TOWARDS A RADIO LICENSING POLICY
FOR
MEDIUM-CAPACITY DIGITAL SYSTEMS IN THE BAND 7.725-8.275 GHz, AND LOW-CAPACITY ANALOGUE AND DIGITAL SYSTEMS IN THE BAND 7.125-7.725 GHz.

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1. OBJECTIVE

The purpose of the paper is to solicit comments from interested parties that would assist the Department of Communications in preparing a licensing policy for radio systems operating in the 7.725-8.275 GHz and 7.125-7.725 GHz bands.

2. INTRODUCTION

This document has been prepared to assist in the identification of requirements for microwave spectrum below 10-GHz for medium-capacity digital and low-capacity analogue and digital systems. It should be read in conjunction with the following draft Standard Radio System Plans (SRSP's) which are being issued simultaneously with this document:

1. SRSP-305 "Technical Requirements for Line-of-Sight Radio Relay Systems Operating in the 7125-7725 MHz Band" and
2. SRSP-306 "Technical Requirements for Line-of-Sight Radio Relay Systems Operating in the 7725-8275 MHz Band".

The aim of this document is to summarize some of the major factors involved in the development of a policy, and to propose one possible policy for the rationalization of the utilization of the microwave spectrum in the 7 and 8 GHz bands, as identified above. There has been no attempt in this paper to treat other bands below 10-GHz, such as those intended specifically for the one-way transmission of TV signals or for ITV.

An announcement regarding this proposed policy and the associated draft SRSP's has been made in the Canada Gazette.

Following the publication of this document there will be a 90-day period during which the Department will receive comments on the proposed policy from the general public and industry. The comments will be made available to interested parties. Those wishing to respond to such comments may do so in writing within a further 60-day period. A final policy will be issued after review of the comments and responses.

3. Background

The major users of the microwave spectrum are the utilities and the telecommunications carriers. The former are primarily those associated with the electrical power industry, the latter are mainly the telephone companies and the railway telecommunications carriers.

3.1 Network Characteristics

The microwave networks operated by the individual utilities are mostly provincial in scale, with interconnection of systems across provincial boundaries, and in some cases across the Canada/U.S. border. The telecommunications carriers operate both regional and inter-regional networks, with interconnection practices similar to that of the utilities. The pattern and the characteristics of the existing terrestrial microwave networks tend to reflect this mixture of regional and inter-regional networks. Telecommunication networks and services designed to meet local or regional requirements have developed differently in the various provinces. The inter-regional networks, on the other hand, overlayed in a sense on this regional pattern are more uniform across the country, both in their general design and in their use of the several microwave bands of the spectrum.

3.2 Traffic Characteristics

The major users of these microwave bands differ in the scale and nature of their traffic. The traffic levels of the utilities, and of certain of the railway telecommunication agencies (expressed in terms of such units as equivalent voice circuits or data rates) are in general lower than those of the carriers. In addition, the monitoring and controlling of utility networks involves signal formats somewhat peculiar to that requirement (e.g. composite tone signals).

3.3 Routes

The microwave networks associated with each of the major users also differ as to the route generally followed. Networks associated with the telephone companies tend to interconnect the major population centres whereas those operated by the railways generally follow the railway routes. Those operated by the utilities tend to follow the same routes as the transmission systems themselves (e.g. oil, gas, or electrical power) and thus connect population centres to the energy source.

3.4 Analogue vs Digital

Transmission of traffic in the microwave bands has until recently been in an analogue form. There is increasing interest, however, in exploiting certain economic and technical advantages of digital techniques. Initial systems, of relatively low capacity, have been put into operation in the region of the 2 GHz microwave band to meet the needs of the utilities and the railway companies. Meanwhile the telecommunications carriers have carried out extensive planning to meet the requirements, on both a national and regional scale, for the development of larger capacity digital systems and networks to handle both voice and data traffic. The identification of the most appropriate spectrum for the accommodation of these initial higher-capacity digital systems, and of planning for the allocation of such spectrum, have been the subjects of extensive consultation between the Department and the operating agencies involved.

4. Current Status

Until recently there has been relatively little competition in Canada for microwave spectrum below 10 GHz. This has allowed for a great deal of flexibility in the allocation of spectrum to the various users but has led to the development of operational parameters for the various bands (in terms of frequency and channel plans) which tend to follow patterns appropriate for satisfying the particular requirements of the operators of higher-capacity systems. Anticipation of competition for the limited amount of spectrum available below 10 GHz has underlined the necessity for a clear identification and a thorough examination of the main issues that have to be addressed, and of the options that may be available for resolving them, if successful planning to meet all the competing needs for spectrum in both an equitable and an efficient manner is to be assured.

