Proposed utilization of the radio spectrum in the range 0.890–10.68 GHz by the fixed service

Government of Canada
Department of Communications

Gouvernement du Canada
Ministère des Communications

PROPOSED UTILIZATION OF THE RADIO SPECTRUM IN THE RANGE 0.890 - 10.68 GHz BY THE FIXED SERVICE

DEPARTMENT OF COMMUNICATIONS

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TABLE OF CONTENTS

1. Introduction

The Department of Communications has reviewed the spectrum utilization for all bands in the frequency range .890-10.68 GHz in which the Fixed service (microwave radio systems) is allocated according to the Proposed Canadian Frequency Allocation Table. The objective of this review was to determine what (fixed) spectrum provisions and regulatory requirements are necessary in the future. Some of the bands in which the Fixed service is not allocated may have undergone allocation changes as a result of WARC '79 and the resulting Proposed Canadian Frequency Allocation Table, but the actual system utilization within these bands has not been addressed in this review. However, the Department reserves the right to review and possibly revise the utilization of these bands at some future date. This review follows the Department's discussion paper of August 1979 which, in inviting public comment, gave an overview of current usage, proposed possible scenarios for future use and highlighted certain issues for consideration. Submissions in public response to this discussion paper have proven to be very helpful and have constituted an essential and fundamental input towards the proposed policy which follows.

The highlights of the conclusions of this review are summarized below:

- all existing services will continue

- essentially all new services as identified in the responses to the discussion paper have been accommodated. e.g.:
  - Multipoint Distribution Systems (MDS) - Video/Data/Voice
  - Distribution Automation (public utilities)
  - various capacities of digital radio, especially very low (VLC) and low capacity (LC)
  - multihop video transmission
  - STL's for AM/FM radio

- innovative and state-of-the-art modes of transmission and service considerations will be encouraged

- simultaneous sharing of the same frequency band will be required on an ever increasing basis. For example, analogue and digital systems may be required to operate side-by-side, and terrestrial systems will be required to coordinate with the geostationary satellite orbit

- use of non-radio alternatives will be encouraged where technically and economically feasible

- frequency diversity will generally not be permitted.

The portion of spectrum under review constitutes the most heavily occupied and hence the most capital intensive part of the radio spectrum currently utilized by Fixed service users. Several new and innovative technological uses of these bands are proposed as was suggested by the various and often differing demands made in the submissions in response to the background paper. Taking all of these into account, an in-depth analysis has been completed and the resulting spectrum and utilization policy proposed here is expected to provide the basis for the use and development of this part of the spectrum for the foreseeable future. Also, as new and more spectrum efficient technologies are developed and eventually implemented, the accompanying replacement of older systems approaching obsolescence is expected to ensure sufficient spectrum availability to accommodate additional new microwave services and configurations as they emerge.

Currently applicable technical criteria for the utilization of most of the bands under consideration in this review are contained in the appropriate Standard Radio System Plans (SRSP's), the majority of which were developed prior to 1975. Consequently, it is the intention of the Department to undertake the necessary revision of these plans, in order to incorporate the technical aspects of this proposed policy revision where there is an identified need to do so.

Two other major activities which have contributed to the development of this proposed policy are the recently completed World Administrative Radio Conference 1979 (WARC '79) and the resultant proposed Canadian Table of Frequency Allocations, Gazetted for public consultation in May 1980, and which will be finalized for implementation on January 1, 1982. The main element emerging from WARC '79 insofar as the Fixed service is concerned is the significantly increased degree of inter-service sharing of specific bands in the entire spectrum. At least two of the immediate ramifications of this will be:

a) the need to increase the utilization of spectrum conserving techniques by whatever means possible; and,

b) the need for planning on the part of users and spectrum regulators in terms of coordination based on long-term projections.

Significantly, none of the various services and types of systems currently being employed in the spectrum under review have been proposed to be eliminated or even to be accommodated in alternative bands, and virtually all new uses suggested in the public review have been accommodated. To this end, Appendix 2 provides a comparison of the amount of spectrum available to specific types of usage prior to the review and the amount of spectrum proposed as a result of the review.

Features of the proposed policy in light of the numerous considerations which emerged during the consultative process are contained in the sections which follow. Comments on the proposals are invited as outlined in the Gazette Notice (see Appendix 3). Based on these comments, a definitive policy will be promulgated.

2. Spectrum Conservation Principles

2.1 Developing and Emerging Technologies

With the necessity to achieve more inter-service sharing coupled with the demand for access to the same spectrum by an increasing number of Fixed service users (i.e. intra-service sharing), it is obvious that new and more efficient means will be required to achieve the inherent increased band occupancy this implies. It has become increasingly apparent that one of the most obvious means at the Department's disposal to achieve these spectrum efficiency objectives is to strongly encourage the use of newly available technologies which would result in increased traffic-carrying capabilities without requiring increased spectrum. Consequently, the Department will, in assessing specific licence applications, measure such proposals in terms of optimum and economically feasible usage of innovative and state-of-the art practices. The Department's evaluation will consider, for both analogue and digital systems, the use of antennas with improved characteristics. For digital systems, in addition to the conventional bits per second per hertz criteria, techniques designed to optimize the fundamental baseband throughout per hertz of radio spectrum will be emphasized. Examples of such techniques would be co-channel cross-polarization, encoding/decoding schemes, digital speech interpolation (DSI), etc. Single side-band amplitude modulation and reductions in FM deviation would be prime examples of such techniques in the analogue mode. In other words, the Department's goal will be to foster increased capacity of existing and future microwave systems without necessarily specifying the method by which this may be achieved, so long as the objective of increased capacity through the use of state-of-the-art technology is attained.

2.2 Spectrum Requirements

2.2.1 Spectrum Requirements for Radio Services Other than the Fixed Service

Throughout the spectrum review process and particularly in the last few years, there has been an accelerated demand for microwave spectrum by other than the Fixed service which sometimes vies with the Fixed service for the same part of the spectrum. In some instances, appropriate sharing with the necessary protection criteria for Fixed services is precluded. Perhaps the best example of this type of conflicting demand is found within the band 890-960 MHz where, to date, the Fixed service has enjoyed primary status. However, the new International Allocation Table for North and South America and other worldwide pressures indicate an increased requirement for spectrum in the longer term by the Mobile service, for example, which is currently growing at an annual rate of about 12 percent and whose needs are best suited to frequencies below 1 GHz.

The Canadian concern of course is to accommodate all Canadian users to the extent possible while ensuring relatively interference-free operation. In this regard, use of the spectrum in other countries on a coordinated basis becomes a prime consideration for purposes of long-term spectrum planning. Accordingly, certain changes in spectrum utilization over time can be expected and, as a result, this policy attempts to provide alternative spectrum to those services expected to be eventually displaced.

2.2.2 Low Capacity Systems

In recent years, the Department has become especially aware of the need for additional spectrum for very low capacity (VLC) and low capacity (LC) systems in certain geographical areas. Traditionally such LC and VLC systems have been concentrated in the 890-960 MHz band. However, in some parts of the country this band is fully occupied and now there are the conflicting spectrum demands by other services (e.g. mobile, personal radio services, etc). It is therefore the Department's view that it would be in the long-term national interest if LC fixed systems were accommodated primarily in the spectrum above 1 GHz where they can reasonably expect a greater degree of protection and longer term tenure. Accordingly, as can be seen in Appendix 2, the Department has made significantly increased spectrum available for these systems. In so doing, the Department has attempted to accommodate future demand for VLC and LC systems as low as possible in the spectrum above 1 GHz, so as to retain, to the extent possible, the desirable propagation, antenna, hop length and other characteristics of operations below 1 GHz.

2.2.3 Medium and High Capacity Systems

There is every indication that the increasing demand for medium capacity (MC) to very high capacity (VHC) digital systems will continue and indeed it is anticipated that in most instances, digital systems will eventually replace analogue systems. To accommodate this projected requirement, the Department is making available some six to seven times more spectrum in the range .890-10.68 GHz than is currently available for this type of use. Much of this spectrum

consists of existing analogue microwave bands which will be shared with digital systems but there are also several bands that would be dedicated exclusively to digital use at these capacity levels. It should be noted, however, that, as for all services, the accommodation of MC to VHC digital systems below 10 GHz is being taken into account in the Department's current review of both proposed and existing usage of the spectrum in the frequency range 10-30 GHz. A proposed policy for this range of spectrum will soon be issued for public comment.

2.2.4 Video Transmission Requirements

Until now, virtually the only exclusive band available for multi-hop video transmission has been the 8275-8500 MHz band which can accommodate up to eight channels of video. In response to a demonstrated need, the Department is proposing to make available spectrum capable of carrying an additional eight channels in the 6425-6590 and 6770-6930 MHz band for systems with high growth two-way potential; that is, applicants would have to have the potential to completely occupy the band with video or other traffic. Also, if further spectrum is required, the 1900-2290 MHz band could be considered. However, the 1900-2290 MHz band should be seen as a last choice for multi-hop video, since the Department does not wish to have this type of service in more bands than absolutely necessary. One reason for this is that by keeping the growth of analogue systems in a minimum number of bands, digital systems can grow more efficiently. As has been established in previous departmental policies, proposed systems with low growth and/or only one-way potential should consider frequency bands above 10 GHz.

Examples of such systems would be Studio-Transmitter Links (STL's) or the types of systems for which there could possibly be a spectrum requirement as a result of the review currently in progress entitled "Review of Certain Aspects of the Microwave Radio Relay System Licensing Policy Related to Intercity Delivery of Signals for Use by a Broadcasting Undertaking". If the result of the Intercity TV review permits such systems there would be a need to establish standards for the quality of transmission. In this same vein, additional spectrum is also being made available for TV pickups and temporary TV links in the 2450-2550 MHz band. Moreover, with the availability of tunable and portable equipment and in order to maximize the efficient utilization of the spectrum, a method of sharing common frequencies would be implemented for such temporary links and, it is anticipated that this will remove certain administrative difficulties inherent in the current system.

The Department is also of the opinion that current technology now permits the utilization of digitized video encoding and bandwidth reduction techniques. These would be especially applicable to the conveyance of radar. Users will therefore be expected to review the performance criteria of their systems in order to ensure that maximum possible spectrum efficiency techniques are being employed wherever possible.

