Communications Canada

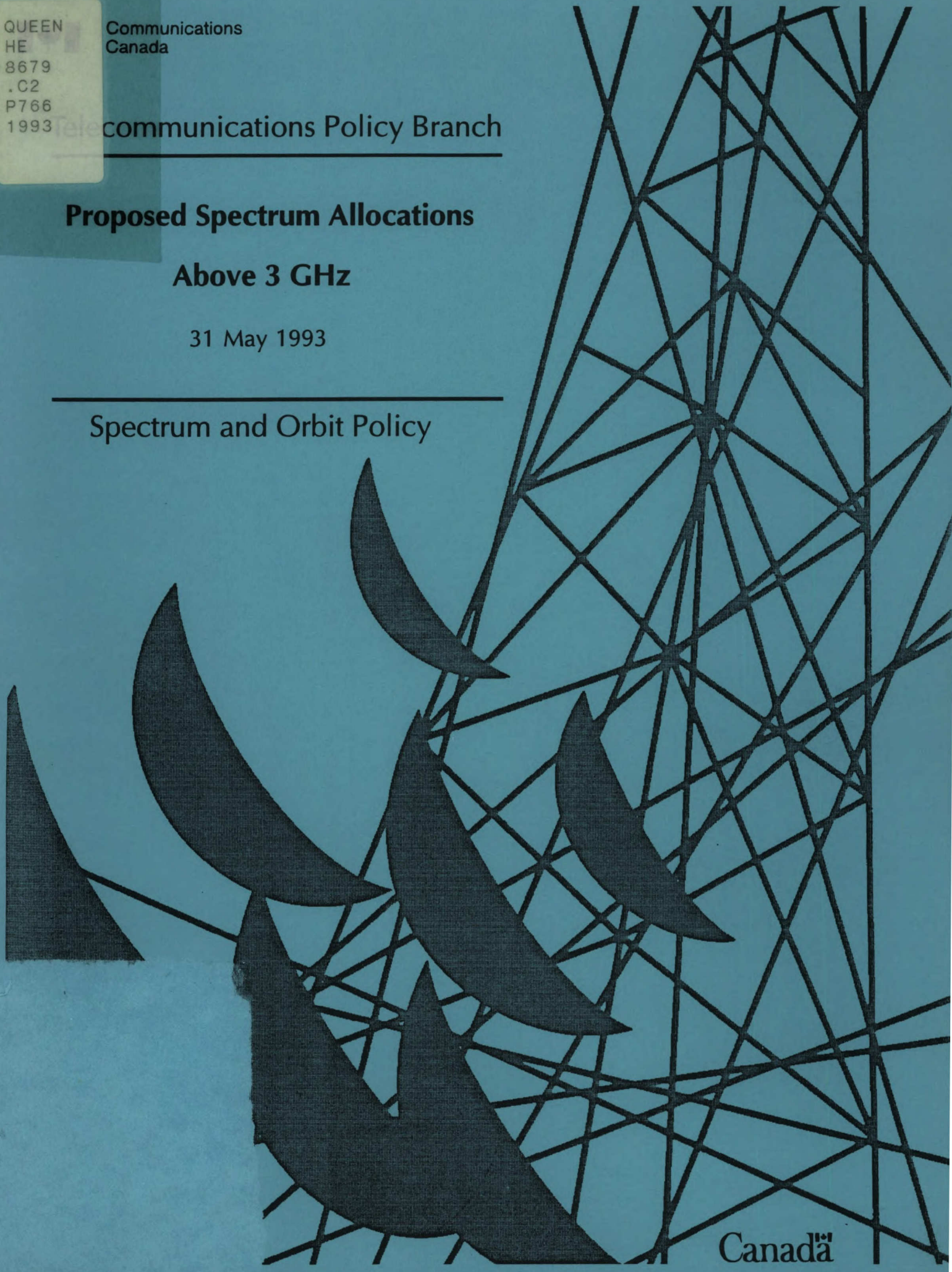
Telecommunications Policy Branch

Proposed Spectrum Allocations

Above 3 GHz

31 May 1993

Spectrum and Orbit Policy



Canada

Preface

As a consequence of 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, the Department has undertaken a comprehensive Spectrum Policy Review covering a wide range of spectrum allocation and utilization issues. This document forms part of the Review and addresses specific proposals for

- **spectrum allocations above 3 GHz.**

Other documents being released for public comment separately address and propose

- **spectrum allocations in the HF band (3-30 MHz);**
- **spectrum allocations and spectrum utilization in the range 30-960 MHz;**
- **spectrum allocations in the 1-3 GHz range;**
- **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 the relevant Spectrum Utilization Policies and, eventually to the Standard Radio System Plans.

Executive Summary

Introduction

This document reviews the Canadian radio frequency allocations in the frequency range 3 GHz to 160 GHz, and proposes a number of changes to the spectrum allocated to radiocommunication services in specific bands within that frequency range, and to the conditions governing the use of these bands.

This is the first major review of the Canadian Table of Frequency Allocations (hereinafter called the Canadian Table) since 1982. That review had been undertaken to reflect the decisions taken by the International Telecommunications Union (ITU) during the 1979 General World Administrative Radio Conference (WARC). This review is principally undertaken at this time to reflect the decisions taken at WARC-92 in Torremolinos, Spain. The 1992 Conference reviewed the utilization of a number of specific frequency bands in Article 8 of the Radio Regulations, ranging from the band 5900-5950 kHz used for HF broadcasting to the band 156-158 GHz used for passive systems in the earth exploration-satellite service. The Conference also decided on changes to a number of other Articles of the Regulations related to these modified allocations, such as changes to the technical constraints within which systems must operate so as to permit sharing among systems operating in these bands, and changes to the administrative regulations with which systems must comply in order to be listed in the ITU Master Frequency Register.

The Canadian Table is generally consistent with Article 8 of the Radio Regulations, except where it is necessary to reflect a Canadian requirement that is different from that of the ITU as a whole. However, such deviations must also include the requirement that Canadian systems be coordinated when so required with systems in other countries that conform to the Radio Regulations.

This document only addresses changes to the Canadian Table in the 3 to 160 GHz frequency range. It is one of a series of documents dealing with changes to the Canadian Table and associated spectrum utilization policies in specific bands. Other documents in the series cover the following:

- **spectrum allocations in the HF band (3-30 MHz);**
- **spectrum allocations and spectrum utilization in the range 30-960 MHz;**

- o **spectrum allocations in the 1-3 GHz range;**
- o **spectrum utilization for certain services above 1 GHz.**

Significant allocation proposals above 3 GHz

The significant allocation issues addressed in this document, in increasing order of radio frequency, are:

1. the use of the 7 GHz band for feeder links to sound broadcasting satellites;
2. the use of the 11 GHz and 13 GHz bands by the fixed-satellite service;
3. the use of the 12 GHz and 17 GHz bands for television delivery by broadcasting satellites, and associated feeder links in the 17 GHz, 18 GHz, and 25 GHz bands;
4. the use of the 16 GHz, 24 GHz and 32 GHz bands by Airport Surface Detection Equipment (ASDE) in the radionavigation service;
5. the designation of specific fixed-satellite bands in the 18 GHz and 28 GHz region to accommodate the requirements for feeder links of non-geostationary (non-GSO) mobile satellites;
6. the accommodation of multi-purpose fixed-satellite and mobile-satellite systems in the bands 20 GHz and 30 GHz;
7. the allocation of spectrum in several bands at 25 GHz and above for scientific satellite applications; and
8. the accommodation at 30 GHz of satellite beacon transmitters of satellite systems operating in the bands 20 GHz and 30 GHz.

The actions proposed in respect of each of these eight issues are briefly outlined in the following sections.

1. The use of the 7 GHz band for feeder links to sound broadcasting satellites.

The sound broadcasting-satellite service (BSS) may be implemented in the band 1452 - 1492 MHz. Such systems will require fixed-satellite Earth-to-space feeder links above 3 GHz. There are two regulatory approaches to meeting this requirement: either simply allow the feeder link to be

coordinated in any Earth-to-space fixed-satellite band at the time of implementation, or designate a particular band for the sound BSS application. It is proposed that the latter approach be followed and that the band 7025-7075 GHz be used for that purpose, not wider bandwidth fixed-satellite bands, because of the inefficiencies that would result. **Canadian Footnote C014A is proposed** accordingly to designate the 7025-7075 GHz fixed-satellite service band as the one to be used primarily for feeder links of sound BSS systems.