In light of the utilization of the microwave spectrum and the requirements for additional allocations to accommodate the growth of the various services, there are three major interrelated issues to be addressed:

(i) The identification of a general set of guidelines for the rationalization of the utilization of the microwave spectrum below 10 GHz for terrestrial relay systems;

(ii) the identification of spectrum to be utilized for the operation of national and regional medium-capacity digital systems;

(iii) the identification of spectrum to be utilized for the operation of lower-capacity analogue and digital systems on a regional scale, taking into account the possible need for inter-province connection and connection across the Canada/U.S. border.

5. General Guidelines

The need for a periodic review of the radio spectrum arises, among other reasons, because of the need to respond to the growth or decline of certain services, the emergence of new services or the potential for technological developments to permit a more efficient use of the spectrum. Generally speaking, any review of the radio spectrum in the future can be expected to take place in an environment where scarcity of spectrum and competing demands are characteristic. The results of such a review are likely, therefore, to include measures such as the restructuring of bands of spectrum and possibly the imposition of constraints requiring sharing and co-ordination.

To arrive at the best possible policies for the use of the spectrum a number of factors must be taken into account including:

(i) The need to achieve a balance between a desire for flexibility (reflecting the inevitable uncertainty in estimates of spectrum requirements) and a desire to permit a degree of stability for systems and network planning over a time scale comparable to the estimated operating lifetime of equipment;

(ii) The need to provide sufficient flexibility to allow for regional differences in the requirements for services and spectrum but at the same time to be able to cope with issues of a national scale;

(iii) The need to achieve a balance between certain technical issues such as

- sharing between analogue and digital systems, and between digital systems themselves, both with respect to colocated or separated systems,

- the extent to which cross-polarization can be exploited, in the case of both analogue and digital operation, in order to increase the potential capacity of a band and therefore retard the estimated saturation or congestion date,
- tradeoffs between space and frequency diversity arrangements.

Taking into account these various factors, the Department has considered certain guidelines from which a policy can be derived for the utilization of the microwave spectrum below 10 GHz for the operation of terrestrial radio relay systems.

(a) The Department recognizes that the implementation of any policy to reorient the pattern of utilization of a part of the spectrum must involve a certain transition or adjustment period, during which both the planning and the operational processes can accommodate themselves to either a restructured band or to development in a different part of the spectrum. Ideally, it would be desirable to consider the time scale of such a transition period in terms of the estimated lifetimes of equipment and schedules for its replacement.

(b) The implementation of such a policy would need to take into account special frequency, channel, and diversity plans, the geographical distribution of the networks in question, the institutional arrangements that impact on the amount of spectrum needed to maintain a particular service, and technological developments.

(c) If the ideal process mentioned in a) proves not to be feasible because of time constraints, or because of local situations related to the pattern of past development of the utilization of the spectrum, then the most practical alternative arrangement or coordination scheme would have to be developed in order to satisfy all of the requirements in as equitable a manner as possible.

(d) The economic impact of such alternative arrangements would have to be shared in an appropriate manner among all the parties involved, with due account being taken of all of the relevant circumstances.

As a result of both an examination of the present pattern of utilization of the spectrum and consultation with the major operating agencies, the Department is satisfied that the number of cases for which careful coordination arrangements will likely be required below 10 GHz will be such that satisfactory solutions to these specific situations can be found without undue economic hardship or degradation of the utilization of the spectrum. The Department is also satisfied that, with sound planning, adequate and appropriate spectrum can be provided to meet satisfactorily all of the requirements estimated for the operation of the several classes of microwave systems, both analogue and digital, and that the spectrum will be utilized in an efficient manner. Policies and plans for the different Regions or Provinces, while being designed so as to fit into the general scheme, can be tailored appropriately so as to reflect both the requirements and the present patterns of utilization of the several bands.

There is no intention of departing from the traditional practice in Canada of not allocating spectrum exclusively to specific agencies or of protecting spectrum for utilization on an exclusive basis by specific agencies. The practice would continue of allocating spectrum to classes of service primarily on the basis of economic and technical considerations. However, because of the differences among the various services in the nature of their requirements for spectrum, certain services or agencies tend to predominate inevitably in certain bands of the spectrum primarily because of such factors as channel and frequency plans. Thus one would

envisage those agencies associated with a particular service being able to identify certain bands within which they may expect to efficiently satisfy their long-term requirements for spectrum.

