	11	0	284	11	20	43
1972	31	63	17	55	15	36	331	17	33	65
1973	41	32	27	59	19	27	375	13	59	79
1974	60	46	33	22	35	84	417	11	79	34
1975	74	23	52	58	42	20	454	9	97	23

\* Frequencies Assigned (including all previous assignments)

\*\* Growth from Previous Year (%)

TABLE 3.b

Band	Compounded Annual Growth		Standard Deviation
	<u>1963-1973</u>	<u>1970-1975</u>	<u>1970-1975</u>
30-50 MHz	39%	40%	15.3%
138-144 MHz	45%	42%	19.5%
148-150.8 MHz	13%	31%	31.4%
150.8-174 MHz	15%	12%	3.0%
450-470 MHz	62%	47%	23.0%

TABLE 3.c

\*Predicted Future Progression of Assigned Frequencies

<u>Year</u>	<u>30-50 MHz</u> (1000 Avail)	<u>138-144 MHz</u> (200 Avail)	<u>148-150.8 MHz</u> (88 Available)	<u>150.8-174 MHz</u> (691 Available)	<u>450-470 MHz</u> (800 Avail)
1977	.	.	72	.	210
1978	.	149	94	.	308
1979	.	211	124	714	453
1980	.	300	162	800	666
1981	.	426	212	896	979
1982	780	605	278	1,004	1,439
1983	1,092	860	364	1,124	2,115
1984	1,529	1,221	477	1,259	3,109
1985	2,140	1,733	625	1,410	4,570
1986	2,997	2,461	819	1,579	6,718
1987	4,195	3,495	1,073	1,769	9,876
1988	5,873	4,963	1,405	1,981	14,518
1989	8,223	7,048	1,841	2,219	21,341
1990	11,512	10,008	2,412	2,485	31,371

\* i) Using 1970-1975 growth rates (See Table 3.b)

ii) Assuming unlimited available frequencies

NOTE: Figures are reproduced only as they approach the actual number of frequencies available in each band.

TABLE 3.d

Predicted Number of Assigned Frequencies in 450-470 MHz with  
Additional Load from Excessive Requirements in Other Bands

<u>Year</u>	
1976	143
1977	210
1978	314
1979	500
1980	869 <--- Available Frequencies (800) Exceeded in 1980.
1981	1,454
1982	2,267
1983	3,496
1984	5,536
1985	8,419
1986	12,515
1987	18,349
1988	26,681
1989	38,613
1990	55,729

I.A.4. REGINA

TABLE 4.a

Past Progression of Assigned Frequencies

Year	30-50 MHz		138-144 MHz		148-150.8 MHz		150.8-174 MHz		450-470 MHz	
	<u>1*</u>	<u>2**</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>
1966	6	20	0	0	1	0	67	26	5	0
1967	8	33	0	0	2	100	77	15	5	0
1968	10	25	6	-	4	100	86	12	8	60
1969	10	0	7	17	5	25	98	14	8	0
1970	13	30	8	14	6	20	101	3	10	25
1971	15	15	8	0	7	17	113	12	10	0
1972	20	33	8	0	7	0	127	12	10	0
1973	22	10	8	0	9	29	146	15	14	40
1974	26	18	9	13	10	11	161	10	17	21
1975	32	23	11	22	10	0	186	16	23	24

\* Frequencies Assigned (including all previous assignments)

\*\* Growth from Previous Year (%)

TABLE 4.b

Band	Compounded Annual Growth		Standard Deviation
	<u>1963-1973</u>	<u>1970-1975</u>	<u>1970-1975</u>
30-50 MHz	20%	20%	8.8%
138-144 MHz	-	7%	10.1%
148-150.8 MHz	37%	11%	12.3%
150.8-174 MHz	12%	13%	2.4%
450-470 MHz	16%	18%	17.2%

TABLE 4.c

\*Predicted Future Progression of Assigned Frequencies

<u>Year</u>	<u>30-50 MHz</u> (1000 Avail)	<u>138-144 MHz</u> (200 Avail)	<u>148-150.8 MHz</u> (88 Available)	<u>150.8-174 MHz</u> (691 Available)	<u>450-470 MHz</u> (800 Avail)
1985	.	.	.	.	120
1986	.	.	.	713	142
1987	.	.	.	806	168
1988	.	.	.	911	198
1989	.	.	.	1,029	233
1990	.	.	.	1,163	275

- \* i) Using 1970-1975 growth rates (See Table 4.b)
- ii) Assuming unlimited available frequencies

NOTE: Figures are reproduced only as they approach the actual number of frequencies available in each band.

TABLE 4.d

<u>Year</u>	<u>Predicted Number of Assigned Frequencies in 450-470 MHz with</u> <u>Additional Load from Excessive Requirements in Other Bands</u>
1985	120
1986	142
187	203
1988	338
1989	491
1990	667 ←--- Does Not Exceed Available Frequencies by 1990.

I.A.5

Sharing Levels\* - December 22, 1976

<u>30-50 MHz</u>												Total Assigned Frequencies
(% of Frequencies Assigned Only Once, Twice, etc.)												
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>&gt;10</u>	
Winnipeg	71.8	20.5	2.6	-	-	-	-	2.6	-	-	-	39
Edmonton	67.7	26.2	3.1	1.5	-	1.5	-	-	-	-	-	65
Calgary	72.7	22.7	4.5	-	-	-	-	-	-	-	-	88
Regina	84.6	5.1	5.1	-	-	-	-	-	-	-	5.1	39

<u>138-144 MHz</u>												Total Assigned Frequencies
(% of Frequencies Assigned Only Once, Twice, etc.)												
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>&gt;10</u>	
Winnipeg	85.7	14.3	-	-	-	-	-	-	-	-	-	28
Edmonton	65.3	14.3	6.1	-	2.0	6.1	2.0	-	2.0	-	2.0	49
Calgary	72.4	13.8	1.7	-	3.4	1.7	3.4	1.7	1.7	-	-	58
Regina	73.9	26.1	-	-	-	-	-	-	-	-	-	23

<u>148-150.8 MHz</u>												Total Assigned Frequencies
(% of Frequencies Assigned Only Once, Twice, etc.)												
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>&gt; 10</u>	
Winnipeg	68.3	22.2	4.8	1.6	-	-	3.2	-	-	-	-	63
Edmonton	50.0	25.0	13.6	6.8	-	-	-	-	-	2.3	2.3	44
Calgary	57.1	22.4	10.2	4.1	-	2.0	-	-	2.0	-	2.0	49
Regina	80.0	13.3	6.7	-	-	-	-	-	-	-	-	15

\*Within 70 miles of the centers of the respective cities.

150.8-174 MHz

(% of Frequencies Assigned Only Once, Twice, etc.)

	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>&gt; 10</u>	Total Assigned Frequencies
Winnipeg	38.9	16.0	6.1	2.8	2.5	7.8	7.8	7.8	7.8	-	2.6	643
Edmonton	44.7	23.8	13.4	6.2	2.1	1.7	0.8	1.5	0.8	1.1	4.0	530
Calgary	45.4	27.2	11.5	3.7	3.3	1.2	2.0	1.0	1.0	0.8	2.9	511
Regina	70.2	12.2	9.0	1.6	1.6	0.4	1.2	0.4	1.2	0.8	1.2	245

450-470 MHz

(% of Frequencies Assigned Only Once, Twice, etc.)

	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>&gt; 10</u>	Total Assigned Frequencies
Winnipeg	91.7	7.3	0.9	-	-	-	-	-	-	-	-	109
Edmonton	70.3	18.1	3.8	2.7	2.2	1.1	-	-	0.5	0.5	0.5	182
Calgary	65.4	19.9	7.4	1.5	0.7	2.9	1.5	-	0.7	-	-	136
Regina	92.1	2.6	5.3	-	-	-	-	-	-	-	-	38

Appendix I.B.

TABLE 1

	<u>Channel Now Allocated</u>	<u>Additional Allowable Allocations</u>
<u>ALBERTA</u>		
Calgary	2,4,9,16,22,38,44,50,73,79	(not required)
Edmonton	3,5,11,13,17,23,46,52,58,74,80	(not required)
Grande Prairie	10,13,51,80	18,34,68
Lethbridge	7,10 <sup>L</sup> ,13,23,58,64,80	(not required)
Lloydminster	2,4,8,16 <sup>L</sup>	25,43
Medicine Hat	6,8,49,65,71	20,37
Red Deer	6,8,31,59,65	47
<u>SASKATCHEWAN</u>		
Regina	2,9,13 <sup>L</sup> ,18,24,47,53,71,77	(not required)
Moose Jaw	4,7,16,26,55	35,44
Swift Current	5,12,40,56	14,27
Saskatoon	8,11,13 <sup>L</sup> ,17,23,33,54,70,76	(not required)
North Battleford	6,7,39,71	14,49,58
Prince Albert	3 <sup>L</sup> ,5,9 <sup>L</sup> ,18,24,77	50
<u>MANITOBA</u>		
Brandon	2 <sup>L</sup> ,4,5,21,37,63	(not required)
Portage la Prairie	17,38,(but covered by Winnipeg)	(not required)
Thompson	4,5 <sup>L</sup> ,7,9,16	(many additional possible)
Winnipeg)	3,6,7,9,13,20,26,36,42,48,71,77,83	(not required)

NOTE: With the exception of limited allocations (indicated by an <sup>L</sup>), all of the above are full power allocations. All existing UHF allocations and "taboos" have been accounted for.