2. The use of the 11 GHz and 13 GHz bands by the Fixed-Satellite Service.

Balancing the available amount of uplink and downlink spectrum for Canadian domestic fixed-satellite systems was an objective of Canadian delegations to both WARC-ORB-88 and WARC-92. A proposal from some Administrations (not including Canada) was to open up the 14.5-14.8 GHz band to general fixed-satellite service (FSS) use. The compromise agreement reached at WARC-92 allocated the band 13.75-14.0 GHz to the fixed-satellite service, with regulations specifying how this service would share the band with the radiolocation service and with scientific satellite services. One of these regulations imposes a minimum earth station antenna diameter size of 4.5 meters, thereby indirectly restricting the number and use of such earth stations.

Given the sensitive nature of the discussions leading to this arrangement at the Conference, **it is proposed that these same modifications in the 13.75-14 GHz band be applicable in Canada.** In addition, it is also proposed that Canada manage the spectrum and orbit resources available to it for domestic fixed-satellite systems by pairing that 13.75-14 GHz band with the 11.45-11.7 GHz band. Both bands are immediately below the 14/12 GHz bands currently used by the ANIK-C and ANIK-E satellites, and this arrangement will effectively increase that the width of that band by 50%. Furthermore, this pairing will encourage the use of larger earth station antennas for 11 GHz downlinks, thereby reducing potential sharing problems with the fixed service in that band. **This pairing is proposed in Canadian Footnote C020B.**

3. The use of the 12 GHz and 17 GHz bands for television delivery by broadcasting satellites, and associated feeder links in the 17 GHz, 18 GHz, and 25 GHz bands.

Prior to WARC-92, the spectrum allocated to the broadcasting-satellite service for television delivery in Region 2 consisted of the following: the band 12.2-12.7 GHz, with its associated feeder links in the band 17.3-17.8 GHz; and the band 22.5-23.0 GHz, with an associated fixed-satellite

uplink allocation in the band 27.0-27.5 GHz, that had been unofficially considered as the feeder link band for 23 GHz BSS systems. There were a number of problems with these allocations at 23 GHz and 27 GHz. BSS systems at 23 GHz would experience high rain attenuation, and would be subject to provisions of Article 14 during coordination. Furthermore, the 23 GHz band could eventually be used by future fixed systems if not for satellite broadcasting. Moreover, there were competing interests in the use of the 27 GHz band for inter-satellite links between scientific satellites, a use not compatible with possible BSS feeder links.

Canada proposed to WARC-92 that the band 17.3-17.8 GHz (instead of 22.5-23.0 GHz) be allocated to broadcasting-satellite systems delivering high-definition television (HDTV), and that the associated feeder links be accommodated in a new band at 22 GHz. Canada's 17 GHz proposal was accepted for Region 2 only. Regions 1 and 3, led by the European Community, chose instead to allocate BSS in the 22 GHz band. New feeder link allocations were agreed in the bands 17.8-18.4 GHz and 24.75-25.25 GHz. Thus, the Canadian objectives of lowering the BSS allocation to 17 GHz so as to reduce BSS system costs, of making the 22 GHz and 23 GHz bands more attractive to fixed use, and of providing spectrum for feeder links outside the FSS 27.5-30 GHz band, were all met.

This sharing arrangement between downlink BSS systems at 17 GHz and feeder uplinks to 12 GHz BSS systems can lead to problems; while interference between transmitting and receiving spacecraft is easily avoided by maintaining slight orbital separations between them, interference from a transmitting feeder-link earth station and individual HDTV receivers renders the same band unusable simultaneously by both services in the same local area. This may not be a problem in Canada for many years, however, because of the large amount of BSS spectrum and orbit resources available to Canada through the 1983 BSS Plan at 12 GHz; this is due to the inherent flexibility of that plan, which allows the delivery of HDTV as well as current television signals at 12 GHz, and because of the spectrum utilization efficiencies achievable with new digital television systems such as the one developed by the Moving Pictures Experts Group (MPEG).

To permit the development of BSS systems at 12 GHz and, presumably later, at 17 GHz and, at the same time, make available as much spectrum as possible for use by other services, it is proposed that initial Canadian 12 GHz BSS systems use the 17.3-17.8 GHz band for their feeder links, as indicated in Appendix 30A of the Radio Regulations (1990). When Canadian BSS requirements expand to the point where there is also a need for the 17 GHz band, future feeder links for 12 GHz BSS systems could be implemented in the band 17.9-18.4 GHz, keeping in mind the desirability of allowing feeder links already established in the band 17.3-

17.8 GHz to operate over their accounting amortization life-time. **This evolutionary shift from 17.3-17.8 GHz to 17.9-18.4 GHz for 12 GHz BSS feeder links is proposed in new Canadian Footnote C020A, without the need to specify dates of conversion at this time.**

The prospect of sharing among the broadcasting-satellite service and the fixed and fixed-satellite (downlink) services in the band 17.7-17.8 GHz is not without raising some concern. WARC-92 placed some limitations on the use of this band after year 2007 by the Fixed-Satellite Service through Footnote 869A, but did not restrict its use by the Fixed Service in any way, although it was realized that in a given local area the operation of Fixed networks would result in harmful interference to broadcasting-satellite receivers.

To resolve sharing concerns between Canada and the United States in this band, a bilateral arrangement was agreed to during WARC-92 which would limit the power-flux-density of broadcasting satellites, as well as that generated across the Canada/US border by fixed systems. Consistent with these concerns, decisions, and arrangements, **it is proposed that Canadian Footnote C020E be adopted**; it is the same as ITU footnote 869A, but with the addition of the Fixed Service with the same status as the Fixed-Satellite Service. **The other proposed addition is Footnote C020F**, which would limit the power-flux-density of broadcasting satellites to the levels prescribed in Article 28 of the Radio Regulations for fixed-satellite systems in this band, consistent with the agreements reached with the USA.

It is proposed that the decisions of WARC-92 regarding the bands 17.3-18.4 GHz, 22.5-23 GHz, 24.75-25.25 GHz and 27.0-27.5 GHz be reflected in the Canadian Table, but be subject to Footnotes C020A, C020E, and C020F.

4. The use of the 16 GHz, 24 GHz and 32 GHz bands by Airport Surface Detection Equipment in the Radionavigation Service.

Airport Surface Detection Equipment (ASDE) is a radiocommunication application within the radionavigation service. ASDE systems are used to control aircraft traffic on the ground and in the air space in the vicinity of major airports. Wide-bandwidth radars with extremely short pulse lengths are required to provide air traffic controllers with information on the position and size of aircraft to within a few meters. Furthermore, ASDE systems are used in part to prevent collisions between large aircraft, and must therefore be treated as a safety-of-life service in the context of Article 9 of the Radio Regulations.

Prior to WARC-92, the radionavigation service was allocated exclusive use of 1,000 MHz of spectrum at 25 GHz and 1,600 MHz of shared spectrum at 32 GHz, frequencies that were appropriate for ASDE applications. At the Conference, the width of this radionavigation band at 25 GHz was reduced to 400 MHz (24.25-24.65 GHz), and the space research service (deep space) was added to the band 31.8-32.3 GHz, subject to Footnote 893 that recalls the safety aspects of the radionavigation service.

In view of the reduction of spectrum suffered at WARC-92 by the radionavigation services at 24 GHz and 32 GHz, an alternative at 16 GHz, specifically the 15.7-16.6 GHz radiolocation band, is being considered for ASDE. USA domestic footnote G59 permits ADSE equipment on a co-equal basis with radiolocation systems in the band 15.7-16.2 GHz. **It is proposed that a new Canadian footnote C020D be added to the Canadian Table** with the same objective of allocating that band to ASDE systems on a co-primary basis, as well as reflecting **the WARC-92 decisions for the 24.25-25.25 GHz and 31.8-32.3 GHz bands.**

5. The designation of specific fixed-satellite bands in the 18 GHz and 28 GHz region to accommodate the requirements for feeder links of non-GSO mobile satellites.