6. Spectrum for the Operation of Medium-Capacity Digital Systems

6.1 General Background

An examination of the future telecommunications requirements of certain carriers for network capacity and spectrum for the transmission of both data and voice traffic indicates that (a) there may be certain advantages, both technical and economic, in meeting those requirements by the increasing utilization of digital techniques, (b) there could be strong economic reasons in support of the concept of over-building the initial digital network along existing microwave transmission routes and on existing structures, and (c) spectrum of the order of up to 500 MHz could be needed. Because of the hop lengths involved in an over-build system, frequencies below 10 GHz would have to be used, in order to avoid problems due to precipitation attenuation although the bandwidth requirement would suggest that one of the higher-capacity microwave bands might be better suited for this application.

In certain regions other forms of transmission network, such as satellite and cable, will develop as circumstances dictate, and will impact on the need for microwave spectrum. Other major users of microwave spectrum in the bands of particular interest in the present context, for example the electrical power utilities, are expected to develop their networks in the form of a combination of analogue and digital. However, the scale of their digital traffic, and thus of their requirement for appropriate spectrum, is likely to be much less than will be the case for the telecommunications carriers. This circumstance as well as the extent to which

suitable bands are now being used, must be taken into account in planning, to ensure that the requirements of all users for spectrum will be met, and that spectrum can be utilized as efficiently as possible.

6.2 The Utilization of the 8 GHz Band (7.725-8.275 GHz)

In September, 1973 the Department submitted a proposal to the CRTPB that the band 7.725 - 8.275 GHz (the 8 GHz Band) would provide the best alternative for spectrum for the licensing of systems for the initial medium-capacity digital network. As a result of further studies related to this proposal and keeping in mind the principles previously mentioned the following issues emerged.

(i) The 8-GHz band is already being utilized in certain regions of Canada, mainly in British Columbia and Quebec, for the operation of analogue systems; by the electrical-power utility in the former, and by both the electrical power utility and by the telecommunications carriers in the latter. The location of these systems relative to the routes of those on which the medium-capacity digital system would be overbuilt varies with the Region or Province involved; the nature of the mutual impact of the operation of the two sets of systems in terms of coordination varies accordingly.

(ii) Any policy to utilize the 8-GHz band for the operation of medium-capacity digital systems would have to take account of three relevant factors - a) the existing analogue systems in the band, b) plans on the part of those users to expand their activities in the band, either by using extra channels on the existing routes or by starting operations on new routes, and c) plans on the part of any users to start

operations in the band. Furthermore, a policy for the band should not result in any undue economic or operational penalty to users of the spectrum, or significant degradation of the efficiency of utilization of the bands involved. This consideration must be kept in mind in ensuring that appropriate spectrum in other bands, or suitable sharing arrangements, are provided to meet the needs of those who may be affected by any constraints placed on the use of the band.

(iii) Propagation behaviour for the hop distances involved, and the resulting measures that may have to be employed to ensure satisfactory operational reliability at 8 GHz will be important in determining the ultimate efficiency of the exploitation of the band. For example, special diversity measures might result in extra loading of towers and also constrain the full use of polarization diversity.

(iv) There is a primary allocation to the Earth Exploratory Satellite Service for a space-earth link in the spectrum region 8025-8400 MHz. This overlaps the 8-GHz band. The spectrum is not being used for this purpose in Canada, but the subject of such a use has figured in preliminary discussions of long-term plans involving possible collaborative space research programs with the USA. The latter's plans, in turn, and particularly as far as projected use of spectrum in this region for down links is concerned, would appear to hinge critically on developments and decisions in that country as to how much signal processing is to be carried out in the satellites, as an alternative to telemetering the raw data to the ground and thus requiring a wider bandwidth.

(v) The need to derive an optimum mix of terrestrial and space facilities is an important factor that has to be considered in any estimate of future needs for radio spectrum for a particular class of service. It is an area under continuous review as technology develops.

6.3 Policy for the 8-GHz Band

It is proposed that this band be utilized for the operation of the systems in the initial medium-capacity digital network. The details of the technical requirements for such systems, and of the licensing procedures and the structuring of the band, are stated in the associated proposed Standard Radio Systems Plan (SRSP) No.306, which is being issued simultaneously with this Licensing Policy.

