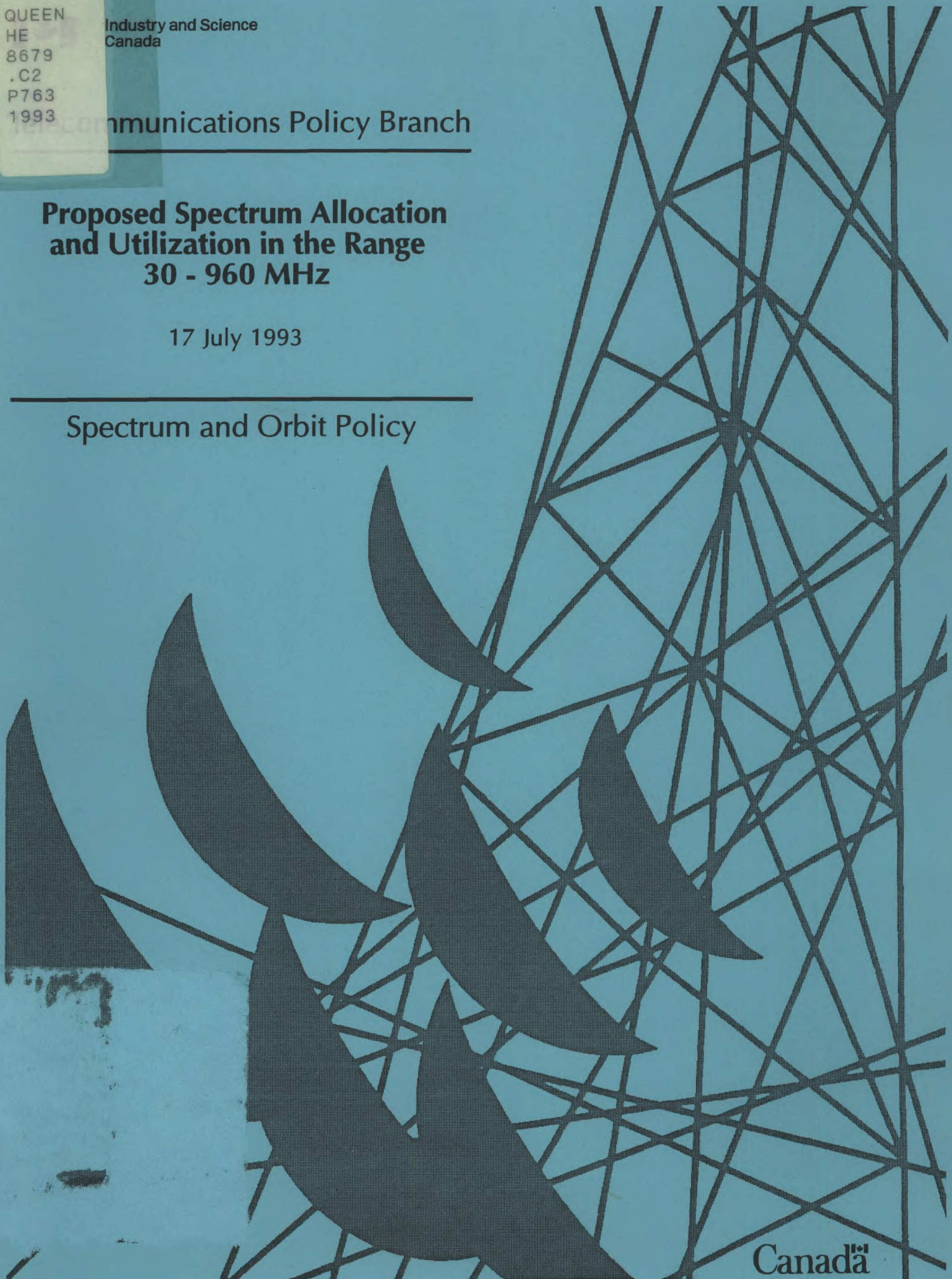
Industry and Science Canada

Communications Policy Branch

Proposed Spectrum Allocation and Utilization in the Range 30 - 960 MHz

17 July 1993

Spectrum and Orbit Policy



Canada

Preface

A spectrum policy document, "Spectrum Allocation and Utilization in Certain Bands in the Range 30.01-896 MHz, Part I (SP 30-896, Part I)" was released in May 1990. As part of a comprehensive Spectrum Policy Review, a study of bands not covered in the Part I document is now undertaken which deals mainly with frequencies in the mobile, broadcasting and amateur services. The Review also considers the new frequency allocations made by the 1992 World Administrative Radio Conference (WARC-92) convened by the International Telecommunications Union (ITU) in Spain, and the ongoing demand for new and existing radio services. This document forms part of this Review and addresses specific proposals for:

- **spectrum allocation and utilization in the range 30-960 MHz.**

Other documents being released for public comment separately address and propose:

- **spectrum allocation in the HF band 3-30 MHz;**
- **spectrum allocation in the 1-3 GHz range;**
- **spectrum allocation above 3 GHz; and**
- **spectrum utilization for certain services above 1 GHz.**

Based on the public comments received on these documents, revisions will be made to the Canadian Table of Frequency Allocations, to relevant Spectrum Utilization Policies and eventually to the Standard Radio System Plans.

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Proposed Spectrum Allocations and Utilization in the Range 30-960 MHz

CHAPTER I

1 . . . . Background

A radio frequency band review in the 30-890 MHz range was begun in 1987 with the release, for public comment, of a discussion paper entitled, **"Utilization of the Radio Frequency Spectrum in the Range 30.01-890 MHz"**. The primary objective was to undertake a systematic review of the allocation and utilization of spectrum resources and the related policy directives which foster their use. A secondary objective was to reassess current spectrum utilization policies to ensure the continued orderly use of the radio frequency spectrum. Both objectives were to be achieved through full public consultation, while encouraging new technology and service applications and the introduction and enhancement of spectrum efficient practices.

In issuing the Discussion Paper, it was recognized that the spectrum under review comprises the most heavily used bands in North America. In addition, the sheer volume of information available and operational rules associated with the existing and projected use of this spectrum could not be given adequate consideration in one review. Consequently, the review was split up into Parts I and II, the former was concluded with the issuance in May of 1990 of the **"Spectrum Allocation and Utilization in Certain Bands in the Range 30.01-896 MHz, Part I"**.

Chapter I of this paper, **"Proposed Spectrum Allocation and Utilization in the Range 30-960 MHz"** makes proposals for some spectrum allocation and utilization policies for those remaining bands not covered in Part I and a few allocations in the 896-960 MHz range. The frequency bands considered in this paper deal mainly with the mobile, broadcasting and amateur services. Also, in this range, it addresses proposed modifications to the Canadian Table of Frequency Allocations, mainly dealing with Low Earth Orbit (LEO) mobile satellites, the aeronautical public correspondence service and the mobile service in the band 942-960 MHz, which resulted from the decisions of the 1992 World Administrative Radio Conference (WARC-92) in Torremolinos, Spain.

Industry and Science Canada invites written submissions from all interested parties on this proposal paper. Submissions should be addressed to the Director General, Telecommunications Policy Branch, Industry and Science Canada, 300 Slater Street, Ottawa, Ontario, K1A 0C8 and to ensure consideration, must be postmarked on or before 20 December 1993 or received by other means by the

same date. All representations must cite the Canada Gazette, Notice publication date, title and the Notice reference number DGTP-002-93/SMEP-011-93 (see Annex C). Then, based on the results of public consultation, the revisions to the Canadian Table of Frequency Allocations will be released in early 1994 and the spectrum utilization policies will begin to be issued later in 1994.

2 Theme Questions

Introduction

The original Discussion Paper raised seven theme questions for public consultation. The themes were: Low Power Devices; Introduction of New Technologies; Personal/Business Radio Service; UHF Television Broadcasting; Land Mobile and UHF Television Spectrum Sharing; Strategy for Implementing More Spectrum-Efficient Systems; and, Industry Development.

Given the period of time and the development of new technologies and services that have taken place since the theme questions were first posed, the results of consultation will be limited to the those which are currently relevant. The following is a synopsis of those results.

2.1 . . . . . Low Power Devices

This theme question sought input to the following four questions:

a) **Should there be a more liberalized use of the bands in the range from 30.01 to 47 MHz for various low power devices?**

b) **Are there other more suitable bands than those currently available for these uses, such as the band (40.98-41.015 MHz) also designated for Industrial, Scientific and Medical (ISM) purposes?**

c) **What restrictions, constraints, etc. should there be on the use of these bands for these services?**

d) **What is the need for compatibility in North America for frequency bands and other technical factors?**

Public Comments

An equal number of respondents were both in favour of and opposed to introducing low power devices more liberally in the 30.01 to 47 MHz range of frequencies.

With respect to placing low power devices in the current ISM bands, no respondent voiced any opposition. Some suggested approaches

included first introducing a small number of units/low power devices as a test for potential frequency sharing problems.

The majority of respondents believed that strict power, frequency and emissions restrictions were imperative to protect current licensed users against harmful interference. This was viewed as being crucial by current providers of radio services with safety service and military applications. Other respondents recommended that the use of non-radio technologies be encouraged. It was felt that these measures, along with protection against interference from low power devices, were the minimum requirement for more liberalized use of low power devices in the 30.01 to 47 MHz and 40.98 to 41.015 MHz bands. Other respondents agreed but felt that any restrictions should only be sufficient to achieve a harmoniously shared spectrum environment.

All respondents felt that a certain degree of equipment standards and technical restrictions uniformity between Canada and the U.S. was fundamental to securing a competitive environment and economies of scale for manufacturers of low power devices.

Discussion

The use of low power radio frequency equipment in Canada has traditionally been achieved through an exemption from radio licensing where the device meets certain prescribed technical and regulatory pre-conditions. In special cases, where equipment does not meet technical, operating or regulatory requirements, the radio equipment is licensed.

Existing procedures for obtaining an exemption from licensing generally tend to be device specific. This situation has led to regulations that are increasingly unwieldy and administratively burdensome for the user. As a result of technical innovation and a growing demand for an ever-increasing variety of consumer products utilizing radio frequencies, all aspects of the operation of this type of equipment is being reviewed with a view to streamlining the administrative and technical functions associated with obtaining an exemption from licensing.

Conclusion

It is concluded that liberalization (i.e. more bands being opened up) of spectrum use for low power devices in the bands 30.01 to 47 MHz might lead to more effective spectrum utilization of certain portions that remain largely unused.

2.2 . . Introduction of New Technologies

This theme question sought input to the following areas:

a) **New technologies such as Amplitude Compandored Side-Band (ACSB), mobile digital radio, narrow-banding techniques and other new techniques for increasing the general level of spectrum utilization for mobile radio.**

b) **Appropriate bands in which such new technologies should be introduced bearing in mind that the allocation of additional spectrum to the mobile service has not yet been demonstrated as necessary for this purpose.**

c) **What incentives, if any, could be used to foster the introduction of these techniques?**

Public Comments

A number of respondents supported the introduction of a new technology provided that the technology that is proposed to be introduced in a given frequency band sufficiently proves to be spectrum efficient. This could be achieved through engineering studies which would also consider the economic impact on commercial providers of related radio services. In other words, the introduction of new technologies would not be economically disruptive to existing services and the spectrum policy principle of "phased implementation" of proposed spectrum utilization policy changes would be maintained. This well-established policy principle ensures that spectrum utilization changes are not disruptive to existing spectrum users and provides for sufficient periods of radio equipment amortization in cases where spectrum utilization policy changes require a transition to new technology and often new radio equipment.

Some respondents, in addressing new narrow-band technologies cautioned that: while the use of new narrow-band technologies are strongly advocated, such approaches are already reaching the stage of diminishing returns due to compatibility and cost; it is inappropriate to introduce narrower technologies into existing bands heavily populated by wide-band technology; and narrow-banding techniques have not proven to be the only alternative leading to spectrum efficiency. The reaction to the introduction of narrow-band applications, however, was positive overall.

With respect to digital mobile radio technology, some respondents believed that, to be effective, it must also be compatible with other analogue technologies currently in use.

On the matter of the introduction of ACSB technology, safety service providers believed ACSB to be: more susceptible to interference than FM systems operating on adjacent and co-channels; inferior in quality to the present FM standard; not readily adapted to signalling and data

applications; and requiring its own designated sub-band (subject to a market supply of equipment). Although a small number of respondents actively supported this technology, considerable opposition and caution on proceeding with it was expressed.

In general, and in relation to questions b) and c), individual respondents recommended that:

- frequency allocations be made for each new narrow-band modulation technique to encourage its development and reduce the cost of equipment;

- substantially reducing levels of mobile traffic loading for the first five years, is seen as being counter-productive.

- new techniques may initially mean expensive user equipment. If there is low loading, small numbers of the new equipment will be sold. This would keep equipment costs high and perpetuate low use and thus poor spectrum utilization;

- mandatory minimum receiver standards be continued as a possible method of improving spectrum efficiency;

- where possible, consideration be given to designating new bands (or sub-bands) as "green space" adjacent to existing land mobile frequency bands to make it more economical and practical to produce hardware and migrate to these new technologies; and

- spectrum between 30.01 and 47 MHz, and 72-73 MHz, may be appropriate for new technology, and the existing low level of occupancy in these bands means that compatibility with existing technology is consequently not an issue.

Discussion

The introduction of new technology is often driven by its ability to provide new services and reduce the cost of communications. In some instances, the availability of a particular technology also has the potential to increase spectrum utilization. For example, the advent of digital technology in cellular radio is not only leading to improvements in service and increased privacy of communications, but also to significant increases in spectrum efficiency.

The central issue to be addressed here is how the introduction of new technology can improve efficient utilization of the radio frequency spectrum and to what extent its introduction should be encouraged. Related topics could include which technologies should be supported, what strategies will be necessary for their adoption and how the introduction of new technology can accommodate existing radio systems. One consideration in evaluating the introduction of a new

technology, or improvements in existing technology, is whether it is both backward and forward compatible, i.e. capable of operating with existing and future/emerging radio services. Many new technologies or improvements, however, may not meet these conditions. One focus of this policy proposals paper, therefore, is to suggest strategies for implementing more spectrum efficient technologies.

Conclusion

It is concluded that the introduction of new digital technology in the mobile bands has the potential to greatly enhance spectrum efficiency while providing new and innovative service applications. The challenge is to develop transition plans which promote and facilitate the introduction of more spectrum efficient technology while minimizing difficulties with existing mobile systems. Technologies offering improved spectrum efficiency with minimal disruption to existing services are encouraged and given preference in licensing over conventional systems.

2.3 . . . . Personal/ Business Radio Service

This theme question dealt with the factors upon which a decision to establish such a service would be based. In presenting this theme question, it was hoped to identify the need, if any, for this type of service and to obtain information on the manner in which it would be implemented and operated.

Public Comments

Responses to the current inquiry into low cost personal/business radio elicited no apparent support for this type of service. In fact, a significant number of respondents were completely opposed to the introduction of such a service. Most respondents questioned the need for such a new service when the General Radio Service (GRS) and Radio Common Carriers already fulfil most personal and business needs. Other comments ranged from concern that the 216-220 MHz frequency band would eventually become an unregulated band with the same characteristics as the current GRS band. Only a few respondents supported the introduction of such a service. One of the concerns for these respondents was that without a concrete implementation plan that could be reviewed, the practicality of this type of service was difficult to judge. However, a proposal has been received for an implementation plan and some of the main factors of this plan are set-out in Annex A.

Discussion

The creation of a personal type of radio service is a subject on which we have previously initiated public discussion. At each opportunity, the viability has been evaluated based on the potential for filling a user/ market niche, the efficiency of the radio service, and the cost of equipment and economic viability of the service.

In the intervening period since the consideration of this type of service first began, various means of communication, directly available to the

public, have evolved significantly from both technological development and service availability perspectives. General Land Mobile Radiotelephone Service with access to the public switched network is available throughout Canada; Radio Common Carriers have made significant inroads towards providing radiocommunications facilities, in an economical manner. Also, the nation-wide and successful implementation of the cellular radio service currently has the capacity of reaching over 80 % of the Canadian population and provides to the subscriber a reliable and efficient means of communicating on the move. Looking to the future with emerging technologies such as digital cordless telephone, advanced mobile, mobile satellite and developments in personal communications, it is anticipated that these technologies will lead to universal availability and choice of personal and portable access to the public switched telephone network for all Canadians by the turn of the century.

Conclusion

It is concluded that based on a repeated lack of public interest to establish such a service and the recognition of evolving technologies and radio services which would appear to fulfil developing personal and business needs, there has not been a demonstrated need for a personal/business radio service in the 216-220 MHz band. However, public comments are invited on the personal/business radio service implementation plan advanced by a respondent and as outlined in Annex A.

2.4 ..... UHF Broadcasting

The theme question of UHF television broadcasting dealt with the UHF television band as a candidate for future non-broadcasting and new broadcasting applications (such as wireless office local area networks, low-power video re-transmitters, wireless microphones, multi-point data distribution systems, sound broadcasting by satellite and land mobile systems) and views on modification to spectrum allocation.

The future evolution of television broadcast systems is an important aspect of Canada's cultural identity and social well-being. The present television system standard used in Canada, 525 line NTSC (National Television Systems Committee), has remained unchanged for more than thirty years. Fundamental changes are expected to take place in the next five to ten years with the introduction of advanced digital television productions and broadcasting technology.

Spectrum studies by the FCC and the Advisory Committee on Advanced Television indicate that between 95 and 99 percent of all existing television stations could be assigned an additional 3 or 6 MHz. These are based upon utilization of the "taboo channels" within

the existing allotment plan and transmitter spacings of 160 kilometres - less than half the present spacings of co-channel stations.

Public Comments

Comments were requested on potential demands for new services, alternative bands for new applications, continuing need for UHF over-the-air broadcasting and services sharing. With respect to the use of the UHF television band for broadcasting services, public responses indicated that: there will not likely be any additional spectrum for broadcasting; universal coverage cannot be provided by any other means; alternative means are unable to meet regulatory and statutory delivery requirements of the broadcaster; there is a need to accommodate future digital and advanced broadcasting services; the final direction of over-the-air advanced television standards, sometimes referred to as High Definition TV (HDTV) is likely to be known in 1995; and there is no policy to preclude enhanced-quality, terrestrially delivered off-air television services.

Regarding the use of this band for other services, comments included the following: further use of the band for broadcasting should be frozen; a reassessment of the band should consider the imbalance in favour of broadcasting; alternative technologies such as cable and fibre should be used to provide specialized services; broadcast spectrum could be reduced by eliminating "taboos" and improving television receiver specifications; this band is a prime candidate for future non-broadcasting applications (no specific future demand was made by commenters other than land mobile services); the phasing out of VHF television should be considered.

Discussion

Some of the issues associated with the introduction of advanced television systems in Canada as identified by interested parties include the following: regulation should not be placed in a way that will reduce CATV system competitiveness with other technologies for the delivery of advanced television; regulators should not be distracted by the promise of either fibre optic delivery to the home or DTH (Direct to Home) satellite delivery; conventional over-the-air broadcasters are likely to have major difficulties with the introduction of advanced television because of spectrum considerations and the enormous capital outlays required; the duplication of broadband access facilities should be avoided; current restrictions on ownership of CATV delivery facilities should be reviewed; strong opposition to any policy action by government that would have the effect of prescribing any single delivery mechanism as the sole method; and efficient use of the spectrum should be one of the prime considerations during the deliberations on the introduction of advanced television systems. For technical, economic and good spectrum management reasons, many expressed the view that the primary initial transmission medium in Canada may be the cable television industry with delivery as well through satellite-to-cable services.

Studies conducted on advanced TV Broadcasting indicate that the introduction of 6 MHz simulcast systems are easier to implement than 6+3 MHz systems. Preliminary results indicated that with reduced protection criteria assumed for advanced television channels, it would be likely that most or all of existing Canadian TV channel assignments could be accommodated with simulcast 6 MHz non-compatible and 3 MHz augmentation scenarios. However, the augmentation approach would require the use of many of the current unused allotments and thus have an impact on future growth.

Television technology is global and competitive. Within the past few years, immense strides have been made in the research and development of digital transmission, digital receivers and signal compression. As well, these delivery systems have evolved to become more cost-effective. Optical fibre cable delivery and direct broadcasting satellites represent future approaches to television delivery as alternatives to over-the-air broadcasting systems.

Conclusion

It is concluded that, in the longer term, the use of the standard 6 MHz NTSC signals will provide, with a potential 6 MHz available to each broadcaster to deliver the advanced television service, an implementation schedule and direction for advanced television broadcasting. Furthermore, by early 1995, the FCC are likely to make their decision on the advanced television transmission standard which will impact directly on the allotments to be utilized in Canada. In collaboration with Canadian industry, Industry and Science Canada will commence in 1993 further consultation on the implementation of advanced television services and the use of the UHF broadcasting spectrum for advanced television broadcasting.

Initially, in the near term, NTSC and advanced television services will be simulcast. When the conversion is sufficiently mature, Industry and Science Canada will reassess the utilization of these bands (see section 3.2 for further discussion).