TABLE 2

Authorized Services - December, 1976

<u>Alberta</u>	<u>CBC ENGLISH</u>	<u>CBC FRENCH</u>	<u>CTV ENGLISH</u>	<u>OTHER</u>
Calgary	CBRT (Ch 9)	-	CFCN (Ch 4)	CFAC (Ch 2)
Edmonton	CBXT (Ch 5)	CBXFT (Ch 11)	CFRN (Ch 3)	CITV (Ch 13)
Grande Prairie	CBXAT (Ch 10)	-	CFRN (Ch 13)	-
Lethbridge	CBRT (Ch 10)	-	CRCN (Ch 13)	CJOC (Ch 7)
Lloydminster	CKSA (Ch 2)	-	CITL (Ch 4)	-
Medicine Hat	CHAT (Ch 6)	-	CFCN (Ch 8)	-
Red Deer	CKRD (Ch 6)	-	CFRN (Ch 8)	-
 <u>Saskatchewan</u>				
Regina	CBKRT (Ch 9)	CBKFT (Ch 13)	CKCK (Ch 2)	-
Moose Jaw	CBKMT (Ch 4)	-	CKMJ (Ch 7)	-
Swift Current	CJFB (Ch 5)	-	CKMC (Ch 12)	-
Saskatoon	CBKST (Ch 11)	-	CFQC (Ch 8)	-
North Battleford	CKBI (Ch 7)	-	CFQC (Ch 6)	-
Prince Albert	CKBI (Ch 5)	-	-	-
 <u>Manitoba</u>				
Brandon	CKX (Ch 5)	-	CKYB (Ch 4)	-
Portage la Prairie	-	-	-	-
Thompson	CBWTT (Ch 7)	CBWFT (Ch 5)	CKYT (Ch 9)	-
Winnipeg	CBWT (Ch 6)	CBWFT (Ch 3)	CKY (Ch 7)	CKND (Ch 9)

Appendix I.C.

TABLE 1

Cumulative Licensed Frequencies (890-960 MHz)

	<u>Alberta</u>			<u>Sask.</u>			<u>Manitoba</u>			<u>N.W.T.</u>		
	<u>C.C.*</u>	<u>P.**</u>	<u>O.***</u>	<u>C.C.</u>	<u>P.</u>	<u>O.</u>	<u>C.C.</u>	<u>P.</u>	<u>O.</u>	<u>C.C.</u>	<u>P.</u>	<u>O.</u>
1966	5	0	5	0	12	4	0	0	3	0	0	0
1967	7	1	6	0	12	4	0	0	3	0	0	0
1968	7	7	6	0	24	4	0	0	3	0	0	0
1969	7	7	6	0	24	4	0	0	5	0	0	0
1970	7	7	6	0	24	6	0	0	5	0	0	0
1971	14	9	6	0	24	6	0	0	5	0	0	0
1972	21	12	6	25	24	6	4	0	5	10	0	0
1973	21	31	6	53	24	6	4	0	5	18	0	0
1974	33	45	6	81	24	6	10	0	5	18	0	0
1975	51	73	8	141	24	6	16	0	5	22	0	0
1976 <sup>#</sup>	76	77	8	189	24	6	32	0	5	26	0	2

\* Common Carrier

\*\* Pipeline

\*\*\* Other

<sup>#</sup> As of November 1, 1976.

NOTE: This sub-spectrum became popular in 1972, probably due to Farinon equipment.

TABLE 2

<u>Bandwidth (KHz)</u>	<u>Frequencies (Number of)</u>
<500	50
500-1000	19
1000-1500	26
1500-2000	10
2000-2500	15
2500-3000	108
3000-3500	61
3500-4000	148
4000	8

NOTE: The approximate range of usual bandwidths for a particular number of voice channels are as follows:

12 Channels	567 - 1022 KHz
24 Channels	705 - 2716 KHz
60 Channels	2120 - 3640 KHz
120 Channels	2850 - 4596 KHz
(STL's)	(<500 KHz)



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TO  
A  
DGTR: J. DeMercadoFROM  
DE  
RDC: W. A. R. Johnston

SECURITY CLASSIFICATION DE SECURITE

OUR FILE / N. REFERENCE

6110-24 (RCES)

YOUR FILE / V. REFERENCE

DATE

January 4, 1977

SUBJECT  
OBJETSub-Allocation of Frequencies in the 410-414 and 415-419 MHz Bands  
for Municipal Services

The frequencies presently available for municipal services in the VHF and UHF bands cannot accommodate future growth requirements for these services without a considerable amount of hardship. This hardship is primarily due to the limited number of available RF channels in the bands which were sub-allocated for municipal services. This necessitates the use of frequencies outside this sub-allocation when additional radio channels are required. In most cases the existing radio equipment is incompatible for this type of expansion.

Preliminary forecasts for Edmonton and Winnipeg indicate that at least 30 duplex pairs are required by the year 1985 for the municipal safety services. To prevent "boxing in" of these services the Central Region intends to open the sub-bands 413-414 MHz and 418-419 MHz for municipal safety services. It is intended to use the following criteria.

## I. Centres with populations of 200,000 or more

Primary Service: Municipal Safety (Police, Fire, and Ambulance)Secondary Service: Municipal Public Transportation Systems

## II. Centres with population between 75,000 and 200,000

Primary Service: All municipal servicesSecondary Service: Fixed Service

## III. Low populated areas

Primary Service: Municipal and Fixed

The reason for selecting the 413-414 and 418-419 MHz slots is two-fold.

1. These slots are adjacent to the 414-415 and 419-420 slots which are presently allocated for the fixed service. There is a great demand, in the remote areas, for fixed systems which require capacities equivalent to 12-24 voice channels. Since in these areas criteria III applies some existing congestion will be alleviated by the arrangement suggested.

2. With a change in technology, such as, software controlled digital systems, it is possible at a future date, municipal services could use a single integrated system. Such a system may require less than a 1 MHz wide slot. When this materializes part of suggested spectrum can be allocated to the fixed service at a later date.

The selection of the municipal sub-allocations will also leave two 3 MHz slots. These slots can be used for the CTCA requirements. The chairman of the CTCA, Mr. G. Hauch of the Manitoba Telephone System (MTS) has indicated that the proposed sub-allocation does not have an adverse impact on the CTCA proposal submitted to the Department.

The Central Region has to assign frequencies for the Winnipeg and Edmonton systems by the end of January 1977, and it would be appreciated to receive your comments by January 26, 1977. If these comments are favourable, arrangements should be made to insert an appropriate statement in SRSP-501.



W. A. R. Johnston  
Regional Director  
Central Region

c.c. DGTN, J. Gilbert  
DXS, W. W. Scott  
RDA  
RDO  
RDQ  
RDP  
RCR  
RCE

DTS -- W. J. Wilson

RDC - W. A. R. Johnston

SECURITY CLASSIFICATION DE SÉCURITÉ
OUR FILE / N <sup>O</sup> DE RÉFÉRENCE 6110-24 (RCES)
YOUR FILE / V <sup>OTRE</sup> RÉFÉRENCE
DATE October 15, 1976

SUBJECT / OBJET  
WIDE AREA PAGING

(The use of radio links to interconnect local paging systems.)

This refers to your memorandum with attached report, dated September 10, 1976, concerning the MacLean-Hunter (M-H) application for a multipoint distribution system (MDS) to serve a paging network in the Toronto area.

The report, entitled "Wide Area Paging", actually is a survey to determine the best suitable way to accommodate the MacLean-Hunter application. The rationale used for this application then forms the background to the proposed use of the 2500 MHz band.

Although the 2500 MHz band appears to be the most suitable frequency band, from a technical point of view for an MDS, the use of point-to-point radio links to interconnect, and the use of MDS to serve various paging systems, raises the question whether such applications should be entertained before a policy has been adopted for wide area paging.

It is felt that with the non-existence of such a policy, the allocation of frequency band to accommodate wide area paging systems is premature.

The questions which should be considered can be summarized as follows:

1. What is the Department's view on wide area paging?
2. If wide area paging is allowed:
  - a) should such a system employ "tone-only" or "tone plus voice"?
  - b) How many competing systems should be allowed?
  - c) Should radio trunking systems be permitted to interconnect systems in various cities or towns, or should the interconnection be supplied by the Telco in that area?
  - d) To what extent should wide area voice paging be allowed in areas where SWAP exists?

On Page 3 of the report, alternatives to the proposed Maclean-Hunter applications are considered. The Central Region would offer the following comments on these alternatives:

1. The present trend is towards the use of packet broadcasting, i.e. Bell Canada's SWAP is now in operation in parts of Ontario and Quebec, paging systems in Amsterdam, Vienna and Chicago employ digital techniques. These techniques are also considered for the Eurocom concept. Packet broadcasting is also utilized to distribute digitized information to mobile printers and other display devices.
2. Voice paging does not represent an effective use of the radio spectrum.
  - a) The capacity is 1/50th or less than that of a tone paging system.
  - b) A higher EIRP is required for the same coverage area.
  - c) Tone paging systems can use up to a single frequency for ton transmitters that are sequentially activated.
  - d) Voice paging transmitters have to be phased within close tolerance, making the use of telephone lines more expensive on account of phase and delay equalizers.
  - e) Preliminary results of the Bell SWAP system indicate public acceptance and good growth.
3. Storage devices are state-of-the-art, but availability depends on the market potential, i.e. the deployment of voice systems instead of digital paging systems may have an adverse effect on further development of storage devices.
4. Landlines are possible with the appropriate delay and phase equalizers. Private line service at \$5/mile/month could be more economical compared to a microwave system, especially when in cost comparison the criteria of NSP115 are used.

The allocation of a frequency band for an RDS system will undoubtedly favour a further deployment of area wide voice paging systems.

It is recommended that the use of a radio system for the distribution of paging signals be kept in abeyance until a policy for the paging and other RCC types of systems has been adopted, and that a meeting be held between Headquarters' and Regional staff members to discuss these matters in more detail.

Please inform me on the action to be taken by Headquarters.