WARC-92 decided on a number of new allocations to the Mobile-satellite service (MSS) in the 1 to 3 GHz region of the spectrum. Some of these allocations may be used by low Earth orbit (LEO) mobile satellite systems. Given that spectrum is at a premium in the 1 to 3 GHz range, operators of these systems are likely to implement their feeder links to gateway stations in fixed-satellite bands. Some LEO MSS systems are contemplating the 20 and 30 GHz fixed-satellite bands for this purpose.

However, spectrum sharing between a (GSO) fixed-satellite system and the feeder links of a LEO MSS system can create problems because, at some point in the path of the LEO satellite, the LEO satellite, the GSO satellite, and the earth station of one of these systems will be in a straight line. For a short period of time there will be harmful interference into one system or the other. Which system is interfered with will depend on the characteristics of the two systems and whether transmission is upwards or downwards; but it virtually impossible to avoid harmful interference at all times into both networks.

For these reasons **it is proposed, in Footnote C020G, that a 100 MHz wide band, in both Fixed Service bands at 18 and 28 GHz, be designated for use for LEO MSS feeder links**. The particular bands proposed are 18.82-18.92 GHz for downlinks and 28.62-28.92 GHz for uplinks, chosen for ease of coordination with terrestrial fixed networks.

6. The accommodation of multi-purpose fixed-satellite and mobile-satellite systems in the bands 20 GHz and 30 GHz.

A new generation of communication satellites operating in the 30 and 20 GHz bands are being developed in Canada at the DOC Communications Research Centre (CRC), and in the United States by National Aeronautics and Space Administration (NASA) and a number of commercial interests. These satellites will have extensive on-board processing capabilities for re-modulation, multiplexing and switching, and will cater to a wide variety of communications requirements, ranging from stations of the VSAT category to personal-access satellite terminals. It was proposed by Canada, Mexico and the United States that the bands 19.7-20.2 GHz and 29.5-30 GHz be allocated to a new satellite service to accommodate these innovations. After lengthy discussion, it was decided instead to raise the status of the mobile-satellite service to co-primary in these bands in Region 2, but only in 100 MHz wide bands in Regions 1 and 3, and to impose by footnote a number of constraints on the use of these bands by the mobile-satellite service.

This type of system continues to be developed in Canada, but within the constraints imposed by WARC-92. Moreover, the decisions taken at WARC-92 reflect a negotiated compromise among differing interests and Canadian systems operating in these bands will be subject to ITU coordination procedures. **It is, therefore, proposed that the decisions of the Conference for Region 2 be incorporated into the Canadian Table without change.**

7. The allocation of spectrum in several bands at 25 GHz and above for scientific satellite applications.

A relatively large number of additional allocations were decided on at the Conference for the space research service, the Earth exploration-satellite service, and the inter-satellite service, services of great interest to space agencies around the World, including the Canadian Space Agency. These include the addition of the inter-satellite service at 25 GHz, of the space research service at 32 GHz, 34 GHz, 37 GHz, 40 GHz and 75 GHz, and of the Earth exploration-satellite service at 39 GHz and 156 GHz.

The most significant of these, in terms of sharing with other services which may be used in Canada, are the inter-satellite service in the band 25.25-27.5 GHz, the space research (deep space) (space-to-Earth) service in the band 31.8-32.3 GHz, and the space research (space-to-Earth) service in the band 37-38 GHz. The new space services in the 25 GHz

and 37 GHz bands are subject to power-flux-density limits that make sharing with the fixed service feasible. Sharing with the radionavigation service in the 32 GHz band is also acceptable, because the radionavigation service is recognized as a safety service (see discussion above on allocations for ASDE systems), and so has certain priorities in the event that coordination of a radionavigation system becomes necessary. Use of the band 27-27.5 GHz by the fixed-satellite service is less attractive than before because of the addition of the inter-satellite service and the additional sharing constraints; however, this is not a major concern because other fixed-satellite bands were allocated for broadcasting-satellite feeder links (see discussions above on allocations to broadcasting satellites and their feeder links).

In summary, new allocations to scientific satellite services are available for Canadian and other space agencies, and their use will not place restrictions upon other allocations that might be used in Canada. **It is proposed that these new allocations be added to the Canadian Table.**

8. The accommodation at 30 GHz of satellite beacon transmitters of satellite systems operating in the bands 20 GHz and 30 GHz.

It is expected that in the coming decade fixed-satellite systems and multi-purpose satellite systems will be implemented in the 30 GHz and 20 GHz bands. One of the problems encountered in using these bands is the high attenuation of signals under heavy rain conditions. One way to overcome this problem, at least partially, at 30 GHz is to use uplink power control, ie. by transmitting a stronger signal from an Earth station during a rain storm, so as to receive the same signal strength at the satellite in all weather conditions. To optimize the design of such a system, it is best to measure the Earth station-to-satellite path conditions in real time at the frequency being used, ie. at 30 GHz in this case.

The Conference approved footnotes in the band 27.5-30 GHz that permit the operation of beacons in the satellite, thus permitting the conduct of these measurements from the ground. A limitation to the power levels of these beacons has also been imposed to protect fixed systems and other fixed-satellite systems in the band. **It is proposed that these footnotes be included in the Canadian Table.**

Summary

Specific proposals for changes to the Canadian Table of Frequency Allocations, in the context of the above eight topics and other decisions taken at WARC-92, can be found in the main document. These proposals are presented on a band-by-band basis, showing the existing Canadian and ITU allocations as well as the proposed changes. Relevant issues of a general nature are briefly discussed in Annex A. Background information relating to each radiocommunications service, that was considered in developing these proposals, can be found in Annex B.

The public is invited to submit written comments on these proposals, questions and observations in this document, to the Director-General, Telecommunications Policy Branch, 300 Slater Street, Ottawa, Ontario, K1A 0C8, by 1 October, 1993. Canada Gazette Notice DGTP-004-93 should be referenced in all replies. The Department will study all public comments and take them into consideration in the revision of the Table which is planned to be released early in 1994.

Table of Contents

Glossary

This glossary defines (and as necessary describes) terms used in the document and its annexes. These terms are:

AMSC	American Mobile Satellite Consortium
AMSS	Aeronautical Mobile-Satellite Service
Article	a portion of the Radio Regulations of the ITU
ASDE	Airport Surface Detection Equipment
ATV	advanced television
BSS	Broadcasting-Satellite Service
Big LEO	a satellite system using a LEO orbit and spectrum in the 1 to 3 GHz range
Canadian Table	the Canadian Table of Frequency Allocations
CAN****	a Canadian proposal number to a WARC, eg. WARC-92
CCIR	International Radio Consultative Committee, replaced by the Radiocommunications Bureau or Sector of the ITU
C-band	fixed-satellite bands between 3.4 GHz and 7.075 GHz
CEPT	European Post and Telecommunication Commission
CRC	Communications Research Centre
CRTC	Canadian Radio telecommunications and Television Commission
Conference	the 1992 WARC in Torremolinos, Spain
dBW	logarithm of a power level compared to 1 watt
$dB(W/m^2)$	logarithmic measure of power flux-density in watts per square meter
deep space	space more than 2×10^6 kilometres from the earth, ie. beyond the Moon
EHF	Extra High Frequency range, 3×10^{10} to 3×10^{11} hertz
EIRP	effective isotropic radiated power
e.i.r.p.	alternate representation, effective isotropic radiated power
ESA	European Space Agency
FM	Frequency Modulation or Frequency Modulated
FS	Fixed Service
FSS	Fixed-Satellite Service
GSO	the Geostationary Satellite Orbit, including inclined orbits that are close to the geostationary orbit, in which a satellite is seen from the ground as being stationary
HDTV	High Definition Television
EO	Highly Elliptical Orbit, with a minimum altitude similar to a LEO and a maximum altitude possibly greater than a GSO
HF	the High Frequency band, from 3×10^6 to 3×10^7 hertz
IFRB	International Frequency Registration Board
ISDN	Integrated Services Digital Network
ITU	International Telecommunication Union
IVHS	Intelligent Vehicle Highway System