2.5 . . . . . Spectrum Sharing: Land Mobile and UHF Television

The theme of spectrum sharing was premised on the possibility of the limited introduction of land mobile services within television channel frequencies in a channel that could not be assigned for television broadcasting use due to the constraints caused by receiver related "taboos". These channels could therefore be used for land mobile services or for other low-power broadcasting services or for the introduction of other services.

However, once these services were introduced into the broadcasting service spectrum, there are future constraints and trade-offs in terms of adding new television channels, interference to broadcasting services or restricting or precluding the implementation of advanced television services.

Public comments were requested in the Discussion Paper on whether limited sharing should be allowed, what criteria should be used, what restrictions should apply, possible timing, degree and geographical areas of sharing.

Public Comments

Sharing of UHF television spectrum for mobile radio services was encouraged by a number of respondents to relieve congestion in a few large urban areas as it was not considered an impediment to the development of broadcasting services. However, other interested parties indicated that sharing could result in the following hardships to television service: increased interference to existing television broadcasting services; restrictions in the future ability to rearrange television allotments; constraints on future flexibility to introduce new broadcasting technologies; and economic harm to broadcasters.

Discussion

To date, we have reviewed the potential impact of sharing of UHF television spectrum with mobile services through contracted studies and monitored the actual spectrum sharing in the USA. Land mobile sharing with broadcasting spectrum was also allowed for a limited time during the Winter Olympics in Calgary. We have also actively pursued studies associated with UHF broadcasting spectrum and requirements for advanced television services. In addition, the Radio Advisory Board of Canada (RABC) established ad hoc working groups to review the question of spectrum sharing and associated conditions. Based on a review of television allotments and assignments in the Toronto, Montreal and Vancouver areas, there was unused spectrum within Channels 14-20 which could potentially be utilized for land mobile sharing for a limited period of time, until growth requirements for TV channel allotments materialized or advanced television services were introduced. These potential channel frequencies, however, were not common between the three metropolitan cities.

Industry and Science Canada, based on this review, will not consider the possibility of land mobile sharing with UHF television broadcasting spectrum at this time. This is due to the fact that there is no demonstrated growing need or significant interest to develop interim mobile service in broadcasting spectrum. Also, advanced developments in digital technology and system design for land mobile systems have already increased spectrum capacity several fold in certain existing mobile bands/applications.

Conclusion

It is concluded that given the potential for the introduction of improved television services in the UHF television band, it does not appear prudent to reduce flexibility of this deployment at this time through the introduction of mobile services in currently unused portions of the UHF television plan.

2.6 .... Strategy for implementing more spectrum-efficient systems in currently used spectrum

The land mobile radio service is growing at a significant rate and although we have been successful in the past, in providing additional spectrum in the bands below 1 GHz, spectrum for the land mobile service has become very congested in large metropolitan centres. It is unlikely that any significant additional amount of spectrum below 1 GHz can be made available. Currently, the land mobile radio service operates in the bands 50, 150, 400, 800 and 900 MHz and employs various channel bandwidths of 20, 25 and 30 kHz. In addition, there are radio systems in the bands 420 and 900 MHz that currently operate at a channel spacing of 12.5 kHz.

One way of meeting future demands is with the use of digital technology developed for cellular radio which will result in a reduction in the effective voice channel bandwidth e.g. from 30 to 10 kHz. Further reductions of equivalent bandwidths to 5 kHz are foreseen.

The potential impact of employing digital technology using TDMA, FDMA, CDMA or other techniques, in the existing conventional land mobile bands is to increase the number of available voice channels and the re-use of frequencies. This prospect not only will benefit the users of the land mobile service in accommodating their future demands in the present frequency bands but also can more readily provide for data transmission and other new services. Another important feature of these new techniques is the potential lower cost in the long term relative to the present analogue FM equipment. This will be an important additional factor to be considered in future land mobile systems.

To enable the introduction of the new technology in the conventional land mobile bands, it would require that:

- Channelling and sub-band plans be developed for candidate bands taking into consideration equipment and system characteristics and requirements of various users of the land mobile service.

- Consultation with Canadian industry be aimed at the development of equipment standards for the new technology and the associated criteria to be used in the assignment strategy.

- An assignment strategy be based on the selected introduction plan.

- The spectrum efficiency of evolving radio systems through engineering studies has been sufficiently proven. Such studies would also provide a preferred focus on proposed policy

options that will result in a positive economic impact for commercial providers of related radio services.

Public Comments

Comments on the feasibility of the previously-mentioned options were invited and the majority of respondents on the safety services side of land mobile spectrum usage advocated that:

- enhanced equipment specifications be introduced to achieve greater spectrum efficiency, but that the economic aspects and restrictive access results should be carefully considered and made liberal enough to allow sufficient bandwidth for encrypted voice transmissions;

- enhanced specifications for safety equipment be governed by price and availability;

- "change-over" frequencies be sufficient in number and the "change-over" time be long enough for the user to adjust to change;

- trunking technology be encouraged for mid-to-large systems but not for large area systems;

- self-regulation be encouraged for channel loading and access to frequencies; and

- municipal government needs be given greater recognition.

Discussion

The land mobile radio service continues to grow at a considerable rate. In May of 1989 Arthur D. Little forecasted that the growth rate to 1996 in North America would be 63% for paging, 32% for private dispatch and 154% for cellular radio. Current shorter term projections indicate that the growth rate may be even more substantial with an anticipated overall annual growth rate for mobile radiocommunication services of between 10% and 25%.

To ensure that many views are brought forward, including those which are invited through public consultation on the proposals herein, several independent studies were contracted out that will contribute to the long range planning goals for land mobile spectrum use. Of these, three studies are particularly relevant and these are highlighted in Annex B.

The Digital Evolution from Analogue

While it is apparent that the growth of mobile services will in the long term be significant, the currently projected sharp rates of growth may be tempered, if only somewhat, by the introduction of new competitive alternatives to the traditional dispatch category of land mobile radio services. Although we have been successful in the past,

on national and international levels, in making additional spectrum in the bands below 1 GHz available for mobile services use, spectrum has become very scarce. It is unlikely, therefore, that any significant amounts of additional spectrum allocation below 1 GHz can be made available to the land mobile service. Spectrum above 1 GHz and particularly around 2 GHz will be available. New mobile spectrum; however, will still need to be liberated from existing services in an orderly and timely manner. This will enable a methodical displacement and accommodation of existing systems.

One way of meeting future demands below 1 GHz is with the use of more efficient radio systems and technologies. A transitionary step towards digital applications would be the increased use of trunking techniques which can result in significant short term increases in spectrum capacity[1]. The new digital technology being developed for the second generation cellular systems will have a significant impact on other land mobile radio services. The radiocommunication industry in North America is currently implementing second generation cellular systems of a much higher spectral efficiency to replace the existing analogue systems in the 800 MHz cellular bands.

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1) Current and ongoing internal studies on technology options and implementation suggest that in a 3-channel trunked public dispatch system, spectrum capacity may be increased by some 41% compared to that of a non-trunked system.

These second generation systems utilize digital technology where voice is coded and transmitted digitally resulting in reduction in the effective voice channel bandwidth from 30 to 10 kHz. The ultimate aim of this technology is to achieve an equivalent 6.25 kHz and/or 5 kHz radio frequency channel bandwidth per voice circuit. This digital technology, in combination with TDMA and CDMA access techniques, is now being successfully implemented in various locations in North America and equipment utilizing this technology is already available in the market place for cellular system applications. In terms of digital technology developed specifically for land mobile applications, certain advancements are already being achieved. For example, the work of the Association of Public Safety Communication Officers (APCO 25) standards committee in the U.S. aims for 6.25 kHz channelling in the near future. Channelling of 12.5 kHz for digital equipment is currently being marketed by several North American manufacturers.

The potential impact of employing new digital technology in the existing conventional land mobile bands may increase the number of available voice channels by an initial factor of three to five with a possible overall ten fold increase or greater in the future as further

capacity improvements are introduced. This prospect not only will benefit the users of the land mobile service in accommodating their future demands in the present frequency bands but also can provide additional capability to accommodate data transmission and other new services. Practically speaking; however, the full extent of capacity improvements will only be achieved through the consolidation of many private radio systems or radio common carriers. This will enable the development of the critical traffic necessary to get ten fold increases or greater. Another important feature of the new equipment being implemented for the second generation system is its potential lower cost relative to the present analogue FM equipment. This will be an important factor in future land mobile systems. The by-product of second generation equipment that utilizes digital transmission and reception techniques will be a significant improvement in the privacy of communications.

Significant Mobile Service Changes in the U.S.

In the United States of America, the Federal Communications Commission (FCC) is in the midst of concluding public consultation on the "refarming" of spectrum below 512 MHz. This consultation, the details of which are covered in section 2.3 of Chapter II, explores proposals to increase channel capacity below 512 MHz, promote efficient use of these channels and simplify policies and regulations that govern their use. Proposed methods for increasing spectrum efficiency include implementation of 6.25 kHz channel spacing or less in the frequency bands 421-430 MHZ, 450-470 and 470-512 MHz and 5 kHz channel spacing in the frequency bands 72-76 MHz and 150-174 MHz. The FCC had initially proposed an implementation date reductions in channel spacing plans for these frequency bands; however, in recent public discussions with interested parties, the FCC have indicated that they may not stick to the proposed schedule if it hinders rather than supports the transition to more spectrum efficient technologies.

In a public consultation that preceded the "refarming" review, the FCC re-allocated the 220-222 MHz band for narrow-band use by the land mobile service. Consequently, the FCC has adopted a set of rules to: support and accelerate the use of narrow band technology for private land mobile operations; implement narrow-band technology to enable the reallocation of existing spectrum into 200 channel frequency pairs in 2 MHz of spectrum; and cease amateur radio service operation. Among the 200 newly created channels, there are 60 for national services and 140 for regional or local government and non-government users to share.

A "preferred channel" allocation approach encouraging trunking and digital transmission applications has been adopted for the 220-222 MHz band that is expected to result in additional spectrum efficiency gains. In another novel approach, the FCC has also decided to "set-

aside" some 10 channels for public safety to operate mobile and portable stations on a nation-wide basis to increase the effectiveness of inter-communications during emergencies and safety of life operations. This 'set-aside' will be reviewed in 5 years to determine whether this spectrum is being under-utilized.

A Canadian Perspective for the Mobile Service

Spectrum congestion for the mobile service has reached a critical stage in several major metropolitan areas in Canada. As a result the bands 138-174, 406.1-410, 410-420, 420-430 and 450-470 MHz are some of the most utilized bands in the metropolitan centres of Montreal, Toronto and Vancouver. These bands have seen significant annual increases in frequency assignments between the years 1987 and 1990 alone. This trend has resulted in several shortages of useable and assignable spectrum. For example, in the metropolitan area of Montreal, the 420-430 MHz band is completely assigned.

Conclusion

It is concluded that by accelerating the use of trunking techniques to improve spectrum efficiency, this alone would not be sufficient to help to ease spectrum congestion in the long term. To implement real spectrum efficient technology it may be necessary to vacate portions of spectrum to adopt new channelling plans and system applications. Any real gains in spectrum efficiency would neither be quick enough to meet burgeoning mobile spectrum demands, nor significant enough to address serious congestion levels in major metropolitan areas. Instead, a more practical solution for the long term requirements for mobile spectrum would be to implement more efficient modulation techniques, such as those becoming available through digital transmission, as expediently as possible. Although digital transmission technology currently has the greatest possibility of achieving increased spectrum efficiency, other techniques such as trunking and technologies such as amplitude compandored side-band that result in improved spectrum efficiency should also be encouraged. It is this strategy upon which Industry and Science Canada invites comment on the questions raised in the following part of this conclusion.

Chapter II of this paper outlines technology options and associated technical implementation strategies. **Industry and Science Canada encourages interested parties to comment on Chapter II as it will form a complementary part of the development of the final spectrum redeployment option for spectrum utilization below 1 GHz.** In addition, to the technologies applications options to be discussed in Chapter II, comments on the following questions are invited:

1) **What is the preferred re-deployment option (outlined in Chapter II) for mobile bands between 100 and 500 MHz**

given that they are virtually exhausted in major metropolitan areas?

2) What types of spectrum efficient technologies would be most cost-effective?

3) Should there be a moratorium on spectrum for fixed services below 900 MHz and how best could this be accomplished in order to minimize the impact on existing services?

4) The objective of re-deployment of mobile bands between 100 and 500 MHz is to release core spectrum to meet the increasing demand by land mobile services for the next 20-30 years. In this regard:

a) What would be the best strategy for the implementation of more efficient spectrum usage in the mobile bands in the range 100 to 500 MHz and which band should first be deployed?

b) What would be a reasonable time table for more efficient usage of the existing mobile bands (e.g. a multi-staged process)?

c) What is the realistic equipment amortization period for service providers to move to more efficient usage such as digital technology applications?

d) What would be the best overall assignment plan for mobile bands between 100 and 500 MHz if it were totally re-planned?

e) What incentives could be introduced to encourage a re-deployment plan?

f) What mechanisms could be introduced to enable large spectrum users to utilize excess spectrum capacity (e.g. leasing excess capacity to other spectrum users)?

g) What would an effective plan for having small to medium users to pool spectrum (e.g. increased trunking)?

h) How could similar mobile spectrum users be more effectively integrated together?

Comments on these questions will enable the development of a responsive re-deployment plan and spectrum policies that will sustain

mobile service growth in the 100 to 500 MHz range. Further spectrum utilization proposals are presented for public comment in section 3.1.

2.7 ..... Industry Development

A central issue to be addressed in this policy proposals paper is the role that the Industry and Science Canada should play to foster the development of a strong Canadian industry, concentrating on the frequency range 30-960 MHz.

Discussion

The recently enunciated **"Spectrum Policy Framework for Canada"** will ensure that the Canadian radiocommunications evolves in an orderly fashion at the forefront of global communications developments while continuing to meet the needs of all Canadians at an affordable cost.

The mechanism to promote this objective includes: research and development; industry development; and application of new technologies and new services. Mechanisms such as R&D Advisory Boards have been put in place to strengthen linkages between research laboratories and universities, businesses, and users of communications services and products. The strategy for the two other elements, i.e. industry development and new applications, is now being developed for the mobile and fixed areas of radiocommunications.

There is, in summation, a strong case for active participation by Industry and Science Canada in the development of the Canadian radio industry through the expansion of existing radio services and through promoting and encouraging the implementation of new services and new technology applications so as to better serve the needs of all Canadians. It is proposed to continue to pursue these objectives. In the past, this mandate has been actively pursued in the field of satellite communications and has resulted in international recognition of Canada's expertise in space applications and significant net economic benefit to Canada. Developing a similar strategy for mobile and fixed radiocommunications is timely as market forces and technological advances are fuelling a major structural shake-up of the industry in response to the information age.

Public Comments

The majority of respondents were of the opinion that we should continue its active role in industry development. Some of the important issues that the respondents wanted to be either maintained or strengthened were the promotion of competition within industry, the encouragement of industry in seeking technological solutions for problems in the respective radio services, continued R&D funding, the letting of technology research contracts, and the government\industry role in spectrum utilization policy development. All of these areas, it was expressed, could be buttressed by flexible spectrum policy and

regulatory frameworks and a rational long term plan for spectrum utilization in the range 30-896 MHz. A small number of respondents felt that the we should not play an active 'force-fit' role in industry development and believed that the short term success of R&D funding has yielded few long term benefits for industry.

Conclusion

It is concluded that Industry and Science Canada will continue on its course of setting well-balanced spectrum utilization policies in cooperation with industry to gain maximum economic benefit, effective and efficient use of spectrum resources in order to maintain a high standard of social well-being and affordable access to radio services for all Canadians.

3. Spectrum Allocation and Utilization Proposals

Introduction

This part of Chapter I deals mainly with mobile, broadcasting and amateur services in the 30.01- 806 MHz frequency range. For each band(s) in a particular service, there is a presentation of the existing frequency allocation in the Canadian Table of Frequency Allocations; a discussion of the utilization of the band(s) and issues to be resolved; and proposals to confirm or modify the existing allocation and spectrum utilization including the rationale behind the proposals.

3.1 . . . . . Mobile

The following is a broad introduction on the 30-50 MHz range of frequencies, a band-by-band chart maps-out the proposed spectrum utilization policies and the rationale behind the proposed spectrum utilization. The remaining mobile services bands are treated on an individual band-by-band basis with a discussion of the particular band, the domestic allocation and the proposed spectrum utilization policy.

3.1.1 . . . . . Existing Canadian Allocations

30.005-30.01 MHz

MOBILE
SPACE RESEARCH
Fixed

30.01-37.5 MHz

MOBILE
Fixed

37.5-38.25 MHz

MOBILE
Fixed
Radio Astronomy

38.25-39.986 MHz

MOBILE
Fixed

39.986-40.02 MHz

MOBILE
Fixed
Space Research

40.02-40.98 MHz

MOBILE
Fixed

40.98-41.015

MOBILE
Fixed
Space Research

41.015-47 MHz

MOBILE
Fixed

47-50 MHz

MOBILE
Fixed

Discussion

Frequency bands in the range 30-50 MHz are all allocated on a primary basis to the mobile service and on a secondary basis to the fixed service. In addition to these allocations, the space research service is also allocated on a secondary basis in the 30.005-30.01, 39.986-40.02 and 40.98-41.015 MHz bands and the radio astronomy service is allocated on a secondary basis in the band 37.5-38.25 MHz. Operation in this range of frequencies is in both simplex and duplex. Among the many uses in this range are ones like radio paging (at 35 MHz), large land mobile radio systems operation by common carriers (GLMRS-30.01-37.5 MHz), automatic repeaters (30-50 MHz), emergency traffic control systems and remote control of fire alarm systems (38-43.62 MHz), ISM operations(40.66-40.70 MHz), common carrier radio systems, and mobile usage along the Canada/U.S. border (at 49 MHz). In the mobile service in the 30-50

MHz range, 25 kHz channel spacing is common. The range is relatively lightly used due to the possibility of interference from neighbouring television bands and varying propagation characteristics.

In general the propagation characteristics of the 30-50 MHz range are such that interference from distant signals is a common occurrence at various degrees throughout the range. These propagation anomalies, which change with the seasons and time of day or night, make this range of frequencies more attractive for use by some radio system applications and services.

Ionospheric scatter propagation transmission permits communication in this frequency range and over large distances approaching 2000 kilometres. However, this characteristic is often more closely associated with using the ionosphere for long distance communications below 30 MHz. Between 30 and 50 MHz, ionospheric propagation is much less stable and not good enough for mobile communications due primarily to the higher incidence of inter-system interference that can occur. Generally, the propagation transmission stability is better at the higher end of this frequency range than the lower portion. Regardless, this spectrum has remained largely unused.

Radio systems in the range of frequency bands from 30.005 to 50 MHz use 20 kHz channel spacing. In particular, the bands in the range of frequencies 30.005-40.02 MHz, are very lightly used.

Domestic Allocation

The domestic allocations as specified previously and in the Canadian Table of Frequency Allocations for these bands, remain unchanged.

Proposed Utilization

The following charts outline the proposed spectrum utilization for these bands and the rationale for such use.

RANGE (MHz)	PROPOSED UTILIZATION	RATIONALE
30.005-30.01	It is proposed that: - this band be amalgamated with the band 30.01-37.5 MHz.	This band is far too narrow to support unique applications.
30.01-37.5	It is proposed that: - the band 36.0-37.5 MHz be designated for the development and testing of new mobile and fixed long range transmission techniques. - there be no new assignments for the fixed and mobile service in this band and that new users be accommodated in either the bands 37.5-38.25 MHz or 42-50 MHz. - current usage by licensed mobile and fixed users continue. - the bands 30.005-30.01 MHz and 30.01-33.0 MHz and the band 33.0-36.0 MHz be designated to unlicensed low power systems.	These assignments will not be afforded any protection and will be treated in the same way as the unlicensed low-power systems operating in the ISM bands. This may enable industry to further explore the possibilities of this under-utilized portion of the spectrum and, by virtue of the nature of this band, develop and test various long-range transmission techniques. The higher segments offer the same advantages, in terms of radio coverage, but are less susceptible to abnormal propagation phenomena caused by ionospheric variations.
37.5-38.25	It is proposed that: - this band be reserved exclusively for new licensed mobile and fixed service users.	Apart from abnormal propagation phenomena, which are caused by ionospheric variations and are less pronounced than in the band 30.0-37.5 MHz, this portion of the spectrum satisfies long-range communication requirements in mountainous regions.
38.25-39.986	It is proposed that: - current usage by licensed mobile and fixed users continue. - this band be designated for the use of long-range transmission applications, with a view to meeting requirements for point-to-point, point-to-multipoint and radio paging communications.	Since the abnormal propagation phenomena caused by ionospheric variations are less severe in this band, it could be used to meet long-distance radio coverage requirements in hilly and mountainous regions. Current applications include fixed emergency traffic control applications, remote control of fire alarm systems and possible applications include radio links between radio paging stations, ranging and telemetry.