2.2.5 AM/FM Studio-Transmitter Links (AM/FM STL's)

In frequency congested areas, the Department has experienced increasing difficulty in providing appropriate individual frequency assignments for studio-transmitter links in support of broadcasting

undertakings. This difficulty could be expected to become even more acute with the possible introduction in the near future of amplitude modulation (AM) stereo broadcasting. To provide for this growing need, 10 MHz of spectrum in the band 1700-1710 MHz would be made available which should accommodate this particular usage for the foreseeable future. Moreover, the practice of carrying AM/FM STL's in the TV-STL band as a sub-carrier of the video will continue to be encouraged.

2.3 Non-Radio Alternatives

Throughout this document it will be noted that emphasis is placed on the fundamental aspects of spectrum sharing and spectrum efficiency. This is particularly so as a result of the increasing demand both domestically and internationally for access to the radio frequency spectrum. It is therefore axiomatic that the Department encourage and pursue to the maximum extent possible the use of non-radio alternatives by users where such means can realistically be employed from a technological and economic point of view. Consequently, applicants may expect departmental emphasis on the use of non-radio alternatives such as fibre optics and cable, especially in areas where microwave bands are congested, where system lengths are short and where these alternatives can reasonably be employed.

2.4 New Applications

The Department has begun to receive numerous proposals for new types of service applications as a result of expanding needs or technological developments. Many of these proposed uses are suited to the spectrum between 1-10 GHz. Among these are multipoint distribution systems (MDS) for both video, data [e.g. Distribution Automation (DA)] and voice. The Department

proposes to satisfy both of these requirements to a significant degree. In the case of MDS video, a judicious, coordinated sharing scheme is proposed in the band currently designated for Instructional Television (ITV) applications (2548-2686 MHz). A requirement has been identified for distribution automation (DA) for public utilities of which the prime user in the immediate future would appear to be electric power utilities. This is currently envisaged to be for the control of major segments of the electrical distribution hierarchy. While DA could be accommodated in several bands, portions of the band 2290-2460 MHz are recommended at this time.

As has been mentioned, responses to the Department's discussion paper contained requests for spectrum to either extend existing frequency allocations or to make spectrum available for new uses. In attempting to accommodate these requirements, the Department has found it necessary to propose their implementation in parts of the spectrum which could create new opportunities for equipment manufacturers in either the modification of existing equipment or alternatively the the manufacture of new equipment. Consequently, it is emphasized that the entire question of equipment availability has been a prime consideration throughout this review and that, in issuing this proposed policy, the Department is most interested in the comments of users and manufacturers concerning the proposed implementation of extended or new spectrum usage.

3. Technical Considerations

3.1 Branching or Spur Route Channels

Systems should be engineered so that the frequencies assigned to a main route system can be re-used on the first link of the branching or spur routes. Where this is impossible and expansion to full capacity of one of the routes is blocked by

a branching or spur route link, then the frequency band 6425-6590/6770-6930 MHz may be employed for the first link of the branching or spur routes. An example of where this problem could arise would be a location where the geography does not permit sufficient antenna discrimination to be obtained at the branch-off angle.

3.2 Future Review of Band Utilization

Periodically, a review will be made to ascertain whether or not this planned system utilization, with respect to previously stated needs, in given bands was correct. Where it is evident that the utilization within a band (or bands) has not developed as anticipated, alternative needs may be considered.

3.3 Analogue/Digital Sharing

Despite the indication that many of today's microwave systems may be ultimately replaced by systems utilizing digital modulation, it is recognized that for the present and for an uncertain interim period, an analogue/digital mode sharing of certain bands will prevail. In these bands, existing frequency plans will remain in force to avoid disruption of analogue systems; conversely, the design of digital systems in these bands will be constrained by the existing frequency plans. Initially, this state of affairs is expected to be evident in the 1710-1900 MHz, 1900-2290 MHz, 3500-4200 MHz and 7125-7725 MHz bands among others. However, in those bands designated exclusively for digital systems, appropriate channelling of the band will be effected to take full advantage of digital transmission.

Finally, as a fundamental aspect of spectrum conservation, it is proposed that all new analogue and digital systems will be

required to employ a two frequency rather than a four frequency plan in all microwave bands in which it is technically feasible to do so. Examples of this requirement would be in the 6425-6590 MHz and 7125-7725 MHz bands among others. Moreover, existing systems employing a four frequency plan would be required to convert to a two frequency plan in those bands where it is technically feasible to do so within five years of the coming into effect of a final policy, or be prepared to immediately change those hops which would block the establishment of a standard two frequency plan system.

3.4 Diversity

In the past, the Department has generally permitted frequency diversity when a specific degree of protection has been requested. However, the result of this has caused a high degree of spectrum consumption. If we are to meet the requirements of other systems competing for the same spectrum, then this practice must be modified. Considering frequency diversity systems to consist of a separate channel protecting a number of working channels, those systems where the number of working channels is relatively small constitute the cases where most spectrum is to be gained by eliminating frequency diversity. Consequently, the initial thrust in eliminating frequency diversity can be expected to be towards those systems where the ratio of working to protection channels is lower. The Department therefore proposes that licensees be given a period of five years from the issuance of a final .890-10.68 GHz policy to reconfigure their systems such that frequency diversity is not employed. If after this period, RF channel(s) employed for frequency diversity are determined to be blocking a proposed standard (non frequency diversity) system, the licensee will immediately be required to make whatever technical modifications are necessary in order to remove the possible interference conflict. Moreover,

applications for new systems in bands where frequency diversity had previously been permitted would no longer be authorized. Proposed or existing systems maintaining a need for protection would be required to utilize other means (e.g. space diversity and/or hot-standby on the same frequency) to achieve the required reliability.

4. Proposed Utilization of Each Band

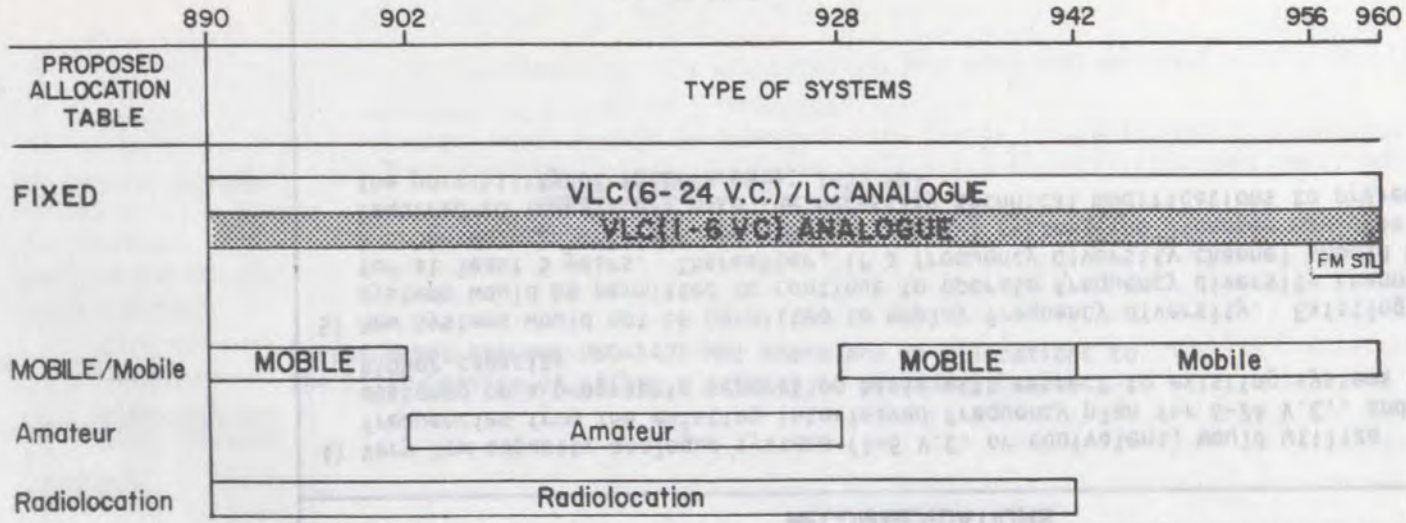
This section shows how the factors discussed above are proposed to be taken into account in each of the bands allocated to the Fixed service in the frequency range .890-10.68 GHz. All systems indicated in the Tables of Section 4 are in accordance with with the proposed Canadian Frequency Allocation Table. It should be noted in interpreting the bar charts that all services that are "recommended" are in addition to those shown as "existing".

SECTION 4

CURRENT AND PROPOSED UTILIZATION OF THE RADIO SPECTRUM BETWEEN 0.890 - 10.68 GHz BY THE FIXED SERVICE

890 - 960 MHz BAND

(SRSP-310)



NOTE: In ITU Region 2, the band 902-928 MHz (centre frequency 915 MHz) is designated for Industrial, Scientific and Medical (ISM) applications. Radiocommunication services operating within this band must accept harmful interference which may be caused by these applications.

-LEGEND-

RECOMMENDED

EXISTING

MOBILE..... Primary
Mobile..... Secondary
VLC..... Very Low Capacity
L.C. ..... Low Capacity
V.C..... Voice Channels

RECOMMENDATIONS

1) It is anticipated that Mobile services (e.g. Land Mobile, Personal Radio Service (PRS), Air/ground public correspondence, etc.) may start to have a great influence in portions of this band in the near future. Fixed system users should be aware of this and consequently, it is recommended that the licensing of Fixed systems be reduced especially in metropolitan areas and those regions near the Canada/U.S. border. Also, existing system users could at some point in time, be required to transfer to other bands, especially in these areas.

2) A small portion of the bands 890-902 and 928-942 MHz may be designated for a new Personal Radio Service (PRS).

3) The FM STL band 956-960 MHz would be retained. Overflow from the FM STL band and possibly AM stereo STL's would be accommodated in the newly designated band 1700-1710 MHz.

890-960 MHz BAND (CONT'D)
(SRSP-310)

RECOMMENDATIONS

4) Very low capacity analogue systems (1-6 V.C. or equivalent) would utilize frequencies from the existing interleaved frequency plan for 6-24 V.C., and be assigned on a geographic separation basis with respect to existing systems of higher capacity.