Ku-band	fixed-satellite or broadcasting-satellite frequency bands between 10.7 GHz and 14.8 GHz
Ka-band	the fixed-satellite 30/20 GHz
LAN	Local Area Network
LEO	Low Earth Orbit non-geostationary usually circular orbit of about 1000 Km altitude
LMSS	Land Mobile-Satellite Service
Little LEO	a satellite system using LEO orbits and frequencies below 1 GHz
MEO	Mid Earth Orbit non-geostationary, usually circular, with an altitude of about 10,000 Km
MMSS	Maritime Mobile-Satellite Service
MPEG	moving picture experts group, or a digital television coding scheme developed by that group
MSAT	The Canadian Mobile-Satellite system
MSS	Mobile-Satellite Service
NASA	the National Aeronautics and Space Administration of the USA
NASDA	the National Space Development Agency of Japan
non-GSO	any satellite orbit which is not geostationary or close to geostationary (see definition of GSO)
NTSC	National Television Standards Committee, or the current North American television signal format of that committee
PCS	Personal Communications System
PSK	Phase-Shift Keying or Phase-Shift Keyed
PSTN	public switched telephone network
RARC	a Regional Administrative Radio Conference
RR	Radio Regulation (of the ITU)
Region 1	an ITU-defined region of the world, in this case Europe, Africa, all of Russia, and parts of the Middle East
Region 2	an ITU-defined region of the world, in this case North and South America
Region 3	an ITU-defined region of the world, in this case Asia and Australia but not including Russia
RF	Radio Frequency
RR	Radio Regulation(s)
SHF	Super-High Frequency band, 3×10^9 to 3×10^{10} hertz
SP	Spectrum Utilization Policy
TDRSS	Tracking and Data Relay Satellite System of NASA
TVRO	Television Receive-Only satellite earth terminal
VHF	Very High Frequency band, 3×10^7 to 3×10^8 hertz
VSAT	very small aperature (satellite earth) terminal
UHF	Ultra High Frequency band, 3×10^8 to 3×10^9 hertz
W/m^2	watt per square metre

WARC	World Administrative Radio Conference
WARC-MOB	a specialized WARC in 1987 to consider mobile and mobile-satellite services
WARC-ORB	a specialized two-session WARC in 1985 and 1988 to consider the planning of space services
6/4 GHz	the fixed-satellite frequency bands 5.925-6.425 GHz uplink and 3.7-4.2 GHz downlink
13/11 GHz	the fixed-satellite frequency bands 13.75-14 GHz and/or 12.75-13.25 GHz uplink and 10.7-11.7 GHz downlink
14/11 GHz	the fixed-satellite frequency bands 14.0-14.5 GHz uplink and the bands 10.7-11.7 GHz downlink
30/20 GHz	the satellite frequency bands 27.5-30 GHz uplink and 17.7-20.2 GHz downlink

Proposed Spectrum Allocations
Above 3 GHz

1 .... Introduction

This document presents the results of a spectrum review undertaken by the Department of Communications, and proposes a number of changes to the Canadian Table of Frequency Allocations (hereinafter referred to as the Canadian Table) for the frequency bands above 3 GHz. The main event leading to this review was the 1992 World Administrative Radio Conference (WARC-92) convened by the International Telecommunications Union (ITU) in Torremolinos, Spain, from 3 February to 4 March, 1992. The decisions taken at that Conference were related to the spectrum allocations to the various radiocommunications services contained principally in Article 8 of the ITU Radio Regulations, and to related spectrum utilization matters in other Articles. This document proposes certain changes to the Canadian Table as a result of the changes made by WARC-92 to the ITU Article 8 Table of frequency allocations. Related consequential changes are also proposed in this document in bands that were not specifically considered by the Conference.

The last major review of the Canadian Table above 3 GHz was done following the General WARC-79; the revised Canadian Table was issued by the Department in January 1982. Smaller changes to the Canadian Table were made in 1986 to reflect ITU allocation decisions taken at WARC-MOB-83 and at WARC-ORB-85, and in March 1991 following WARC-MOB-87 and WARC-ORB-88.

Proposals for changes to the Canadian Table are presented here on a band-by-band basis, ie. all proposed changes to the Canadian Table affecting a given band are made in one place. General background information and the issues relating to these proposed changes are discussed in Annex A to this document, and the discussion of the requirements of specific services, particularly from a Canadian perspective, can be found in Annex B. Further detailed information on spectrum/orbit resources available to the fixed-satellite service (FSS) in Canada is given in Annex C, and similar considerations relating to the broadcasting-satellite service (BSS) are covered in Annex D. Annex E is the Gazette Notice associated with these proposals.

To assist the reader, specific references to the relevant background material contained in the annexes are made as appropriate throughout this document.

Finally, as specified in the associated Gazette Notice (Annex E), comments are invited from all interested parties concerning the particular proposals contained in this document. Comments should be sent to the:

Director General
Telecommunications Policy Branch
Department of Communications
300 Slater Street
Ottawa, Ontario
K1A 0C8

by 1 October, 1993.

The Department will review in detail all comments received and take them into account in the final revision of the Canadian Table of Frequency Allocations. The revised Table is expected to be released early in 1994. Copies of the submissions received 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.

2 . . . . Presentation Format

Proposed changes to the Canadian Table are presented in this document on a band-by-band basis in order of increasing frequency, in separate sections. In many cases, changes proposed for one band are related to those proposed for another; these inter-relationships are discussed in the text accompanying these proposals.

Each section proposes a change to the Canadian Table in a specific band and includes, in the following order:

- a description of the Region 2 and Canadian allocations in effect before WARC-92;
- a description of the decisions of the WARC relating to the band;
- a brief discussion of the factors involved in a possible change to the Canadian table, with references to the various annexes as appropriate;
- the proposed change in the Canadian Table; and
- information about any accompanying Spectrum Utilization Policy, if one is current or is being proposed.

Tables in each section show the existing (pre-WARC) allocations and the post-WARC allocations. Each of these in turn indicate, for the band in

question, the Region 2 and the Canadian allocations. These four attributes are identified by use of the following editorial presentations:

- table entries or footnotes in the relevant Region 2 table but not in the Canadian table **are included and struck out**; this applies to both the current and proposed table entries;
- 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 for new footnotes;
- table entries or footnotes in the WARC-92 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 omitted from the post-WARC or "proposed" table**. Their omission is evident by their inclusion in the pre-WARC 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 specified in the second and third indents above.

3 Proposals for the Canadian Table

3.1 . 5925-7075 MHz

Existing Canadian Allocations

The band 5925-7075 MHz is currently allocated on a co-primary basis to the fixed and the fixed-satellite service (Earth-to-space), as indicated below:

5925-7075 MHz FIXED FIXED-SATELLITE (Earth-to-space) 792A ~~MOBILE~~ 791 809

The standard frequency and time signal-satellite service may be authorized in the band 6425-6429 MHz, subject to Article 14, according

to Footnote 791. Footnote 792A notes that in the band 6725-7025 MHz the fixed-satellite service is subject to the allotment plan in Appendix 30B of the Radio Regulations. Footnote 809 notes that passive sensor measurements are carried out over the oceans, but the footnote does not give such use of the band any status. The mobile service is allocated on a primary basis in the ITU Table, but is not allocated in the Canadian Table, in part because in Canada transportable stations are licensed in the fixed rather than the mobile service.

WARC-92 Activity

WARC-92 did not consider the band 5925-7075 MHz, other than through an initial consideration of Canadian Proposal CAN/23/85, a proposal to designate the band 7025-7075 MHz for use within the fixed-satellite service for feeder links to BSS (sound) systems in the 1.4 GHz frequency range. The WARC allocated the band 1452-1492 MHz to the broadcasting-satellite service, subject to Footnote 722A and to Resolution 528 (COM 4/W), but did not have time to consider subsequently the question of feeder links to sound broadcasting-satellite systems in that band. Thus the Canadian proposal CAN/23/85 was neither accepted nor rejected.

Discussion

In Section 7.2 of Annex B, the reasons for designating a specific fixed-satellite (earth-to-space) band for BSS (sound) feeder links were discussed, and the band 7025-7075 MHz is suggested through a process of eliminating almost all other bands allocated to the FSS (earth-to-space). In summary, the reasons for designating a specific band for BSS (sound) feeder-link use are to allow designers of BSS (sound) systems to use a frequency band in which spectrum/orbit resources are available, and to prevent the inefficient use of much wider bandwidth FSS bands. The reason for designating the 7025-7075 MHz band in particular is that, because of decisions taken at WARC-ORB in 1985 and in 1988, it is not as useful for other FSS uses as other bands allocated to the FSS (space-to-earth) below 30 GHz.