RANGE (MHz)	PROPOSED UTILIZATION	RATIONALE
39.986-40.02	It is proposed that: - this band be amalgamated with the band 40.02-40.98 MHz.	This band is far too narrow to support unique applications.
40.02-40.98	It is proposed that: - the current usage by licensed mobile and fixed users continue. - this band be designated to unlicensed low-power systems.	These assignments will not be afforded any protection and will be treated in the same way as the low-power systems operating in the ISM bands.
40.98-41.015	It is proposed that: - this band be amalgamated with the 40.02-40.98 MHz band.	This band is far too narrow to support unique applications.
41.015-47.0	It is proposed that: - the band 42.00-47 MHz be designated for mobile applications. - the band 41.015-42.00 MHz be designated to unlicensed low-power systems.	Many land mobile users have already migrated to the cellular service and as a result fewer channels are being assigned to the urban and private radio paging services. Consequently, the introduction of new mobile and fixed applications is encouraged.
47.0-50.0	It is proposed that: - the current mobile usage be maintained in order to satisfy the requirements of users of the land mobile service.	This band best meets the requirements of long-range radio coverage and is also the least affected by abnormal propagation phenomena.

3.1.2 . . . . . Existing Canadian Allocation

72-73 MHz

FIXED
MOBILE

Discussion

The band 72-73 MHz is allocated to the fixed and mobile services on a primary basis. Assignments in this band are used at 20 kHz channel spacing and at low power for industrial applications such as in-plant communications, control of machinery and other similar functions, wireless microphones, model control (aircraft), and recently for low power data communications.

Frequency assignments in this band are made in a manner that minimizes the potential of interference to broadcast services in the adjacent band (TV channels 3 and 4), to aeronautical marker beacons (74.8-75.2 MHz) and to avoid the specific channels used for aircraft model control.

Individual frequency assignments are currently identified for specific uses as required, e.g. 72.58 MHz is selected for low power data communications, and 61 discrete frequencies from 72.01 to 72.99 MHz are used for aircraft models.

While present usage is minimal, it is anticipated that the spectral demand will increase in this band and the other bands in the 72-76 MHz range (exclusive of the band 74.8-75.2 MHz which is used for aeronautical radionavigation). This anticipated demand is due to the increasing need for spectrum for low power applications such as in-plant paging and intercommunications, radio local area networks, radio control and alarm functions.

Domestic Allocation

The domestic allocation as specified above and in the Canadian Table of Frequency Allocations for this band, remains unchanged.

Proposed Utilization

It is proposed that this band continue to be utilized to accommodate the types of low power radio applications and unlicensed very low power applications previously-mentioned. In addition, comments are now invited on suggested methods for improving the utilization of this band in Canada.

3.1.3 . . . . . Existing Canadian Allocations

138-143.6 MHz

FIXED
LAND MOBILE
SPACE RESEARCH (space-to-earth)

143.6-144 MHz

FIXED
LAND MOBILE
Space Research (space-to-earth)

148-149.9 MHz

FIXED
MOBILE

150.05-156.7625 MHz

MOBILE
Fixed

156.7625-156.8375 MHz

MARITIME MOBILE (distress and calling)

156.8375-174 MHz

MOBILE
Fixed

Discussion

The 138-174 MHz frequency range was one of the first exploited for mobile radio systems due to good propagation. The channel spacing of the mobile bands in this range was reduced several times during the early days of mobile service implementation. However the current channel spacing of 30 kHz has remained unaltered since the 1960's. Spectrum utilization has been improved through the use of interstitial assignments. This has been a solution applied primarily in urban areas, due to the intense demand for mobile systems in this frequency range and the development of mobile equipment with improved receiver selectivity.

However, the large growth in mobile usage over the last few years has been accommodated by opening higher frequency bands, 400 MHz, 800 MHz and now 900 MHz. The matter of accessing additional mobile spectrum in higher bands (around 2 GHz) is being addressed as part of other public discussion papers entitled, **"Spectrum Allocation in the 1-3 GHz Range"** and **"Spectrum**

Utilization for Certain Services above 1 GHz" which have just been released. However, the presence of existing services and the technical challenges of using this higher range of spectrum, raise a question of how balance will be achieved in meeting the spectrum needs of "conventional" mobile systems throughout this broad frequency range. Rather than rely entirely on access to new spectrum, it is a strongly held view resulting discussions with members of the land mobile industry that, a strategy to effectively deploy systems with more efficient spectrum utilization techniques should be adopted. Deployment of systems using such techniques could take place in the mobile frequency band ranges 138-174 MHz and 406.1-470 MHz. More specifically there is more benefit to first begin deployment in the lower frequency range e.g. 138-174 MHz. However, in heavily congested Canada/U.S. border areas equal emphasis may have to be placed upon the frequency bands around 400 MHz. This is critical to enable more users to take advantage of the favourable propagation characteristics in these bands.

Several techniques have evolved that would lead to improved utilization. For example, one that has been deployed extensively in the frequency bands opened in the 1980's is the use of trunking technology. This takes advantage of the use of frequency arrangements for trunked bands cleared for the mobile service. The implementation of trunked systems in bands extensively used by single channel mobile services raises additional challenges but should be considered. A more productive method of realizing a significant improvement in spectrum utilization would be the adoption of modulation techniques with greater communication capacity for a given bandwidth. There have been a number of developments in narrow-band analogue technology over the past years. However, of greater potential benefit in easing the severe state of spectrum congestion for land mobile frequencies in the long term, is an immediate move to introduce digital technology and its consequent spectrum efficiency gains in the previously-mentioned frequency band ranges.

The frequency band 156.7625 -156.8375 is exclusively used by the Maritime Mobile Service for digital selective calling for distress and safety calling in accordance with Appendix 18 of the International Telecommunication Union Radio Regulations. Other Appendix 18 frequencies in and around the 157 MHz band will continue to be used for the maritime mobile service in accordance with existing agreements. The land mobile use of some of these frequencies, as permitted by ITU footnote 700, will remain unchanged.

Domestic Allocation

It is proposed that the domestic allocations as specified previously and in the Canadian Table of Frequency Allocations for the bands 138-

148.0 MHz and 150.05-174 MHz, remain unchanged (The bands 148-149.9 MHz and 149.9-150.05 MHz are discussed in Section 4.2).

Proposed Utilization

It is proposed to introduce an implementation strategy to encourage the deployment of mobile radio systems using digital technology or other spectrum efficient transmission techniques, for improving the utilization of the frequency band range 138-174 MHz. Comments are invited, in terms of the questions posed in section 2.6, on suggested methods of deploying these mobile systems using digital technology or other spectrum efficient transmission techniques.

3.1.4 .... Existing Canadian Allocation

216-220 MHz

FIXED
MARITIME MOBILE

Discussion

The band 216-220 MHz is allocated to the fixed and maritime mobile services on a primary basis. Fixed radio system linking is permitted in areas at least 170 km from navigable waterways where the Canadian Coast Guard may eventually elect to establish maritime mobile service in this band. Some separation between fixed assignments and TV Channel 13 is also required to protect TV reception.

At the 1987 World Administrative Radio Conference for Mobile Satellite Services, Canada proposed Footnote 627A, additionally allocating the band 216-220 MHz in Canada to the land mobile service on a primary basis. It was indicated that prior to any decision to implement land mobile operations on a wide-scale basis in this band, a public consultation would be held to assess the needs of the land mobile service vis-a-vis those of the maritime mobile service. Comments are now invited in this regard.

Proposed Domestic Allocation

It is proposed that the domestic allocations as specified previously and in the Canadian Table of Frequency Allocations for this band, be modified to add the land mobile service on a primary basis according to the following allocation table.

216-220 MHz
FIXED MARITIME MOBILE **LAND MOBILE 627A**

627A Additional allocation: in Canada, the band 216-220 MHz is also allocated to the land mobile service on a primary basis.

Proposed Utilization

It is proposed that consideration be given to designating the band 216-220 MHz for the implementation of land mobile service as a co-primary service with the fixed and maritime mobile services.

3.1.5 . . . . Existing Canadian Allocation

402-403 MHz

METEOROLOGICAL AIDS
Earth Exploration Satellite (Earth-to-space)
Fixed
Mobile except aeronautical mobile

Discussion

The band 402-403 MHz is allocated domestically on a primary basis to meteorological aids, and on a secondary basis to earth exploration satellite (Earth-to-space), fixed, and mobile (except aeronautical mobile). Canadian operations consist of meteorological weather balloons operated by the Atmospheric Environment Service at remotely operated upper air weather stations. The weather balloon operations are centred on the frequency 403 MHz but due to equipment design, require additional frequency protection.

Usage by the secondary services is limited.

Domestic Allocation

It is proposed that the domestic allocations as specified previously and in the Canadian Table of Frequency Allocations for this band, remain unchanged.

Proposed Utilization

It is proposed that the current utilization of the frequency band 402-403 MHz as previously-mentioned, remain unchanged.

3.1.6 .... Existing Canadian Allocation

403-406 MHz

METEOROLOGICAL AIDS
Fixed
Mobile except aeronautical mobile

Discussion

The band 403-406 MHz is allocated world-wide on a primary basis, to meteorological aids, and on a shared secondary basis, to fixed and mobile (except aeronautical mobile). The Canadian allocation includes mobile satellite except aeronautical mobile-satellite (Earth-to-space) on a shared primary basis with meteorological aids. Canadian operations consist of meteorological weather balloons operated by the Atmospheric Environment Service at remotely operated upper air weather stations. The weather balloon operations are centred on the frequency 403.0 MHz but due to equipment design, require additional frequency protection.

There has been increased usage in this band by systems gathering weather related information via telemetry. These systems, typically located on remote mountain tops, forested areas and highway mountain passes, consist of remote sensors that gather meteorological data and transmits it to a central "hub" station for analysis. Assignments are made on the basis of 25 kHz channelling. Present usage by the secondary services is limited, however it is felt that this band could be used more for fixed telemetry systems.

Domestic Allocation

It is proposed that the domestic allocations as specified previously and in the Canadian Table of Frequency Allocations for this band, remain unchanged.

Proposed Utilization

It is proposed to continue to permit the 403-406 MHz band, to be utilized for meteorological aids. Also, more emphasis will be placed on utilizing the band by fixed systems for the gathering of non-telemetry data.

3.1.7 . . . . Existing Canadian Allocation

406.1-410 MHz

RADIO ASTRONOMY
MOBILE except aeronautical mobile
Fixed

Discussion

The band 406.1-410 MHz is allocated to the radioastronomy, mobile and mobile-satellite services on a primary basis and the fixed service on a secondary basis.

Subject to certain requirements of the Canada-U.S. sharing arrangement[2)], there are frequencies available in the 406.1-409.0 MHz band for mobile assignment, in either a simplex or duplex configuration, depending on identified regional needs.

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2) Arrangement between the Canadian and US Administrations Concerning the Use of the 406.1 to 430 MHz Band in Canada-United States Border Areas.

In the band 409.0-410.0 MHz, there are 40 channels of 25 kHz spacing, paired with 420.0-421.0 MHz in a duplex configuration. **Spectrum Utilization Policy SP 450 MHz** (dated May 1986) and **Radio System Plan RP 013** (dated October 1988) outline the current spectrum utilization policy applicable to the 409.0-410.0 MHz and 420.0-421.0 MHz bands.

The above paired bands could be appropriate spectrum for the introduction of narrow-band (i.e. 12.5 kHz) radiocommunication techniques. Permitting a channelling plan of 12.5 kHz in this band, where feasible, would facilitate the entry of new narrow-band equipment while minimizing the impact on existing systems in those areas where this spectrum is extensively utilized.

The use of frequency band 406.1-410.0 MHz is facilitated by footnote 650 in the Canadian Table of Frequency Allocations, which specifies that interference protection be provided to radioastronomy operations in the band. There are two sites in Canada protected by this provision, the Algonquin Radioastronomy Observatory in Ontario and the Penticton Radioastronomy Observatory in British Columbia. Currently, radioastronomy research has intensified at the Algonquin Radioastronomy Observatory. Such research continues at the Algonquin facility using a 46 m antenna at 408 MHz. Until such time as we are made aware of a change in research activity, it will continue to apply the current protection zones around the Algonquin and Penticton facilities as defined in 1982 (also see SP 450 MHz dated May, 1986).

Domestic Allocation

It is proposed that the domestic allocations as specified previously and in the Canadian Table of Frequency Allocations for this band, remain unchanged.

Proposed Utilization

It is proposed that the current utilization of the 406.1-410 MHz band and the protection zones established in 1982 in Ontario and Quebec for the Algonquin Radioastronomy Observatory remain unchanged. Comments are solicited in this regard. For example, would it be appropriate to establish sun-set time frames for protection zones as a criterion for ongoing review of this band?

3.1.8 .... Existing Canadian Allocation

410-414 MHz

MOBILE except aeronautical mobile
FIXED

Discussion

The band 410-414 MHz is allocated to the mobile and fixed services on a primary basis. Frequencies in this band are assigned according to a 25 kHz channel spacing plan with duplex assignments paired with the band 415-419 MHz. The band 410-414 MHz includes users of province-wide and some municipal mobile and fixed radio systems.

Domestic Allocation

It is proposed that the domestic allocations as specified above and in the Canadian Table of Frequency Allocations for this band, remain unchanged.

Proposed Utilization

It is proposed to introduce an implementation strategy to encourage the deployment of mobile radio systems using digital technology or other spectrum efficient transmission techniques, for improving the utilization of the frequency band range 410-414 MHz. Comments are invited, in terms of the questions posed in section 2.6, on suggested methods of deploying these mobile systems using digital technology or other spectrum efficient transmission techniques.

3.1.9 .... Existing Canadian Allocation

414-415 MHz

FIXED
Mobile except aeronautical mobile

Discussion

The band 414-415 MHz is allocated to the fixed service on a primary basis and the mobile service on a secondary basis. Frequencies in this band are assigned according to a 25 kHz channel spacing plan with point-to-point duplex links paired with the band 419-420 MHz. The protection of the primary service precludes extensive mobile use.

Domestic Allocation

It is proposed that the domestic allocations as specified previously and in the Canadian Table of Frequency Allocations for this band, remain unchanged.

Proposed Utilization

It is proposed that the current usage of the 414-415 MHz band by the fixed service on a primary basis and the mobile service on a secondary basis continue.

3.1.10 . . . . Existing Canadian Allocation

415-419 MHz

MOBILE except aeronautical mobile
FIXED

Discussion

The band 415-419 MHz is allocated to the mobile and fixed services on a primary basis. Frequencies in this band are assigned according to a 25 kHz channel spacing plan and paired with the band 410-414 MHz. The band is typically used for provincial government high-capacity mobile radio systems.

Domestic Allocation

It is proposed that the domestic allocations as specified above and in the Canadian Table of Frequency Allocations for this band, remain unchanged.

Proposed Utilization

It is proposed to introduce an implementation strategy to encourage the deployment of mobile radio systems using digital technology or other spectrum efficient transmission techniques, for improving the utilization of the frequency band range 410-414 MHz. Comments are invited, in terms of the questions posed in section 2.6, on suggested methods of deploying these mobile systems using digital technology or other spectrum efficient transmission techniques.

3.1.11 . . . Existing Canadian Allocation

419-420 MHz

FIXED
Mobile except aeronautical mobile

Discussion

The band 419-420 MHz is allocated to the fixed service on a primary basis and to the mobile service on a secondary basis. Frequencies in this band are assigned according to a 25 kHz channel spacing plan and paired with the band 414-415 MHz for point-to-point radio systems. Due to its fixed primary status, the band is used to a much greater extent for fixed radio systems.

Domestic Allocation

It is proposed that the domestic allocations as specified above and in the Canadian Table of Frequency Allocations for this band, remain unchanged.

Proposed Utilization

It is proposed that the current usage of the 419-420 MHz band by the fixed service on a primary basis and the mobile service on a secondary basis continue.

3.1.12 . . . Existing Canadian Allocation

420-430 MHz

MOBILE except aeronautical mobile
Fixed

C10

Discussion

The band 420-430 MHz is allocated on a primary basis to the mobile service and on a secondary basis to the fixed service.

The entire 420-430 MHz band is subject to potential interference from U.S. radiolocation operations during periods of emergency. Trunked duplex mobile radio systems operations are also located in this band (see document RP 003). Congestion of traffic/frequencies is intensive in the large metropolitan areas. The 420-421 MHz portion of the band is paired with mobile transmit frequencies at 409-410 MHz for General Land Mobile Radio Service (GLMRS) operations.

Canadian footnote C10 permits the operation of radiolocation stations on a case-by-case basis subject to non-interference where such operations cannot be accommodated in the band 430-450 MHz. Frequencies in this band are assigned in accordance with a Canada/U.S. sharing agreement.

In order to maximize utilization of this frequency band to its full potential, the introduction of more efficient technologies should be encouraged. Trunking systems should continue as a transition to digital applications and the consequential spectrum efficiency increases that may be achieved.

Domestic Allocation

It is proposed that the domestic allocations as specified previously and in the Canadian Table of Frequency Allocations for this band, remain unchanged.

Proposed Utilization

It is proposed to introduce an implementation strategy to encourage the deployment of mobile radio systems using digital technology or other spectrum efficient transmission techniques, for improving the utilization of the frequency band range 420-430 MHz. Comments are invited, in terms of the questions posed in section 2.6, on suggested methods of deploying these mobile systems using digital technology or other spectrum efficient transmission techniques.

3.1.13 . . . Existing Canadian Allocation

450-470 MHz

MOBILE
Fixed

Discussion

The band 450-470 MHz is allocated on a primary basis to the mobile service and on a secondary basis to the fixed service. International footnotes permit the operation of amateur-satellites and space research stations subject to certain conditions.

This band is used extensively for mobile services in larger urban areas. Given the predisposition for spectrum congestion in these areas, this band could be more efficiently utilized through the introduction of spectrum efficient technologies.

Domestic Allocation

It is proposed that the domestic allocations as specified previously and in the Canadian Table of Frequency Allocations for this band, remain unchanged.

Proposed Utilization

It is proposed to introduce an implementation strategy to encourage the deployment of mobile radio systems using digital technology or other spectrum efficient transmission techniques, for improving the utilization of the frequency band range 450-470 MHz. Comments are invited, in terms of the questions posed in section 2.6, on suggested methods of deploying these mobile systems using digital technology or other spectrum efficient transmission techniques.

3.2 . . Broadcasting

The FM broadcasting band in the 88-108 MHz range was addressed in the **Spectrum Allocation and Utilization in Certain Bands in the Range 30.01-896 MHz, Part I.**

3.2.1 . . . . Existing Canadian Allocations

Broadcasting (VHF)

54-72 MHz
76-88 MHz
174-216 MHz

Broadcasting (UHF)

470-608 MHz
614-806 MHz

Discussion

The bands 54-72 MHz, 76-88 MHz, 174-216 MHz, 470 - 608 MHz and 614 - 806 MHz are allocated on a primary basis to the TV broadcasting service. We have actively pursued studies associated with UHF broadcasting spectrum and requirements for Advanced Television services. In addition, the Radio Advisory Board of Canada (ad hoc working group) carried out a study on the availability of spectrum. While the RABC concluded that there were certain broadcasting band channels where sharing was possible, these channels were not common across Canada and hence not particulary suitable for use by the land mobile service. No demonstrated need for mobile sharing resulted from the study in the UHF band and in the medium term we will not pursue any further activity for the study of spectrum sharing between broadcasting and mobile services.

Domestic Allocation

It is proposed that the domestic allocations as specified previously and in the Canadian Table of Frequency Allocations for these bands, remain unchanged.

Proposed Utilization

It is proposed, in the medium term, to continue the utilization of these bands for NTSC television broadcasting and future ATV television broadcasting. Initially, NTSC and Advanced Television services will be simulcast. When the conversion to ATV is sufficiently mature, Industry and Science Canada will reassess the utilization of these bands.

3.3 . . . . . Amateur

3.3.1 Existing Canadian Allocation

AMATEUR

50-54 MHz

Discussion

The band 50-54 MHz is allocated to the amateur service on a primary basis. Due to the proximity of this band to the edge of the television broadcast band there exists, in some areas, the potential for radio frequency interference resulting in lower usage in those areas. The band, however, due to good propagation characteristics remains popular with amateurs for long distance transmissions.

Domestic Allocation

It is proposed that the domestic allocations as specified above and in the Canadian Table of Frequency Allocations for this band, remain unchanged.

Proposed Utilization

It is proposed that the existing amateur usage of the band 50-54 MHz remain unchanged.

3.3.2 .... Existing Canadian Allocation

144-148 MHz

AMATEUR
AMATEUR-SATELLITE (144-146 MHz)

Discussion

The band 144-148 MHz is allocated on a primary basis to the amateur and the band 144-146 MHz is allocated on a primary basis to the amateur satellite services. Further, and in accordance with an international footnote, this band may be used by administrations to meet the needs of international disaster communications in relation to relief operations necessary due to natural disasters.

This band is generally used in Canada and worldwide by amateurs for satellite communications, repeater operations, weak signal propagation, and packet data communications. These amateur bands are actively utilized. Further, and as a result of the availability of low cost commercial equipment, active utilization of the 144-148 MHz band is increasing in the major populated centres of Canada.

There is a heavy world-wide use of this band by amateur enthusiasts.