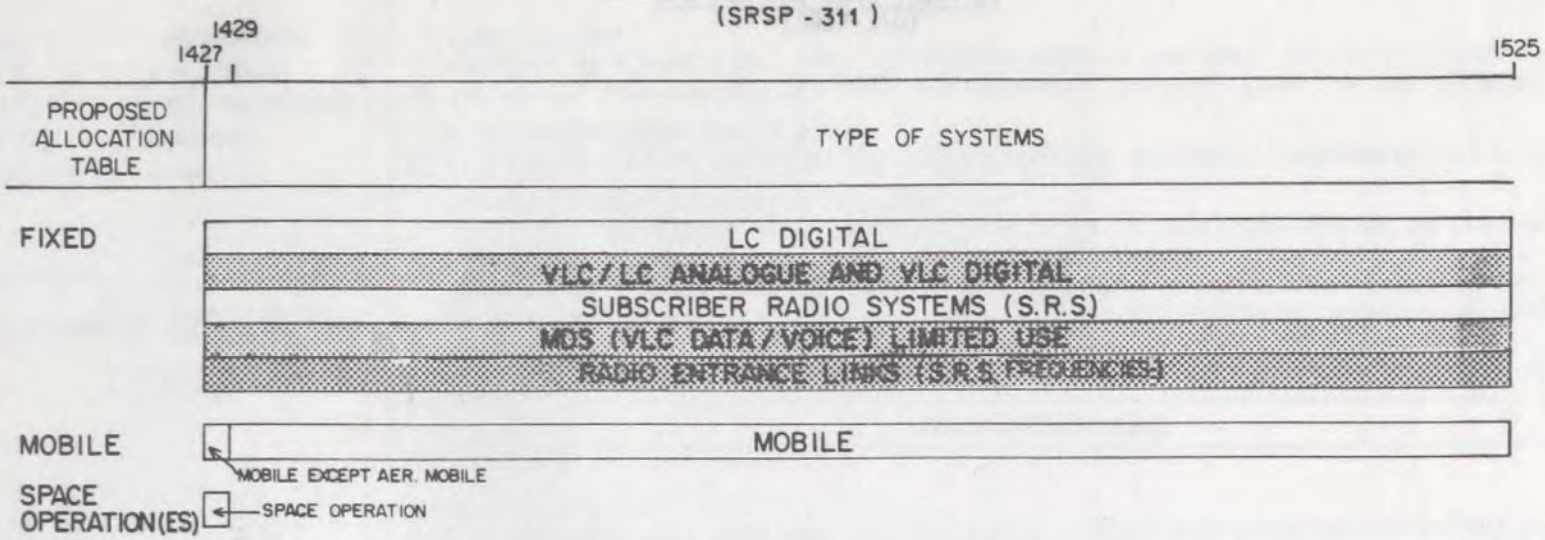
5) New systems would not be permitted to employ frequency diversity. Existing systems would be permitted to continue to operate frequency diversity channels for at least 5 years. Thereafter, if a frequency diversity channel should block a proposed standard (non frequency diversity) system, the licensee would be required to immediately make the necessary technical modifications to prevent the possibility of interference.

BANDS BETWEEN 960 - 1427 MHz

In the bands between 960-1427 MHz there are no allocations to the FIXED Service on either a primary or secondary basis.

BAND 1427-1525 MHz

(SRSP - 311)



-LEGEND-

RECOMMENDED

EXISTING

E-S..... EARTH-TO-SPACE
VLC..... VERY LOW CAPACITY
LC..... LOW CAPACITY
MDS..... MULTIPOINT DISTRIBUTION SYSTEMS

RECOMMENDATIONS

POINT-TO-POINT SYSTEMS

1) VLC/LC analogue and VLC digital systems are recommended. They would employ the same RF channels as presently allocated to the existing LC digital systems so as not to interfere with the existing SRS channeling plan.
2) New systems would not be permitted to employ frequency diversity. Existing systems would be permitted to continue to operate frequncy diversity channels for at least 5 years. Thereafter, if a frequency diversity channel should block a proposed standard (non-frequency diversity) system, the licensee would be required to immediately make the necessary technical modifications to prevent the possibility of interference.
3) A two-frequency plan is preferred for digital systems. The Department may consider waiving this recommendation in special circumstances if technical and/or economic justification is provided.
4) A four-frequency plan is permitted for analogue systems.

BAND 1427-1525 MHZ (CONT'D)

(SRSP - 311)

RECOMMENDATIONS

SUBSCRIBER RADIO SYSTEMS-TELEPHONE (SRS)

1) Multipoint distribution systems (MDS) permitting other than rural telephone service would include multistation systems (VLC data and voice). Such applications are recommended to be on a limited basis only, due to the requirement for sharing with SRS (telephone), analogue and digital point-to-point systems and aeronautical telemetry.
2) Radio Entrance Links employing S.R.S. frequencies would be permitted for S.R.S. systems.
3) Frequency diversity would not be permitted for S.R.S. systems.

For specific frequency channeling plans for existing digital and S.R.S. systems, please refer to SRSP 311.

1525 - 1535 MHz

The band from 1525-1535 MHz is treated as part of a group of miscellaneous bands at the end of this section.

BANDS BETWEEN 1535 - 1660.5 MHz

In the bands between 1535-1660.5 MHz there are no allocations to the FIXED service on either a primary or secondary basis.

1660.5 - 1668.4 MHz AND 1668.4 - 1670 MHz

These bands are treated as part of a group of miscellaneous bands at the end of this section.

BANDS BETWEEN 1670 - 1700 MHz

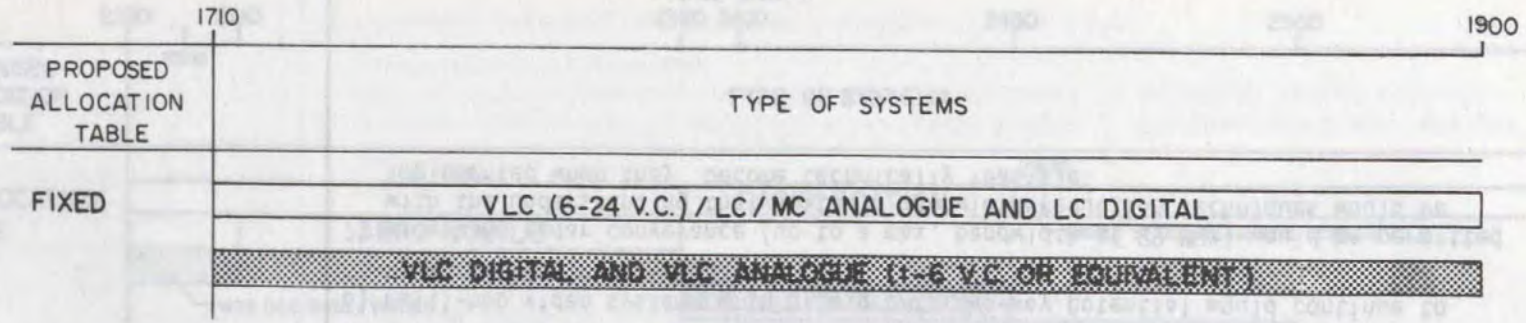
In the bands between 1670-1700 MHz there are no allocations to the FIXED service on either a primary or secondary basis.

1700 - 1710 MHz

The band from 1700-1710 MHz is treated as part of a group of miscellaneous bands at the end of this section.

BAND 1710-1900 MHz

(SRSP-303)



-LEGEND-

RECOMMENDED

EXISTING

VLC..... Very Low Capacity

LC..... Low Capacity

MC..... Medium Capacity

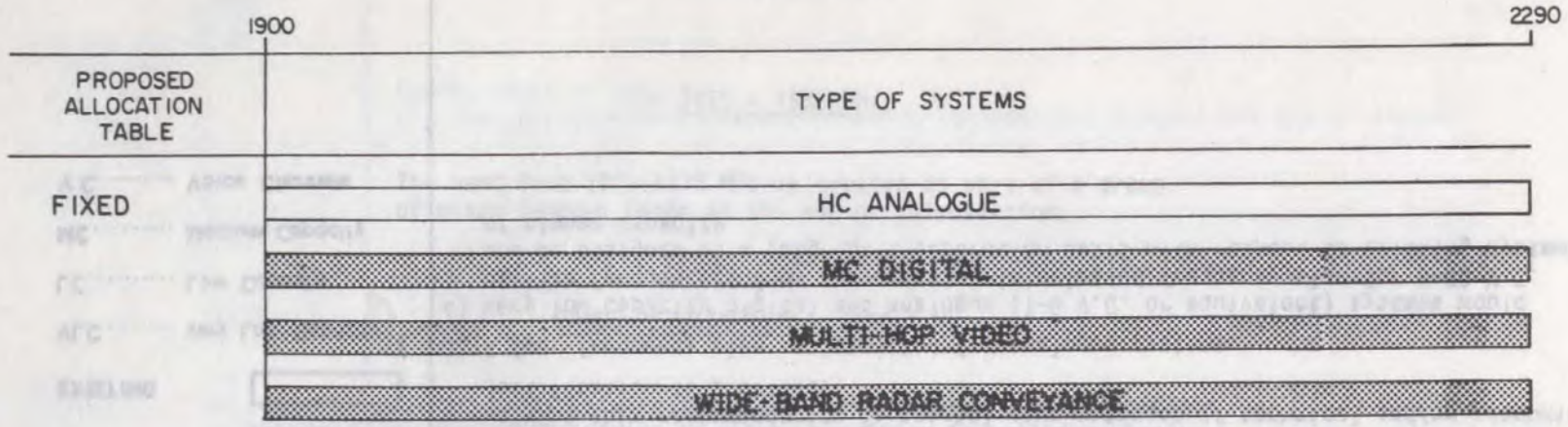
V.C..... Voice Channels

RECOMMENDATIONS

1) New systems would not be permitted to employ frequency diversity. Existing systems would be permitted to continue to operate frequency diversity channels for at least 5 years. Thereafter, if a frequency diversity channel should block a proposed standard (non-frequency diversity) system, the licensee would be required to immediately make the necessary technical modifications to prevent the possibility of interference.
2) A two-frequency plan is preferred for digital systems. The Department may consider waiving this recommendation in special circumstances if technical and/or economic justification is provided.
3) A four-frequency plan is permitted for analogue systems.
4) Very low capacity digital and analogue (1-6 V.C. or equivalent) systems would utilize frequencies from the existing interleaved frequency plan for 6-60 V.C. and be assigned on a geographic separation basis with respect to existing systems of higher capacity.