Proposed Canadian Table

For the above reasons it is proposed that the fixed-satellite service (earth-to-space) be designated as the band to be used for BSS (sound) feeder links, by adding footnote C014A to the band 5925-7075 MHz, as follows:

5925-7075 MHz	
	FIXED
	FIXED-SATELLITE (Earth-to-space) 792A C014A
	~~MOBILE~~
	791 809

C014A The fixed-satellite service (Earth-to-space) in the band 7025-7075 GHz shall be used by Canadian satellite networks exclusively for feeder links to broadcasting-satellite (sound) systems operating in the frequency band 1452-1492 MHz. Feeder links of such broadcasting-satellite systems shall use this band to the extent possible before a different fixed-satellite (Earth-to-space) band is so used.

3.2 . . 10.7-11.7 GHz

Existing Canadian Allocations

The band 10.7-11.7 GHz is allocated in Canada on a co-primary basis to the fixed and fixed-satellite (space-to-Earth) services. The band is also allocated on a secondary basis to the mobile, except aeronautical mobile, service in the ITU Table, but this allocation is not included in the Canadian Table. Footnote 792A recalls that the fixed-satellite service in the sub-bands 10.7-10.95 GHz and 11.2-11.45 GHz is planned in accordance with Appendix 30B of the Radio Regulations (see Annex C). Canadian footnote C016 provides protection to passive services in the adjacent band 10.6-10.7 GHz.

10.7-11.7 GHz	
	FIXED
	FIXED-SATELLITE (space-to-Earth) 792A
	~~Mobile except aeronautical mobile~~
	C016

792A (Orb-88) The use of the bands 4500-4800 MHz, 6725-7025 MHz, 10.7-10.95 GHz, 11.2-11.45 GHz, and 12.75-13.25 GHz by the fixed-satellite service shall be in accordance with the provisions of Appendix 30B.

C016 Users are urged, in their planning of operations in the band 10.7-10.95 GHz for the fixed-satellite service, to give all practicable protection to the passive operations in the adjacent band 10.6-10.7 GHz.

WARC-92 Activity

The Conference did not consider this band specifically. However, the Conference allocated 250 MHz of new fixed-satellite spectrum in the

Earth-to-space direction on a shared primary basis in the 13.75-14.0 GHz band, subject to new footnotes 855A and 855B. The 11.45-11.7 GHz band is a possible downlink pair to that band in the implementation of Canadian domestic fixed-satellite networks.

Discussion

The uses and constraints of the new fixed-satellite band 13.75-14 GHz is discussed below in Section 3.3 above. The 11.45-11.7 GHz band is seen as a logical downward extension of the current 11.7-12.2 GHz band for domestic FSS networks, just as the band 13.75-14.0 GHz is a downward extension of the 14.0-14.5 GHz band. Both the uplink band 13.75-14 GHz and the corresponding 11.45-11.7 GHz band share the spectrum with other services and, thus, networks with fewer and larger Earth stations are more appropriate in these bands. To ensure good utilization of the spectrum and orbit resources available, as discussed in Section 3.0 of Annex A, a footnote specifying that this pairing be followed is proposed. It is assumed that with such a footnote in effect, the 14/12 GHz band for a future Canadian 14/12 GHz FSS network might be as much as 750 MHz in width, with traffic requiring fewer larger Earth stations being accommodated in the lower 250 MHz of that 750 MHz band.

Proposed Canadian Table

Based on the above, it is proposed that a new footnote C020B be added to the band 11.45-11.7 GHz to pair the use of this band to that of the band 13.75-14.0 GHz for Canadian domestic FSS networks. As a consequential change, footnote C016 would no longer apply to the 11.45-11.7 GHz band, a 750 MHz portion of the 11.6-11.7 GHz passive band, nor would footnote 792A that recalls the bands to be used in accordance with Appendix 30B; thus, both should be deleted from the band.

10.7-**11.45 GHz**	FIXED FIXED-SATELLITE (space-to-Earth) 792A ~~Mobile except aeronautical mobile~~ C016
11.45-11.7 GHz	FIXED FIXED-SATELLITE (space-to-Earth) ~~792A~~ C020B ~~Mobile except aeronautical mobile~~ ~~C016~~

C020B In the use of the fixed-satellite service by networks used for domestic fixed-satellite applications, the band 13.75-14.0 GHz in the Earth-to-space direction shall be used in conjunction with the band 11.45-11.7 GHz in the space-to-Earth direction.

3.3 . . 12.2-12.7 GHz

Existing Canadian Allocations

The band 12.2-12.7 GHz is currently allocated on a co-primary basis to the fixed, broadcasting, and broadcasting-satellite services, with the addition of footnotes 839 constraining the use of the fixed-satellite and broadcasting services, 844 protecting broadcasting-satellite assignments from interference from terrestrial networks, and 846 providing satellite systems in the band with the flexibility to accommodate both fixed-satellite and broadcasting-satellite traffic. The use of the band by the broadcasting-satellite service is specified by the Plan of Appendix 30.

12.2-12.7 GHz	FIXED ~~MOBILE except aeronautical mobile~~ BROADCASTING BROADCASTING-SATELLITE 839 846 C020 844

839 (Orb-88) The use of the bands 11.7-12.2 GHz by the fixed-satellite service in Region 2 and 12.2-12.7 GHz by the broadcasting-satellite service in Region 2 is limited to national and sub-regional systems. The use of the band 11.7-12.2 GHz by the fixed-satellite service in Region 2 is subject to previous agreement by administrations concerned and those having services, operating or planned to operate in accordance with the Table, which may be affected (see Articles 11, 13, and 14). For use of the band 12.2-12.7 GHz by the broadcasting-satellite service in Region 2, see Article 15.

844 (Orb-85) In Region 2, in the band 12.2-12.7 GHz, existing and future terrestrial radiocommunication services shall not cause harmful interference to the space services operating in conformity with the Broadcasting-Satellite Plan for Region 2 contained in Appendix 30 (Orb-85).

846 (Orb-85) In Region 2, in the band 12.2-12.7 GHz , assignments to stations in the broadcasting-satellite service in the Plan for Region 2 contained in Appendix 30 (Orb-85) may also be used for transmissions in the fixed-satellite service (space-to-Earth), provided that such transmissions do not cause more interference or require more protection from interference than the broadcasting-satellite service transmissions operating in conformity with the Region 2 Plan. With respect to the space services, this band shall be used principally for the broadcasting-satellite service.

C020 In Region 2, in the band 12.2-12.7 GHz, assignments to stations in the broadcasting-satellite service made available in the plan to be established by the 1983 regional administrative radio conference for Region 2 may also be used for transmissions in the fixed-satellite service (space-to- Earth), provided that such transmissions do not cause more interference or require more protection from interference than the broadcasting-satellite service transmissions operating in accordance with the plan. With respect to the space services, this band shall be used principally for the broadcasting-satellite service. The lower limit of this band shall be modified in accordance with the decisions of that conference for Region 2 (see No. 841).

In combination, these allocations and Appendix 30 give the broadcasting-satellite service a higher status than the so-called co-primary terrestrial services in the band, they allow Canada to use six orbital positions in the Plan of Appendix 30 (see Annex D), and they provide considerable flexibility in how these orbital assignments are used.

WARC-92 Activity

The question how to accommodate HDTV BSS requirements was discussed in detail, but the only direct connection with the 12 GHz BSS allocation at the Conference was the US proposal for a footnote in this band making the band available for HDTV application. The proposal was not adopted by the WARC. In Canada's view, that proposal was not necessary, given the flexibility of the Appendix 30 Plan (see Annex D).

A related activity was the allocation of spectrum to the broadcasting-satellite service in the 17.3-17.8 GHz band, co-primary with the feeder link allocation and Plan of Appendix 30A, and the additional allocation of BSS feederlink spectrum in the bands 18.1-18.4 GHz (augmenting the allocation in the band 17.3-18.1 GHz) and 24.75-25.25 GHz. The question of how these feederlink bands might be used is discussed in Section 7.1 of Annex B.