Domestic Allocation

It is proposed that the domestic allocations as specified above and in the Canadian Table of Frequency Allocations for this band, remain unchanged.

Proposed Utilization

It is proposed that the existing amateur usage of the band 144-148 MHz remain unchanged.

3.3.3 ..... Existing Canadian Allocation

220-225 MHz

AMATEUR

Discussion

The band 220-225 MHz is allocated on a primary basis to the amateur service.

This band is presently designated exclusively to the amateur service and is used for repeaters, fixed, auxiliary and control links, beacons, weak signal propagation, and packet data communications. Amateur utilization of the band is moderate; however, it is recognized that the growth has been hampered by a lack of suitable equipment. A review of amateur use and band plans indicates that most operations are concentrated in the upper portion of the band.

Recent decisions by the FCC to implement narrowband land mobile use in the 220-222 MHz portion of this band may encourage an interest for a similar radio service in Canada. However, sufficient discussion has not taken place to determine the level of interest for land mobile service. We now invite comments on the proposed allocation and utilization policies that follow including suggestions on ways in which legitimate land mobile needs and amateur radio usage could be balanced.

Regardless of the outcome of public consultation and the related spectrum allocation and utilization policies that are developed for further discussion, the 220-222 MHz portion of this band will be the basis for the imminent negotiation of a Canada/U.S. sharing arrangement to accommodate U.S. land mobile use in border areas.

Proposed Domestic Allocation

It is proposed to solicit comments on the interest for and against the potential of reallocating the 220-222 MHz portion of the band to the mobile service while maintaining the allocation in the 222-225 MHz portion of the band for the amateur service. To properly address this issue we invite comment on the following questions:

1) **Is there a clear interest and need for the band 220-222 MHz to be re-allocated for mobile use?**

2) **In the present environment, where the band 220-222 MHz is not available for amateur service in the U.S., what would be the impact on Canadian amateurs, if this band was to be re-allocated to mobile?**

3) **What measures can be taken to effectively deal with cross-border frequency coordination between U.S. land mobile users and Canadian radio amateurs?**

Proposed Utilization

It is proposed that any change to the current exclusive utilization of the band 220-225 MHz by the amateur service only occur following a complete discussion of the issues raised in the preceding questions and future public consultation.

3.3.4 . . . . Existing Canadian Allocation

430-450 MHz

RADIOLOCATION
Amateur

Discussion

International footnotes permit the operation of amateur-satellites and space research stations subject to certain conditions. The band 430 - 450 MHz is allocated in Canada to radiolocation on a primary basis and to the amateur service on a secondary basis.

Domestic Allocation

It is proposed that the domestic allocations as specified above and in the Canadian Table of Frequency Allocations for this band, remain unchanged.

Proposed Utilization

It is proposed that the use of this band will continue to be designated to radiolocation on a primary basis and amateur on a secondary basis.

4 Allocation Proposals Resulting from WARC-92

Introduction

The 1992 World Administrative Radio Conference (WARC-92) made a number of allocations modifications to the International Table of Frequency Allocations. In the 30-896 MHz range the main changes to the International Table were to make allocation provisions for the development of mobile-satellite services using Non-Geostationary Orbit (Non-GSO) of Low Earth Orbit Satellite (LEO) system. Also, the mobile service was elevated to primary status in the band 942-960 MHz for Region 2.

This section will propose changes to the Canadian Frequency Allocation Table taking into account decisions of WARC-92. Industry and Science Canada will deal with other decisions of WARC-92 in other frequency bands in a series of policy proposals papers being issued separately.

4.1 . . Presentation Format

The presentation of the following allocation proposals is made on a band-by-band basis. In certain cases proposed changes in one band are related to proposed changes in another; the connections between these proposed changes are made in the accompanying text related to those proposals. Each section has a proposed change to the Canadian table in a specific band.

Short tables in each section show the existing (pre-WARC) allocations and the post-WARC allocations. Each of these two short tables for the band in question indicate both the Region 2 (the Americas) allocations and the Canadian allocations or proposed allocations. This information can be obtained from these tables by following the notation:

* table entries or footnotes in the relevant Region 2 table but not in the Canadian table **are included and struck out**;

* table entries or footnotes in the relevant Canadian table but not in the ITU Region 2 table **are included and underlined**;

* **new Canadian footnotes have the notation "CnnnL"**, the normal notation "Cnnn" for a Canadian footnote, followed by a letter A, B, etc., as is done in the ITU Table for new footnotes;

* table entries or footnotes in the WARC Final Acts but not in the pre-WARC table **are typed in bold**; and

* table entries or footnotes that were in the pre-WARC ITU table but are not in the WARC Final Acts **are simply deleted from the**

post-WARC or "proposed" table. Their deletion is evident by their inclusion in the pre-WARC Table but not the post-WARC Region 2 ITU table. Where such an entry or footnote is proposed to be retained in the Canadian Table it is included and underlined as discussed in the second indent above.

4.2 ..... Non-Geostationary Mobile-Satellite Systems below 1 GHz

Existing Canadian Allocations

137-138 MHz
148-149.9 MHz
149.9-150.05 MHz
400.15-401 MHz

In Canada the 137-138 MHz band is allocated to the space operation and meteorological-satellite services on a primary basis and to the space research service on a secondary basis. The 148-149.9 MHz band is allocated on a primary basis to the fixed and mobile services. The 149.9-150.05 MHz band is allocated on a primary basis to the radionavigation-satellite service. The 400.15-401 MHz band is allocated on a primary basis to the meteorological aids, meteorological-satellite and space research services and on a secondary basis to the space operation service.

137-138 MHz

SPACE OPERATION (space-to Earth)
METEOROLOGICAL-SATELLITE (space-to-Earth)
~~SPACE RESEARCH (space-to-Earth)~~
Space Research (space-to-Earth)
~~Fixed~~
~~Mobile except aeronautical mobile (R)~~

~~596~~ ~~597~~ ~~598~~ ~~599~~

148-149.9 MHz
FIXED MOBILE 608
149.9-150.05 MHz
RADIONAVIGATION-SATELLITE 609 609A C19

400.15-401 MHz
METEOROLOGICAL AIDS METEOROLOGICAL-SATELLITE (space-to-Earth) SPACE RESEARCH (space-to-Earth) Space Operation (space-to-Earth) ~~647~~

WARC Decision

WARC-92 made a number of allocations for the mobile-satellite service (MSS) for non-GSO satellite systems in the previously-mentioned bands. The WARC-92 decisions made provision for the introduction of LEO MSS world-wide with limitations to safeguard existing services. The Conference established a coordination process, Resolution 46(WARC-92)[3] , for non-GSO Mobile Satellite service below 3 GHz with other radio systems, both within the same service and with other services (e.g. mobile and fixed).

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3) ITU Resolution 46 (WARC-92): Interim Procedures for the Coordination and Notification of Frequency Assignments of Non-Geostationary Satellite Networks in Certain Space Services and the Other Services to Which the Bands are Allocated.

Discussion

Canada had extensive consultation with industry in preparation for the Conference and established that there was interest in Canada to establish Mobile Satellite Service (MSS) using Low Earth Orbit satellite technology.

In particular, there was expressed interest in establishing non-GSO systems in the 137-138 and 148-149.9 MHz bands to provide low-

priced short duration messaging and position determination services. In proceeding to establish a Canadian position on such a proposal the Canadian mobile industry raised concerns on the potential for interference to mobile services (including paging) and fixed services in the 148-149.9 MHz band. Consequently, extensive studies were conducted on the 148-149.9 MHz band and alternative bands.

Studies undertaken on the 148-149.9 MHz band identified a potential of interference from high power continuous duty paging transmitters to spacecraft receivers; and from mobile earth stations into terrestrial mobile and fixed services. The interference probability of mobile earth stations to the mobile and fixed services was determined to be quite small if the message lengths were kept short and low duty cycle of transmissions were employed. It was also determined that a better choice of band for Canada would be 149.9-150.05 MHz in view of the absence of terrestrial services and the phasing-out of the "Transit" radionavigational satellite system by 1997.

It became clear that, prior to WARC-92 studies of potential interference and the general conclusion achieved with the proponents of MSS and the mobile industry, Canada needed to establish mechanisms to protect existing services from potential interference. Specifically, Canada would have to ensure that meteorological services in the 137-138 MHz band would be protected as well as existing mobile and fixed services in the 148-149.9 MHz band. In addition, it was realized that sharing arrangements would have to be established among service users to further mitigate any potential for interference.

Due to the potential impact of the band 137-138 MHz allocations on existing services, WARC-92 (Footnote No. 599A) established flux-density limits for the coordination of space stations with respect to terrestrial services. In addition, all administrations are required to protect the radio astronomy service in the 150.05-153 MHz band from harmful interference. Also, further requirement (Footnote No. 599B) limited the use of the bands 137-138 MHz, 148-149.9 MHz and 400.15-401 MHz to non-GSO satellite systems. Other provisions, (Footnote Nos. 608A, 608B, 608C and 609B) were adopted to prevent the mobile-satellite service from neither restraining the development of other existing services in these bands nor causing harmful interference or claiming protection from interference to and from existing services.

WARC-92 allocated the band 137-138 MHz to the mobile-satellite (space-to-Earth) service: on a primary basis in the sub-bands 137-137.025 MHz and 137.175-137.825 MHz; and on a secondary basis in the sub-bands 137.025-137.175 MHz and 137.825-138 MHz. Subject to certain requirements (Footnote Nos. 599A, 599B, 608A and 608C), the band 148-149.9 MHz was allocated on a primary basis to the mobile-satellite service. The band 149.9-150.05 MHz was allocated to

the mobile-satellite on a secondary basis until January 1, 1997 and thereafter on a primary basis. Also, the Conference allocated the band 400.15-401 MHz to the mobile satellite service.

The referenced footnotes were adopted to ensure that mobile-satellite service use will not have a significant impact on existing fixed, mobile and meterological services.

There are a number of issues to explore in the consideration of the implementation of mobile satellite service. The first issue is the potential for sharing the spectrum among a number of licenses for non-GSO satellite systems. There is the obvious need to find the required degree of balance in access to spectrum among the licensees, taking into account that many potential applicants will be allied with multinational firms providing services to many countries. To some extent these alliances will influence the choices made for sharing the spectrum. However, there are specific Canadian concerns such as the existing use of the band 148-149.9 MHz for fixed and mobile services. Canada would encourage the introduction of the mobile satellite systems in the bands 149.9-150.05 MHz to the extent possible, in order to mitigate any potential problem of sharing with the fixed and mobile services. The band 149.9-150.05 MHz will not become available until 1997 and its bandwidth is limited. Nevertheless there are some indications that it will likely be sufficient to meet Canadian needs, if available on an exclusive basis.

The FCC has developed domestic rules for the use of non-GSO mobile satellite systems in the United States. We recognize that these US domestic decisions will influence the outcome of any co-ordination negotiations with the United States for frequency spectrum for Canadian use. However, Canada will negotiate for the use of mobile satellite frequencies that will maintain the protection of the existing Canadian mobile and fixed stations in the band 148-149.9 MHz. As part of this priority, Canada will strive to obtain maximum access to the band 149.9-150.05 MHz which becomes a primary status for land mobile satellite service in 1997.

In a similar manner, Canada will negotiate to obtain suitable provisions for the mobile satellite service in the band 137-138 MHz compatible with the needs of the meteorological satellite service.

The sharing of spectrum in the band 148-149.9 MHz between the mobile satellite services with the fixed and mobile services has been part of a study which indicates the possibility of obtaining a workable sharing arrangement.

Comments are invited on the means of implementing sharing of the mobile satellite service with the fixed and mobile services. Comment

is also invited on the feasibility of constraining mobile satellite operations to certain sub-bands in the 149.9-150.05 MHz range. What is the feasibility of modifying mobile operations (such as paging) in order to clear specific sub-bands as a means of easing the access to the mobile satellite service?

Proposed Canadian Allocations

It is proposed to modify the domestic allocation Table for these bands for mobile-satellite service using non-GSO satellite systems according to the WARC-92 decisions. Protection of the continued use of the fixed, mobile and meteorological services in these bands will be maintained. Canadian footnote **ADD CXX** proposes the requirement for a sharing arrangement to be established with terrestrial services before the implementation of mobile-satellite service in the band 148-149.9 MHz. The incorporation of these footnotes will achieve an appropriate level of protection to enable new and existing services to develop.

It is proposed that the domestic allocations be modified to reflect the decisions taken at WARC 92 as follows:

137-137.025 MHz SPACE OPERATION (space-to-Earth) METEOROLOGICAL-SATELLITE (space-to-Earth) ~~SPACE RESEARCH (space-to-Earth)~~ Space Research (space-to-Earth) **MOBILE-SATELLITE (space-to-Earth) 599B** ~~Fixed~~ ~~Mobile except aeronautical mobile (R)~~ ~~596~~ ~~597~~ ~~598~~ ~~599~~ **599A**
137.025-137.175 MHz SPACE OPERATION (space-to-Earth) METEOROLOGICAL-SATELLITE (space-to-Earth) ~~SPACE RESEARCH (space-to-Earth)~~ Space Research (space-to-Earth) **Mobile-Satellite (space-to-Earth) 599B** ~~Fixed~~ ~~Mobile except aeronautical mobile (R)~~ ~~596~~ ~~597~~ ~~598~~ ~~599~~ **599A**

137.175-137.825 MHz SPACE OPERATION (space-to-Earth) METEOROLOGICAL-SATELLITE (space-to-Earth) ~~SPACE RESEARCH (space-to-Earth)~~ Space Research (space-to-Earth) **MOBILE-SATELLITE (space-to-Earth) 599B** ~~Fixed~~ ~~Mobile except aeronautical mobile (R)~~ ~~596~~ ~~597~~ ~~598~~ ~~599~~ **599A**
137.825-138 MHz SPACE OPERATION (space-to-Earth) METEOROLOGICAL-SATELLITE (space-to-Earth) ~~SPACE RESEARCH (space-to-Earth)~~ Space Research (space-to-Earth) **Mobile-Satellite (space-to-Earth) 599B** ~~Fixed~~ ~~Mobile except aeronautical mobile (R)~~ ~~596~~ ~~597~~ ~~598~~ ~~599~~ **599A**

ADD 599A The use of the band 137-138 MHz by the mobile satellite service is subject to the application of coordination and notification procedures set forth in Resolution 46 (WARC-92). However, coordination of a space station of the mobile-satellite service with respect to terrestrial services is required only if the power flux density produced by the station exceeds -125dB (W/m^2/4 kHz) at the Earth's surface. The power flux-density limit shall apply until such time as a competent world administrative radio conference revises it. In making assignments to the space stations in the mobile-satellite service in the above band, administrations shall take all practicable steps to protect the radio astronomy service in the 150.05-153 MHz band from harmful interference from unwanted emissions.

ADD 599B The use of the bands 137-138 MHz, 148-149.9 MHz and 400.15-401 MHz by the mobile-satellite service and the band 149.9-150.05 MHz by the land mobile-satellite service is limited to non-geostationary satellite systems.

148-149.9 MHz FIXED MOBILE **MOBILE-SATELLITE (Earth-to-space) 599B** 608 **608A 608C CXX**
149.9-150.05 MHz RADIONAVIGATION-SATELLITE **LAND MOBILE-SATELLITE** **(Earth-to-space) 599B 609B** **608B** 609 609A ~~**C19**~~

ADD CXX In the band 148-149.9 MHz, the implementation of the mobile-satellite service in Canada is dependent on the establishment of an agreed sharing arrangement with users of the fixed and mobile services in this band.

ADD 608A The use of the band 148-149.9 MHz by the mobile-satellite service is subject to the application of the coordination and notification procedures set forth in Resolution 46 (WARC-92). The mobile-satellite service shall not constrain the development and use of fixed, mobile and space operation services in the band 148-149.9 MHz. Mobile earth stations in the mobile-satellite service shall not produce a power flux-density in excess of -150 dB(W/m^2/4 kHz) outside national boundaries.

ADD 608B The use of the band 149.9-150.05 MHz by the land mobile-satellite service is subject to the application of the coordination and notification procedures set forth in Resolution 46 (WARC-92). The land mobile-satellite service shall not constrain the development and use of the radionavigation-satellite service in the band 149.9-150.05 MHz. Land mobile earth stations of the land mobile-satellite service shall not produce power flux-density in excess of -150 dB(W/m^2/4 kHz) outside national boundaries.

ADD 608C Stations of the mobile-satellite service in the band 148-149.9 MHz shall not cause harmful interference to, or claim protection from stations of the fixed or mobile services... (in many countries including Canada)... that operate in accordance with the Table of Frequency Allocations.

ADD 609B In the band 149.9-150.05 MHz, the allocation to the land mobile-satellite service shall be on a secondary basis until 1 January 1997.

400.15-401 MHz

METEOROLOGICAL AIDS
METEOROLOGICAL-SATELLITE (space-to-Earth)
SPACE RESEARCH (space-to-Earth) **647A**
MOBILE-SATELLITE (space-to-Earth) 599B
Space Operation (space-to-Earth)

~~647~~ **647B**

ADD 599B The use of the bands 137-138 MHz, 148-149.9 MHz and 400.15-401 MHz by the mobile-satellite service and the band 149.9-150.05 MHz by the land mobile-satellite service is limited to non-geostationary satellite systems.

ADD 647A The band 400.15 - 401 MHz is also allocated to the space research service in the space-to-space direction for communications with manned space vehicles. In this application, the space research service will not be regarded as a safety service.

ADD 647B The use of the band 400.15 - 401 MHz by the mobile-satellite service is subject to the application of the coordination and notification procedures set forth in Resolution 46 (WARC-92). However, coordination of a space station of the mobile-satellite service with respect to terrestrial services is required only if the power flux-density produced by the station exceeds -125 dB ($W/m^2/4$ kHz) at the Earth's surface. The above power flux density limit shall apply until such time as a competent world administrative radio conference revises it. In making assignments of the space stations in the mobile-satellite service in the

above band, administrations shall take all practicable steps to protect the radio astronomy service in the band 406.1 - 410 MHz from harmful interference from unwanted emissions.

4.3 . . . . . WARC-92 Secondary Allocations to the Mobile-Satellite Service

Existing Canadian Allocations

312 - 315 MHz
387 - 390 MHz

In Canada the bands 273-328.6 MHz and 335.4-399.9 MHz are allocated on a primary basis to the fixed and mobile services.

273-322 MHz
FIXED MOBILE ~~641~~ C5 C7 C8

335.4-399.9 MHz
FIXED MOBILE ~~641~~ C5 C7

WARC Decision

WARC-92 made secondary allocations in the bands 312-315 MHz and 387-390 MHz to the mobile-satellite service.

Discussion

These modifications to the International Table of Frequency Allocations in the above-mentioned bands for mobile-satellite services were made to accommodate the interests of some other administrations. As the mobile-satellite service allocations are secondary and subject to the coordination process of Resolution 46, it would be appropriate to include them in the Canadian Table.

Proposed Canadian Allocations

It is proposed that the **Canadian Table of Frequency Allocations** be modified to include mobile-satellite service use on a secondary basis and that footnote 641A(WARC-92) also be added to the domestic Table. The inclusion of footnote 641A provides for mobile-satellite service on a secondary basis. Although Canada has no particular interest in these secondary mobile-satellite service allocations, such a

service needs to be coordinated under Resolution 46 and it would be useful to align the Canadian and International Tables. The provision of Canadian footnote C7 is achieved and consequently can be suppressed in the sub-bands 312-315 MHz and 387-390 MHz.

Proposed Canadian Tables:

The proposed modifications to the **Canadian Table of Frequency Allocations** are as follows:

273-312 MHz FIXED MOBILE ~~641~~ C5 C7 C8
312-315 MHz FIXED MOBILE **Mobile-Satellite (Space-to-Earth) 641 641A** C5 ~~C7~~ C8
315-322 MHz FIXED MOBILE ~~641~~ C5 C7 C8

335.4-387 MHz FIXED MOBILE ~~641~~ C5 C7

387-390 MHz FIXED MOBILE **Mobile-Satellite (Space-to-Earth) 641 641A** C5 ~~C7~~
390-399.9 MHz FIXED MOBILE ~~641~~ C5 C7

ADD 641A The bands 312 - 315 MHz (Earth-to-space) and 387-390 MHz (space-to-Earth) in the mobile-satellite service may also be used by non-geostationary-satellite systems. Such use is subject to the application of the coordination and notification procedures set forth in Resolution 46(WARC-92).

C7 Subject to an agreement obtained under the procedure set forth in Article 14, the bands 235-322 MHz and 335.4-399.9 MHz may be used by the mobile-satellite service.

4.4 . . . . . WARC-92 Space Research Allocations

Existing Canadian Allocations

400.15 - 401 MHz (see section 4.2 for Table)
410 - 420 MHz

In Canada the 410-420 MHz frequency range is divided into sub-bands. The 410-414 and 415-419 MHz sub-bands are allocated on a primary basis to the mobile service and on a secondary basis to the fixed service. In the 414-415 and 419-420 MHz sub-bands allocation is on a primary basis to the fixed service and on a secondary basis to the mobile service.