BAND 1900 - 2290 MHz

(SRSP - 304)



RECOMMENDED

EXISTING

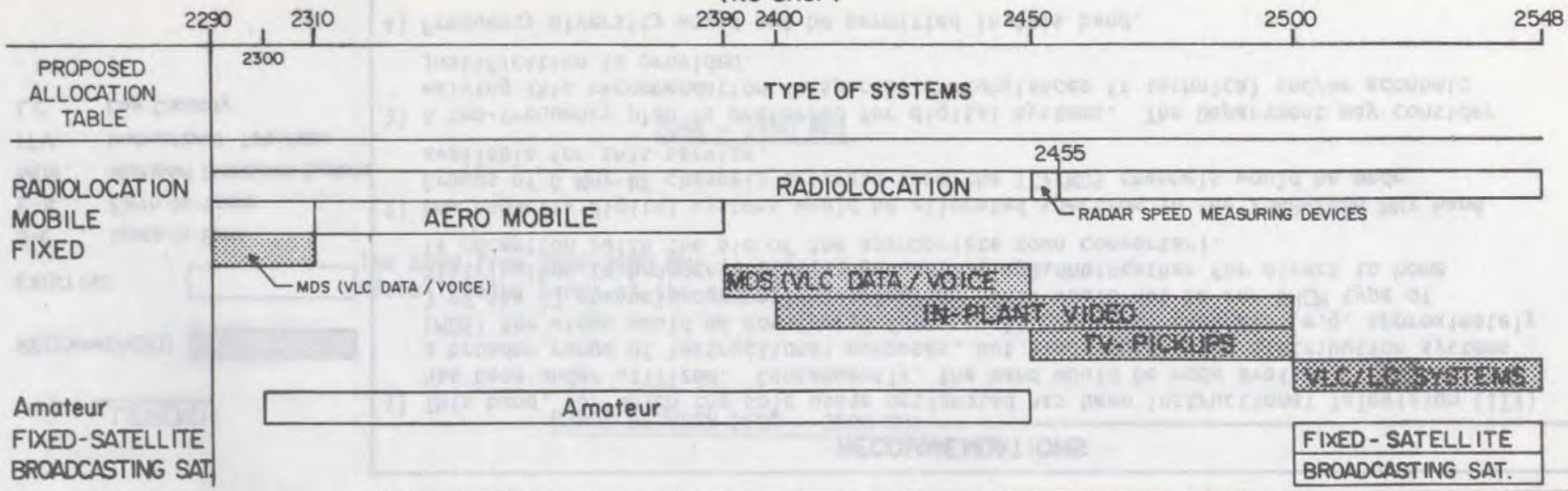
MC..... MEDIUM CAPACITY
HC..... HIGH CAPACITY

RECOMMENDATIONS

1) A two-frequency plan for digital systems would be required.
2) A four-frequency plan is permitted for analogue systems.
3) Analogue and digital systems would share existing frequency channeling plan of SRSP 304.
4) High capacity analogue systems would continue to utilize the band.
5) Medium capacity digital systems would be allowed.
6) Multi-hop video systems with high growth two-way potential would continue to be permitted in this band.
7) Wide band radar conveyance (up to a max. bandwidth of 29 MHz) would be permitted with the understanding that suitable bandwidth reduction techniques would be implemented when they become technically feasible.

2290 - 2450 MHz
2450 - 2548 MHz

(NO SRSP)



RECOMMENDED

EXISTING

MDS.... MULTIPOINT DISTRIBUTION SYSTEMS

VLC..... VERY LOW CAPACITY

LC..... LOW CAPACITY

RECOMMENDATIONS

1) 2290-2310 MDS (VLC Data/Voice). Distribution automation for public utilities (not to individual subscriber level) could be considered in this band.

2) 2310-2390 Aeronautical Mobile Telemtery (WARC'79).

3) 2390-2450 MDS (VLC Data/Voice). Distribution automation for public utilities (not to individual subscriber level) could be considered in this band.

4) 2400-2500 Low powered in-plant assignments for conveyance of video permitted.

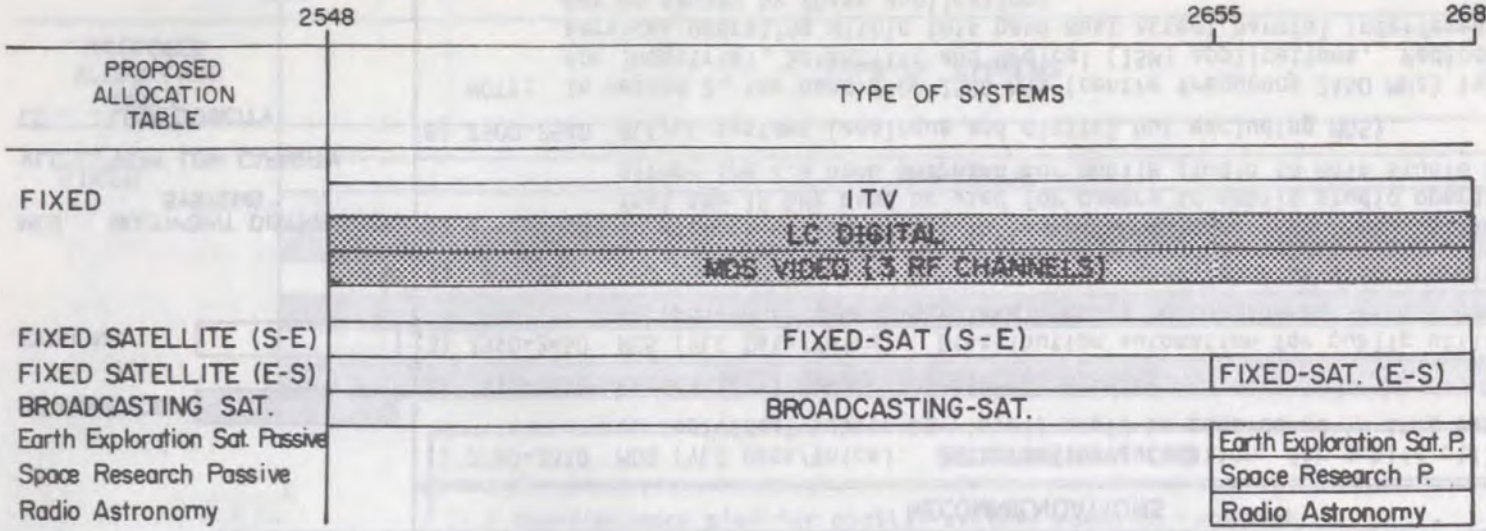
5) 2450-2500 TV pickups and temporary TV links. For TV pickup links, it is recommended that the 15 GHz band be used for camera to mobile studio operation and either the 2.5 or 6 GHz band for mobile studio to main studio operations.

6) 2500-2548 VLC/LC systems (analogue and digital but excluding MDS).

NOTE: In Region 2, the band 2400-2500 MHz (centre frequency 2450 MHz) is designated for Industrial, Scientific and Medical (ISM) applications. Radiocommunication services operating within this band must accept harmful interference which may be caused by these applications.

BAND 2548 - 2686 MHz

(SRSP - 300)



- LEGEND -

RECOMMENDED

EXISTING

S-E ..... Space-to-Earth
E-S ..... Earth-to-Space
MDS ..... Multipoint Distribution Systems
ITV ..... Instructional Television
LC ..... Low Capacity

RECOMMENDATIONS

1) This band, for which the sole usage designated has been Instructional Television (ITV) has been under utilized. Consequently, the band would be made available for not only a broader range of instructional purposes, but also, multipoint distribution systems (MDS) for video would be considered for a small number of channels (e.g. approximately 3 of the 23 channels currently available). This would not be for VHCM type of distribution to broadcast receiving undertakings, but rather for direct to home TV reception (with the aid of the appropriate down converter).

2) Low capacity digital systems would be allocated spectrum in the 2548-2686 MHz band. Groups of 6 MHz RF channels separate from the ITV/MDS channels would be made available for this service.

3) A two-frequency plan is preferred for digital systems. The Department may consider waiving this recommendation in special circumstances if technical and/or economic justification is provided.

4) Frequency diversity would not be permitted in this band.

2686 - 2690 MHz

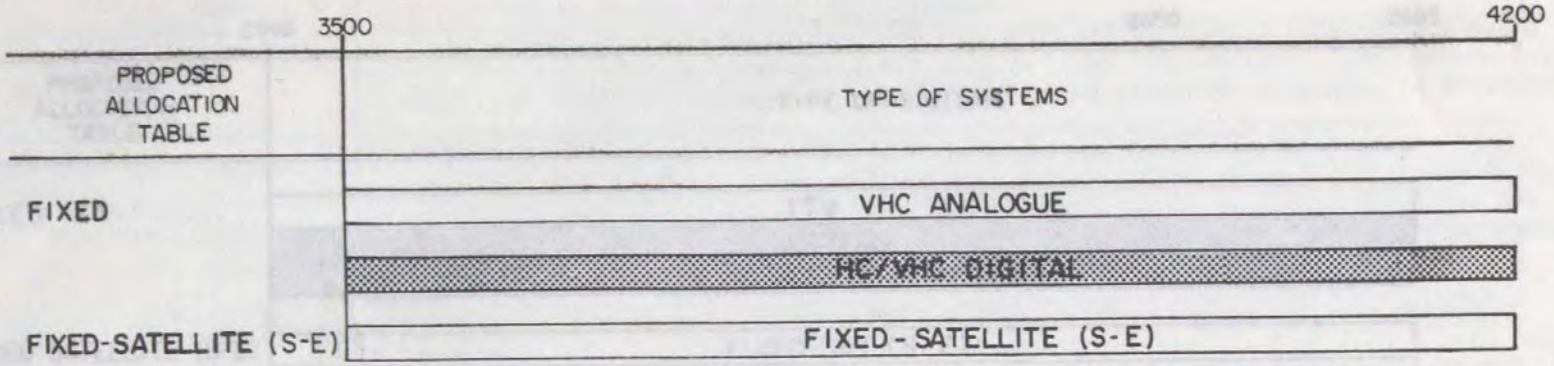
The band from 2686-2690 MHz is treated as part of a group of miscellaneous bands at the end of this section.

BANDS BETWEEN 2690 - 3500 MHz

In the bands between 2690-3500 MHz there are no allocations to the FIXED service on either a primary or secondary basis.

BAND 3500 - 4200 MHz

(SRSP-302)



-LEGEND-

RECOMMENDED

EXISTING

S-E ..... Space to Earth

HC ..... High Capacity

VHC..... Very High Capacity

RECOMMENDATIONS

1) High capacity and very high capacity digital systems would in all probability not occur in the same geographical area, except possibly at the intersection of feeder routes, therefore, both HC and VHC digital systems would be permitted in this frequency band.

2) With the eventual phasing out of the existing analogue systems, the frequency band could be re-structured to accommodate digital systems.