Proposed Canadian Table

It is proposed that the Canadian Table be unchanged from that existing before the WARC, except for

- the deletion of footnote C020, having become no longer necessary since it is almost identical to the ITU footnote 846, which also includes WARC-ORB-85 modifications not included in C020; and

- the addition of footnote C020A to ensure that the provision of feeder links to the broadcasting-satellite service is done in a manner that does not constrain the use of the radio spectrum for other services any more than is necessary to provide a cost-effective BSS system and associated feeder links.

12.2-12.7 GHz	FIXED ~~MOBILE except aeronautical mobile~~ BROADCASTING BROADCASTING-SATELLITE 839 846 ~~C020~~ C020A 844

The proposed new footnote C020A is as follows:

C020A Feeder links to broadcasting-satellite systems operating in the band 12.2-12.7 GHz shall be accommodated in the band 17.3-17.8 GHz in accordance with Appendix 30A of the ITU Radio Regulations, unless it is necessary to use another band because of the operation or planned operation of a broadcasting-satellite system in the 17 GHz band, taking into account the need to use feeder-link equipment over its accounting amortized lifetime. In that situation, operators are urged to consider use of the band 17.9-18.4 GHz for the provision of feeder links to broadcasting-satellite systems operating in the 12.2-12.7 GHz band, and use of the band 24.75-25.25 GHz for the provision of feeder links to broadcasting-satellite systems operating in the band 17.3-17.8 GHz.

It is also proposed that Footnote C020A be applicable in the bands 17.3-17.7 GHz, 17.7-17.8 GHz, 17.8-18.1 GHz, 18.1-18.4 GHz, and 24.75-25.25 GHz.

3.4 . . 13.75-14 GHz

Existing Canadian Allocations

Currently, the band 13.4-14 GHz is allocated to the radiolocation service on a primary basis, and the Standard Frequency and Time Signal-Satellite (Earth-to-space) and Space Research services on a secondary basis, with radiolocation devices also being allowed on spacecraft on a secondary basis in accordance with footnote 713 for earth exploration-satellite and space research applications. Other footnotes 853, 854, and 855 allocate additional bands in other administrations but do not affect Canadian use of the band.

13.4-14.0 GHz	RADIOLOCATION Standard Frequency and Time Signal-Satellite (Earth-to-space) Space Research 713 ~~853~~ ~~854~~ ~~855~~

713 In the bands 1215-1300 MHz, 3100-3300 MHz, 5250-5350 MHz, 8550-8650 MHz, 9500-9800 MHz, and 13.4-14.0 GHz, radiolocation stations installed on spacecraft may also be employed for the earth exploration-satellite and space research services on a secondary basis.

WARC-92 Decision

As discussed in Section 2.0 of Annex B, the WARC allocated the band 13.75-14.0 GHz (the upper 250 MHz of the band 13.4-14 GHz) to the fixed-satellite service (Earth-to-space) on a primary basis. This allocation was agreed to as an alternative to a proposal made by several administrations to open the band 14.5-14.8 GHz to generic FSS use rather than restricting the use of that allocation to BSS feeder links through footnote 863.

Inter-service sharing arrangements in the 13.75-14 GHz band were agreed to at the Conference. New ITU footnote 855A specifies the sharing constraints between the co-primary radiolocation and FSS (Earth-to-space) services, and new footnote 855B specifies the sharing between the FSS and the earth exploration-satellite and space research services, as follows:

855A In the band 13.75-14 GHz, the e.i.r.p. of any emission from an earth station in the fixed-satellite service shall be at least 68 dBW, and should not exceed 85 dBW, with a minimum antenna diameter of 4.5 meters. In addition the e.i.r.p., averaged over one second, radiated by a station in the radiolocation and radionavigation services towards the geostationary orbit shall not exceed 59 dBW. These values shall apply subject to review by the CCIR and until they are changed by a future competent world administrative radio conference (see Resolution 112, WARC-92).

where Resolution 112 is a new ITU resolution of WARC-92 entitled "Allocation of Frequencies to the Fixed-Satellite Service in the Band 13.75-14 GHz"; and

855B In the band 13.75-14 GHz geostationary space stations in the space research service, for which information for advance publication has been received by the IFRB prior to 31 January 1992, shall operate with an equal basis with stations in the fixed-satellite service ; after that date new geostationary space stations in the space research service will operate on a secondary basis. Until 1 January 2000, stations in the fixed-satellite service shall not cause harmful interference to non-geostationary stations in the space research and earth exploration-satellite services; after that date these non-geostationary space stations will operate on a secondary basis in relation to the fixed-satellite service.

Discussion

As discussed in Section 2.0 of Annex B, there is a fixed-satellite requirement for use of this band for both domestic and international

commercial FSS networks. There is also a continuing requirement for radiolocation use of the band by government systems.

The technical parameters of 855A are being studied by Study Group 4 of the CCIR, as requested in Resolution 112. However, as discussed in Section 3 of Annex A, FSS networks need to be coordinated in detail with networks of other administrations and, therefore, must be designed in accordance with the parameters agreed to by WARC-92 or by a future WRC, because they specify the conditions of sharing between systems of different administrations.

Another factor is the use of the band for domestic fixed-satellite systems, as discussed in 3.2 above. For the reasons outlined therein, it is proposed to pair the 13.75-14.0 GHz fixed-satellite uplink band used for domestic networks, with the 11.45-11.7 fixed-satellite downlink band through new footnote C020B. Note that this footnote does not apply to international FSS networks that are used primarily for communications across the Atlantic and Pacific Oceans, in which the frequency pairing is very different from that of domestic systems.

Proposed Canadian Table

Based on the above, it is proposed that for this band, the Canadian Table be the same as the ITU table, with new footnotes 855A and 855B unchange but with the deletion of in-country footnotes 853, 854, and 855, as in the current Canadian Table, and the addition of C020B specifying the pairing of the 13.75-14.0 GHz band with the 11.45-11.7 GHz band for domestic FSS systems. With these changes the Canadian table is proposed to be:

13.4-13.75 GHz	RADIOLOCATION Standard Frequency and Time Signal-Satellite (Earth-to-space) Space Research 713 ~~853~~ ~~854~~ ~~855~~
13.75-14 GHz	RADIOLOCATION FIXED-SATELLITE (Earth-to-space) Standard Frequency and Time Signal-Satellite (Earth-to-space) 713 ~~853~~ ~~854~~ ~~855~~ **855A** **855B** C020B

C020B (see Section 3.2 above.)

3.5 . . 15.7-16.6 GHz

Existing Canadian Allocations

In Canada, the band 15.7-16.6 GHz is allocated exclusively to the radiolocation service. Footnotes 866 and 867 are "in country" ITU footnotes that do not affect Canadian use of the band.

15.7-16.6 GHz
RADIOLOCATION
~~866~~ ~~867~~

WARC-92 Activity

The use of the band 15.7-16.6 GHz was not reviewed at WARC-92. However, the Conference reduced significantly the bandwidth available to the radionavigation service in the 25 GHz band. This band had been considered for use by Airport Surface Detection Equipment (ASDE). Because of that change in the 25 GHz range, the 16 GHz band is considered here for ASDE use.

Discussion

Wide-band radar systems are being considered for traffic control of aircraft on the ground or in the immediate air space at major airports. Wide bandwidths are required to achieve good range discrimination (see Section 8.0 of Annex B). Prior to the Conference a prime band for this application was the 24.25-25.25 GHz band; however, the WARC reduced the radionavigation band at 25 GHz to a 400 MHz bandwidth, only 200 MHz of which is an exclusive allocation.

In the USA, the band 15.7-16.2 GHz is allocated to ASDE through US domestic footnote G59, and ASDE is being considered for implementation in the band for both civilian and military use. Given that ASDE equipment is thus already available in the band, and that in such bands sharing arrangements are only required with immediate neighbours (see Section 2.0 of Annex A), consideration is given to making that band available for ASDE use in Canada, without constraining use of higher frequency bands at 24 GHz or 32 GHz for that application. This could be done either by a footnote similar to the US footnote G59, or by allocating the band to the radionavigation service per se. The former approach is preferred, so that the radionavigation use is limited to ASDE, the use for which the band has been identified.