410-414 MHz MOBILE except aeronautical mobile ~~FIXED~~ Fixed
414-415 MHz FIXED ~~MOBILE except for aeronautical mobile~~ Mobile except aeronautical mobile
415-419 MHz MOBILE except aeronautical mobile ~~FIXED~~ Fixed
419-420 MHz FIXED ~~MOBILE except aeronautical mobile~~ Mobile except aeronautical mobile

WARC Decision: WARC-92 made an allocation in the 400 MHz range to support the space research service.

Discussion The Conference allocated the band 400.15-401 MHz for the space research (space-to-space) service (non-safety service) with footnote 647A, in addition to sharing with the newly allocated mobile-satellite service **(see section 4.2 for Proposals)**. Also, space research (space-to-space) was allocated on a secondary basis in the band 410-420 MHz subject to the provisions of footnote 651A. This will enable the service to co-exist with terrestrial mobile and fixed services in the band 410-420 MHz.

Proposed Canadian Allocations The allocation for space research (space-to-space) on a secondary basis in the 400 MHz range will have benefit for the Canadian Space Agency for joint projects with other space services. It is proposed that the domestic allocations for these bands, be modified to reflect the WARC-92 decision and be as follows:

410-414 MHz	MOBILE except aeronautical mobile ~~FIXED~~ Fixed **Space Research (space-to-space) 651A**
414-415 MHz	FIXED ~~MOBILE except aeronautical mobile~~ Mobile except aeronautical mobile **Space Research (space-to-space) 651A**
415-419 MHz	MOBILE except aeronautical mobile ~~FIXED~~ Fixed **Space Research (space-to-space) 651A**
419-420 MHz	FIXED ~~MOBILE except aeronautical mobile~~ Mobile except aeronautical mobile **Space Research (space-to-space) 651A**

ADD 651A Use of the band 410-420 MHz by the space research service is limited to communications within 5 km of an orbiting, manned space vehicle.

4.5 . . . . . WARC-92 Modifications for Mobile Services

Existing Canadian Allocation

849 - 851 MHz
894 - 896 MHz
942 - 960 MHz

In Canada within the allocation for the band 806-890 MHz for the mobile service on a primary basis and to the fixed service on a secondary basis, the sub-band 849-851 MHz is designated to aeronautical mobile service (Air-to-Ground public correspondence APC) . Also, within the band 890-902 MHz allocated to fixed and mobile services on a primary basis, the sub-band 894-896 MHz is designated to aeronautical mobile service. Furthermore, the existing Spectrum Allocation and Utilization Policy in the band 896-960 MHz (SP 896-960 MHz) includes the specific sub-band designations for the spectrum 942-960 MHz. As the Canadian Table of Frequency Allocations (March 1991 edition) does not provide the detailed spectrum designations, the Table presented here for the band 942-960 MHz elaborates the existing Canadian allocation in SP 896-960 MHz.

806-890 MHz
MOBILE ~~FIXED~~ Fixed ~~BROADCASTING~~ ~~692A~~ 700 C11
890-902 MHz
FIXED MOBILE except aeronautical mobile Radiolocation C5A 704A ~~705~~

942-944 MHz
FIXED Mobile

944-948.5 MHz FIXED ~~Mobile~~ MOBILE
948.5-952 MHz FIXED ~~Mobile~~ MOBILE
952-953 MHz FIXED Mobile
953-956 MHz FIXED Mobile
956-960 MHz FIXED Mobile

WARC Decision

WARC-92 recognized the operation of aeronautical mobile service at 800 MHz in Canada, the United States and Mexico by adding footnote 700A in the International Table allocating sub-bands 849-851 MHz and 894-896 MHz to the aeronautical mobile service on a primary basis. Also, the Conference at the request of Canada, elevated the mobile service to primary in Region 2 for the band 942-960 MHz.

Discussion

A Canadian objective was to elevate the mobile service to primary status in Region 2 in the band 942-960 MHz in order to support the implementation of mobile service such as digital cordless telephone service. This objective was met by elevating the mobile service to co-primary with the fixed service in Region 2 (similar to other Regions). This allocation change will facilitate coordination of mobile service with the U.S. and may assist potential export of Canadian digital cordless technology to other countries. Although Canada did not propose any designation of spectrum for aeronautical public

correspondence (APC), the aim was to minimize impact on existing fixed service allocations in the 1-3 GHz range being proposed by the European block for APC.

Canada joined with the USA to recognize APC in the bands 849-851 and 894-896 MHz. An in-country footnote was then developed to ensure that protection of existing fixed systems in these bands is maintained. This was determined to be a practical solution in the short term, until such time as the future growth of APC requires migration of the service to the world-wide designations of the bands 1670-1675 MHz and 1800-1805 MHz achieved at WARC-92.

Proposed Canadian Allocations

The **"Spectrum Allocation and Utilization in Certain Bands in the Range 30.01-896 MHz, Part I"**, dated May 1990, sets out the current allocations, including those for APC. Adoption of footnote 700A will recognize the APC service in the 800 MHz range and it should provide the flexibility to allow implementation of service in the new bands 1670-1675 and 1800-1805 MHz at some time in the future. It is proposed that the domestic allocations for the bands 849-851 MHz and 894-896 MHz be modified to include footnote 700A.

The elevation of the mobile service to co-primary with the fixed service provides the flexibility to implement either mobile or fixed in various sub-bands in the frequency range 942-960 MHz. It is proposed that the existing domestic allocations specified for the band 942-960 MHz reflected in the **Spectrum Allocation/Utilization Policy, SP 896 MHz**, be added to the next edition of the Canadian Table and be further modified as follows:

(i) 944-948.5 MHz

~~FIXED~~
Fixed
MOBILE

948.5-952 MHz

~~FIXED~~
Fixed
MOBILE

Proposal: To update the Canadian Table according to SP 896 MHz, dated September, 1991.

Reason: To reflect the present allocation and utilization of these sub-bands and given that fixed users have been notified that the service is secondary.

(ii) 952-953 MHz

FIXED (* multi-point communications systems - MCS)
~~Mobile~~
MOBILE

Proposal: That mobile service be elevated to co-primary.

Reason: Some of the out-stations of MCS applications need a degree of portability and mobility. This will provide reasonable flexibility.

(iii) 953-956 MHz

FIXED
~~Mobile~~
MOBILE (* Held in reserve)

Proposal: That mobile service be elevated to co-primary.

Reason: Alignment with Region 2 and to provide flexibility for the designation of this spectrum based on a future policy review.

The Proposed Modifications to the Canadian Table are as follows:

806-890 MHz
MOBILE ~~FIXED~~ Fixed ~~BROADCASTING~~ ~~692A~~ 700 **700A** C11

890-902 MHz
FIXED MOBILE except aeronautical mobile Radiolocation C5A **700A** 704A ~~705~~

ADD 700A Additional allocation: in Canada, the United States and Mexico, the bands 849 - 851 MHz and 894 - 896 MHz are also allocated to the aeronautical mobile service on a primary basis, for the public correspondence with aircraft. The use of the band 849-851 MHz is limited to transmissions from aeronautical stations and the use of the band 894-896 MHz is limited to transmissions from aircraft stations.

942-944 MHz
FIXED ~~**MOBILE**~~ Mobile
944-948.5 MHz
~~FIXED~~ Fixed **MOBILE**
948.5-952 MHz
~~FIXED~~ Fixed **MOBILE**

952-953 MHz FIXED **MOBILE**
953-956 MHz FIXED **MOBILE**
956-960 MHz FIXED ~~**MOBILE**~~ Mobile

Annex A

Personal/Business Radio Service

During the analysis of public comments on this theme question, we a proposal entitled, **A Plan for a New Canadian Personal/Business Radio Service**. While public comment to such a proposal has been largely opposed to the introduction of such a service, as stated in theme question 2.3, a number of comments stated that an decision was difficult in the absence of a plan. It is for this reason that a precis of this plan is offered below:

The plan proposes the establishment of a personal/business radio service, to be known simply as the Public Radio Band (PRB). It suggests that such a service would enable Canadians, whom for whatever reason are unable to use current radio services for personal or business purposes, to have access to a portion of spectrum with radio equipment and associated licence fees at a low cost. In addition to personal and business applications the service would enable access to safety services and cross-service communications between all users of PRB frequencies.

This proposal on PRB points-out that while spectrum below 50 MHz may be relatively less used than, atmospheric anomalies may render spectrum unsuitable for such a service. The ideal portion of spectrum is stated to be that between 216 and 220 MHz. An included band plan divides the spectrum among the various personal, business and safety service users and their uses i.e. network, station-to-station, repeater etc..

The following chart outlines the band plan in the proposal that has been received:

Frequency Range (MHz)	Type of Usage
216.020-216.140	Maritime (216.100 MHz/calling channel)
216.160-216.240	Aeronautical (216.200 MHz/calling channel)
216.260-216.380	Group Network (216.300 MHz/calling channel)
216.400-216.480	Provincial Police (216.400 MHz/calling channel)
216.500-216.580	Police - 911 Emergency (216.500 MHz/calling channel)
216.600-216.640	Fire - Ambulance (216.600 MHz/calling channel)
216.660-216.740	Hospital (216.700 MHz/calling channel)
216.760-216.820	Auto Services - Towing (216.800 MHz/calling channel)
216.840-216.980	Travellers Information/Aid/hotels (216.900 MHz/calling channel)
217.00-217.100	Portable Transmit to Base (Receive channels 219.020-219.180 MHz)
217.200-217.380	Car Transmit to Base (Receive channels 219.220-219.380 MHz)
217.400-217.580	Truck Transmit to Base (Receive channels 219.400-219.580 MHz)
217.600-217.980	Repeater Input (Receive channels 219.620-219.980 MHz)
218	Weather Broadcast (one way)
218.020-218.180	Traffic Information Broadcasting (218.100 MHz- car to car traffic Information/help channel)
218.200 -218.380	Portable to Portable (218.300 MHz/calling channel)
218.400-218.580	Car to Car (218.500 MHz/calling channel)
218.600-218.780	Truck to Truck (218.700 MHz/calling channel)
218.800-218.980	Base to Base(218.900 MHz/calling channel)
219.000-219.180	Base Transmit to Portable (Receive channels 217.020-217.180 MHz)
219.200-219.380	Base Transmit to Car (Receive channels 217.220-217.380 MHz)
219.400-219.580	Base Transmit to Truck (Receive channels 217.400-217.580 MHz)
219.600-219.980	Repeater Transmit(Input channels 217.620-217.980 MHz)

Annex B

1) The March 1990 study by ADGA entitled,"**A Study of Future Spectrum Requirements for Mobile Radio Communications in Canada**".

In the ADGA study overall spectrum requirements by the year 2001 were projected to be about 400 MHz of additionally required spectrum for mobile services. The report concluded that "Current Canadian spectrum allocations are barely able to accommodate the projected requirements in 1991" and that this will become a significant issue towards the second half of the 1990's "unless highly efficient spectrum techniques are employed". To address most of the relevant variables for long term spectrum projection, ADGA developed a spectrum projection model that made use of several accepted forecasting techniques for mobile services. While this model has been valuable as a tool that is complementary to all of the methods of spectrum need projection that is currently utilized, it is clearly only one technique of many used to project spectrum demand. Consequently, given all the other data to which we have access, the projection of an additionally required 400 MHz for mobile services by the year 2001 is considered to be on the high side. However, these results do serve to further underline the current and growing state of congestion below 1 GHz.

2) The March 1990 study by Wescom Communications Research International Inc., entitled,"**Report on the Assessment of Means to Increase the Efficiency of the Existing Spectrum Assigned for Land Mobile Radio Service Use**".

The Wescom Communications Research International Inc. study focused on the means to increase efficiency within the existing bands and concluded that "the direction long range planning should take to increase spectrum capacity" would be "to encourage the use of data message transmission, increase the use of trunked systems... and support the introduction of digital narrow band technology when it becomes available." The preferential choice of access technologies favoured either NBTDMA or NBFDMA. We agree with these conclusions that the conversion to digital systems must be phased-in and must recognize the steps necessary to ensure a viable economic and operational transition for the mobile service providers\users. Such a transition, from analogue equipment to digital equipment has to be done in an orderly manner.

3) The May 1990 study by Lapp-Hancock Associates Limited entitled, "**Planning for Digital Mobile: A Report on Spectrum Planning Issues Related to New Technology for Land Mobile Radio**".

The objective of the Lapp-Hancock Associates Limited study was to make recommendations on the introduction of digital technology for the mobile radio service. While this study also concluded that an evolution from analogue to digital technology was necessary to ease spectrum congestion, it went on

further to suggest a preferred access technology, i.e. TDMA because it " ... can be introduced with less disruption of the existing services, will have lower equipment costs and provide automatic trunking facilities."

While TDMA appears to be the accepted mode of access technique, other studies are currently underway, like those which support the Code Division Multiple Access (CDMA) technology. United States safety organizations have also recently voiced favour towards CDMA which is the only access technique that will apparently meet their specific safety service requirements. Serious consideration must be given to the choice of access technique that may become a standard which through its universality will promote technological development solutions for increased spectrum usage rather than hinder these efficiency goals.

Annex C

INDUSTRY AND SCIENCE CANADA

RADIOCOMMUNICATION ACT

NOTICE NO. DGTP-002-93 / SMEP-011-93

Proposed Spectrum Allocation and Utilization in the Range 30-960 MHz

This notice announces the release of a proposed spectrum policy paper for public comment entitled, Proposed Spectrum Allocation and Utilization in the Range 30-960 MHz. This proposals paper follows the May 1990 release of a spectrum policy, entitled Spectrum Allocation and Utilization in Certain Bands in the Range 30.01-896 MHz - Part I.

Based on the assessment of public comments made during the first phase of the review and internal study, Industry and Science Canada herewith makes proposals for those bands not covered in Part I which deal mainly with the mobile, broadcasting and amateur radio services. A major proposal is made for the re-deployment of the mobile bands between 100-500 MHz with more spectrally efficient systems.

Moreover, proposals are made to modify the Canadian Table of Frequency Allocations and consider utilization proposals resulting from the decisions taken at the recent 1992 World Administrative Radio Conference (WARC-92). The proposals are mainly on spectrum for Low Earth Orbit (LEO) Mobile Satellites and Mobile Services.

Written submissions from all interested parties on the proposals paper are now invited.

Copies of the subject document are available from Information Services, Industry and Science Canada, 300 Slater Street, Ottawa, Ontario K1A 0C8, 613-990-4900 or from its regional offices (formerly the Department of Communications) in Moncton, Montréal, Toronto, Winnipeg and Vancouver.

Submissions should be addressed to the Director General, Telecommunications Policy Branch, Industry and Science Canada, 300 Slater Street, Ottawa, Ontario K1A 0C8, to be received on or before December 20, 1993. All representations should cite the Canada Gazette, Part I, and the notice publication date, title and reference number.

Written comments received in response to this notice will be made available for viewing by the public two weeks after the closing date of this notice, during normal business hours, at Industry and Science Canada Library, 300 Slater Street, Ottawa, Ontario and at the regional offices in Moncton, Montréal, Toronto, Winnipeg et Vancouver.

Furthermore, approximately two weeks after the close of the comment period, copies may be obtained, by mail order or over the counter, from ByPress Printing and Copy Centre Inc., 300 Slater Street, Unit 101A, Ottawa, Ontario K1P 6A6, 613-234-8826. Reasonable costs of duplication will be charged.

Dated at Ottawa, this 8th day of July, 1993.

Michael Helm
Director General,
Telecommunications Policy

Nisar Ahmed
Director General,
Engineering Programs

CHAPTER II

Introduction of New Technology in the Land Mobile Frequency Bands 100 - 500 MHz

Engineering Programs Branch
Industry and Science Canada

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CHAPTER II

Introduction of New Technology in the Land Mobile Frequency Bands 100-500 MHz

SECTION 1

1.0 Introduction

The objective of this discussion paper is to examine ways that mobile frequency bands between 100 MHz and 500 MHz may accommodate the increasing demand for mobile radio services, technology advances and new types of services. These bands are considered to be very suitable for land mobile dispatch operations due to favourable propagation conditions. Hence, considering the potential benefits of the application of new more spectrally efficient technology, the time is opportune to begin replanning in these bands.

The demand for use of the radio spectrum has continued to grow at an increasing rate over the past 25 years. This applies particularly to the land mobile dispatch service (LMDS) which is considered essential for many safety and commercial services in Canada. It is evident that many Canadian cities are experiencing severe congestion problems in certain VHF and UHF mobile bands and that shoe-horning more systems in these bands is becoming increasingly difficult and in some cases not possible. In fact, in the more congested centres the communication needs of new and existing businesses requiring radio dispatch capabilities will not be met, in any timely fashion, if new, spectrally efficient technology is not introduced into the appropriate frequency bands.

As per the allocation proposals in the recently gazetted document Allocation Proposals 1-3 GHz, additional spectrum for conventional mobile services, used primarily for dispatch type communications, may not be available in the bands below 3 GHz in the foreseeable future. It will be necessary to consider means by which the capacity of the existing land mobile frequency bands could be increased.

Potential means of improving spectrum user efficiency include, but are not limited to:

- Introduction of new modulation and coding techniques
- Improvement in operational practices
- Increased use of multi-user trunking
- Introduction of improved channel assignment techniques

Any one of the above could provide an incremental improvement to relieve frequency congestion. However the projected growth rate of mobile communications suggests that reliance upon only one of the above techniques, practices and technologies could have limited effect. Studies have indicated that there are a number of technology options such as frequency, time and code division multiple access systems which could be available for land mobile dispatch operations. Furthermore, the user applications will include voice and data messaging and auxiliary data applications such as geomatic and monitoring data.

Consequently a long term solution must be found. This will likely be a combination of many technological advances and operational improvements. These solutions will almost certainly impact a large number of existing users as well as new users of the land mobile dispatch service. To succeed, regulatory bodies, users and equipment suppliers will need to co-operate to implement these measures.

Introduction of new technologies in the existing mobile bands is timely for a number of reasons:

1. High levels of frequency congestion exist in urban centres.
2. Digital technology is available.
3. United States is currently considering refarming initiatives.

The frequency bands under study comprise of the following:

138 - 174 MHz
406 - 430 MHz
450 - 470 MHz

The frequency band 27-50 MHz is not considered at this time due to its limited use in most parts of the country. This is due in part to propagation anomalies and its susceptibility to man-made noise. Similarly, the 72-76 MHz is also not considered due to limited use.

This discussion paper attempts to describe the existing land mobile environment by addressing frequency congestion, demand for future growth, and the technology options which may be used in future land mobile radio systems, all within a changing North American environment. The objectives of increased utilization efficiency is best achieved with slightly different transitional strategies in each of the three bands under consideration. These strategies form a framework for the deployment of new technologies in the land mobile dispatch bands, and are presented as proposals in this paper. These proposals also complement those in Chapter 1.

Comments are invited on all sections of Chapter 2. It should be noted that the transition proposals represent an initial view on the subject, focusing on the major objectives that should be used in an implementation framework. Comments from operators, equipment/service suppliers and interested parties will be used to formulate a final set of objectives and they will help in the development of more detailed transition plans.

SECTION 2

2.0 Background

The 138-174 MHz and 406-470 MHz bands are the 'workhorse' allocations of the public and private land mobile systems in Canada. Over the years these bands have been extensively used and they have evolved to suit specific user requirements which vary across the country. It is to be noted that the major Canadian metropolitan centers of Montreal, Toronto and Vancouver lie within the US Canada coordination zone and the spectrum must be shared between the two countries. Consequent on this and other factors the frequency sub-block allocations differ from one region of Canada to another.

Channel spacing in the 138-174 MHz band is 30 kHz. In the more congested metropolitan areas, interstitial channels are utilised and are spaced at 15.0 kHz from the primary channels.

The 406-430 MHz and 450-470 MHz bands are managed according to national frequency sub-allocation plans and channelling plans which include guidelines for coordinating and sharing frequencies along the Canada/U.S. border (SP-30-896 MHz; SP 450 MHz; RP 013; SRSP-501). Variations in these plans have been developed to suit specific local and regional mobile dispatch services. The primary and interstitial channel spacings in these bands are 25 kHz and 12.5 kHz respectively.

2.1 Present Usage Profile

2.1.1 Urban Mobile Radio Environment

The VHF band, 138-174 MHz, has been extensively used in all metropolitan areas and there are no vacant assignable frequencies. New assignments can only be made as frequencies are vacated by existing users. Channel sharing, the use of interstitial assignments and other spectrum reuse measures have optimized the use of this very popular band. Frequency congestion is severe in Edmonton, Winnipeg, Toronto and Montreal.

The UHF (406-470 MHz) bands are heavily used in the metropolitan areas in Canada with severe congestion in Toronto and Montreal.

Annex 1 describes in further detail the current usage profile in each region of Canada and identifies the areas of significant frequency congestion.

2.1.2 Rural Mobile Radio Environment

As expected, the rural mobile environment is not as congested as in urban centres in the frequency bands under consideration. However, in terms of frequency assignments, there are a considerable number of land mobile base stations licensed in Canada in rural areas.

In general the number of mobiles associated with one base station is smaller in the rural areas as compared to the urban areas.