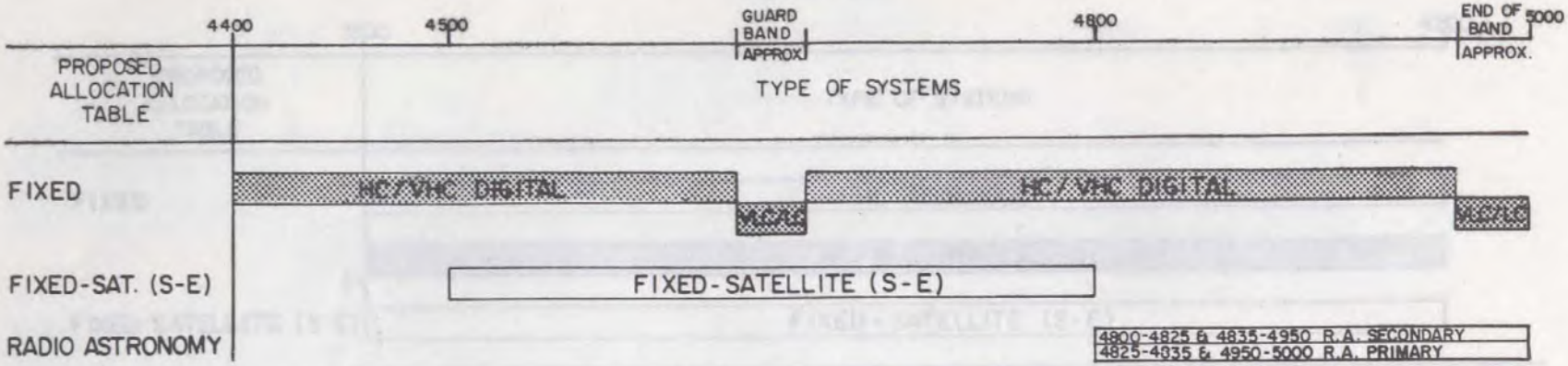
3) A two-frequency plan would be required for both analogue and digital systems.

BANDS BETWEEN 4200 - 4400 MHz

In the bands between 4200-4400 MHz there are no allocations to the FIXED service on either a primary or secondary basis.

BAND 4400-5000 MHz

(NO SRSP)



- LEGEND -

RECOMMENDED

EXISTING

S-E..... Space-to-Earth
VLC..... Very Low Capacity
LC..... Low Capacity
HC..... High Capacity
VHC..... Very High Capacity

RECOMMENDATIONS

1) High capacity and very high capacity digital systems would in all probability not occur in the same geographical area, except possibly at the intersection of feeder routes, therefore, both HC and VHC digital systems would be permitted in this band.

2) Very low capacity and low capacity analogue and digital systems could be inserted in the guard band of the HC/VHC digital channeling plan and equal space at the end of the band.

3) This is a possible candidate band for DND FIXED service (including transportable) tactical communications. If and when this need arises, such systems would also be accommodated on a coordinated basis.

4) A two-frequency plan would be required for HC and VHC digital systems.

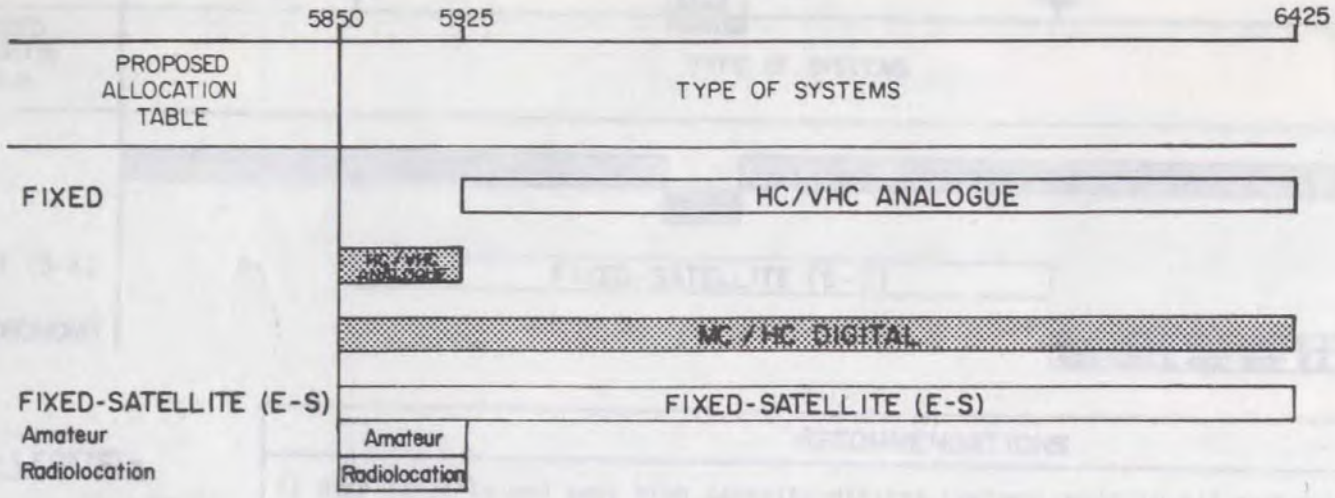
5) Close coordination will be required between the FIXED, FIXED-SATELLITE and RADIO ASTRONOMY services.

BANDS BETWEEN 5000 - 5850 MHz

In the bands between 5000-5850 MHz there are no allocations to the FIXED service on either a primary or secondary basis.

BAND 5850-6425 MHz

(SRSP-301)



-LEGEND-

RECOMMENDED

EXISTING

E-S..... Earth-To-Space
MC..... Medium Capacity
HC..... High Capacity
VHC..... Very High Capacity

RECOMMENDATIONS

1) As a result of WARC'79, the FIXED service obtained a 75 MHz downward extension to 5850 MHz, which as indicated above, has been proposed for inclusion in the Canadian Allocation Table. Consequently, the band available to the FIXED service would now be 5850-6425 MHz.

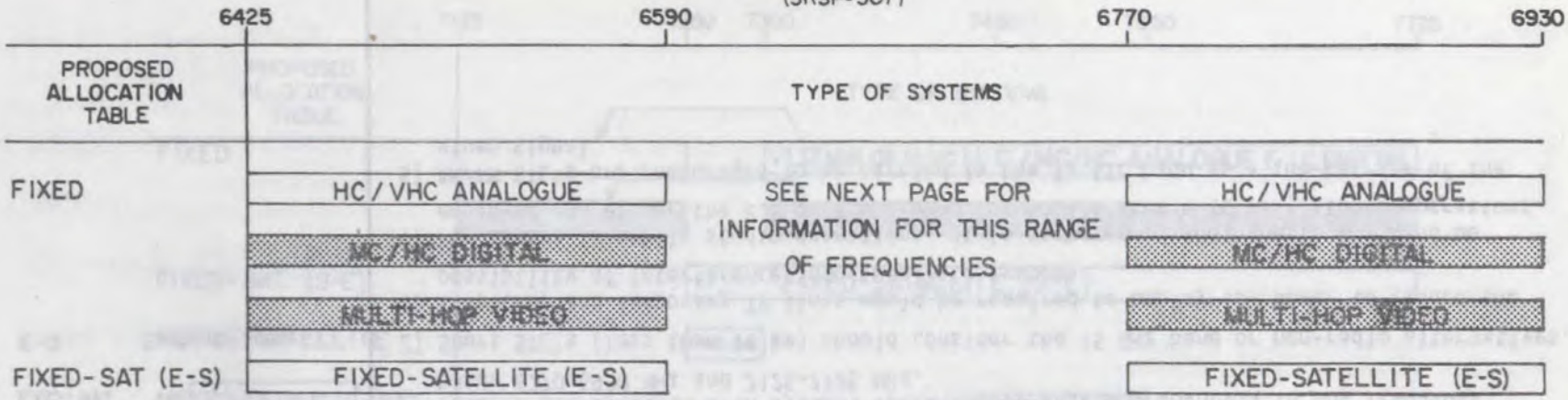
2) Analogue and digital systems would share the existing frequency channeling plan of SRSP 301 for the present time. However, with the anticipated increase in voice channel capacity in this band in the future, the frequency band would require re-channeling. At that time, it would be proposed to re-channelize this band to take advantage of the additional spectrum between 5850-5925 MHz.

3) A two-frequency plan would be required for analogue and digital systems.

4) Frequencies for auxiliary radio-relay systems would be deleated.

BANDS 6425 - 6590 MHz
6770 - 6930 MHz

(SRSP-307)



- LEGEND -

RECOMMENDED

EXISTING

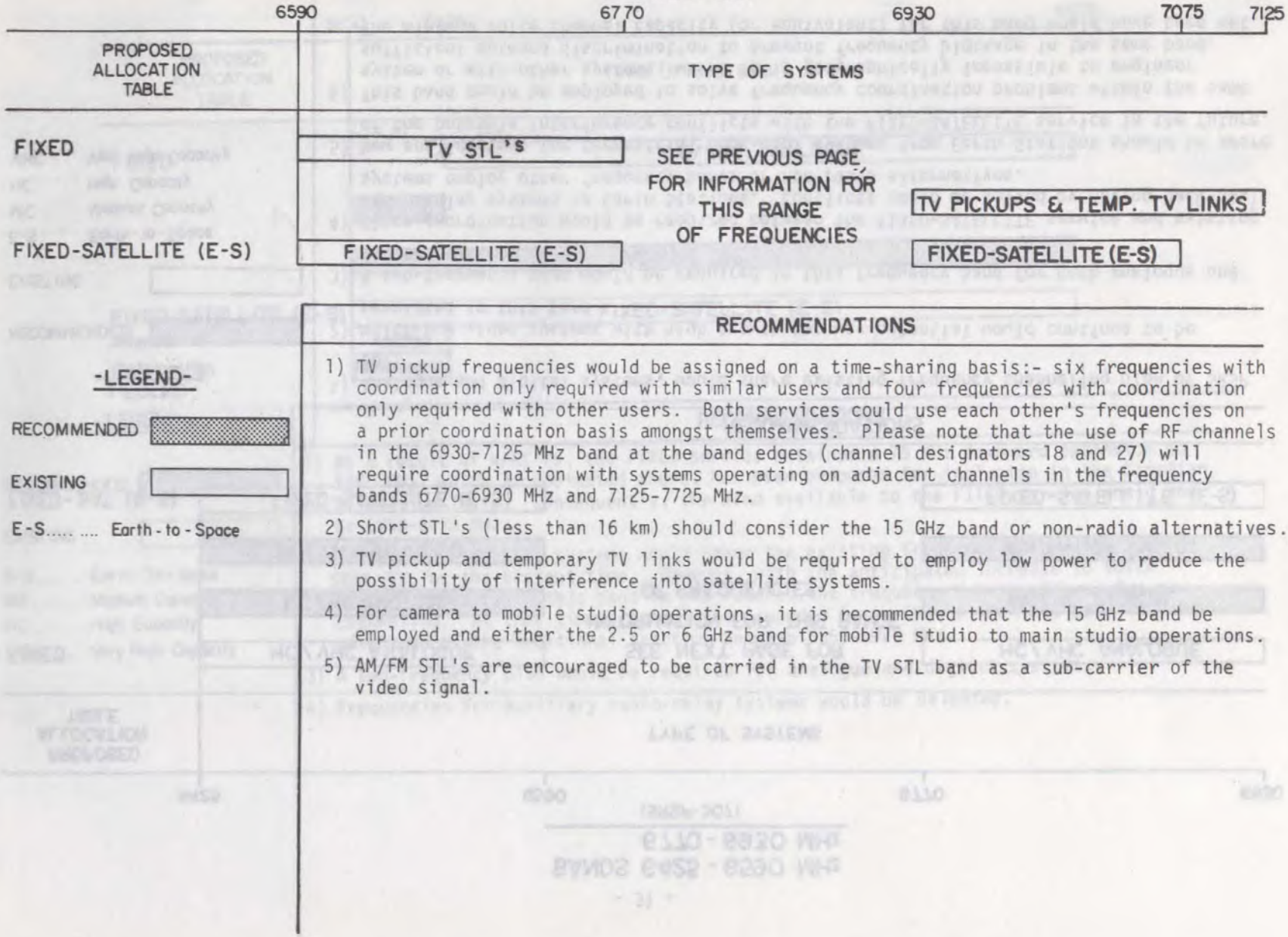
E-S ..... Earth-to-Space
MC ..... Medium Capacity
HC ..... High Capacity
VHC ..... Very High Capacity