Proposed Canadian Table

It is proposed that the 15.7-16.2 GHz portion of the 15.7-16.6 GHz band be made available for ASDE, through the addition of Canadian footnote C020D, as indicated below:

15.7-16.6 GHz	
	RADIOLOCATION
	C020D

C020D In the sub-band 15.7-16.2 GHz the radionavigation service, limited to the use of Airport Surface Detection Equipment (ASDE), is also allocated on a primary basis.

3.6 . . 17.3-17.7 GHz

Existing Canadian Allocations

Prior to the Conference, the band 17.3-17.7 GHz was allocated on a world-wide basis, and in the Canadian table, as shown below, to the fixed-satellite service on a primary basis and to the radiolocation service on a secondary basis. Footnote 869 limited the use of the fixed-satellite service to feeder-links for the broadcasting-satellite service, as specified in Appendix 30A.

17.3-17.7 GHz		
	FIXED-SATELLITE (Earth-to-space)	869
	Radiolocation	
	~~868~~	

869 (Orb-85) The use of the band 17.3-18.1 GHz by the fixed-satellite service (Earth-to-space) is limited to feeder links for the broadcasting-satellite service. For the use of the band 17.3-17.8 GHz in Region 2 by the feeder links for the broadcasting-satellite service in the band 12.2-12.7 GHz, see Article 15A.

The ITU Table also included footnote 868, which allocates the band in certain countries to the fixed and mobile services on a secondary basis; this in-country footnote is not in the Canadian Table since it does not affect Canadian use of the band.

WARC-92 Decision

At WARC-92, the broadcasting-satellite service was added to this band in Region 2 on a primary basis. (Note that in Regions 1 and 3 the new allocation to the broadcasting-satellite service was made instead to the 21.4-22 GHz band.) At the Conference, Canada and Brazil initiated discussions to have the new broadcasting-satellite service in this band instead of at higher-frequency bands, including the 22 GHz band. Two additional footnotes were added by the Conference in this band to complement this new broadcasting-satellite allocation:

- footnote 868A, which states that the sharing between the fixed-satellite assignments of Appendix 30A and assignments of the

new broadcasting-satellite service shall be in accordance with changes to Annex 4 of Appendix 30A. (This footnote was based on a Canadian WARC proposal.)

- o footnote 869A, which states that the allocation to the broadcasting-satellite service comes into effect on April 1, 2007. (A similar initial date pertains to the initiation of the service in the 22 GHz band in the other regions.)

Discussion

The existing ITU and Canadian tables allocate the band 22.5-23 GHz to the broadcasting-satellite service, shared on a co-primary status but under Article 14, with the fixed, mobile, and inter-satellite services. With the development of high-definition television (HDTV) and its possible delivery by satellite, the need to change this allocation had been recognized by the ITU and by Canada in its preparations for WARC-92. In those preparations, it had been concluded that the 17.3-17.8 GHz band was the best band for such an allocation, both because of lower rain attenuation and associated system costs at 17 GHz compared with higher frequencies, and to make the 22 and 23 GHz bands available for other services as required. Region 2 agreed with and adopted this Canadian proposal to the WARC.

It was recognized by the WARC that the 17 GHz band in Region 2, and the 22 GHz band in Regions 1 and 3, will not be required for some time; as a result, a delay in the activation of these allocations until 1 April 2007 was specified in new footnote 869A for Region 2. It is not anticipated that the allocation will be required in Canada before that date (see Section 6.0 of Annex B); thus, 869A is proposed for the Canadian Table as well. Moreover, many potential HDTV and Advanced Television (ATV) applications in Canada can be implemented at 12 GHz, given the flexibility of the Appendix 30 plan and the fact that Canadian assignments in that plan cover all frequencies in specific orbit locations (see Annex D). To use this 12 GHz band efficiently, and to make the 17 GHz band available for other uses as long as possible, it is proposed to add footnote C020A to the Canadian Table (see Section 3.3 above and Section 3.7 below for related information).

Proposed Canadian Table

Based on the above, on consideration of the 12.2-12.7 GHz band above, and on consideration of requirements for Canadian broadcasting-satellite systems and their associated feeder links as discussed above in Sections 6.0 and 7.1 of Annex B, it is proposed that the Canadian Table in the band 17.3-17.8 GHz read as follows:

17.3-17.7 GHz	FIXED-SATELLITE (Earth-to-space) 869 **BROADCASTING-SATELLITE** Radiolocation ~~868~~ 868A 869A C020A

where the new ITU footnotes are

868A In the band 17.3-17.8 GHz, sharing between the fixed-satellite service (Earth-to-space) and the broadcasting-satellite service shall be in accordance with the provisions of Annex 4 of Appendix 30A.

869A In Region 2, the allocation to the broadcasting-satellite service in the band 17.3-17.8 GHz shall come into effect on 1 April 2007. After that date, use of the fixed-satellite (space-to-Earth) service in the band 17.7-17.8 GHz shall not claim protection from and shall not cause harmful interference to operating systems in the broadcasting-satellite service.

Two Canadian footnotes are proposed for this band: one relating to the implementation of broadcasting-satellite feeder links, and the other (a modification to 869A) relating to inter-service sharing in the band 17.7-17.8 GHz. These are:

C020A (See Section 3.2 above.)

C020E (See Section 3.7 below. Note that 869A and C020E are the same in the band 17.3-17.7 GHz, but their differences in the band 17.7-17.8 require that 869A be replaced by C020E throughout the band 17.3-17.8 GHz.)

3.7 . . 17.7-17.8 GHz

Existing Canadian Allocations

The current Canadian allocation of the band 17.7-17.8 GHz is to the fixed and the fixed-satellite (space-to-Earth) and (Earth-to-space) services. Currently, this band is a sub-band of the band 17.7-18.1 GHz.

17.7-18.1 GHz	FIXED FIXED-SATELLITE (Earth-to-space) (space-to-Earth) 869 ~~MOBILE~~

The mobile service is allocated in the ITU Region 2 Table, but is not allocated in the current Canadian Table for reasons discussed in Section 3.0 of Annex B.

WARC-92 Decision

As discussed above in Section 3.6, the WARC allocated the band 17.3-17.8 GHz to the broadcasting-satellite service and adopted footnotes 868A and 869A that specify inter-service sharing in the band. 869A specifies that the fixed-satellite service (space-to-Earth) shall be secondary to the broadcasting-satellite service after 1 April 2007, but puts no constraints on the sharing between the fixed and broadcasting-satellite services.

A separate US/Canada Coordination Agreement was reached on how to share the band between the broadcasting-satellite and the fixed services near the Canada/US border. That agreement included the following:

1. The power flux density limit already established in Article 28 for this band will be applied to the BSS for the protection of the fixed service;

2. There will be a new ITU footnote ensuring protection of the BSS from FSS (space-to-Earth) operations;

3. The BSS will not, except by mutual agreement, be implemented before 1 January 2007;

4. Neither country will authorize new fixed systems in this band, except under the conditions specified in indent 5 below; and,

5. Fixed systems operating in the band 17.7-17.8 GHz in either country will be required to make whatever adjustments are necessary so as to limit the aggregate power flux density of such systems into the neighbouring country to -109 dB(W/m^2) over any 1 MHz in this frequency band in any area where the BSS is in use. This value may be modified by mutual agreement.

Note that items 2 and 3 above were included in the Final Acts of the Conference.

Discussion

Consideration of the proposed allocation to the broadcasting-satellite was discussed above in Sections 6.0 of Annex B and 3.6 above; the required bandwidth is 17.3-17.8 GHz. The ITU has decided that such systems should be implemented only after 1 April, 2007; it would be difficult to implement systems before that date, as discussed in Section 3.0 of Annex A.