W. A. R. JOHNSTON

W. A. R. Johnston  
Regional Director  
Central Region

HT:bg

cc DGTN - J. Gilbert

RDP

RDO

RLQ

RDA ✓

RCR

RCE



## THE INTRODUCTION OF NEW FACILITIES TO THE LAND MOBILE MARKET

### Introduction.

The basic data for this appendix were obtained from a survey carried out under contract for the Spectrum & Radio Systems Policy Branch of the federal Department of Communications over the period July 1975 to July 1976. The study was carried out as a survey of users of land mobile radio in an attempt to determine certain parameters of their usage as well as their present and future needs. The survey was approved by the Special Surveys Coordination Division of Statistics Canada with respect to study objectives, methodology and content. The data from the survey respondents was coded and processed by computer to form the statistical outputs which are presented later in this report. Respondents to the survey were segregated into three main groups:

1. Business and commercial users
2. Federal and provincial users
3. Municipal users.

It should be noted that the municipal category contained the emergency services, such as police, fire and ambulance.

### Objectives of Survey.

The objectives of the survey were to gather data necessary to enable the Department of Communications:

1. to trace the historical pattern of land mobile radio development within user categories and geographic regions of Canada;
2. to assess the types of services provided by mobile radio, the prevalent types of technical features of mobile radio systems, and the extent of usage;
3. to assess the probability of adoption of new land mobile radio facilities and services.

### Methodology.

Question 18 of the survey (shown as an attachment) refers to the possibility of incorporating new facilities into the land mobile radio systems of existing users. This question was asked of each of the three main types of users and the responses have been aggregated. These are shown in Tables 1, 2, 3 and 4, referring to the responses of

1. Business and Commercial
2. Federal and Provincial
3. Municipal, and
4. All Respondents to the survey respectively.

Although the total number of responses is small in comparison to the total number of land mobile radio systems in Canada, the sample can be expected to give an assessment of the probability of incorporating new facilities into the systems of existing users in the future.

An assessment of the estimated spectrum requirements for operation of each of the new services listed in Question 18 has been made. These estimates range from no additional bandwidth or channel requirements (but increased loading) for particular services to a full additional land mobile channel for other services. An example of the first case would be Automatic Vehicle Identification while an example of the latter situation could be services such as Facsimile. Table 5 is the estimate of spectrum required for the operation of each service.

### Observations

#### (a). Summary of all User Categories.

Out of a total of 630 respondents, of all three user classes, approximately 230 did not answer one of the sub-questions.

##### Summary of responses:

- 3% now utilize some form of new facility as specified in Question 18.
- 11% have no information on these new facilities and declined to comment on possible usage.
- 71% will not use new facilities.
- 7% undecided as to possible usage.
- 8% definitely will use new facilities.

Out of all classes of respondents who stated they would incorporate new facilities into their systems:

- 50 stated they would incorporate new facilities within the next 5 years.
- 8 only respondents stated that incorporation of new facilities would be beyond 5 years from the 1975-76 survey period.

On a summary basis, 10% of all classes of respondents expressed a definite viewpoint in support of the incorporation of new facilities (no-Yes in the Tables), and 86% of these indicated such facilities would be incorporated within the next five years.

#### (b). Spectrum Requirements for New Facilities.

As shown in Table 5, out of 11 new facilities, 6 would definitely require use of an additional channel and a further three could utilize the existing channel adding to its utilization only two of the facilities were anticipated to have a negligible effect on spectrum requirements.

## CONCLUSIONS.

1. The new facilities listed in the survey appear not to have been widely marketed at this point due to the relatively large proportion (11%) of survey respondents unfamiliar with them.
2. Although not widely marketed, 3% of existing systems already are making use of some new facilities and an additional 8% indicated that they intended to incorporate such new facilities, most within the next five years. Therefore, approximately 11% of the existing land mobile system markets will form a base for the marketing of new facilities. When sold on a wider basis, the market for such new facilities should be considerably larger than this 11% figure.
3. Introduction of new facilities requires an additional channel, or at least, increased loading of the existing channel in most cases. From a review of Table 5, the additional overall spectrum requirement arising out of an 11% market penetration for new services would amount to approximately 8% (ie. a land mobile system spectrum requirements will, in future, be approximately 8% greater due to the use of new facilities than if conventional land mobile systems were in use).
4. Although the sample size for the survey was small, it was representative of the mobile user population. Due to its small size, extrapolation of the figures above over the whole mobile population would not likely give an accurate assessment of future use; however, lacking further data this report can serve as an indication of future needs.

TABLE 5

SPECTRUM REQUIREMENTS FOR NEW FACILITIES

NEW FACILITIES	CHANNEL REQUIREMENTS		
	Additional	Increased Loading	No Spectrum Effect
(A) FACSIMILE	X		
(B) TELETYPE (HARD COPY)	X		
(C) DATA TERMINAL (1) From Dispatcher to Mobile (2) From Mobile to Dispatcher	X		
	X		
(D) SLOW SCAN TELEVISION (1) From Dispatcher to Mobile (2) From Mobile to Dispatcher	X		
(E) COMPUTER ASSISTED DISPATCH		X	
(F) COMPUTER INPUT FROM VEHICLE	X		
(G) COMPUTER RETRIEVAL FROM VEHICLE	X		
(H) INDIVIDUAL SELECTIVE SIGNALLING			X
(I) SELECTED GROUP (NOT "ALL-CALL") SIGNALLING			X
(J) AUTOMATIC VEHICLE IDENTIFICATION		X	
(K) AUTOMATIC VEHICLE LOCATION		X	

## FUTURE

3. There are a number of facilities that are technically feasible now and will, in all probability, become available on mobile radio systems. Some of those facilities have been listed below. If you are likely to incorporate any facility (i.e. if you check either "Likely" or "Definitely" which are in the shaded area) indicate the time frame of possible application by checking the more appropriate box of the next two. If the facility is already in use, check the first column.

FOR EXPLANATION OF THE FOLLOWING  
TERMS, SEE DEFINITIONS

[illegible]

JUL 18, 1977

## SPECIAL FACILITIES/INTRODUCTION OF NEW TECHNOLOGY

PAGE 1

CLASS OF USER  
SPECILA FACILITIES SUMMARY  
SPECILA FACILITIES SUMMARY

## BUSINESS &amp; COMMERCIAL

FACILITY	00	01	02	03	04	05	06	07	08	09	NO	YES	TOTAL
01. FACSIMILIE	137	6	27	70	39	7	2	1	1	1	109	3	297
02. TELETYPE	137	5	22	66	44	3	4	2	1		112	6	297
03. DATA TERMINAL (1)	135	7	19	74	44	6	6				118	6	297
04. DATA TERMINAL (2)	134	8	18	75	42	7	6		1		117	6	297
05. SLOW SCAN TV (1)	141	1	22	75	45	3	3				120	3	297
06. SLOW SCAN TV (2)	140	2	22	75	45	3	2		1		120	2	297
07. C.A.D.	135	2	21	70	47	7	8				117	8	297
08. C.I.V.	136	2	18	70	44	3	11		1		114	11	297
09. C.R.V.	136	1	19	69	46	8	8	1	2		115	9	297
10. I.S.S.	127	9	20	49	45	12	22	2	4		94	24	297
11. S.G.S.	133	6	21	53	50	11	13	1	2		103	14	297
12. A.V.I.	127	5	23	57	45	14	15	2	2		102	17	297
13. A.V.L.	127	5	25	58	43	16	14	1	1		101	15	297
	1,745	59	277	663	579	110	114	10	16	1	1,442	124	3,861

## CODE

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- 01 - Number of respondents whose system presently uses the new facility (Questionnaire: In System Now).
- 02 - Number of respondents who had no information on the facility.
- 03 - Number of respondents who definitely would not incorporate the new facility.
- 04 - Number of respondents who thought it unlikely they would incorporate the new facility.
- 05 - Number of respondents who were undecided.
- 06 - Number of respondents who would likely incorporate the new facility.

- 07 - Number of respondents who would definitely incorporate the new facility.
- 08 - Number of respondents who would incorporate the new facility in the next five years.
- 09 - Number of respondents who would incorporate the new facility later than the next five years.
- No - Number of respondents who would not forecast use of the new facility. (Codes 03 and 04 combined).
- Yes - Number of respondents who would forecast use of the new facility (Codes 06 and 07 combined).

## CLASS OF USER

## SPECILA FACILITIES SUMMARY

## SPECILA FACILITIES SUMMARY

## FEDERAL/PROVINCIAL

FACILITY	00	01	02	03	04	05	06	07	08	09	NO	YES	TOTAL
01. FACSIMILIE	6	2	1	2	5	1					7		17
02. TELETYPE	4	4	1	1	6		1				7	1	17
03. DATA TERMINAL (1)	6	1	1	4	3	1	1				7	1	17
04. DATA TERMINAL (2)	6		1	4	4	1	1				8	1	17
05. SLOW SCAN TV (1)	6		1	4	6						10		17
06. SLOW SCAN TV (2)	6		1	4	6						10		17
07. C.A.D.	6		1	3	5	1	1				8	1	17
08. C.I.V.	6		1	3	6		1				9	1	17
09. C.R.V.	6		1	3	5	1	1				8	1	17
10. I.S.S.	3	5	1		2	5	1				2	1	17
11. S.G.S.	6	1		1	3	4	2				4	2	17
12. A.V.I.	5		1	3	3	3	2				6	2	17
13. A.V.L.	5		1	3	5	1	2				8	2	17
	71	13	12	35	59	18	13				94	13	221

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- 07 - Number of respondents who would definitely incorporate the new facility.
- 08 - Number of respondents who would incorporate the new facility in the next five years.
- 09 - Number of respondents who would incorporate the new facility later than the next five years.
- No - Number of respondents who would not forecast use of the new facility. (Codes 03 and 04 combined).
- Yes - Number of respondents who would forecast use of the new facility (Codes 06 and 07 combined).