RECOMMENDATIONS

1) Analogue and digital systems, would share existing frequency channeling plan of SRSP 307.
2) Multi-hop video systems with high growth two-way potential would continue to be permitted in this band.
3) A two-frequency plan would be required in this frequency band for both analogue and digital systems.
4) Close coordination would be required between the FIXED-SATELLITE service and existing FIXED relay systems to Earth Stations. Conflicts could be solved by having back-haul systems employ other frequency bands or non-radio alternatives.
5) New applications for terrestrial back-haul systems from Earth Stations should be aware of the possible interference conflicts with the FIXED-SATELLITE service in the future.
6) This band could be employed to solve frequency coordination problems within the same system or with other systems, where it is geographically impossible to engineer sufficient antenna discrimination to prevent frequency blockage in the same band. The minimum voice channel capacity (or equivalent) for this band would have been met.

BANDS 6590-6770 MHz 6930-7125 MHz

(SRSP-308)

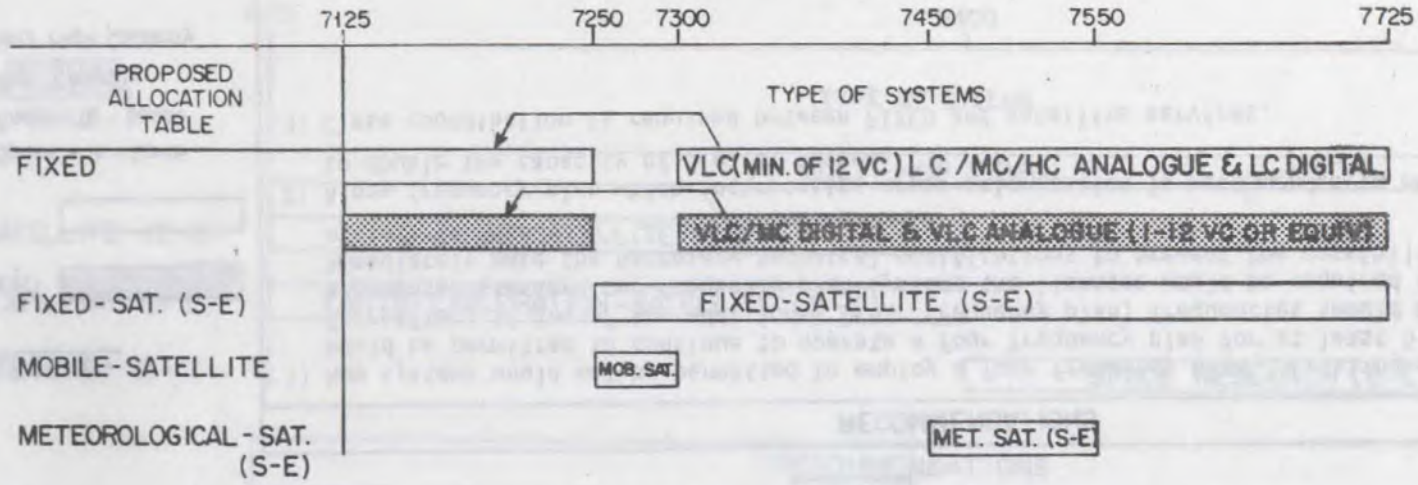


RECOMMENDATIONS

1) TV pickup frequencies would be assigned on a time-sharing basis:- six frequencies with coordination only required with similar users and four frequencies with coordination only required with other users. Both services could use each other's frequencies on a prior coordination basis amongst themselves. Please note that the use of RF channels in the 6930-7125 MHz band at the band edges (channel designators 18 and 27) will require coordination with systems operating on adjacent channels in the frequency bands 6770-6930 MHz and 7125-7725 MHz.
2) Short STL's (less than 16 km) should consider the 15 GHz band or non-radio alternatives.
3) TV pickup and temporary TV links would be required to employ low power to reduce the possibility of interference into satellite systems.
4) For camera to mobile studio operations, it is recommended that the 15 GHz band be employed and either the 2.5 or 6 GHz band for mobile studio to main studio operations.
5) AM/FM STL's are encouraged to be carried in the TV STL band as a sub-carrier of the video signal.

BAND 7125-7725 MHz

(SRSP-305)



-LEGEND-

RECOMMENDED

EXISTING

S-E ..... Space-To-Earth
VLC ..... Very Low Capacity
LC ..... Low Capacity
MC ..... Medium Capacity
VC ..... Voice Channels

RECOMMENDATIONS

1) New systems would not be permitted to employ a four frequencey plan. Existing systems would be permitted to continue to operate a four frequency plan for a at least 5 years. Thereafter, if one of the additional (four frequency plan) frequencies should block a proposed standard two frequency plan system, the licensee would be required to immediately make the necessary technical modifications to prevent the possibility of interference.

2) New systems would not be permitted to employ frequency diversity. Existing systems would be permitted to continue to operate frequency diversity channels for at least 5 years. Thereafter, if a frequency diversity channel should block a proposed standard (non frequency diversity) system, the licensee would be required to immediately make the necessary technical modifications to prevent the possibility of interference.

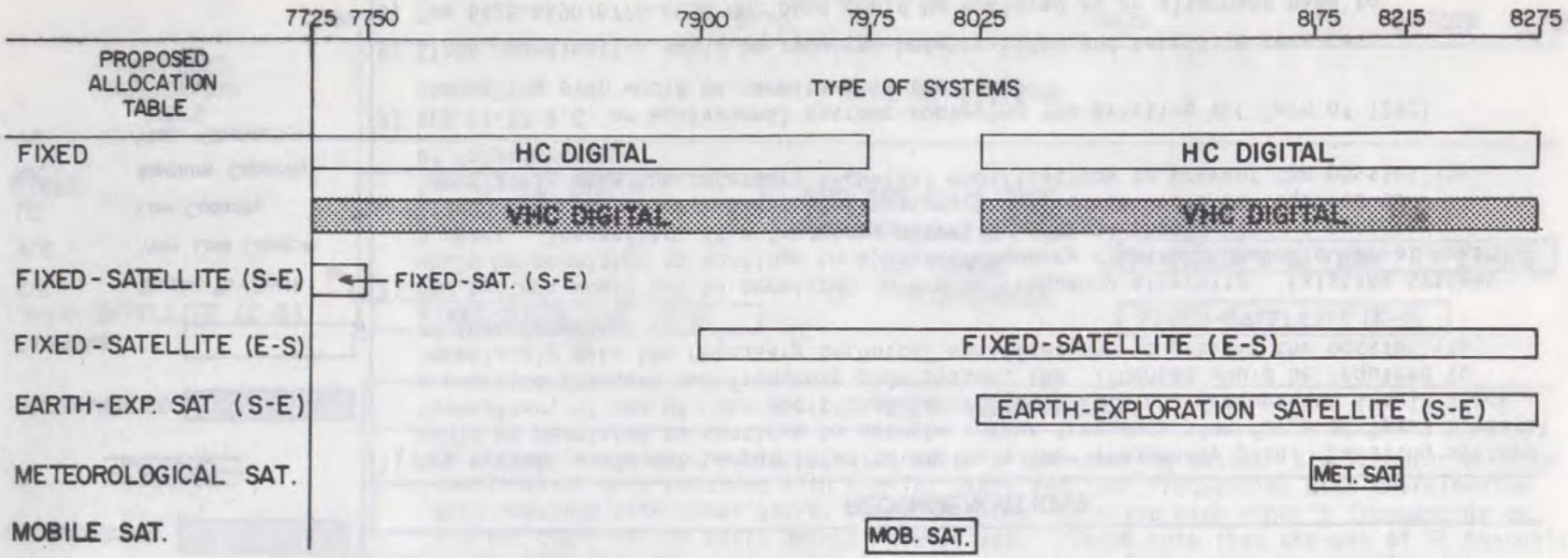
3) VLC (1-12 V.C. or equivalent) systems employing the existing VLC (min of 12VC) channeling plan would be permitted in the band.

4) Close coordination would be required between FIXED and satellite services.

5) The 6425-6590/6770-6930 MHz band could be employed as an alternate band to 7125-7725 MHz to solve frequency coordination problems.