2.2 Spectrum Projection Demands and Availability

The major large urban cores in Canada are the heaviest users of the land mobile spectrum and as such have been providing a useful measure with which to assess spectrum demands in Canada. They have been used in the past to signal the first warning of any spectrum shortage as well as to estimate future demands for spectrum needs in Canada. These large urban centres exhibit the heaviest communication traffic and by satisfying their spectrum needs, it is safe to say that Canada's land mobile spectrum demands can be met. Toronto, Montreal and Vancouver represent good examples of the heaviest traffic generating urban cores in Canada.

2.2.1 Demand Projection

For the purpose of understanding the present usage and demands in the bands proposed for refarming (138-174 MHz and 406-470 MHz bands), Toronto and Montreal are selected for spectrum assessment. All the major urban cores in Canada are located within the Canada/United States coordination zone and as such they have to share the available spectrum with users in the USA. Other factors affecting the availability of spectrum are those resulting from the current technology employed in land mobile radio equipment such as permissible co-channel, adjacent channel, and intermodulation interferences,etc. As a result, effectively there are only 43 MHz and 39 MHz of usable traffic carrying spectrum in Toronto and Montreal, respectively. In these bands, present usage in Toronto and Montreal is 247 and 239 Erlangs of voice communications traffic. Private land mobile service has been growing at an annual rate of around 10% and it is expected that similar growth will be maintained in the future for the same type of voice based traffic. However, new data based applications are expected to increase dramatically in the future. At an annual growth rate of 10%, the demand for voice based services will increase 2.5 fold by the year 2000 and 6 fold by the year 2010 not taking in consideration demand for data transmission which is expected to increase substantially. Using current FM technology, increased allocation of spectrum will be needed to accommodate these demands. (See Figures 1a and 1b)

2.2.2 Capacity Improvement due to Technology Introduction

To meet the projected future demand, and noting that there is no additional spectrum below 1 GHz that can be made available, it is necessary that new, more spectrally efficient technologies be introduced in the existing land mobile VHF and UHF bands. Utilizing the proposed 5 KHz effective voice channel bandwidth, and the present peak-hour loading criteria, the present available VHF and UHF spectrum can accommodate more than 10 times the amount of voice based traffic. Additional benefits could be achieved by trunking. Both channel-by-channel or block replacement can provide a practical means to meet future demand.

Fig. 1a Traffic Projection in the VHF/UHF Bands Without Trunking
Toronto

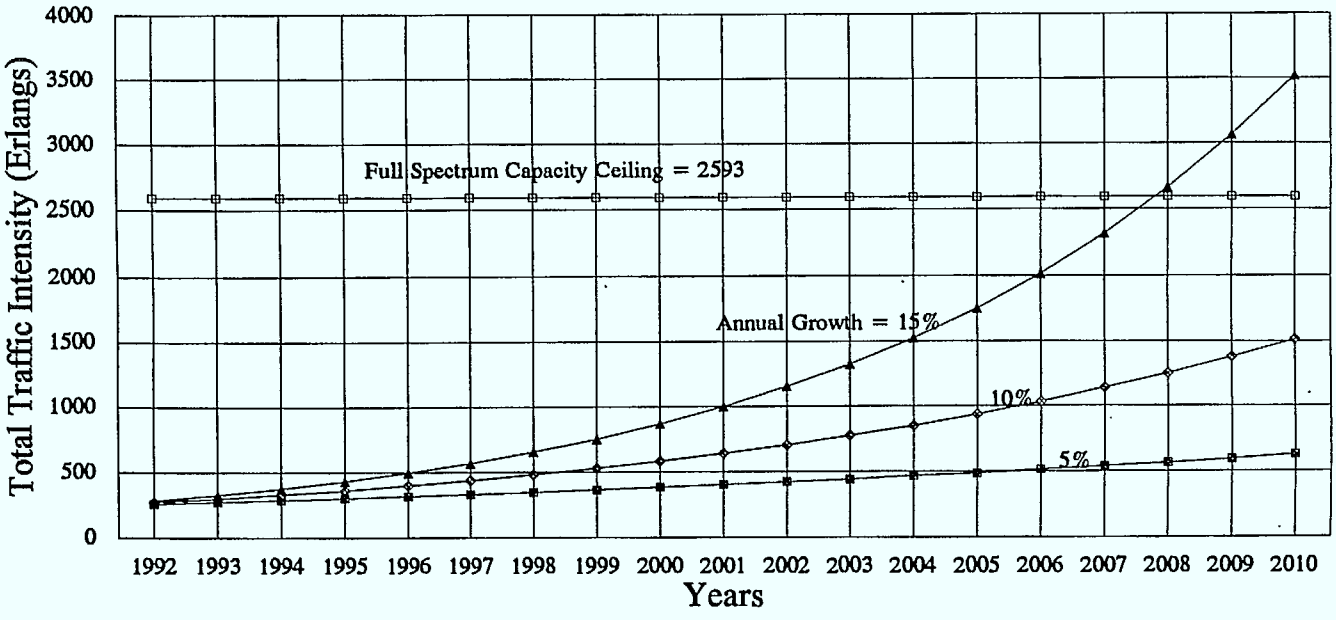
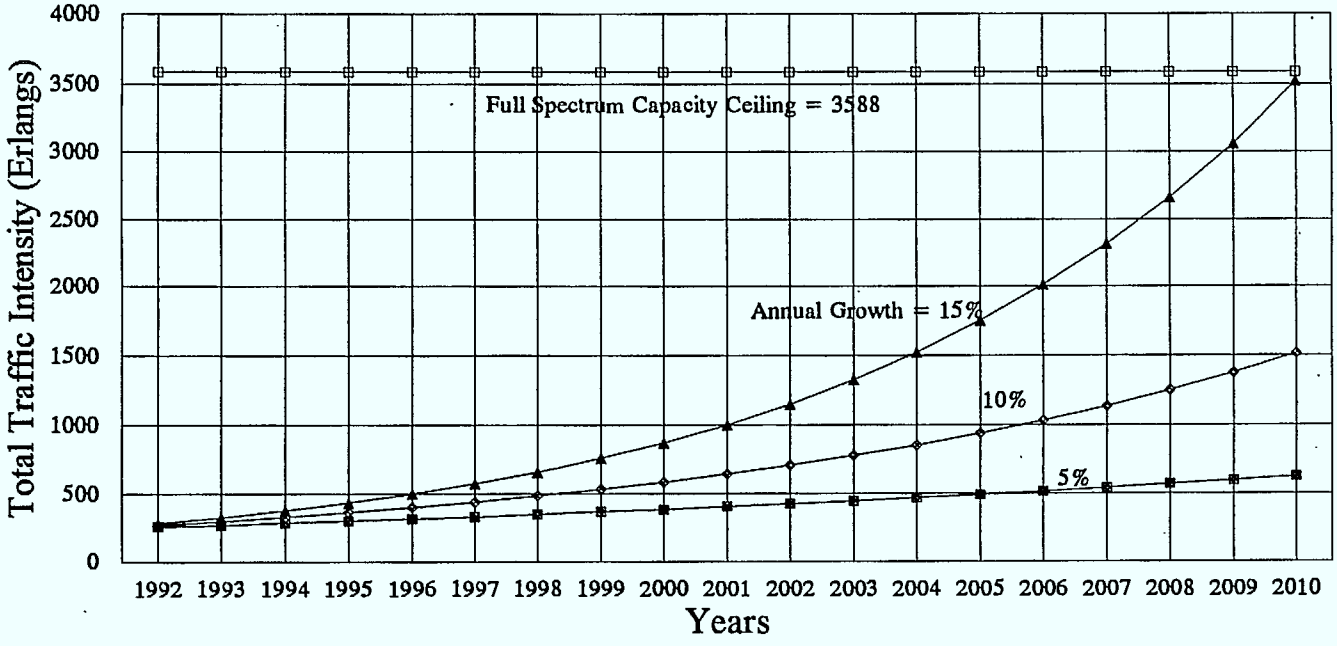


Fig. 1b Traffic Projection in the VHF/UHF Bands with Trunking
Toronto



2.3 Observations on the Implications of the FCC Proposals on the Present Canadian Channelling

The Federal Communications Commission (FCC) released a Notice of Proposed Rulemaking (NPRM) containing a set of proposals designed to increase channel capacity in the frequency bands below 512 MHz, and to promote more efficient use of these channels.

There are three major items of interest to Canada in this document. First, channel splitting is proposed as a means of increasing the capacity. The FCC refarming proceeding calls for two channel-width standards, 5 kHz and 6.25 kHz. Second, a channel exclusivity option in the bands above 150 MHz is proposed. This approach called "exclusive use overlay" involves achieving exclusivity through consensus among existing users. Third, new technical and operational standards are being proposed by the FCC to reduce transmitted power and antenna height limits which would permit efficient geographic co-channel reuse. A brief summary of the FCC NPRM may be found in Annex 2.

Regional sub-allocation plans have evolved to meet local mobile service needs. As a result, these sub-allocation plans may vary across the country from region to region and in some cases from district to district. In the UHF band, Standard Radio System Plan - 501 outlines the technical requirements for land mobile and fixed radio services operating in the 406.1-430 MHz & 450-470 MHz bands.

Frequency sub-allocation plans or frequency guidelines from two different regions are provided in Annex 3, Tables A-1 and A-2, in order to illustrate the inter-regional variations. Tables A-3 and A-4 outline the Canadian 400-470 MHz frequency sub-allocation plan, and Table A-5 provides the FCC frequency sub-allocation plan for 406-470 MHz.

Observations:

1. All Canadian channels in the 450-470 MHz band (except those listed in Table A-4) are presently offset by 12.5 kHz from U.S. channels. If the FCC implements the 6.25 kHz narrowband channels in this band, the offset between the Canadian and U.S. channels will be greatly reduced. The 25 kHz Canadian channels will overlap four U.S. channels as shown in Figure 2.3.1. For those channel frequencies that rely on the offset to reduce the interference between the Canadian/U.S. assignments, problems could arise with the proposed 6.25 kHz channels. If Canada were to adopt a plan similar to the FCC channel splitting proposal, our 6.25 kHz channels would be aligned in this band as shown in Figure 2.3.1.

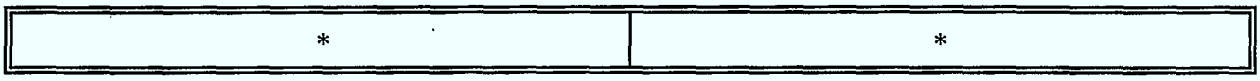
2. In the UHF band, the U.S. proposes to make wide use of low power operations. These secondary channels would be spaced roughly every 25 kHz and offset 3.125 kHz from the primary channels on either side. Many of these proposed low power channels fall on the centre frequency of Canadian channels. Interference problems could arise due to these new U.S. assignments.

3. During the proposed transition period when the U.S is reducing their 25 kHz channels to 6.25 kHz, adjacent channel interference protection would not be provided. To avoid such

problems, licensees in the U.S. would be advised to reduce the bandwidth of their receivers.[1] The question arises as to whether or not this will affect Canadian frequencies.

4. American base stations operating on adjacent narrowband frequencies would not require a separation distance to prevent interference. The U.S. proposes to use new emission masks to provide 40 dB of attenuation at the edge of the authorized channel, 50 dB attenuation at the edge of the authorized bandwidth of the adjacent channel, and 65 dB of attenuation thereafter.[2] Base stations in the various bands would be subject to well laid out ERP and effective antenna height limits.

One 25 kHz U.S. channel currently used in 450-470 MHz band



Two Canadian channels offset 12.5 kHz from U.S. channels

Four 6.25 kHz U.S. channels
created from one 25 kHz channel as proposed by FCC

Channel alignment if Canada were to adopt the 6.25 kHz channel splitting plan proposed by the FCC

Figure 2.3.1. Canadian/U.S. Channel Offset in 450-470 MHz
(*) indicates the centre frequency of the channel

[1] FCC Notice of Proposed Rulemaking, PR-Docket No. 92-235, Page 13

[2] Ibid, page 15.

SECTION 3

3.0 Technology and Engineering Considerations

3.1 Technology Options

The technology options available to the land mobile service are expanding as advances in microelectronics are finding their way into the design of transmission and network control equipment. This section explores some of these options with sufficient detail to allow the reader to comment on the suitability and role of the technology in the future use of the VHF/UHF land mobile bands. It is recognized that a number of readers will be very familiar with the technology subject matter, at much further depth than presented here.

3.1.1 Introduction

One of the most significant trends in telecommunications is the rapid introduction of digital technology in most communication systems. Digital technology makes available very powerful signal processing techniques at relatively low cost to provide low rate speech coding, trunking, error correction and efficient modulation schemes. Some of the strengths of digital technology include the following:

- Robustness to noise and interference signals, rendering it more tolerant to co-channel and adjacent channel interference, thermal noise, etc.
- May enable enhanced communications privacy.
- Provides efficient multiplexing of a variety of message types such as voice, data, facsimile, etc.
- Compatibility with multiple access schemes such as FDMA, TDMA and CDMA.

However, digital modulation is more susceptible to rapid degradation and failure than analogue modulation in low and marginal signal to noise environments.

3.1.2 Modulation and Coding Technology

Advances in modulation and coding techniques will result in less bandwidth being used to transport a voice or data signal. This reduction will permit more users to operate on the 'freed-up' spectrum thus increasing the total throughput of the existing bands. Perhaps the most significant returns of any of the related technology advances to these bands will be found here.

3.1.2.1 Voice Encoding

Efficient digital speech coding algorithms now permit telephony quality voice to be transmitted at data rates below 9.6 kbps. The speech coder known as the vector sum excited linear prediction (VSELP) coder provides telephony quality at a code rate of 8 kbps. This is the coder selected for use in the second generation North American cellular system (digital).

Other coding techniques could be suitable for dispatch operations using lower bit rates. For example, APCO[4]-25 has specified a requirement of 4.8 kbps for speech coding.

3.1.2.2 Modulation Schemes

Modulation techniques available today can provide a bandwidth efficiency of greater than 1.5 bits/sec/Hz in the land mobile service. This could result in a reduction of RF bandwidth requirement for voice transmission.

3.1.3 Data Messaging

In the Land Mobile Dispatch Service (LMDS), the use of data messaging in place of voice messaging can result in the accommodation of larger number of users per radio channel.

For example, a voice message in the dispatch service may require about 20 seconds of air-time, while a data message with the same information content, requires about 2 seconds of air-time, an improvement by a factor of 10.

The use of data messaging provides several additional advantages such as more accurate message reception and the ability to store and forward messages.

3.1.4 Packet Radio

Packet radios send transmissions of a fixed number of bits in short bursts. A long message would be broken down into a number of packets with each packet likely containing:

- the information bits;
- the sequence of the packet in the complete message;
- the address information;
- the control information: and
- the overheads consisting of sync and error detection bits.

The next packet in the sequence is not transmitted until the acknowledgement of the previous packet has been received. The routes taken by the individual packets from the source to the destination need not be the same. At the destination, the packets will be re-assembled in the correct sequence to obtain the correct message.

3.1.5. Access Techniques

Multiple Access Schemes (TDMA,FDMA,CDMA)

Multiple Access Techniques such as FDMA, TDMA and CDMA are candidates for implementation in the VHF/UHF private land mobile bands. Each scheme will have its advantages and disadvantages.

3.1.5.1 Narrowband TDMA (NBTDMA)

The NBTDMA multiple access technology has been selected for the North American, second generation, cellular radio system (digital).

In the initial phases of NBTDMA, three equivalent voice channels would be provided in 30 kHz RF bandwidth giving a spectral efficiency improvement of three over the current usage. Industry is well on the way to achieving 6 voice channels in a 30 kHz RF band.

In a NBTDMA dispatch system a C/I of 10 dB at the coverage contour would be adequate. The impact on the transmit power, range and coverage area of the existing LMDS system by using NBTDMA should be minimal if the thermal noise power in 30 kHz remains the same. The present frequency stability requirement is $\pm$ 2.5 ppm for mobiles and $\pm$ 1.5 ppm for base stations. For digital systems, the frequency stability for base stations is enhanced to $\pm$0.25 ppm; for mobiles, there is a requirement for their oscillators to be locked to the base station emissions to ensure an accuracy of $\pm$200 Hz. The NBTDMA provides flexibility in the use of voice or data.

3.1.5.2 Narrowband FDMA (NBFDMA)

In the VHF band, each 30 kHz RF channel could be replaced by three 10 kHz carriers. Eventually, when the technology is available, the 30 kHz channel will be replaced by six 5 kHz carriers. In the UHF, each 25 kHz RF carriers could be replaced by two 12.5 kHz RF carriers initially and by four 6.25 or 5 kHz RF carriers when that technology becomes available.

Due to the increased number of RF channels, the channel assignment process may become more complex. Some of the additional narrowband channels could cause co-channel interference with the existing interstitial channels. Adjacent channel interference from or into new narrowband systems is possible and should be given special attention in the development of technical standards and channel plans. Also noise floor in urban areas may increase if the transmit power levels are maintained due to higher power density levels in the narrower channels. Technical studies are required to determine the extent of this problem including the possible effects on the coverage area due to power reductions.

NBFDMA requires stable local oscillators in the base stations and in the mobile stations. If the current frequency stability specifications are retained, the mobile station oscillator could drift by $\pm$1125 Hz at 450 MHz, introducing a frequency error of 45% if the channel bandwidth is 5 kHz, and 22.5 percent in 10 kHz channel. This would cause the signal to be distorted and cause adjacent channel interference, consequently the frequency stability performance would have to be improved.

3.1.5.3 Code Division Multiple Access (CDMA)

CDMA is a more distributed form of multiple access technique with inherent interference diversity and immunity. When spreading the energy over a very large bandwidth, it may be possible to overlay a direct sequence CDMA system on existing narrowband users without adversely affecting either one. This type of CDMA could be used in a high-traffic density area.

Unlike digital NBFDMA and digital NBTDMA, CDMA requires a much larger RF channel bandwidth, typically 1.25 MHz in each direction. However each 1.25 MHz channel is capable of carrying a large number of coded channels. A typical CDMA system for the land mobile service could have the following characteristics:

- voice code rate = 8 kbps;
- per voice channel RF bandwidth = 1.25 MHz;
- (Eb/No) = 7 dB at BER = $1x10^{-3}$;
- single cell coverage area with 120° cell sectorization;
- use of voice activation; and
- power control in both the reverse and forward directions.

The above assumptions imply that there is no interference from outside the single cell and that the power control system is ideal. Under these assumptions, the number of voice channels in a 1.25 MHz band is about 270. By comparison, the existing analogue FM/FDMA system can accommodate 42 voice channels. In a practical system, errors in the power control system would reduce the channel capacity of the CDMA system. Even by using complex receivers and measuring equipment at the base station, the measurement accuracy presents a challenge with a variance below 1 dB.

Adaptive power control of the output powers of all the mobiles in the coverage area is of vital importance to the operation of the system. A system may operate satisfactorily with C/I of -15 dB. Under ideal conditions this would permit frequency re-use in all adjacent cells. In LMDS systems, two CDMA cases are of interest:

1. Multi-user, multi-base station case. In this case, which is typical for LMDS systems, each CDMA system is operated and maintained by an independent operator and consists of a base station and several mobiles located within the coverage area of that base station. The base station controls the power levels of all the mobiles in its coverage area. It is assumed that the independent operators in neighbouring cells use the same CDMA RF channel;

2. Integrated radio system which uses a common base station but the mobiles independent operators use the same CDMA RF channel. The CDMA channels are duplex channels with 1.25 MHz of channel bandwidth in each direction.

In the multi-user, multi-base station scenario, though an independent operator would be able to dynamically control the power outputs of all the mobiles in its coverage area, it would be very difficult to control the power outputs of the interfering mobiles in neighbouring cells. The interfering mobile's output power, being uncontrolled by the wanted base station, could seriously reduce the capacity of the system, depending on its relative distance from the wanted base station.

In the integrated radio system approach the output powers of all the mobiles from the different LMDS systems are dynamically controlled at the common base station. The near-far phenomenon can be controlled allowing full deployment of CDMA technology.

CDMA can accommodate good quality voice and variable data rates. Users can be added or removed from a system very easily by assigning or eliminating unique pseudo-random codes to the user. It is not conducive to mobile-to-mobile communications due to difficulty in controlling the power level at the mobile receiver and the need to have code book addresses at each mobile. Since CDMA uses very wide RF channels, very little spectrum management is required regarding frequency stability, adjacent channel interference, co-channel interference, interstitial channel interference, intermodulation, etc.

3.1.6 Trunking

In a trunked system, users share a pool of channels and are only allocated a channel when they need to make a call. The controller of the system automatically searches for and assigns a user an open channel belonging to that trunk (or pool of channels). In practice, not all users wish to make a call at the same time and trunking theory is based on the probability that there will be an open (or free) channel when required. As the number of channels in the pool increases, the trunking efficiency, defined as the ratio of the traffic intensity per channel in the trunked system to the traffic intensity in a channel of an untrunked system, also increases. Trunking technology provides more efficient use of the radio spectrum in terms of the number of users (or messages) that can be supported. For example, a 3-channel trunked system in a public dispatch system would improve a channel traffic capacity by a factor of 41% over a non-trunked system, depending on the traffic loading.