## CLASS OF USER

## SPECIAL FACILITIES SUMMARY

## SPECIAL FACILITIES SUMMARY

## MUNICIPAL

FACILITY	00	01	02	03	04	05	06	07	08	09	NO	YES	TOTAL
01. FACSIMILE	92	2	22	77	91	12	2	9	1		168	11	316
02. TELETYPE	90	2	15	90	79	18	4	9	1		169	13	316
03. DATA TERMINAL (1)	84	19	13	68	79	15	9	16	3	2	147	25	316
04. DATA TERMINAL (2)	91	12	14	70	83	14	8	12	3	1	153	20	316
05. SLOW SCAN TV (1)	94	1	28	86	83	13	1	7		1	163	8	316
06. SLOW SCAN TV (2)	97		30	77	81	13	1	9			158	10	316
07. C.A.D.	87	1	18	73	82	13	12	18	4		155	30	316
08. C.I.V.	91	3	17	76	86	13	7	13	2		162	20	316
09. C.R.V.	93	3	20	72	84	11	7	16	2		156	23	316
10. I.S.S.	84	21	21	46	71	28	17	16	4		117	33	316
11. S.G.S.	91	18	18	48	74	26	11	15	6	1	122	26	316
12. A.V.I.	89	2	18	61	88	20	6	15	6	1	149	23	316
13. A.V.L.	92	1	23	60	87	21	5	16	2	1	147	21	316
	1,175	85	257	698	1,068	217	92	171	34	7	1,966	263	4,108

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- 08 - Number of respondents who would incorporate the new facility in the next five years.
- 09 - Number of respondents who would incorporate the new facility later than the next five years.
- No - Number of respondents who would not forecast use of the new facility. (Codes 03 and 04 combined).
- Yes - Number of respondents who would forecast use of the new facility (Codes 06 and 07 combined).

FACILITY	00	01	02	03	04	05	06	07	08	09	NO	YES	TOTAL
01. FACSIMILE	235	10	50	145	135	26	4	16	2	1	284	14	630
02. TELETYPE	231	11	38	159	129	26	9	11	2		288	20	630
03. DATA TERMINAL (1)	225	27	33	146	126	22	16	16	3	2	272	32	630
04. DATA TERMINAL (2)	231	20	33	149	129	22	15	12	4	1	278	27	630
05. SLOW SCAN TV (1)	241	2	51	159	134	16	4	7		1	293	11	630
06. SLOW SCAN TV (2)	243	2	53	156	132	16	3	9	1		288	12	630
07. C.A.D.	226	3	40	146	134	21	21	18	4		288	39	630
08. C.I.V.	233	5	36	149	136	21	19	13	3		285	32	630
09. C.R.V.	235	4	40	144	135	20	16	17	4		279	33	630
10. I.S.S.	214	35	42	95	118	45	40	16	8		213	58	630
11. S.G.S.	230	25	39	102	127	41	26	16	8	1	229	42	630
12. A.V.I.	221	7	42	121	136	37	25	17	8	1	257	42	630
13. A.V.L.	224	6	49	121	135	38	21	17	3	1	256	38	630
	2991	157	546	1796	1706	345	219	181	50	8	3502	400	

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- 09 - Number of respondents who would incorporate the new facility later than the next five years.
- No - Number of respondents who would not forecast use of the new facility. (Codes 03 and 04 combined).
- Yes - Number of respondents who would forecast use of the new facility (Codes 06 and 07 combined).



## FORECAST FOR CONVENTIONAL LAND MOBILE SPECTRUM REQUIREMENTS

### Introduction

The material presented in this forecast of land mobile spectrum requirements was developed from a report by Quasar Systems Ltd. entitled "Land Mobile Systems: A Forecast for Major Urban Centres". In addition, assumptions and loading criteria supported by various departmental and external studies including the FCC have been used.

The forecast of spectrum requirements for mobile are presented in terms of ranges of additional spectrum rather than specific values to parallel the forecasts of land mobile systems given the Quasar report. An intermediate range forecast is given for the year 1985 and a long range forecast for the year 2000.

The spectrum requirements for each forecast period result from loading the land mobile channels by varying numbers of land mobile systems. The number of systems per channel (i.e., loading ratio) which can, in practice, be employed is based on the number of mobiles in each of the systems and their collective operational message requirements (i.e., maximum permissible waiting time, average message length, etc.).

### Loading criteria

A review of the present land mobile systems indicates that there are approximately 6.2 mobile licences for every land mobile base station in 1976.

Therefore, on a Canada wide average, there are 6.2 mobiles in the average Canadian land mobile system. There are however, indications that the average number of mobiles per system in the larger urban areas is higher than this figure and vice-versa.

The loading of channels by land mobile systems is treated in two ways. The first method uses the FCC land mobile loading criteria developed for assigning channels to new systems in the 900 MHz frequency band (806-890 MHz). These criteria relating to conventional dispatch type systems in terms of mobile loading are:

- police traffic	50	mobiles	per	duplex	pair
- business	90	"	"	"	"
- other	70	"	"	"	"
- motor carrier, buses	150	"	"	"	"

The criteria also specify that no more than 5 independent user systems may share a duplex pair nor when a duplex pair is shared, can more than a combined total of 50 mobiles operate on it.

From the Quasar study which was based upon numbers of land mobile and using the FCC loading criteria, no more than 5 systems could share the same duplex pair (or 2.5 systems per single channel). Under the assumptions that:

- a) all new conventional land mobile systems will be operated in the duplex mode
  - b) new land mobile systems will have on average less than 10 mobiles each (i.e., to ensure no more than 50 mobiles operating on a duplex pair)
- and using the FCC loading criteria, the following analysis has been prepared for Toronto:

In Toronto, approximately 40% of allocated land mobile frequencies are not useable due to:

- intermodulation products or other interference with existing licences stations
- prior co-ordinated U.S. use of a portion of the channels (for users in Buffalo, etc.)

protection of off-air reception of channel 7 VHF-TV by Toronto viewers (land mobile assignments in the 170-174 MHz portion of the VHF mobile band interfere with reception)

Assuming that some new land mobile systems can be accommodated in existing land mobile allocations until the FCC loading level is reached, the following spectrum requirements are necessary

For Toronto - 1985

Most probable number of systems forecast (from the Quasar study)	8,900	(High estimate 11,400 Low estimate 7,000)
Number of channels required to accommodate new systems	$\frac{8,900}{2.5} = 3,560$ useable	

Although at present only 60% of allocated land mobile channels are useable for reasons already discussed, this ratio should increase to approximately 70% since interference to the channel 7 TV assignment causes a fixed reduction in useable spectrum, not one which increases with the air increase in the land mobile allocation. Therefore, a figure of 70% useable will be used below.

Number of allocated channels required =  $\frac{3,560}{.7} = 5,086$

Number of channels presently allocated in existing land mobile allocations = 3,000 channels (approximately)

Additional number of channels required	5,086
	- 3,000
	2,086

Assuming a standard 25 KHz required channel bandwidth, additional land mobile spectrum requirement to accommodate new systems:

= 2,086 X .025 MHz  
= 52.1 MHz additional

The table gives the results of the analysis of spectrum requirements for 1985 for other major Canadian cities using the FCC loading criteria and also the existing loading level for the 150-170 MHz portion of the VHF band in Toronto.

As an alternative to the use of the FCC loading criteria of 2.5 systems per channel, the existing level of loading for the 150-170 MHz band in Toronto could be chosen. As may be seen in Appendix I, Attachment B additional system growth (i.e, base station growth) has not occurred apparently due to its already high level of assignment. The band is in essence saturated at an average level of 3.25 systems per channel. (There are 1972 base stations in the 150-174 MHz band shown in Attachment B and 581 channels in the 150.8 to 170 MHz band and approximately 25 channels in the 170-174 band in Toronto). As most systems in this band are simplex, no correction for low proportion of duplex systems will be made.

CITY	NUMBER OF LAND MOBILE SYSTEMS		RATIO OF PRESENT USEABLE CHANNELS TO ALLOCATED CHANNELS	ADDITIONAL SPECTRUM REQUIRE- MENTS	
	1976	1985		2.5 systems/ channel 25 kHz	3.25 systems/ channel 25 kHz
TORONTO	2,812	8,950	70%	52 MHz 29	23 MHz
MONTREAL	2,726	7,800	75%	29	5
VANCOUVER	1,936	7,800	75%	29	5
EDMONTON	1,190	4,200	80%	0	0
HALIFAX	503	1,500	80%	0	0

The following points should be noted concerning the analysis:

1. The loading ratio of 3.25 systems per channel presently existing in Toronto in the 150-174 MHz band can be assumed to be the practical saturation level for loading as the growth of new base station assignments in this band in Toronto has dropped to zero due to the problems of accommodating new systems in the existing electromagnetic environment.
2. The distance from the border and from U.S. population centres has a significant impact in determining spectrum requirements.
3. The overall land mobile system loading existing in Toronto for all land mobile bands at present is approximately 1.5 systems per channel. To increase this loading to the maximum FCC rate of 2.5 may be very difficult or impossible due to the present electromagnetic environment in Toronto (i.e., placement and power levels of existing stations, operational constraints, etc.)

#### Summary and Conclusions

1. Using the forecast of land mobile systems for 1985 presented in the Quasar study, and two different loading ratios, the additional spectrum requirements for Toronto lie between 23 and 52 MHz. Additional spectrum requirements for Vancouver and Montreal for 1985 lie between 5 and 29 MHz.
2. It is anticipated that neither Edmonton nor Halifax will require additional land mobile spectrum by 1985.
3. Due to likely changes in technology, uncertainty in and lack of data, no definitive forecast of land mobile spectrum requirements could be given beyond 1985 in the Quasar Report; however, using the same assumptions and techniques used above, the range of spectrum requirements for 2000 will lie within the following bounds.