BAND 7725 - 8275 MHz

(SRSP-306)



-LEGEND-

RECOMMENDED

EXISTING

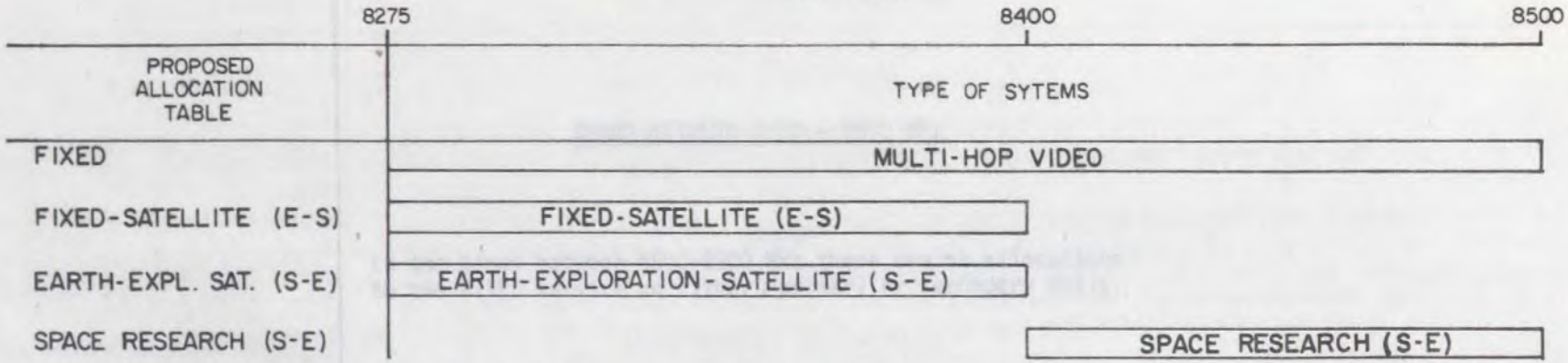
S-E ..... Space - To - Earth
E-S..... Earth - To - Space
HC..... High Capacity
VHC..... Very High Capacity

RECOMMENDATIONS

1) New systems would not be permitted to employ a four frequency plan. Existing systems would be permitted to continue to operate a four frequency plan for at least 5 years. Thereafter, if one of the additional (four frequency plan) frequencies should block a proposed standard two frequency plan system, the licensee would be required to immediately make the necessary technical modifications to prevent the possibility of interference.
2) A new frequency plan which incorporates cross-polarization is recommended in order to double the capacity of digital systems.
3) Close coordination is required between FIXED and satellite services.

BAND 8275 - 8500 MHz

(SRSP - 309)



RECOMMENDED

EXISTING

E-S..... Earth - to - Space

S-E..... Space - to - Earth

RECOMMENDATIONS

1) Single hop video links would be discouraged in the future in this frequency band.
2) Proposed short-haul systems (less than 65 km) would not be permitted in this band. Recommend the 15 GHz band or employ non-radio alternatives.
3) Existing short-haul systems (less than 65 km) in the 8275-8500 MHz band should be encouraged to consider the 15 GHz band or non-radio alternatives (especially in metropolitan or congested areas), whenever it is technically and economically feasible to do so.
4) Because of congestion in this frequency band, recommend bands 1900-2290 and 6425-6590/6770-6930 MHz, for systems having high growth two way potential. For systems with low growth two way potential or one way systems, recommend a band above 10 GHz.
5) Users of this frequency band who are currently exceeding the RF channel bandwidth would be required to periodically review the performance criteria of their systems from a spectrum efficienty point of view with the overall objective of employing appropriate and available bandwidth reducing techniques.
6) Digitized video will be permitted in this frequency band providing the bandwidth did not exceed 18.75 MHz.

BAND 8275 - 8500 MHz (CONT'D)

(SRSP-309)

RECOMMENDATIONS

7) Effective spectrum sharing between the FIXED and SATELLITE/SPACE services will be accomplished through present coordination procedures.

8) Depending on the outcome of the 'Intercity Microwave Licensing Policy Review', which is currently in progress some of the above recommendations concerning multihop video could be modified.

BANDS BETWEEN 8500 - 9800 MHz

In the bands between 8500-9800 MHz there are no allocations to the FIXED service on either a primary or secondary basis.

BAND 9800 - 10000 MHz

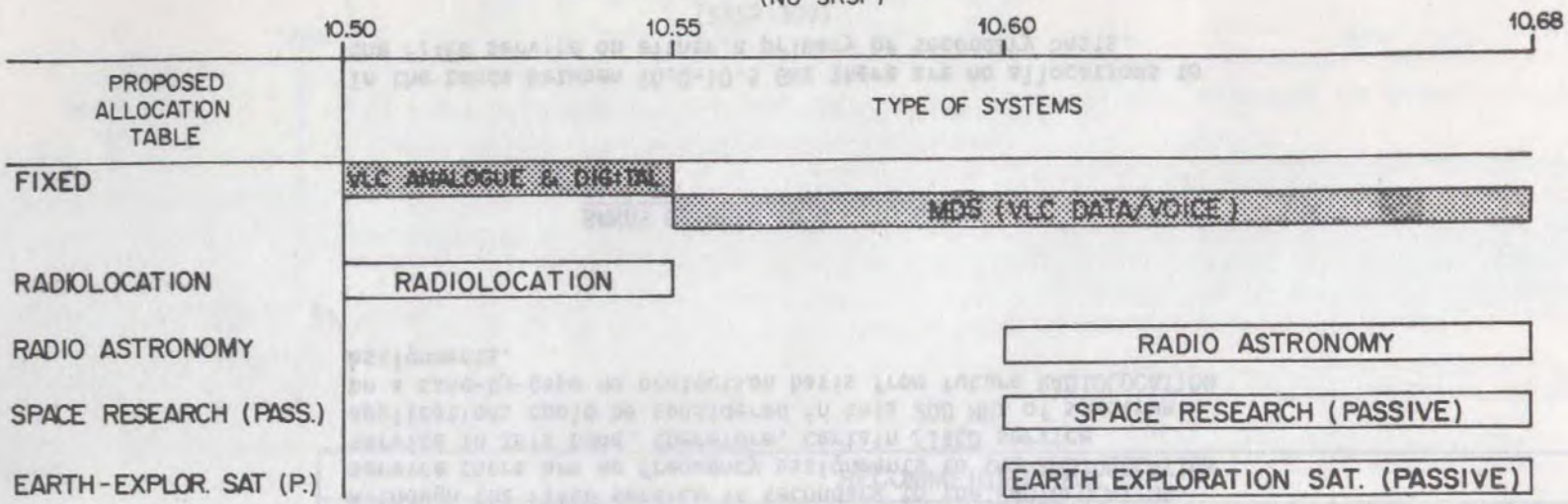
Although the FIXED service is secondary to the RADIOLOCATION service there are no frequency assignments to the RADIOLOCATION service in this band, therefore, certain FIXED service applications could be considered in this 200 MHz of spectrum on a case-by-case no protection basis from future RADIOLOCATION assignments.

BANDS BETWEEN 10.0 - 10.5 GHz

In the bands between 10.0-10.5 GHz there are no allocations to the FIXED service on either a primary or secondary basis.

BAND 10.50-10.68 GHz

(NO SRSP)



-LEGEND-

RECOMMENDED

EXISTING

MDS..... MULTIPOINT DISTRIBUTION SYSTEMS

VLC..... VERY LOW CAPACITY

RECOMMENDATIONS

1) For MULTIPOINT DISTRIBUTION (VLC data/voice) services, it is recommended that the band 10.55-10.68 GHz be employed. However, non-radio alternatives should be investigated for this intra-city type service.

2) In view of the fact that the band 10.55-10.68 GHz has been extended downwards to 10.50 GHz (as a result of WARC'79) for the FIXED service, it is recommended that the 10.50-10.55 GHz section of the band be designated for use by very low capacity systems (analogue and digital). Proposed FIXED systems should be made aware of the possibility of interference to and from RADIOLOCATION services (for example: low powered speed measuring devices on 10.525 GHz).

3) Coordination will be required between FIXED, RADIO ASTRONOMY, RADIOLOCATION, SPACE RESEARCH AND EARTH EXPLORATION SATELLITE SERVICES.

MISC. BANDS

(NO SRSP's)

BAND 1525-1535 MHz

PROPOSED ALLOCATION TABLE	TYPE OF SYSTEMS
SPACE OPERATION (S-E)	SPACE OPERATION (S-E)
Earth Expl.-Satellite)	Earth Exploration-Satellite
Fixed	Fixed
Mobile	Mobile
MARITIME MOB-SAT(S-E) 1530-1535 MHz ONLY)	MARITIME MOBILE-SATELLITE (S-E) 1530-1535 MHz ONLY

BAND 1660.5-1668.4 MHz

RADIO ASTRONOMY	RADIO ASTRONOMY
SPACE RESEARCH (P)	SPACE RESEARCH (PASSIVE)
Fixed	Fixed

BAND 1668.4-1670 MHz

FIXED	FIXED
RADIO ASTRONOMY	RADIO ASTRONOMY
METEO AIDS	METEOROLOGICAL AIDS

-LEGEND-

RECOMMENDED

EXISTING

RECOMMENDATIONS	
1) 1525 - 1535	Because the FIXED service is secondary in this band to other services, no recommendation made relating to this service.
2) 1660.5-1668.4	Because the FIXED service is secondary in this band to other services, no recommendation made relating to this service.
3) 1668.4-1670	As there is only 1.6 MHz available to the FIXED service in this band, no recommendation made at this stage.

MISC. BANDS (con't)

(NO SRSP's)

BAND 1700 - 1710 MHz

PROPOSED ALLOCATION TABLE	TYPE OF SYSTEMS
FIXED	FM AND POSSIBLY AM STEREO STL's
MET. SAT. (S-E)	METEOROLOGICAL - SATELLITE (S - E)

BAND 2686–2690 MHz

FIXED	VLC ANALOGUE & DIGITAL
FIXED SAT.	FIXED - SATELLITE (E-S) (S-E)
BROADCASTING SAT.	BROADCASTING - SATELLITE
Earth Expl.-Sat (Passive)	Earth Exploration - Satellite (Passive)
Radio Astronomy	Radio Astronomy
Space Research (Passive)	Space Research (Passive)

- LEGEND -

RECOMMENDED

EXPANDING

S-E..... Space-To-Earth

E-S..... Earth - To - Space

VLC..... Very Low Capacity

RECOMMENDATIONS		
1) 1700 - 1710	OVERFLOW FOR FM STL's	from 956 - 960 MHz AND POSSIBLY FOR AM STEREO STL'S.
2) 2686 -2690	VLC ANALOGUE & DIGITAL	One-way Radio Paging Fixed Links.

5. Conclusion

The proposals contained in this document embody the Department's spectrum utilization policy for the bands under review for the forseeable future, based and predicated to a large degree on known user needs, sharing criteria and technological development. Accordingly, as specified in the associated Gazette Notice, a copy of which is contained in Appendix 3, comment is invited from all interested parties concerning the particulars contained in this document. Copies of these submissions will be made available for public inspection at the Department of Communications' Library, Room 1420, 300 Slater Street, Ottawa and at all of the Department's Regional Offices.