Trunking is most efficient when the traffic intensity of a user is small compared to the capacity of a radio channel. This is usually the case in the LMDS.

3.2 Spectrum Engineering Considerations

There are many spectrum engineering considerations in the formulation of a transition to new mobile technology. The most important is to strike the correct balance between the impact on the current users and the necessity of achieving the target goal of providing for growing service demands. Some of the considerations include the following:

1. Attempt to minimize or eliminate the need for separation distance between adjacent channels systems. Furthermore, it may be useful to replace separation distance methodology with, for example, the use of off-channel rejection ratios.

2. Provide for an orderly technology transition taking into account age of equipment and current congestion.

3. Ensure replanning the mobile bands does not restrict innovative technology that may or may not be currently identified, (attempt to be technology neutral).

4. Attempt to harmonize channelling and transition strategies to align with the U.S. to minimize lost spectrum due to a 'poor fit'.

5. Permit rapid deployment of new modulation and coding schemes resulting in reduced channel bandwidth should be allowed to be deployed as quickly as possible.

SECTION 4

4.0 Introduction of New Technology - A Transition Strategy

4.1 Spectrum Usage Objectives

Retention of technological flexibility and practicality of implementation are the key objectives of the transition strategy. Minimal limitations should act as a guide to the type of technology being introduced, as long as spectrum efficiency requirements are met and each system accommodates a reasonable number of users consistent with the equipment capacity. The challenge will be to create achievable implementation plans which are effective and sensitive to possible transition difficulties.

As the major objective of replanning is to increase spectrum efficiency, benchmarks should be set which clearly specify the target performance levels to be achieved within practical timeframes. The following spectrum usage objectives are considered relevant:

1. Provide for voice and data communications in these bands.

2. Ensure that any technology chosen has the potential to support an equivalent RF channel bandwidth of 5 kHz per voice channel.

3. Provide information throughput of at least 1 bit/sec/Hz, independent of technology chosen.

4. Take some immediate action in order to relieve the frequency congestion which presently exits in many Canadian metropolitan centres. This may include the rapid introduction of available technology which as a first step partially meets the spectrum usage objectives. It is recognized that multiple access schemes offering up to 6 channels in a 30 kHz mobile channel are currently available.

5. Ensure that the technology does not impose any undue restriction on the use of existing and new channels.

6. Start the implementation process in the most congested areas as soon as possible. In the non-congested and rural areas, present FM technology could continue to operate and be deployed until such time as it becomes necessary to introduce these new technologies. Mobile systems near the Canada/U.S. border may also be subject to the replanning requirements.

7. Focus the replanning exercise, initially, in the 138 - 174 MHz and 406-460 MHz bands. These are the most heavily congested mobile bands in Canada.

8. Encourage organizations/users currently operating systems in these bands to convert to systems utilizing more spectrally efficient technologies by giving them the incentives of first right of refusal to freed up channels, where the need for additional capacity has been demonstrated.

9. Designate at a future date, systems not meeting the spectrum efficiency targets as non-standard systems. In congested urban areas, this could require the systems operator to either replace/modify the equipment or remove the system in accordance with the spectrum policy.

10. Encourage operators to review their mobile dispatch communications needs and where possible share facilities with other users leading to additional spectrum efficiency benefits. New multi-user systems would be expected to use new spectrally efficient equipment and could be given assignment priority as an incentive.

4.2 Transition Proposal

Based on the above spectrum usage objectives it is possible to develop a number of transition plans which can achieve the desired results with varying degrees of impact on existing mobile systems. These plans may be grouped into the following categories.

- Gradual channel by channel deployment of new technology.
- Scheduled deployment of new technology in blocks of spectrum.

In each category, proposals can be formulated to meet the spectrum usage objectives outlined in section 4.1. However, at this point it is difficult to predict the implementation dates due to the uncertainty of technology developments. These dates could be established after receiving public comments from manufacturers and service providers on the suitability of the equipment change-out and the timing of the technology.

Within the urban centres, the mobile system operators routinely replace aging or out-dated equipment as a normal part of doing business. This provides an opportunity for the introduction of new more spectrally efficient equipment at a convenient time for the operator. In the land mobile service, r.f. equipment is normally amortized over 8-10 years, however, it could be kept in service for much a longer period. In order to speed up the deployment process it may be necessary to specify the conditions by which an operator must convert to the new technology. It is necessary that associated equipment standards be developed as early as possible to facilitate the deployment of new technologies.

As noted earlier in this document the channelling arrangements in these bands vary across the country to meet local needs and conditions. Given the extensive use of this band and to harmonize the operation, in the intermediate period, of systems utilizing present and new technologies, it would seem reasonable to develop a national approach to:

- facilitate maximum utilization of the spectrum;
- harmonize Canada/USA spectrum usage;
- accommodate national, regional and local requirements.

4.2.1 138-174 MHz

The land mobile stations in the 138-174 MHz bands operate on 30 kHz channels.

4.2.1.1 FDMA Technology

For the FDMA technology, the main element of the transition strategy could be to offer 3 channelling plans by which new and existing systems can evolve step-by-step as technology becomes available. Figure 2a shows the 3 channelling plans, 15 kHz, 10 kHz and 5 kHz. Each plan is keyed on the centre frequency of the existing 30 kHz channels.

The timing of the transition of systems from 30 kHz technology to 15 kHz, 10 kHz and 5 kHz will be largely governed by the availability of technology.

4.2.1.2 TDMA Technology

TDMA technology is now available which would allow operators to convert existing 30 kHz channels immediately. For broader TDMA channels, multiple consecutive 30 kHz channels could be combined to provide for this need. (Figure 2b)

4.2.1.3 CDMA Technology

To accommodate CDMA technology, contiguous 30 kHz channels are required to make up the CDMA channel. In the case of 1.25 MHz CDMA nominal channel, 42 x 30 kHz channels are required (Figure 2.c).

4.2.1.4 Deployment Plan

Presently, the major metropolitan centres in Canada are experiencing severe congestion in the 138 - 174 MHz bands. It is necessary that some immediate measures be employed in order to provide adequate new spectrum for new licences.

1. Freeze licensing of new systems in areas of high congestion.

2. Development of technical standard(s) for the introduction of selected new more spectrally efficient technology(ies).

3. In the case of the deployment of FDMA technology, development of a 15 kHz, 10 kHz and 5 kHz channelling plan by collapsing the existing channels as shown in Figure 2a.

4. After the adoption of any new standard(s), new applicants must comply with the new requirements. Applicants outside the congested areas should be encouraged to employ systems under the new standard(s).

5. Systems utilizing present 30 kHz FM technology would become non-standard after a specified period of time and may require replacement of equipment to conform to the new standards.

6. Systems in urban centres would be expected to meet the 5 kHz efficiency standard by a predetermined date, which could vary from urban centre to urban centre. These measures would only be applied in areas of high congestion or in border areas where a negotiated agreement on channel usage requires Canadian systems to meet new standards.

4.2.1.5 Discussion

The transition strategy proposed for the 138-174 MHz provides either for a channel by channel or block replacement. This could be achieved by converting to more efficient technology within the operators existing channel or by shifting to another channel.

4.2.2 406-430 MHz and 450-470 MHz

The land mobile stations in the 400 MHz frequency bands operate on 25 kHz channels.

4.2.2.1 FDMA Technology

In the case of the FDMA technology, a 12.5 kHz channel plan and 5 kHz or 6.25 kHz channel plan could be provided if and when such technology becomes available. These channelling plans could be practical in that existing operators could or retrofit their equipment within the currently assigned channels. (Figure 3a)

4.2.2.2 TDMA Technology

For the existing 25 kHz channels TDMA technology is now available which would allow operators to convert immediately. For broader TDMA channels, multiple consecutive 25 kHz channels could be combined to provide for this need. (Figure 3b)

4.2.2.3 CDMA Technology

To accommodate CDMA technology, contiguous 25 kHz channels are required to make up the CDMA channel. In the case of 1.25 MHz CDMA channel, 50 x 25 kHz channels are required (Figure 3.c).

4.2.2.4 Deployment Plan

The 406 to 470 MHz bands are heavily used in some major metropolitan areas in Canada.

1. Freeze licensing of new systems in areas of high congestion.

2. Development of technical standard(s) for the introduction of selected new more spectrally efficient digital technology(ies).

3. In the case of the deployment of FDMA technology, development of a 12.5 kHz and 5 kHz or 6.25 kHz channelling plan by collapsing the existing channels as shown in Figure 3a.

4. After the adoption of any new standard(s), new applicants must comply with the new requirements. Applicants outside the congested areas should be encouraged to employ systems under the new standard(s).

5. Systems utilizing present 25 kHz FM technology would become non-standard after a specified period of time and may require replacement of equipment to conform to the new standards.

6. Systems in urban centres would be expected to meet the 5 kHz efficiency standard by a predetermined date, which could vary from urban centre to urban centre. These measures would only be applied in areas of high congestion or in border areas where a negotiated agreement on channel usage requires Canadian systems to meet new standards.

4.2.2.5 Discussion

The transition strategy proposed for the 406 MHz to 470 MHz bands provides either for a channel by channel or block replacement. This could be achieved by converting to more efficient technology within the operators existing channel or by shifting to another channel.

Figure 2a FDMA

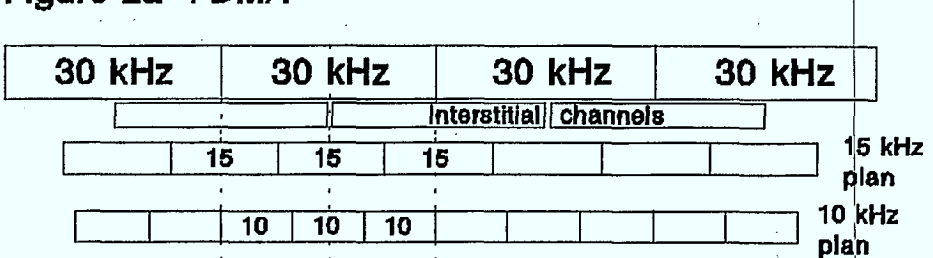


Figure 2b TDMA

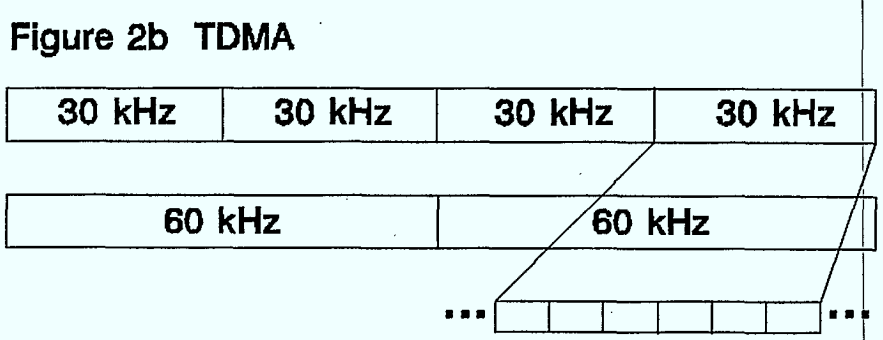
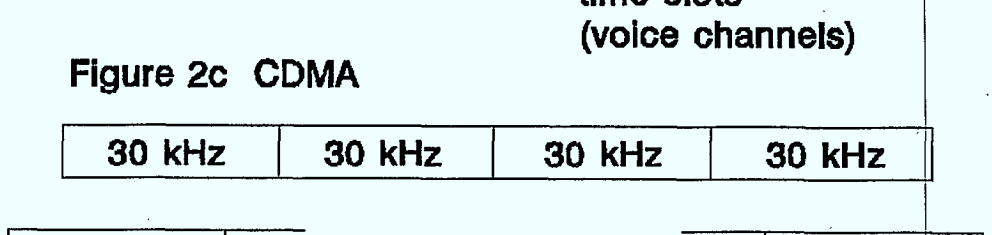


Figure 2c CDMA



Forty-two 30 kHz channels combined produce one 1.25 MHz CDMA channel

Figure 3a FDMA

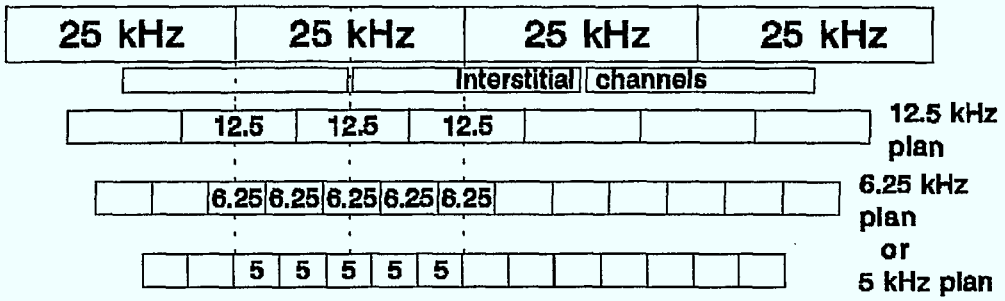


Figure 3b TDMA

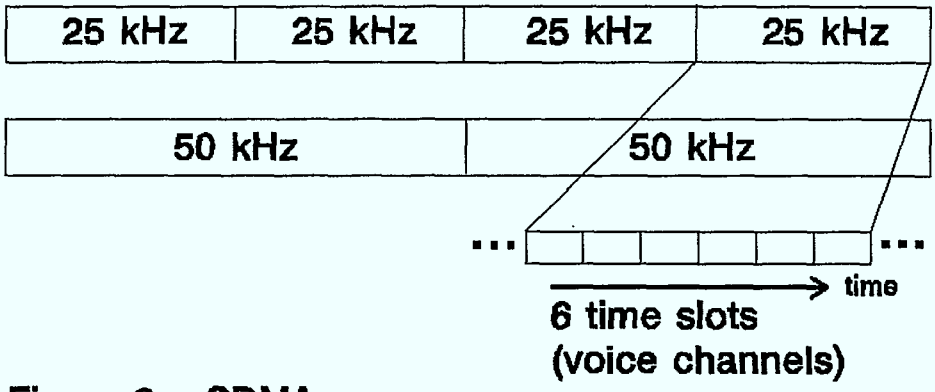
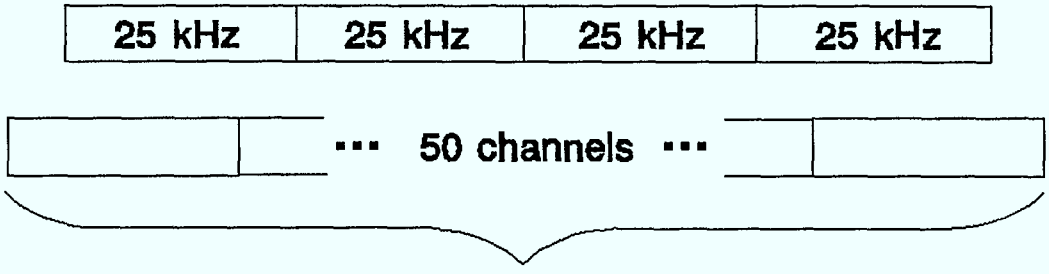


Figure 3c CDMA



Fifty 25 kHz channels
combined produce one
1.25 MHz CDMA channel

ANNEX 1

FREQUENCY BAND	ATLANTIC	QUEBEC	ONTARIO	PRAIRIES	PACIFIC
138-174MHZ	It is difficult to find a clear frequency in the metropolitan areas and there is usually a long waiting period before one can be obtained. Halifax is the most congested metropolitan centre. The major users are RCCs.	Frequency congestion is a problem in Montreal and the surrounding area (within 70 - 80 Km), in Quebec City and along the U.S. border. In Montreal, the shortage of frequencies is very severe and as many as 15 or 16 users share the same frequency.	The demand for both the lower and upper VHF bands is high. The situation is deemed critical in the metropolitan areas especially in the Hamilton, Toronto and Ottawa corridor; along Highway 400, 401; and up to Lake Simcoe. It is normal for users to share a frequency as clear frequencies are rare. Vertical channel loading, frequency sharing, frequency reuse and the use of interstitial frequencies have been employed on a regular basis to make spectrum available. In heavily congested areas such as Toronto, the interstitial channels are used as close as 25 Km to 30 Km to the primary channel. However, these channels cannot be used within the frequency coordination zone along the Canada - USA border. The users in the lower VHF band include municipal services, RCCs and safety services. The upper VHF band is used by a wide variety of users who operate either simplex or duplex systems.	The lower VHF band is used mainly by high capacity (more than 10 mobiles/ system) province-wide mobile services. The users include provincial governments, power/hydro companies and trucking companies. Both simplex and duplex modes of operation are employed. It is difficult to find a clear frequency for simplex operation. On the other hand, a few duplex-pair frequencies are still available in certain parts of region. The upper VHF band is preferred by many users and is consequently heavily congested in most parts of the region.	The lower VHF band is used primarily by safety services. It is difficult to find a clear channel. The upper VHF band is fully congested. There are no available clear channels. Solutions such as the use of interstitial channels are not used in the greater Vancouver and lower mainland areas because of close proximity to the U.S. border.
406-430 450-470 MHZ	Frequency congestion is not a problem and clear frequencies are available in both the UHF bands.	Both bands are congested in Montreal and surrounding area where there are no clear frequencies available. However, clear frequencies are still available. Sherbrooke and Quebec City and in the rest of the province. The main users are municipal and other government departments, RCCMRS and private companies	The lower and upper UHF bands are fully used. Frequency congestion is a serious problem in the "golden horse shoe" area, along Highways 400 and 401, up to Oshawa. The lower UHF band is also congested in the city of Ottawa and along the Canada - U.S. border. These bands are used by a variety of users.	The lower UHF band is heavily used. The main users in this band are municipal services, radio telephone services and RCCs. All simplex frequency assignments in this band have been assigned. The demand is greatest in Alberta where the Department has reassigned an additional one MHz of spectrum from the fixed service to the land mobile service and has made interstitial frequency assignments. The upper UHF band has both simplex and duplex channels available for use.	The lower UHF band is used mainly by local services such as water, sewer and city services. This band is, in general, not congested and frequencies are still available. This is not the case in the upper UHF band which is congested. Users in this band include RCCs, paging companies and private commercial users.

ANNEX 2

FCC INITIATIVE

Summary of FCC's
Notice of Proposed Rule Making

CHANNEL SPLITTING

The proposed set of spectrum efficiency standards would be based on narrowband technology. The current 25 kHz channel spacing would be reduced to 6.25 kHz in the 421-430, 450-470 & 470-512 MHz bands and to 5 kHz channel spacing in the 72-76 & 150-174 MHz bands

The process will occur in two stages, with the first stage requiring users to reduce their occupied bandwidth. Reduced channel deviation would reduce noise caused by and to adjacent channel assignments, and facilitate the addition of new channel assignments as soon as possible.

IMPLEMENTATION

421 MHz - 512 MHz Band

At 421-512 MHz, existing users would be required to reduce transmitter frequency deviation to reduce their occupied bandwidth to 10 kHz by January 1, 1996. Adjacent channel interference protection would not be provided. To avoid such problems, licensees should reduce the bandwidth of their receivers. In the first stage, three channels would be created from every existing channel. A 12.5 kHz channel would be centred on the original channel centre frequency and be licensed to all existing users (see fig. 1c). The other two channels would be 6.25 kHz wide, spaced just above and below the 12.5 kHz channel, and would be available for new users. In the second stage, existing users would move their carrier frequency either up of down 3.125 kHz and continue operation on either one or both of the new 6.25 kHz channels. A licensee would be able to keep the lower 6.25 kHz channel pair if they convert to narrowband technology at least two years before the deadline specified.

150 MHz - 174 MHz

Presently, in the 150-174 MHz band, channels are spaced every 15 kHz and have an occupied bandwidths of 20 kHz (see fig. 1b). Due to the fact the occupied bandwidth is larger than the channel spacing, adjacent channels require a mileage separation. The FCC proposes to reduce the transmitter frequency deviation to reduce the occupied bandwidth to 12 kHz by January 1, 1996. This would reduced the adjacent channel noise and eliminate the need for adjacent channel mileage separations. In phase two, all licensees would be required to use the 5 kHz channels. Existing licensees could remain on one or two of the three channels created from the channel for which they were originally licensed, if they convert to narrowband technology at least 2 years before the deadline. The new 5 kHz channels would be centred at the existing channels, plus 5 kHz above and below the current channel centres.

72 MHz - 76 MHz Band

It is proposed that existing users in the 72-76 MHz band be required to reduce their occupied bandwidth to 10 kHz by January 1, 1996. In the first stage, three channels would be created from the existing channel (see fig. 1a). A 10 kHz channel would be centred on the original channel centre frequency and be licensed to all existing users. The other two channels would be 5 kHz wide, spaced just above and below the 10 kHz channel, and would be available for new users.

As outlined in the FCC document, all stations using frequencies between 150-512 MHz must meet the minimum spectrum efficiency standards by the following dates[4]:

Market Number	Date
1-15	January 1, 2004
16-30	January 1, 2005
31-45	January 1, 2006
46-60	January 1, 2007
61-75	January 1, 2008
76-100	January 1, 2010
Outside Top 100 Markets	January 1, 2012

The markets are high population urban centres which are identified using longitude and latitudes. Markets one and two represent New York city and Los Angles-Long Beach, California respectively.