Spectrum Requirements for 2000

CITY	MINIMUM	MAXIMUM
TORONTO	32 MHz	205 MHz
MONTREAL	9	142
VANCOUVER	16	164
EDMONTON	0	63
HALIFAX	0	0

In arriving at these bounds, the lowest and highest estimates for land mobile system growth was used from the Quasar Report. The minimum spectrum requirement shown about was calculated using this lowest forecast of system growth at an assumed maximum level of system loading (3.25 systems per channel. To determine the maximum spectrum requirement, the highest forecast of system growth shown in the Quasar Report was used using the FCC proposed loading level of 2.5 systems per channel. For each city, the percentage of useable land mobile channel to allocated channels shown earlier in this appendix was used.

An outline of the forecasts and conclusions of the Quasar Report are attached to this appendix.

In summary, this report and analysis relate only to the present day conventional land mobile systems. Any spectrum required for new types of systems (i.e., cellular radio telephone, new citizens band, etc.), would be in addition to the above requirements.

LAND MOBILE SYSTEMS:A FORECAST FOR MAJOR URBAN CENTRES - QUASAR SYSTEMS LIMITED.OUTLINE.

The purpose of this study was to forecast the number of land-mobile systems likely to be in operation in the year 2000.

Since the greatest congestion in the radio spectrum is in densely populated areas, it was decided to prepare estimates of the number of land-mobile systems in five of Canada's larger centres. These centres are Vancouver, Edmonton, Toronto, Montreal and Halifax.

Data giving the number of land-mobile systems for each of these centres for 1973-1977 was obtained from the Integrated Radio Licensing System (IRLS). At the same time, data was obtained for 14 other centres. Statistical analysis of this data suggested that an exponential trend was present. In view of the small number of years of available data, it was necessary to examine other data extending over a longer time period for confirmation. Data examined from these other several other sources also suggested that the underlying growth was exponential. Further, there is very little evidence in the data of a reduction in the rate of growth - even when examining sectors that were said to be mature in 1973.

FORECASTS:

The forecast is presented in two parts. It seems likely that the growth in the number of land-mobile systems will continue strong in the short range. This is especially true with the energy crisis and the escalating cost of labour. The use of land-mobile communications can reduce costs in both of these areas [see, for example, Plotkin (1974)]. Therefore, it is possible to obtain figures through to 1985 based on current growth. For the period 1985 to 2000, it seems likely that the growth in the number of land-mobile systems will be more closely tied to increases in population than it has been in the past. For this period, we present forecasts based on the number of land-mobile systems per 1,000 population and population forecasts prepared by the Ministry of State for Urban Affairs (MSUA).

Since the current strong growth in the number of land-mobile systems shows no sign of diminishing, the forecasts for 1985 are based on a continuation of this growth during the intervening period. Growth in Toronto in the period 1973-1977 occurred at a rate which approximates closely an exponential curve with a growth rate of 13.61% per year. Projecting this forward to 1985 we obtain a figure of 8,900 land-mobile systems in Toronto in that year. The comparable figures for Montreal are a growth rate of 12.79% and 7,800 land-mobile systems in 1985 (for full details, see Chapter 5, Figures 5.1 and 5.2, pp. 26-27).

The forecasts for the year 2000 were based on three hypotheses. The first is that the ratio of land-mobile systems to population will remain constant from 1985 to 2000. It should be pointed out that this is somewhat conservative; between 1973 and 1976, in Toronto this ratio increased by 35.46%, or 10.65% per year. The second is that the ratio of land-mobile systems to population will increase by 50% over the period 1985 to 2000, or some 2.74% per year. The third is that the ratio of land-mobile systems to population will increase by 100% (i.e. double) over the period 1985 to 2000; this is equivalent to 4.73% per year.

The second hypothesis leads us to the figure of 14,700 systems in Toronto in 2000. This compares with 9,800 systems under the first hypothesis (no growth), and 19,600 under the third hypothesis. Figures for the other centres show a similar pattern; these appear in Table 5.5, p. 30. An illustration of the growth in Toronto appears in Figure 6.1; growth patterns for the other centres are similar.

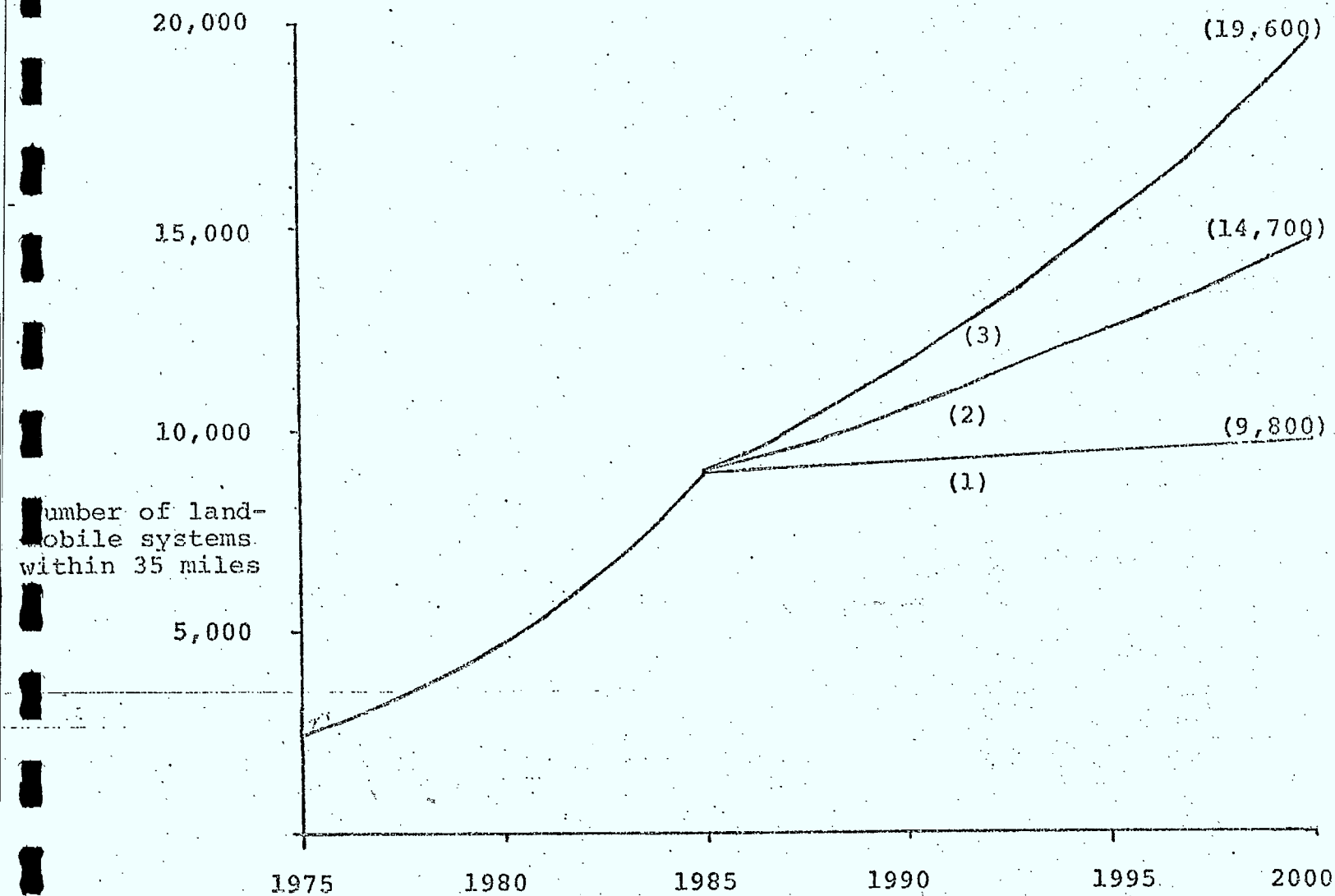


FIGURE 6.1: The Growth in Land-Mobile Systems in Toronto  
(for illustrative purposes only)

NOTES:

- (1) Assuming no growth in market penetration (number of systems per 1,000 population) after 1985
- (2) Assuming 50% growth in market penetration from 1985 to 2000 (2.74% per year)
- (3) Assuming 100% growth in market penetration from 1985 to 2000 (4.73% per year).

## CONCLUSIONS

In this section we summarise briefly the findings of this study.

The objective of this study is to forecast the number of conventional land-mobile systems\* in 5 major urban centres across Canada, namely Vancouver, Edmonton, Toronto, Montreal and Halifax.

As part of this study we considered land-mobile systems in almost all the metropolitan areas across Canada (four were excluded; see Chapter 2). In addition, we looked at various sectors of the economy, including Transportation, Communications, Public Administration and Construction.

In all of the major centres except Sudbury, the growth rate of the number of land-mobile systems exceeded 11% per year. The growth rate in the sectors of Forestry and Mines and Oils was low, as might be expected; in all other sectors the growth rate exceeded 9% per year. The overall growth rate for all the centres was 14.13% per year. This compares with a growth rate of 10.07% per year in the number of land licences in the Private Commercial service category since 1963, and a similar growth in the U.K. of 13.57% in the number of radio-mobile licences issued since 1964.

Two forecasts were prepared; a medium range forecast to 1985, and a long range forecast to the year 2000.

---

\* New types of land-mobile communications, such as cellular, are not included in these forecasts.

CENTRE	POPULATION	NUMBER OF LAND-MOBILE SYSTEMS		
		(1)	(2)	(3)
Toronto	3,320,141	9,800	14,700	19,600
Montreal	3,019,339	8,200	12,200	16,300
Vancouver	1,473,592	8,900	13,400	17,900
Edmonton	858,163	5,500	8,200	11,000
Halifax	317,518	1,600	2,400	3,200

TABLE 5.5: Number of Land-Mobile Systems  
in the year 2000

NOTES:

- (1) Assuming no growth in market penetration (number of systems per 1,000 population) after 1985.
- (2) Assuming 50% growth in market penetration from 1985 to 2000 (2.74% per year).
- (3) Assuming 100% growth in market penetration from 1985 to 2000 (4.73% per year).