The following considerations will constitute guidelines for the overall utilization of the band -

1) the utilization proposed will be exclusive to medium-capacity digital systems only to the extent that they would be given priority for full development within the band,

2) existing analogue systems operating in the band would be protected, but constraints compatible with 1) would have to be placed on the expansion of such networks and of the utilization of the spectrum by such systems,

3) new systems of class other than medium-capacity digital would be considered for licensing to operate in the band, but only within the constraint specified in 1).

4) flexibility will be exercised in consideration of applications for licenses, so as to take account of local circumstances, but always with the proviso that, in areas of spectrum congestion, the estimated needs for spectrum for the operation of medium-capacity digital systems will be met, and that the spectrum will be utilized as efficiently as possible.

7. Spectrum for the Operation of Lower-Capacity Analogue and Digital Systems

7.1 General Background

It has become apparent that, in order to meet the growth requirements for spectrum on the part of services using the microwave bands for the operation of lower-capacity analogue and digital systems, and to ensure that the spectrum is being utilized as efficiently as possible, particularly in areas where there is strong competition for spectrum for this type of operation, the bands allocated should be used in conformity with a frequency and channel plan of an appropriate design. The design should preferably incorporate the greatest possible degree of flexibility, so as to accommodate a range of needs and circumstances in an effective manner. In particular, the design should permit the band to be used for the operation of higher-capacity analogue systems as well, in regions where spectrum congestion is not anticipated to be a problem and where accommodation of such systems in one of the higher-capacity bands is not considered to be an appropriate alternative.

7.2 The Utilization of the 7-GHz Band (7.125-7.725 GHz)

Two strong considerations suggest that the 7-GHz band should be the initial choice for spectrum for utilization in the manner outlined in the previous paragraph. Firstly, it is already being used for the operation of analogue systems for this type of service, particularly in Ontario and B.C., and the action proposed would make it possible to accommodate not only the growth of the existing systems over a longer time period but also the introduction of new services and systems of the same general type. Secondly, services with lower-capacity

analogue systems presently operating in the 8-GHz band, primarily in B.C. and Quebec, could have their growth requirements accommodated in the adjacent 7-GHz band, in cases where such growth in the 8-GHz band might be considered to be incompatible with the development of the medium-capacity digital networks, and to represent an inefficient use of the spectrum in congested areas. It would be desirable in certain cases, on both technical and economic grounds, that any change of band for the operation of a particular service, if and when any such change might be proposed, should involve the minimum possible shift in frequency.

This concept of the use of the 7-GHz band is not intended to imply that all such low-capacity analogue and digital systems would have to be accommodated only in this band. The main objective is to ensure that there is adequate and appropriate spectrum available that can be used as efficiently as possible by such systems in congested areas.

7.3 Policy for the 7-GHz Band

It is proposed that this band be utilized for the operation of a hierarchy of low-capacity systems, both analogue and digital. The details of the technical criteria for these systems, the licensing procedures, and the structuring of the band, are presented in the associated proposed Standard Radio Systems Plan (SRSP) No.305, which is being issued simultaneously with this Licensing Policy.

A number of considerations, of the same general nature as those specified in the previous section with respect to the 8-GHz band, will constitute guidelines for the application of the above proposal in the overall utilization of the 7-GHz band -

1) the low-capacity analogue and digital systems would be given priority for full development within the band,

2) existing higher-capacity systems operating in the band would be protected, but constraints compatible with 1) would have to be placed on the expansion of such networks and of the utilization of the spectrum by such systems,

3) new systems of class other than low-capacity analogue and digital would be considered for licensing to operate in the band, but only within the constraint specified in 1),

4) flexibility will be exercised in consideration of applications for licenses, so as to take account of local circumstances, but always with the proviso that, in areas of spectrum congestion, the estimated needs for spectrum for the operation of low-capacity systems will be met, and that the spectrum will be utilized as efficiently as possible.

8. Policy Review

The process of policy development should be a dynamic one, with policies subject to appropriate review. In the present instance there are two main factors, in particular, that will make such a review important. Firstly, there will be a transition period associated with the implementation of the specific proposals. The nature of the impact of these proposals in terms of changing patterns of spectrum utilization and network development will require close review and assessment. Secondly, rapid developments in both the economics and the technology of digital transmission are likely to take place. These will affect not only the efficiency with which spectrum might be expected to be utilized by such digital systems, but also the schedule of plans by operators of analogue systems to adopt digital techniques.