APPENDIX 1

DEFINITION OF ANALOGUE AND DIGITAL SYSTEM CAPACITIES USED IN THIS DOCUMENT

SYSTEM CAPACITIES	ANALOGUE (voice channels -VC)	DIGITAL
VERY LOW (VLC)	1-24	64 Kb/s to 1.544Mb/s
LOW (LC)	25-120	greater than 1.544 Mb/s to 6.312 Mb/s
MEDIUM (MC)	121-600	greater than 6.312 Mb/s to 44.736 Mb/s
HIGH (HC)	601-1200	greater than 44.736 Mb/s to 90 Mb/s
VERY HIGH (VHC)	1201 & UP	greater than 90 Mb/s

Note - A voice channel (VC) is equivalent to a 4 kHz voice grade circuit.

APPENDIX 2

COMPARISON OF PROPOSED AND EXISTING TOTAL SPECTRUM AVAILABLE

1.0 Summary

Note: 1) Most of the spectrum indicated is shared with other services. See following pages for details.

2) Only sharing with other fixed terrestrial telecommunications services indicated - e.g. services such as satellite, radiolocation, ISM, etc. is not indicated.

1.1 Analogue Systems

System Capacity	Total Proposed Spectrum	Total Existing Spectrum
VLC	926 MHz	670 MHz
LC	922 MHz	860 MHz
MC	790 MHz	790 MHz
HC	1.815 GHz	1.815 GHz
VHC	1.525 GHz	1.525 GHz

1.2 Digital Systems

System Capacity	Total Proposed Spectrum	Total Existing Spectrum
VLC	960 MHz	0 MHz
LC	1.074 GHz	874 MHz
MC	1.815 GHz	0 MHz
HC	2.675 GHz	550 MHz
VHC	1.300 GHz	0 MHz

1.3 Other Services

Type of System Capacity	Total Proposed Spectrum	Total Existing Spectrum
Multipoint Distribution Systems (MDS) - Data/Voice	308 MHz	98 MHz
Multipoint Distribution Systems (MDS) - Video	18 MHz	0 MHz
Subscriber Radio Systems - Telephone (SRS)	98 MHz	98 MHz
Video STL's	180 MHz	180 MHz
FM STL's	14 MHz	4 MHz
Instructional Television (ITV)	138 MHz	138 MHz
TV pickups and Portable TV Links	245 MHz	195 MHz
Multihop Video	940 MHz	615 MHz

2.0 Band by Band Comparision of Proposed & Existing Spectrum Available

2.1 Analogue Systems

2.1.1 Very Low Capacity (VLC)

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)	Comments
890-960			
(902-928/942-960)	44	70	
1710-1900	190	0	- previously 6-24 V.C. - shared with LC analogue and VLC/LC digital (VLC/LC analogue and digital interleaved with MC analogue)
2500-2548	48	0	- shared with LC analogue and VLC/LC digital
4400-5000	40	0	- in the guard band for MC/HC digital shared with LC analogue and VLC/LC digital
7125-7725	600 (1-24VC)	600 (12-24VC)	- interleaved with MC/HC analogue and MC digital and shared with LC analogue and VLC/LC digital
2686-2690	4	0	- shared with VLC digital
Total	926	670	

2.1.2 Low Capacity (LC) Analogue

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)	Comments
890-960			
(902-928/942-960)	44	70	
1710-1900	190	190	shared with VLC/LC digital and VLC analogue (VLC/LC analogue and digital interleaved with MC analogue)
2500-2548	48	0	shared with VLC analogue and VLC/LC digital
4400-5000	40	0	in the guard band for MC/HC digital shared with VLC analogue and VLC/LC digital
7125-7725	600	600	interleaved with MC/HC analogue and MC digital and shared with VLC analogue and VLC/LC digital
TOTAL	922	860	

2.1.3 Medium Capacity (MC Analogue)

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)	Comment
1710-1900	190	190	shared with VLC/LC analogue and LC digital
7125-7725	600	600	shared with HC analogue and MC digital
TOTAL	790	790	

2.1.4 High Capacity (HC) Analogue

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)	Comments
1900-2290	390	390	shared with MC digital
5925-6425	500	500	shared with VHC analogue and MC/HC digital
6425-6590/ 6770-6930	325	325	shared with VHC analogue and MC/HC digital
7125-7725	600	600	shared with MC analogue and MC digital
TOTAL	1815	1815	

2.1.5 Very High Capacity (VHC) Analogue

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)	Comment
3500-4200	700	700	shared with HC/VHC digital
5925-6425	500	500	shared with HC analogue and MC/HC digital
6425-6590/ 6770-6930	325	325	shared with HC analogue and MC/HC digital
TOTAL	1525	1525	

2.2 Digital Systems

2.2.1 Very Low Capacity (VLC) Digital

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)	Comments
1427-1525	98 MHz	0	shared with LC digital and Subscriber Radio Systems (SRS)
1710-1900	190 MHz	0	shared with VLC/LC analogue and LC digital (VLC/LC analogue and digital interleaved with MC analogue)
2500-2548	48 MHz	0	shared with VLC/LC analogue and LC digital
4400-5000	20 MHz	0	shared with VLC/LC analogue, and LC digital in guard band of MC/HC digital
2686-2690	4 MHz	0	shared with VLC analogue
7125-7725	600 MHz	0	interleaved with MC/HC analogue and MC digital and shared with VLC/LC analogue and LC digital
TOTAL	960 MHz	0	

2.2.2 Low Capacity (LC) Digital

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)	Comments
1427-1525	98	84	shared with VLC digital and SRS
1710-1900	190	190	shared with VLC/LC analogue and VLC digital (VLC/LC analogue and digital interleaved with MC analogue)
2500-2548	48	0	shared with VLC/LC analogue and VLC digital
2548-2686	138	0	shared with ITV
7125-7725	600	600	interleaved with MC/HC analogue and MC digital and shared with VLC/LC analogue and VLC digital
TOTAL	1074	874	

2.2.3 Medium Capacity (MC) Digital

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)	Comments
1900-2290	390	0	shared with HC analogue
5925-6425	500	0	shared with HC/VHC analogue and HC digital
6425-6590/ 6770-6930	325	0	shared with HC/VHC analogue and HC digital
7125-7725	600	0	shared with MC/HC analogue
TOTAL	1815	0	

2.2.4 High Capacity (HC) Digital

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)	Comments
3500-4200	700	0	shared with HC/VHC analogue and VHC digital
4400-5000	600	0	shared with MC/VHC digital and VLC/LC digital and VLC/LC analogue in the MC/HC/VHC digital guard band
5925-6425	500	0	shared with HC/VHC analogue and MC digital
6425-6590/ 6770-6930	325	0	shared with HC/VHC analogue and MC digital
7725-8275	550	550	
TOTAL	2675	550	

2.2.5 Very High Capacity (VHC) Digital

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)	Comments
3500-4200	700	0	shared with HC/VHC analogue and HC digital
4400-5000	600	0	shared with MC/HC digital and VLC/LC analogue and digital in the MC/HC/VHC digital guard band
TOTAL	1300	0	

2.3 Other Services

2.3.1 Multipoint Distribution Systems (MDS) - VLC Data/Voice

Bands (GHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)
1.427-1.525	98	98
2.290-2.310	20	0
2.390-2.450	60	0
10.55-10.68	130	0
TOTAL	308	98

2.3.2 Multipoint Distribution Systems (MDS) - Video

	Proposed Spectrum (MHz)	Existing Spectrum (MHz)
2548-2686 (3 RF channels)	18	0
TOTAL	18	0

2.3.3 Subscriber Radio Systems (SRS) - Telephone

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)
1427-1525	98	98
TOTAL	98	98

2.3.4 Video STL's

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)
6590-6770	180	180
TOTAL	180	180

2.3.5 FM STL's

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)	Comments
956-960	4	4	
1700-1710	10	0	also possibly AM STL's
TOTAL	14	4	

2.3.6 Instructional Television (ITV)

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)	Comments
2548-2686	138	138	shared with LC digital
TOTAL	138	138	

2.3.7 TV Pickups and Temporary TV Links

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)	Comments
2450-2500	50	0	shared with radar speedmeters at 2455 MHz
6930-7125	195	195	
TOTAL	245	195	

2.3.8 Multi-hop - Video (two-way high growth potential)

Bands (MHz)	Proposed Spectrum (MHz)	Existing Spectrum (MHz)	Comments
6425-6590/ 6770-6930	325	0	shared with HC/VHC analogue and MC/HC digital (Last choice)
1900-2290	390	390	shared with HC analogue and MC digital
8275-8500	225	225	
TOTAL	940	615	

APPENDIX 3

NOTICE PUBLISHED IN THE

CANADA GAZETTE, PART I

DEPARTMENT OF COMMUNICATIONS

NOTICE No. DGTN-006-81/DGTR-013-81

Proposed Utilization of the Radio Spectrum in the Range 0.890 - 10.68 GHz by the Fixed Service

In August 1979, the Department invited submissions from all interested parties concerning spectrum allocations to the Fixed service in Canada in the band 0.890 - 10.68 GHz.

The Department has reviewed the submissions received and has prepared a paper entitled Proposed Utilization of the Radio Spectrum in the Range 0.890 - 10.68 GHz by the Fixed Service. Copies of this paper may be obtained from Departmental Offices in Ottawa (613-995-8185), Vancouver (604-666-8530), Winnipeg (204-985-4144), Toronto (416-966-6276), Montreal (514-238-2177) and Moncton (506-858-2094).

The Department now invites written submissions from all interested parties on the proposed spectrum utilization in the 0.890-10.68 GHz frequency range.

Submissions should be adressed to the Director General, National Telecommunications Branch, Department of Communications, 300 Slater Street, Ottawa, Ontario K1A 0C8 and, to ensure consideration, must be postmarked on or before November 8, 1981, or received by other means by the same date. All representations must cite the Canada Gazette Part I publication date and the Notice reference number.

Comments received in response to this Notice will be made available for public viewing at the Department of Communications Library, 300 Slater Sreet, Ottawa, and at the Regional Offices of the Department as listed above.

Dated at Ottawa, this 11th day of July, 1981.

J. deMercado
Director General
Telecommunication Regulatory Service
Department of Communications

V. Hill
Director General
National Telecommunications Branch
Department of Communications