CENTRE	1973	1974	1975*	1976	YEARLY AVERAGE (COMPOUND) GROWTH (%)
Toronto	0.74	0.79	0.90	1.00	10.65%
Montreal	0.67	0.74	0.84	0.97	13.21%
Vancouver	1.05	1.16	1.43	1.66	16.65%
Edmonton	1.41	1.69	1.82	2.15	15.03%
Halifax	1.40	1.43	1.69	1.88	10.37%

TABLE 5.4: Number of Land-Mobile Systems  
per 1,000 population (1973-1976)

\* estimated

CENTRE	REGRESSION ESTIMATE	HIGH ESTIMATE	LOW ESTIMATE
Toronto	8,900	11,400	7,000
Montreal	7,800	10,000	6,200
Vancouver	7,800	11,900	5,200
Edmonton	4,200	7,100	2,500
Halifax	1,500	2,500	900

TABLE 5.2: Estimated Number of Land-Mobile Systems  
in 1985 (rounded to the nearest 100)

CENTRE	1973	1974	1975	1976	1977	Total Growth %	Average Compound Growth Rate %	Exponential Regression Growth Rate %	Goodness of fit %
TORONTO	1974	2147	2479	2812	3264	65.35%	13.40%	13.61%	99.25%
MONTREAL	1851	2062	2348	2726	2939	58.73%	12.25%	12.79%	99.19%
VANCOUVER	1167	1321	1642	1936	2135	82.95%	16.30%	17.24%	98.59%
OTTAWA-HULL	677	775	895	1108	1192	76.07%	15.19%	16.05%	98.45%
WINNIPEG	484	545	605	697	851	75.83%	15.15%	14.74%	98.25%
EDMONTON	717	895	988	1190	1284	79.08%	15.68%	15.61%	97.51%
QUEBEC	534	610	721	787	908	70.04%	14.19%	14.07%	99.32%
CALGARY	636	711	864	981	1136	78.62%	15.61%	15.97%	99.45%
LONDON	609	666	742	834	1007	65.35%	13.40%	13.10%	97.80%
HALIFAX	352	361	440	503	549	55.97%	11.75%	12.98%	96.14%
WINDSOR	283	318	351	423	502	77.39%	15.41%	15.39%	98.37%
VICTORIA	319	339	368	482	546	71.16%	14.38%	15.34%	93.80%
SUDBURY	432	449	483	502	517	19.68%	4.59%	4.82%	97.73%
REGINA	177	201	216	259	298	68.36%	13.91%	13.83%	98.38%
ST. JOHN'S	156	171	189	224	238	52.56%	11.14%	11.79%	98.25%
SASKATOON	122	128	137	189	276	126.23%	22.64%	22.42%	86.73%
CHICOUTIMI-JONQUIERE	271	309	350	392	432	59.41%	12.36%	12.42%	99.67%
THUNDER BAY	289	344	379	419	449	55.36%	11.64%	11.39%	97.12%
SAINT JOHN	198	218	246	301	338	70.71%	14.30%	14.94%	98.49%
	11,248	12,570	14,443	16,765	18,861	67.68%	13.79%	14.13%	99.77%

TABLE 4.1: Total Number of Systems



ASSESSMENT OF EXISTING USE OF LAND MOBILE ALLOCATIONSINTRODUCTION.

This report will provide an analysis of the extent of usage of the existing land mobile allocations in various cities in Canada. In the report, the land mobile allocations have been subdivided into six or seven bands. The channel bandwidth and the total number of frequencies or channels which are theoretically available in each band is shown.

As may be seen from reviewing the number of clear frequencies still available in any of the Canadian cities shown in Attachment A, the usage of each of the land mobile bands differs. The lowest band between 30 and 50 MHz is not particularly attractive for land mobile operations due to the interference potential at those frequencies from distant assignments. Each of the other bands appears relatively attractive for use by land mobile operations with the exception of the band from 170-174 in the vicinity of a channel 7 TV assignment where land mobile operations cause interference to television reception.

METHODOLOGY.

An assessment of the overall band utilization was made by comparing the number of clear frequencies to the total number of land mobile frequencies available in the five major Canadian cities shown in Attachment A. The extent of band utilization is shown as a percentage of the number of clear frequency channels compared to the total number of allocated channels for any particular city.

Attachment A-Summary gives the results for these cities. In total, there are approximately 3,068 frequencies or land mobile channels available for use in any one locality.

OBSERVATIONS

Attachment A for each of the cities, gives a point-in-time assessment of the utilization of each of the land mobile bands.

Attachment B for Toronto and Hamilton shows the growth in base station assignments and in mobile licences in the land mobile service in each area over the last five years. The growth rate shown in Attachment B for stations in each of the land mobile bands gives a direct indication of the extent of utilization of that band. For example, in the Toronto district office area, the band from 150-174 MHz has experienced a declining growth rate from 7% during 1973/74 to approximately 0% in 1976/77. This indicates that the band is fully utilized and that all further growth in base stations is directed or diverted into other bands, notably bands 4 and 5 shown in Attachment B. As may be expected, the number of mobiles in the district office areas increase in all bands. This relates basically to the additional loading of mobiles on to existing systems. However, the growth in the number of land mobiles operating in a band will approach zero some years after the growth in base stations has reached the zero level, as each of the channels available in the band reaches its maximum carrying capacity in terms of number of mobiles.

From a review of Attachment A - Summary, it may be seen that the land mobile utilization of the existing allocations is highest in Toronto and lowest in Halifax among the five cities surveyed. In Toronto, only 6% of the total number of channels allocated to land mobile are available as clear frequencies to meet the need of additional users in future. Montreal, Edmonton and Vancouver, all have approximately 25-30% of their allocated land mobile channels available for future assignments. The smallest of the cities, Halifax, still has 85% of its existing land mobile allocation available for future use.

#### CONCLUSIONS.

The following points may be concluded from the assessment of existing land mobile allocation utilization in these five cities of Canada:

1. Toronto has virtually no clear channels for future use and expansion of land mobile systems in the existing land mobile allocations.
2. Montreal, Edmonton and Vancouver, while they do have existing capacity in the present land mobile allocations, will require additional allocations prior to the year 2000 to accommodate even conventional land mobile growth.

ATTACHMENT A - SUMMARY

CITY	NUMBER OF CLEAR FREQUENCIES AVAILABLE FOR ASSIGNMENTS	PRESENT BAND UTILIZATION -- NUMBER OF ASSIGNED FREQUENCY CHANNELS COMPARED TO THE TOTAL NUMBER OF ALLOCATED CHANNELS
VANCOUVER	951	70%
EDMONTON	889	71%
TORONTO	154	94%
MONTREAL	767	75%
HALIFAX	2607	15%

ATTACHMENT A

LAND MOBILE BANDS - VANCOUVER B.C. AREA

<u>BAND MHZ</u>	<u>CHANNELLED</u>	<u>NO. OF FREQS.</u>	<u>CLEAR FREQUENCIES STILL AVAILABLE</u>
30 - 50	20 kHz	999	559
138 -144	30 kHz	200	66
148 -150.8	30 kHz	88	25
150.8-174	30 kHz	581	0
410 -420	25 kHz	400	200 (Approx.)!
450 -470	25 kHz	800	101

NOTE: (1) Unable to determine actual number of frequencies still available for assignment in 410 - 420 MHz band as U.S. listing shows a large number of assignments as continental U.S.A. (Actual co-ordination of specific frequencies needed to obtain more accurate results).

ATTACHMENT A (CONT'D)

LAND MOBILE BANDS -- EDMONTON ALBERTA AREA

<u>BAND MHZ</u>	<u>CHANNELLED</u>	<u>NO. OF FREQS.</u>	<u>CLEAR FREQUENCIES STILL AVAILABLE</u>
30 - 50	20 kHz	999	145
138 -144	30 kHz	200	33
148 -150.8	30 kHz	88	17
150.8-174	30 kHz	715	87
410 -420	25 kHz	400	316
450 -470	25 kHz	800	302

NOTE: Central Region have indicated that about 600 of the 999 Channels in the 30-50 MHz band are not being used in the Edmonton area due to possible interference to TV reception. This constraint plus current assignments leaves a balance of 145 channels available for assignment.

ATTACHMENT A (CONT'D)

LAND MOBILE BANDS - TORONTO ONT. AREAS

<u>BAND MHZ</u>	<u>CHANNELLED</u>	<u>NO. OF FREQS.</u>	<u>COMMENTS</u>
30 - 50	20 kHz	999	About 100 clear frequencies still available for assignment.
138 -144	30 kHz	200	About 15 or 16 frequencies still available for assignment.
148.0-150.8	30 kHz	88	About 5 or 6 frequencies still available for assignment.
150.8-170	30 kHz	581	No clear frequencies available.
170-174	30 kHz	134	This portion of the spectrum restricted in its use due to reception of Channel 7, Buffalo, N.Y. About 20-25 frequencies can be utilized however for low power systems on a case by case basis.
410 -420	25 kHz	400	Reserved primarily in Toronto for Government use. Unable to determine actual number of frequencies still available for Canadian use as U.S. lists show a large number of frequencies as continental <u>U.S.A.</u> (Actual co-ordination of specific frequencies needed to obtain idea).
450 -470	25 kHz	800	About 20 clear frequencies still available for assignment.