A system is located in a market if it has a base station located within 161 km of the specified coordinates. If located within 161 km of more than one market, the earliest market date applies.

EXCLUSIVITY

The FCC proposes to permit exclusive channel assignments in most of the 150-174 MHz, 421-430 MHz, and 450-470 MHz bands through an Exclusive Use Overlay (EUO) plan. Licensees with sufficient loading would be given the opportunity to protect their radio environment by converting currently shared use channels to exclusive use channels.

If concurrence of all large (as defined by loading criteria) co-channel licensees within 80 km of the specified site is achieved, then licensing would be permanently frozen. No additional use of that channel within 80 km would be permitted without concurrence of the EUO licensee. Existing licensees would remain on the channel on a co-primary basis and would be allowed to add new mobiles.

For users requiring multiple sites, two wide area system options are proposed. In the first, each mobile would be counted at every site. The second option would impose loading criteria proportional to the total geographic area protected from further licensing when each site is provided the standard 80 km protection radius.

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[4] Federal Communications Commission, Notice of Proposed Rule Making, PR Docket No. 92-235, Page 72:255.

EFFECTIVE RADIATED POWER REDUCTIONS

Significant reductions in permissible transmitting power levels are proposed by the FCC. Many current licensees use far more power than necessary. Standard limits on ERP to be reduced to 300 watts for the 150-174 and 450-470 MHz bands, and lower ERP limits for systems with antenna heights above average terrain greater than 60 meters. All systems within these bands would be expected to meet the ERP and HAAT limits by January 1, 1996. The FCC indicates this would enable co-channel separations of approximately 80 km.

Power and Antenna Height Limits

25-50 MHz. The maximum transmitter output power is 300 watts.

72-76 MHz. The maximum ERP for stations operating on mobile fixed frequencies is 300 watts. Stations operating on mobile-only frequencies are limited to one watt transmitter output power.

Table C-1 120-216 MHz ERP/Antenna Height		**Table C-2 220-222 MHz ERP/Antenna Height**		**Table C-3 421-430 MHz & 450-470 MHz ERP/Antenna Height[5]**	
(HAAT) meters	(ERP) watts	(HAAT) meters	(ERP) watts	(HAAT) meters	(ERP) watts
Up to 150	500	Up to 150	250	Up to 60	300
150-225	250	150-300	150	60-75	190
225-300	125	300-450	75	75-90	120
300-450	60	450-600	40	90-120	75
450-600	30	600-750	20	120-180	30
600-750	20	750-900	15	Above 180	5
750-900	15	900-1200	10		
900-1050	10	Above 1200	5		
Above 1050	5				

ERP - Effective radiated power in watts
HAAT - Antenna height above average terrain in meters

ADDITIONAL PROPOSALS

A fourth proposal to consolidate the current 19 radio services, or increasing intercategory sharing, was made in the FCC document. Two alternatives were suggested, (1) to consolidate the current radio services into three broad categories (Public Safety, Non-Commercial and Specialized Mobile Radio) plus a General Category Pool encompassing all three service, or (2) to retain the current services and assign to those services their existing frequency assignments but assign all new frequencies to the proposed new broad categories and the General Category pool.

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[5] FCC Notice of Proposed Rule Making, PR Docket 92-235, page 72:248-249.

Emission Masks

Transmitters used in the Land Mobile Radio Services must comply with the emission masks outlined in this section if they are located in the congested urban regions. The measurements of emission power can be expressed in peak or average values provided they are expressed in the same parameters as the unmodulated transmitter carrier power. For transmitters that do not produce a full power unmodulated carrier, the reference to the unmodulated transmitter carrier power refers to the total power.

A) *25-50 MHz 72-76 MHz* For transmitter operating in the 27.41-50 MHz frequency band, the power of any emission must be below unmodulated carrier power (P) as follows:

1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the occupied bandwidth: At least 25 dB.

2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the occupied bandwidth: At least 35 dB.

3) On any frequency removed from the assigned frequency by more than 250 percent of the occupied bandwidth: At least 43 + 10 log P dB or 80 d B, whichever is the lesser attenuation.

B) *72-76 MHz (Mobile Use Only), 150-174 MHz & 216-222 MHz* For transmitters operating in the 138-174 MHz frequency band, any emission must be reduced below the power of the highest emission contained within the occupied channel bandwidth as follows:

1) On any frequency within the occupied bandwidth to the edge of the occupied bandwidth (f_e): Zero dB.

2) On any frequency removed from the edge of the occupied bandwidth, (f_e), to (f_e) + 1.75 kHz: 30 + 20x(f_e) dB, or 55 + log (P), or 65 dB, whichever the lesser attenuation.

3) On any frequency beyond 1.75 kHz removed from the edge of the occupied bandwidth (f_e): at least 55 + 10 log (P) dB.

C) *420-512 MHz.* For transmitters operation in the 406.1-470 MHz frequency band, any emission must be attenuated below the power (P) of the highest emission contained within the occupied channel bandwidth as follows:

1) On any frequency within the occupied bandwidth to the edge of the occupied bandwidth (f_e): Zero dB.

2) On any frequency removed from the edge of the occupied bandwidth, (f_e), to (f_e) + 2.1 kHz: 30 + 16.7x(f_e) dB, or 55 + 10 log (P), or 65 dB, whichever is the lesser attenuation.

3) On any frequency beyond 2.1 kHz removed from the edge of the occupied bandwidth (f_e): At least 55 + 10 log (P) dB.

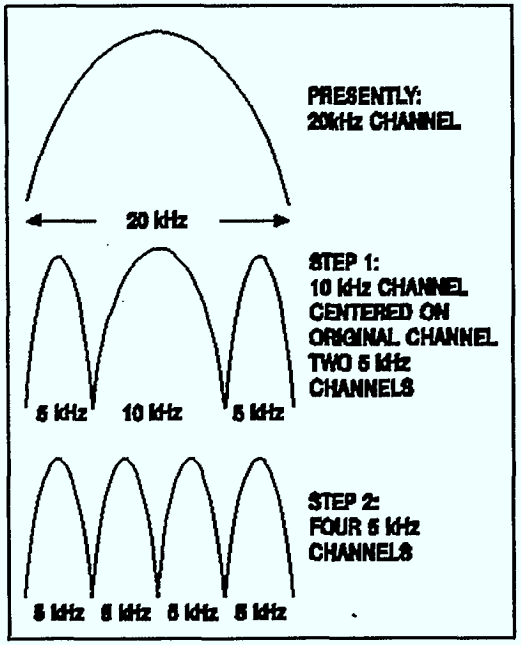

FIGURE 1(a) 72 - 76 MHz

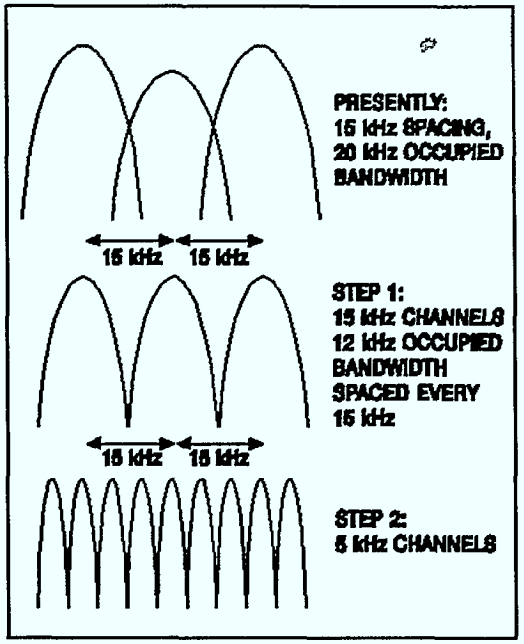

FIGURE 1(b) 150 - 174 MHz

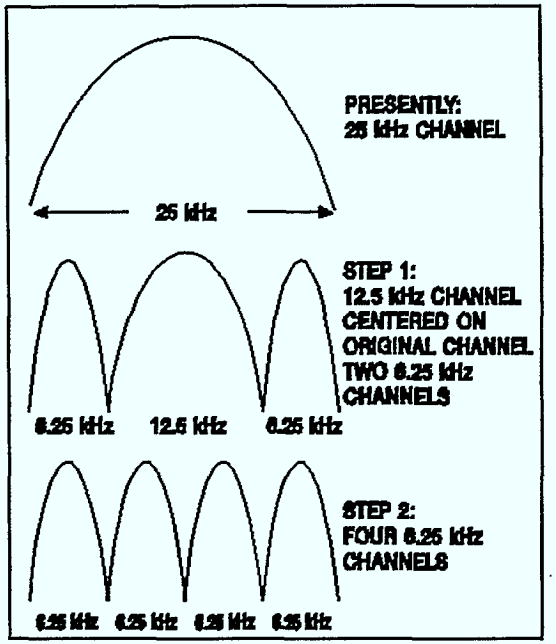

FIGURE 1(c) 421 - 512 MHz

IMPLEMENTATION OF CHANNEL SPLIT

ANNEX 3

Table A-1
Canadian
A Regional VHF Frequency Sub-Allocation Plan - Example 1

138.00 - 149.90 MHz	Canada-wide civil emergency;
Simplex or Duplex	Paging & roaming paging;
	Land mobile.
150.05 - 174.00 MHz	GLMRS, RCMRS, RCC paging;
Simplex or Duplex	Pollution clean up;
	Low power telemetry;
	Low power forestry mobile.

Table A-2
Canadian
A Regional VHF Frequency Sub-Allocation Plan -Example 2

138.00 - 138.69 MHz	Province-wide high capacity*
Duplex Paired With	Oil companies, Utilities;
142.00 - 142.66	Trucking, Paging;
	Provincial governments.
138.70 - 139.29 MHz	Province-wide high capacity*.
Duplex Paired With	Oil companies, Utilities;
141.18 - 141.75 MHz	Trucking, Prov. governments.
139.30 - 142.99 MHz	Province-wide high capacity*
Simplex	systems
143.02 - 143.98 MHz	Local and wide-area operation.
Duplex Paired With	RCCMRS, Point-to-point.
148.01 - 148.97 MHz	
144.00- 148.00 MHz	Amateurs
149.00 - 149.44 MHz	Simplex MRS < Construction
	Private radio paging, DOC;
	Portable rural EMR.
149.45 - 150.00 MHz	EMO, Security.
150.06 - 151.13 MHz	Simplex MRS, Low power, Taxi;
151.14 - 151.99 MHz	Police, Fire & Penitentiary.
152.00 - 152.43 MHz	Simplex MRS, Taxi.
152.45 - 152.90 MHz	GLMRS (base) - Duplex (*).

152.91 - 153.47 MHz	Land mobile/Broadcast Auxil.
153.48 - 152.77 MHz	Land mobile (any one).
153.78 - 155.98 MHz	RCMP, Municipal services (S/D).
	Land mobile (any one).
156.00 - 157.70 MHz	Land mobile
157.45 - 158.10 MHz	GLMRS (mobile) - Duplex (*).
158.79 - 159.46 MHz	RCMP, Municipal services (S/D).
159.50 - 161.49 MHz	Railways.
161.50 - 163.40 MHz	Land mobile.
163.44 - 168.65 MHz	RCC's - Simplex/Duplex.
168.70 - 174.00 MHz	Land mobile

* A wide-area system with large mobile population.
S/D - means simplex or duplex

TABLE A-3
Canadian
Frequency Sub-Allocation Plan for 400 MHz Band

406.10 - 406.47 MHz	Land mobile-Simplex(>50 lat).
406.48 - 406.80 MHz	Land mobile-Duplex.
Paired With	
408.18 - 408.50 MHz	Land mobile-Duplex
406.81 - 408.17 MHz	Land mobile-Simplex.
408.51 - 408.98 MHz	Land mobile-Simplex.
409.00 - 409.99 MHz	AMTS/TRUNK (mobile-duplex)
Paired With	
420.00 - 420.99 MHz	AMTS/TRUNK (base-duplex)
410.00 - 410.99 MHz	Prov-wide MRS/Fixed (duplex).
Paired With	
415.00 - 415.99 MHz	Prov-wide MRS/Fixed - (duplex).
411.00 - 411.99 MHz	Prov-wide MRS - (duplex).
Paired With	
416.00 - 416.99 MHz	Prov-wide MRS - (duplex).
412.00 - 412.50 MHz	Land mobile - (duplex).
Paired With	
417.00 - 417.50 MHz	Land mobile - (duplex).
412.50 - 413.99 MHz	Municipal systems/ Fixed.
Paired With	duplex
417.50 - 418.99 MHz	Municipal system/Fixed.
414.00 - 414.99 MHz	Fixed - duplex.
Paired With	
419.00 - 419.99 MHz	Fixed - duplex
421.00 - 422.16 MHz	National systems - duplex.
Paired With	
426.00 - 427.16 MHz	National systems - duplex.

422.17 - 422.66 MHz .... Trunk systems - duplex
Paired With
427.17 - 427.66 MHz Trunk systems - duplex
422.67 - 422.99 MHz .... Fixed - duplex.
Paired with
427.67 - 427.99 MHz .... Fixed - duplex.
423.00 - 423.50 MHz .... Land mobile - duplex.
Paired with *
428.00 - 428.50 MHz Land mobile - duplex
423.51 - 423.99 MHz .... Fixed - duplex (>50 lat).
Paired with *
428.51 - 428.99 MHz Fixed - duplex (>50 lat).
424.00 - 424.99 MHz .... Land mobile - duplex (>50 lat).
Paired with *
429.00 - 429.99 MHz Land mobile - duplex (>50 lat).
425.00 - 425.48 MHz .... Land mobile - simplex (>50 lat).
425.50 - 425.99 MHz .... National systems - simplex.

TABLE A-4
Canadian
Frequency Sub-Allocation Plan for 450 MHz Band

450.0000 - 451.0000 MHz	Broadcast auxiliary
451.0000 - 453.0250 MHz	Land mobile (base)-duplex.
Paired with	RCCMRS, CNR;
456.0000 - 458.0250 MHz	Land mobile (mobile)-duplex.
453.0250 - 454.0000 MHz	Mobile/Fixed - simplex.
454.0125 - 455.0125 MHz	GLMRS (base) -duplex. *
Paired With	Paging, Low power, RCCMRS;
459.0125 - 460.0125 MHz	Land Mobile (mobile) - duplex. *
455.0250 - 456.0000 MHz	Broadcast auxiliary.
458.0250 - 459.0000 MHz	Land mobile - simplex.
	Canada-wide DEMR, Oil & Gas Co.
460.0250 - 464.0250 MHz	Land mobile (base)-duplex.
Paired With	
465.0250 - 469.0250 MHz	Land mobile (mobile)-duplex.
464.0250 - 465.0250 MHz	Land mobile - simplex.
469.0250 - 470.0000 MHz	Land mobile - simplex.

Note: ALL CHANNELS OFFSET 12.5 kHz FROM U.S. CHANNELS EXCEPT WHERE INDICATED BY *.

Table A-5
U.S. Combined Frequency List 406-460 MHz[1]

406.125 MHz		Hydrological/Meterological data trans.
406.175 MHz		Hydrological/Meterological data trans.
409.675 MHz		Hydrological/Meterological data trans.
409.725 MHz		Hydrological/Meterological data trans.
412.625 MHz		Hydrological/Meterological data trans.
412.675 MHz		Hydrological/Meterological data trans.
412.725 MHz		Hydrological/Meterological data trans.
412.775 MHz		Hydrological/Meterological data trans.
421-430 MHz		3 Border Cities (88.775)
422.190625-424.984275 MHz	....	Land mobile (base) - duplex
Paired With		
427.190625-429.984375 MHz	....	Land mobile (mobile)
424.990625-425.484375 MHz	....	Simplex or paging operations
451.015625-451.784375 MHz	....	Non-Commercial (base) - duplex
Paired With		
456.015625-456.784375 MHz	....	Non-Commercial (mobile)
*** 451.0375-451.7625 MHz	....	General Category - **Low Power** - Simplex Spaced every 25 kHz, offset 3.125 kHz from primary channel
451.790625-451.809375 MHz	....	General Category - **Itinerant**
451.815625-452.509375 MHz	....	Non-Commercial (base) -duplex
Paired With		
456.815625-457.509375 MHz	....	Non-Commercial (mobile)
*** 451.8125-452.0125 MHz	....	Non-Commercial - **Offset** - Simplex Antenna height up to 35 m, Base station @ least 15 km from base operating on freq. offset by 3.125 kHz
*** 452.0375-452.9875 MHz	....	General Category - **Low Power** - Simplex Spaced every 25 kHz, offset 3.125 kHz from primary channel
452.615625-453.009375 MHz	....	Non-Commercial (base) - duplex
Paired With		Includes locomotive
457.615625-458.009375 MHz	....	Non-Commercial (mobile)
453.015625-453.984375 MHz	....	Public Safety - (base) - duplex
Paired With		
458.015625-458.984375 MHz	....	Public Safety - (mobile)
*** 453.0125-453.9875 MHz	....	Public Safety - **Low Power** - Simplex Spaced every 25 kHz, offset 3.125 kHz from primary channel
*** 453.025 - 453.175 MHz	....	Grandfathered Paging - Simplex

[1] FCC Proposed Amendments (Docket 92-235), part 88.1501, pages 72:322-72:394.

453.990625-454.009375 MHz	....	Non-Commercial (base) - duplex
Paired With		Oil Spill
453.990625-454.009375 MHz	....	Non-Commercial (mobile)
456.0375 - 458.0125 MHz	....	General Category - **Low Power** - simplex Spaced every 25 kHz offset 3.125 kHz from primary channel
456.790625-456.809375 MHz	....	General Category - **Itinerant** - duplex
Paired With		6.25 kHz Spacing
456.790625-456.809375 MHz	....	General Category (mobile)
457.515625-457.609375 MHz	....	Non-Commercial - **Low Power** - simplex 6.25 kHz Spacing
*** 458.0375-460.6375 MHz	....	Public Safety - **Low Power** - simplex Spaced every 25 kHz offset 3.125 kHz from primary channel
460.015625-460.634375 MHz	....	Public Safety (base) - duplex
Paired With		
465.015625-465.634375 MHz	....	Public Safety (mobile)
460.640625-461.009375 MHz	....	Non-Commercial (base) duplex
Paired With		
465.640625-466.009375 MHz	....	Non-Commercial (mobile)
461.015625-462.184375 MHz	....	General Category (base) duplex
Paired With		
466.015625-467.184375 MHz	....	General Category (mobile)
462.190625-462.534375 MHz	....	Non-Commercial (base) - duplex
Paired With		
467.190625-467.534375 MHz	....	Non-Commercial (mobile)
*** 460.6625-462.9125 MHz	....	General Category - **Low Power** - simplex Spaced every 25 kHz offset 3.125 kHz from primary channel
*** 462.750 - 462.925 MHz	....	General Category - **Paging** - simplex Spaced every 25 kHz offset 3.125 kHz from primary channel
462.940625-463.184375 MHz	....	Public Safety (base) - duplex
Paired With		
467.940625-468.184375 MHz	....	Public Safety (mobile)
*** 462.9375-463.1875 MHz	....	Public Safety - **Low Power** - simplex Spaced every 25 kHz offset 3.125 kHz from primary channel
463.190625-464.984375 MHz	....	General Category (base) - duplex
Paired With		(some low power simplex assignments)
468.190625-469.984375 MHz	....	General Category (base) - duplex
*** 463.2125-464.9875 MHz	....	General Category - **Low Power** - simplex Spaced every 25 kHz offset 3.125 kHz from primary channel
*** 465.0125-465.6375 MHz	....	Public Safety - **Low Power** - simplex Spaced every 25 kHz offset 3.125 kHz from primary channel

*** 465.6625-467.9125 MHz	....	General Category - **Low Power** - simplex Spaced every 25 kHz offset 3.125 kHz from primary channel
* 467.740625-467.934375	....	Non-Commercial - **Low Power** - simplex Spaced every 6.25 kHz
*** 467.9375-468.1875 MHz	....	Public Safety - **Low Power** - simplex Spaced every 25 kHz offset 3.125 kHz from primary channel
*** 468.2125-469.9625 MHz	....	General Category - **Low Power** - simplex Spaced every 25 kHz offset 3.125 kHz from primary channel
* 469.315625-469.984375	....	General Category - **Low Power** - simplex

Non-Commercial Radio Service: Any business, charitable or non-profit organization, or government agency is eligible to hold a license in the Non-Commercial Radio Service to operate a system that will be used primarily for the licensee's internal use, by the licensee's parent corporation, by a subsidiary of the same parent, or a subsidiary of the licensee.

General Category Pool: encompasses public safety radio services and non-commercial radio services.

Low Power Operations: are secondary,i.e., must protect all other licensed operations and must accept interference from any other operation, and are not available on an exclusive basis.

Itinerant Operations: If a system is in operation at an unspecified temporary site for 180 days or less, it is considered an itinerant operation. No protection is provided from other itinerant users.