ATTACHMENT A (CONT'D)

LAND MOBILE BANDS - MONTREAL QUE. AREA

<u>BAND MHZ</u>	<u>CHANNELLED</u>	<u>NO. OF FREQS.</u>	<u>CLEAR FREQUENCIES STILL AVAILABLE</u>
30 - 50	20 kHz	999	449
138 -144	30 kHz	200	0
148 -150.8	30 kHz	88	1
150.8-174	30 kHz	715	17
410 -420	25 kHz	400	204 (approx.)
450 -470	25 kHz	800	101

NOTE: Unable to determine actual number of frequencies still still available for assignment in 410 - 420 MHz band as U.S. listing shows a large number of assignments as continental U.S.A. (Actual co-ordination of specific frequencies needed to obtain more accurate results).

ATTACHMENT A (CONT'D)

LAND MOBILE BANDS - HALIFAX N.S. AREA

<u>BAND MHZ</u>	<u>CHANNELLED</u>	<u>NO. OF FREQS.</u>	<u>CLEAR FREQUENCIES STILL AVAILABLE</u>
30 - 50	20 kHz	999	943
138 -144	30 kHz	200	147
148 -150.8	30 kHz	88	67
150.8-174	30 kHz	715	307
410 -420	25 kHz	400	382
450 -470	25 kHz	800	759

BASE STATIONS IN THE LAND MOBILE SERVICE  
IN THE TORONTO DISTRICT OFFICE AREA

442: TORONTO	1972/1973	1973/1974	1974/1975	1975/1976	1976/1977
BAND 1 - (27.2250 - 50.0000 MHz)					
- Actual Number Land Stations Licensed at Years End	1096	1126	1061	1113	1119
- Annual % Growth at Years End		2.74%	-5.77%	4.90%	.54%
BAND 2 - (138.0000 - 150.0000 MHz)					
- Actual Number Land Stations Licensed at Years End	126	176	221	232	246
- Annual % Growth at Years End		39.68%	25.57%	4.98%	6.03%
BAND 3 - (150.0001 - 174.0000 MHz)					
- Actual Number Land Stations Licensed at Years End	1718	1840	1922	1973	1972
- Annual % Growth at Years End		7.10%	4.46%	2.65%	-.05%
BAND 4 - (410.0000 - 421.0000 MHz)					
- Actual Number Land Stations Licensed at Years End	30	30	35	53	68
- Annual % Growth at Years End		0.00%	16.67%	51.43%	28.30%
BAND 5 - (450.0000 - 470.0000 MHz)					
- Actual Number Land Stations Licensed at Years End	236	308	449	560	688
- Annual % Growth at Years End		30.51%	45.78%	24.72%	22.86%

4K

LAND MOBILE STATIONS IN THE TORONTO DISTRICT OFFICE AREA

	1972/1973	1973/1974	1974/1975	1975/1976	1976/1977
D 1 - (27.2250 - 50.0000 MHz) - Total Number Stations Licensed at Years End - Annual % Growth at Years End	5773	6213 7.62%	5369 13.58%	5414 .84%	6067 12.06%
D 2 - (138.0000 - 150.0000 MHz) - Total Number Stations Licensed at Years End - Annual % Growth at Years End	616	853 38.47%	1390 62.95%	1410 1.44%	1546 9.65%
D 3 - (150.0001 - 174.0000 MHz) - Total Number Stations Licensed at Years End - Annual % Growth at Years End	14970	18639 24.51%	19600 5.23%	18681 -4.69%	20350 8.93%
D 4 - (410.0000 - 421.0000 MHz) - Total Number Stations Licensed at Years End - Annual % Growth at Years End	0	0	90	353 292.22%	457 29.46%
D 5 - (450.0000 - 470.0000 MHz) - Total Number Stations Licensed at Years End - Annual % Growth at Years End	1637	2437 48.87%	3964 62.66%	5233 32.01%	6301 20.41%

35K  
10/1/77

BASE STATIONS IN THE LAND MOBILE SERVICE  
IN THE HAMILTON DISTRICT OFFICE AREA

443: HAMILTON	1972/1973	1973/1974	1974/1975	1975/1976	1976/1977
BAND 1 - (27.2250 - 50.0000 MHz)					
- Actual Number Land Stations Licensed at Years End	116	141	151	198	239
- Annual % Growth at Years End		21.55%	7.09%	31.12%	20.71%
BAND 2 - (138.0000 - 150.0000 MHz)					
- Actual Number Land Stations Licensed at Years End	26	37	41	51	77
- Annual % Growth at Years End		42.31%	10.81%	24.39%	50.98%
BAND 3 - (150.0001 - 174.0000 MHz)					
- Actual Number Land Stations Licensed at Years End	645	710	759	816	898
- Annual % Growth at Years End		10.08%	6.90%	7.51%	10.05%
BAND 4 - (410.0000 - 421.0000 MHz)					
- Actual Number of Land Stations Licensed at Years End	0	0	0	7	11
- Annual % Growth at Years End		0.00%	0.00%		57.14%
BAND 5 - (450.0000 - 470.0000 MHz)					
- Actual Number Land Stations Licensed at Years End	44	68	95	118	171
- Annual % Growth at Years End		54.55%	39.71%	24.21%	44.92%

LAND MOBILE STATIONS IN THE HAMILTON DISTRICT OFFICE AREA

	1972/1973	1973/1974	1974/1975	1975/1976	1976/1977
ND 1 - (27.2250 - 50.0000 MHz) - Total Number Stations Licensed at Years End - Annual % Growth at Years End	277	401 44.78%	568 41.65%	690 21.48%	822 19.13%
ND 2 - (138.0000 - 150.0000 MHz) - Total Number Stations Licensed at Years End - Annual % Growth at Years End	46	267 480.43%	320 19.85%	423 32.19%	563 33.10%
ND 3 - (150.0001 - 174.0000 MHz) - Total Number Stations Licensed at Years End - Annual % Growth at Years End	3833	4911 28.12%	5550 13.01%	5710 2.88%	6105 6.92%
ND 4 - (410.0000 - 421.0000 MHz) - Total Number Stations Licensed at Years End - Annual % Growth at Years End	0	0	0	44	109 147.73%
ND 5 - (450.0000 - 470.0000 MHz) - Total Number Stations Licensed at Years End - Annual % Growth at Years End	468	586 25.21%	776 32.42%	1170 50.77%	1394 19.15%



## Appendix H: Supporting Studies and Reports

### c) (v) Rate of Channel Consumption for Land Mobile Radio

Distribution

DTS-S

SUBJECT  
OBJET

Rate of Channel "consumption"

SECURITY CLASSIFICATION - DE SÉCURITÉ

OUR FILE - N/ RÉFÉRENCE

6110-24-1 (DTS-5)

YOUR FILE - V/ RÉFÉRENCE

DATE

May 20, 1976

One criteria for the state of congestion in a band is the rate at which channels are "consumed". In this context, the word "consumed" is used to imply that in a given area the consumed channel is no longer vacant. If, in a given city, there are N channels available for land mobile usage in a given band, then that band is said to be in a state of "congestion" when all N channels are consumed. Congestion, however, does not imply that further assignments cannot be made in the band, because channel sharing does permit further loading of these channels. When further loading is impossible without severely degrading the quality of the service, the band is said to be in a state of saturation.

The attached computer printout represents the state of congestion of each VHF/UHF land mobile band within a radius of 70 miles from the centre of each of the major Canadian cities. The data is extracted from the FCC, IRAC and the DOC frequency list data tapes. There are two tables and a graph per page. The figures in the tables represent the total number of channels consumed during or prior to the year indicated. Thus, in Montreal, by 1972, there were 146 channels consumed in the 450-470 MHz band out of a total of N=800. The asterisk graphs are pictorial representations of the number of channels consumed in the band immediately to the left of the graph, and can be used for visual extrapolation. The scale is 1 asterisk per 20 channels for all tables except for the "all bands" table where it is 1 per 35 channels.

A table is also attached indicating the number of channels available to the land mobile service in the various bands in various cities. Note that in certain cities certain channels are not available due to prior allotments as is the case for maritime mobile service in cities within 100 miles from the water bodies. Using this table along with projections in the relevant table the expected date of congestion can be estimated. This congestion date is also shown on the graphs.

c) (v) Rate of Channel Consumption for Land Mobile Radio

Page 2.


The congestion dates as derived from this extrapolation are not to be interpreted as the dates of saturation. The latter is difficult if not impossible to determine with the present state of knowledge because more and more systems can be shoe-horned into a band by sharing, off-set assigning, power limiting and system tailoring using directional antennas. The final state of saturation can only be reached when a specified percentage of users has to wait more than a specified length of time to get on the air, for a specified portion of the day. In fact the only reliable means of predicting saturation is by experience when assignments commence being difficult to make. The congestion date concept, however, is still useful for policy and strategic planning purposes wherein potential problems can be avoided by timely action. It provides a framework within which national solutions (such as spectrum re-allocation) can be imposed given that a problem is only localized in a few key areas. It provides the measure of the urgency for solutions.

Note that in certain areas the number of channels consumed exceeds the number of channels in the bands. This is due to the use of off-set channels which is becoming a widespread practice in Canada and the U.S.

For further discussion, please contact V. Sahay of DTS-S at 6-4749.

Distribution: DTS RDA  
DOS RDC  
J. Braden RDO  
R. Begley RDQ  
SMS RDP

Att.

  
(for M.J. Hunt)



The Economic Aspects of Land Mobile Radio:  
Background Paper for Spectrum Allocation in  
the 406 - 960 MHz Band

In the study of spectrum demands at 406-960 MHz, economic factors must take second place to other considerations for most of the services involved in the band. The economic motive is not paramount in the amateur, radiolocation, radioastronomy and ISM services, and even in TV broadcast it is overshadowed by social and cultural concerns. For the fixed service there is the alternative of other frequencies, or the non-radio medium of cable, to relieve commercial pressures in this band. It is in land mobile, made possible by radio alone and ideally suited to the 406-960 MHz band by transmission, that economics comes into its own. Aeronautical and marine mobile pale by comparison, owing to their much smaller role in the business world and greater freedom from transmission restraints.

An appreciation of the commercial nature of land mobile radio can be obtained from a review of license data. As of March 1977, there were 215,000 mobile units licensed to business users, concentrated in the transport, taxi and construction industries (attachment 1). Only 40,000 licenses were issued to all government agencies, although these represented a somewhat greater number of mobile units since municipal and national defence users operate under a blanket license. If 15 mobiles per license are assumed in the municipal and defence categories, the total mobile population becomes 300,000 units in early 1977, 70% of them in commercial service.

Since the oil crisis of 1973, energy conservation has taken on a new dimension, transcending the familiar boundaries of cost. The public need to relieve the dependence on oil has now a significance not reflected by the market, and in this regard the contribution of mobile radio should be acknowledged. The 24 hour ability to communicate with a vehicle on the road will manifestly save the wasted trips that would

otherwise result from the contingencies of business or government. The difficulty is to calculate the saving; for the reasons discussed below, users do not possess the necessary source data. In the absence of detailed, factual records from the user, recourse must be had to the published estimates of the mileage saved by mobile radio. Those vary from 15% to 40% and if the lower value is applied to the existing population of radio equipped vehicles, the indicated saving is 100 million gallons of motor fuel per year. This benefit is a surprisingly high 0.4% of the total domestic oil consumption for all purposes in 1976. The future growth in oil consumption is difficult to predict, since it will be affected by shortages, conservation and the development of substitute energy sources. What seems certain is that the demand for mobile radio with its attendant fuel efficiencies can only be enhanced as oil supplies become scarce. In Attachment 2 this factor is discounted, and the projected fuel saving of 400 million gallons in the year 2000 may be taken as a conservative estimate.

In order to obtain the benefit of first-hand experience, discussions were held with as many users of mobile radio as time permitted, seven in number:

Diamond Taxi	)	
CP Rail	)	
Abitibi Paper	)	Reported in a companion paper
Smith Transport	)	by P. Julien

Ontario Department of Transportation  
Ontario Hydro  
Consumers' Gas

In such a small sample, no attempt could be made to represent the population of mobile users. Major firms were selected as these would have the resources necessary to study the cost effectiveness of radio,

should they find it desirable. None had done so<sup>1</sup> on the grounds that radio is essential to the firm's operation, and its costs negligible in relation to other business expense. Under these circumstances, there is little justification for elaborate cost studies. An objective assessment of radio would involve a "before and after" comparison, not available in retrospect for most firms and requiring now an expensive, controlled experiment.

The economic justification for mobile<sup>2</sup> radio in the simple case, without considering data systems or specialized design, can be demonstrated by a comparison of vehicle and radio costs. At the very least a vehicle driver, who may also perform other duties, will command \$5 per hour whereas the radio will typically cost \$2.50 per day (attachment 3). This calculation assumes that dispatching can be accomplished with no increase in staff, which would be true in small radio systems. In large systems the allowance for a full-time dispatcher would be prorated over 25 or more vehicles with little effect on the unit cost. At the above rates, the cost of radio will be paid if 30 minutes of driver time can be saved in the day, a not unreasonable expectation. Similarly, an automobile operating at a typical 7¢ per mile,<sup>2</sup> or a small delivery truck at 15¢ per mile,<sup>2</sup> will defray the cost of radio if less than 40 miles can be saved in the day. The combination of driver and vehicle economies makes a powerful argument for radio.

On some occasions the cost of a mobile system can be repaid in a single radio call. The Ontario Government reports of such a case, in which \$80,000 was saved by instructions from the field to delay the pour for a concrete highway bridge. Ontario Hydro expedite the restoration of transmission lines by using a radio-equipped helicopter to locate storm damage and direct the ground crews. The saving of even a

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1 For a complete answer on cost effectiveness studies, refer to the companion paper. Data for these studies is being provided by some of the companies.

2 These costs are for gasoline, maintenance and tires. Fixed costs such as depreciation are excluded.

few hours in this operation is highly significant to the utility, which sustains a loss of \$500,000 per day when a power station is disconnected from the grid. An 8 yard shovel used in open-pit mining is equipped with radio to minimize work stoppages, which cost \$2000 per hour. Numerous other examples can be drawn from industry, wherever vehicles or roving personnel are essential to the functioning of a large undertaking.

It is perhaps unfortunate that the user organizations interviewed in this part of the study (Ontario Hydro, Ontario Department of Transportation, and Consumers' Gas) are utilities or quasi-utilities, with all the priority in radio service that that implies. In the Policy Manual, services for the safety of life and property such as fire, ambulance and police are given precedence over services essential to the operation of utilities, transportation, etc. The line between these two service categories is very thin. Fire protection, for example, is difficult if the roads are not plowed in winter; mobile radio is required for both. In such cases, there is little doubt that frequencies will be made available to meet the public need. What about the small user, not engaged in so important an affair?

The myriad small users of mobile radio, in the construction, manufacturing, resource and service industries, also have a claim on radio frequencies. If the economic impact of radio is not visible because it is diffused over many small users, there is no reason to suppose that it is any the less real, or significant. The public still benefits from improved productivity, fuel savings, and a standard of service not otherwise obtainable. In view of the public benefits it would be preferable not to restrict the demand for mobile services, relying instead upon spectrum management to avoid an undue proliferation of channels and wastage of spectrum. The merit of any mobile licence must be judged in retrospect, by the exercise made of it. For new businesses or service applications, radio usage is necessarily a matter of conjecture, being dependent on the success of the venture. It would be undesirable to stifle opportunities for the small user through the lack of spectrum allocations.

The problem of wasted spectrum is likely to occur least among the major users of radio, who have systems large enough to permit efficiencies through trunking and frequency reuse. Already the firms interviewed have taken steps towards frequency conservation, with the active support of the Department. The Ontario Government proposes to operate its entire radio system for highway maintenance throughout the province on 8 VHF channels and 12 UHF channels. Ontario Hydro conducts all its construction and maintenance of transmission lines on 24 channels in the low band (50 MHz); additional channels are required for generating stations and other purposes. Consumers' Gas needs only 10 UHF channels for its operations, distributed over several communities. These economies of scale are not open to the small mobile user, who must combine with other users to achieve the same result.

The real impact of mobile radio is to be found in the public domain, where unfortunately it is least susceptible to definition in economic terms. Mobile radio was first used in police work, in the early 1930's. Here the public benefit from the protection of life and property is indisputable, although no dollar value can be placed on it. The next mobile application was in taxis, yielding a significant gain to the public in the form of faster service. Since those early days, the instances of public benefit have grown in proportion with the spread of mobile radio. Consumers' Gas undertake to have a repairman on the scene in 15 minutes if a gas leak is reported, minimizing the risk to human life. The public safety depends on the continuous delivery of energy, food and other essential supplies, all requiring radio. The cost of a mobile telephone call is far below the return to the user. How can all these benefits be assessed at their true worth to the public? Not by any known technique of economic analysis.

Conclusion

For anyone familiar with mobile radio, this paper will be no more than a statement of the obvious. The paper is therefore directed to those not conversant with the subject, in the hope that mobile radio will receive its due in the forthcoming reallocation of the 406-960 MHz band. Mobile radio speaks with a small public voice because its economic benefits are incapable of precise determination, and pass unnoticed. This should not be allowed to detract from its rightful claim to spectrum.

J.B. Young  
15 July 77

Distribution of Mobile Licences by  
Industry Sector - 15 March 1977

<u>Service Category</u>	<u>Licences</u>		
Construction	19,673		
Taxi	19,557		
Truck Transport	15,445		
Air Transport	15,117		
Special Trade Contractors	12,755		
Electric Power	12,463		
Railway Transport	10,936		
Logging	10,590	116,536	45.6%
Other Industry		98,899	38.7%
Government Services			
Forestry	7,203		
Highway and Bridge Maintenance	7,200		
Other Federal	12,623		
Other Provincial	9,990		
Other Municipal	2,938	<u>39,954</u>	<u>15.6%</u>
Total Licences		255,389	100.0%

Municipal and National Defence users operate under a blanket licence. On the assumption of 15 mobiles per licence for these users, the total population would be 300,000 mobile radios in March, 1977.

## ATTACHMENT #2

### Fuel Savings Due to Land Mobile Radio

In 1976, the total domestic oil consumption for all purposes was 1,796,000 barrels per day, or 23 billion gallons for the year. (1 barrel = 35 imp. gal.)

In the EEMAC Submission "Spectrum Allocations in the 406-960 MHz Frequency Band" dated 3 Dec 76, a 7.5% annual growth is projected for land mobile radio in the period 1981-2001. This rate allows for market saturation in relation to the 11.5% annual growth experienced in 1964-74, and appears to be reasonable. A 7.5% rate of increase implies that mobile radio and its attendant fuel efficiencies will quadruple by the year 2000.

Assuming a 15% mileage saving due to mobile radio, at 25,000 miles/year and 10 miles/gallon for each vehicle:

Year 1976      Fuel saving per vehicle

$$\frac{25,000 \text{ miles} \times .15}{10 \text{ miles/gal.}} = 375 \text{ gal.}$$

Total fuel saving

300,000 radio-equipped vehicles X 375 gal. = 100 million gallons, approx. or 0.4% of total oil consumption

Year 2000      Total fuel saving = 400 million gallons

CANADA, DEPARTMENT OF COMMUNICATIONS, CENTRAL REGION.

SPECTRUM USAGE AND REQUIREMENTS 406-960 MHz.

TK  
6553  
.C32

Date Due

APR 06 1978

JUL 27 1978

AUG 30 1978

NOV 13 1978

JUN 3 1980

7 NOV 1985

9 JUN 1987