The remaining considerations in this band, then, are the status of the fixed and fixed-satellite (space-to-Earth) services. Canadian proposals to the Conference (proposed footnotes 869A and 869B) stated that in the

ITU Table the fixed, mobile, and fixed-satellite (space-to-Earth) should protect and not claim protection from future operating broadcasting-satellite systems. The Conference agreed to footnote 869A shown in Section 3.6 above (not 869A proposed by Canada to the WARC) which effectively makes the fixed-satellite service downlink secondary to the broadcasting-satellite service, but places no constraints on the fixed service. This omission of the fixed service in 869A was necessary to reach an agreement with the USA at the Conference; instead, the constraints on the fixed and BSS systems in the Canada/USA agreement discussed above complemented the agreement to have BSS allocated in the band subject to 869A. Canada can modify its domestic allocation table to meet its perceived requirements, as long as these are consistent with the ITU Regulations and the Canada/USA bilateral agreement.

Proposed Canadian Table

It is proposed that the fixed, fixed-satellite (Earth-to-space) and (space-to-Earth), and broadcasting-satellite be allocated in the band, subject to

- o the broadcasting-satellite service not being introduced before 1 April 2007;
- o the fixed-satellite (space to-Earth) and the fixed services not causing harmful interference or requiring protection from BSS networks; and
- o broadcasting-satellite service being subject to the power flux-density limits for the fixed-satellite service downlink in Article 28 of the Radio Regulations.

The proposed 17.7-17.8 GHz allocation table is:

17.7-17.8 GHz	FIXED FIXED-SATELLITE (space-to-Earth) (Earth-to-space) 869 **BROADCASTING-SATELLITE** ~~Mobile 869B~~ **868A** ~~**869A**~~ C020A C020E C020F

where the new ITU footnotes and proposed Canadian footnotes are:

868A (see Section 3.6 above)

869A (see Section 3.6 above)

C020A (see Section 3.3 above)

C020E In Region 2, the allocation to the broadcasting-satellite service in the band 17.3-17.8 GHz shall come into effect on 1 April 2007. After that date, use of the fixed service and the fixed-satellite (space-to-Earth) service in the band 17.7-17.8 GHz shall not claim protection from and shall not cause harmful interference to operating systems in the broadcasting-satellite service.

C020F The power flux density limit in Article 28 of the Radio Regulations for the fixed-satellite service in this band shall also apply to the broadcasting-satellite service.

3.8 . . 17.8-18.4 GHz

Existing Canadian Allocations

The services allocated in the current Canadian Table in the band 17.8-18.1 GHz on a co-primary basis are the fixed, fixed-satellite (space-to-Earth), and fixed-satellite (Earth-to-space, subject to footnote 869) services. In the higher band 18.1-18.6 GHz co-primary allocations are to the fixed and fixed-satellite (space-to-Earth) services. These allocations are the same as those in the ITU Table except that the mobile service has been omitted (See Section 3.0 of Annex B).

17.8-18.1 GHz	FIXED FIXED-SATELLITE (space-to-Earth) (Earth-to-space) 869 ~~MOBILE~~
18.1-18.4 GHz	FIXED FIXED-SATELLITE (space-to-Earth) ~~MOBILE~~ 870

WARC-92 Decision

The Conference made no change to the band 17.8-18.1 GHz. (the band is included here because of the possibility of adding footnote C020A to the Canadian Table in the band.) The Conference extended the FSS Earth-to-space band upwards to 18.4 GHz on a world-wide basis, limiting the use of the allocation to BSS feeder links through new footnote 870A. A new in-country *alternative-allocation* footnote 870B was added, but this footnote has no effect on Canadian use of the band.

870A The use of the band 18.1-18.4 GHz by the fixed-satellite service (Earth-to-space) is limited to feeder links for the broadcasting service.

Discussion

As discussed in Section 7.0 of Annex B, the band 17.9-18.4 GHz is considered as a long-term feeder-link band for 12 GHz BSS systems, subject to the constraints imposed by proposed new footnote C020A. Thus the FSS (Earth-to-space) allocation should be in the Canadian Table, subject to both 870A and C020A.

Proposed Canadian Table

It is proposed that the Canadian Table in the band 17.8-18.4 GHz be the same as that agreed to at WARC-92 for Region 2, with the deletion of the mobile service, deletion of footnote 870B, and the addition of footnote C020A, as follows:

17.8-18.1 GHz	FIXED FIXED-SATELLITE (space-to-Earth) (Earth-to-space) 869 ~~MOBILE~~ C020A
18.1-18.4 GHz	FIXED FIXED-SATELLITE (space-to-Earth) **(Earth-to-space) 870A** ~~MOBILE~~ 870 ~~870B~~ C020A

C020A (See Section 3.3)

3.9 . . 18.4-19.7 GHz

Existing Canadian Allocations

The 18.4-19.7 GHz band is allocated in Canada to the fixed and fixed-satellite (space-to-Earth) services. (The band 18.6-18.8 GHz is allocated also to passive scientific satellite services.) These are the same allocations as those in the ITU Table, except that the mobile service has been omitted, as discussed in Section 3.0 of Annex B.

WARC-92 Decision

The Conference made no change to the ITU Table in this band. However, the Conference made a number of allocations to the mobile-satellite service below 3 GHz, and approved procedures in Resolution 46 (COM 5/8) entitled "*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*", through which Low-Earth-Orbiting or LEO mobile satellite systems can be coordinated and implemented. Many of these systems require feeder links in the fixed-satellite service in both the space-to-Earth and Earth-to-space directions. A review of Regulation

2613 at the Conference concluded that such feeder-link networks in the FSS should not cause unacceptable interference to geostationary (GSO) FSS networks in the same band.

Discussion

As discussed in Section 5.2 of Annex B, sharing between GSO FSS networks and feeder links to LEO MSS networks is quite difficult. This is substantiated by work done within Canadian CCIR Study Group 4. Because of these potential difficulties, the possibility of designating a specific FSS band to be used by LEO MSS networks is considered here.

As a first step in narrowing the search for a band that could be so designated, it is noteworthy that a number of potential LEO MSS operators have stated their intention to implement their feeder-link systems in the 30/20 GHz region, ie. from 17.7 to 20.2 GHz for downlinks and 27.5 to 30 GHz for uplinks. This is because lower FSS bands in the 6/4 GHz and 14/11-12 GHz bands are used much more heavily for international and domestic FSS systems using the GSO, and bands higher than 30 GHz are not yet developed for commercial use. Bandwidths in the order of 100 MHz may be necessary to accommodate these systems.

To further narrow the alternatives for selecting a pair of uplink and downlink LEO MSS feeder-link bands, the following factors were taken into account:

1) The bands 19.7-20.2 GHz and 29.5-30 GHz would not be appropriate, as these are being considered for VSAT use and a wide spectrum of applications involving large numbers of small earth terminals, an environment in which sharing with LEO MSS feeder links would be particularly difficult.

2) The designated feeder-link band should be as low in the 30/20 GHz band as possible to allow as much contiguous bandwidth as possible for wide-band GSO FSS systems below 29.5 GHz and below 19.7 GHz.

3) The feeder links should not be in a band being considered for bidirectional use involving BSS feeder links in the bands 17.7-17.8 GHz and 17.9-18.4 GHz, as the further addition of non-GSO systems in the same band may make the resultant sharing constraints overly difficult.

4) The feeder links should not, if possible, be in the band 18.6-18.8 GHz used for passive space research and earth exploration-satellite applications.

5) Sharing with fixed systems in the band 18.14-18.58 GHz used for multipoint communications systems (MCS) may be difficult.

Within these constraints, it must be realized that these LEO MSS systems are global systems; thus, any designated band would eventually have to be adopted world-wide. However, the matter was not discussed at WARC-92, and the only avenue for addressing the matter other than through CCIR activities (which are complementary to this spectrum policy consideration) is through the development of spectrum policy directions in individual countries, with the possibility that such activities may converge.

The following three alternative band pairs were considered for these LEO MSS feeder links:

1) The downlink band 17.8-17.9 GHz and corresponding uplink band 27.5-27.6 GHz. The downlink band was chosen to be as far as possible from the likely initial FSS development of the 30/20 GHz band (ie. in the band 19.7-20.2 GHz), and to be between the BSS band 17.3-17.8 GHz (or BSS feeder-link band) and a possible long-term feeder-link band 17.9-18.4 GHz (see Sections 6.0 and 7.0 of Annex B).

2) The downlink band 18.4-18.5 GHz, just above the bidirectional use of the 18 GHz band, and the corresponding uplink band 28.2-28.3 GHz (each one beginning 1.7 GHz below the top edge of the 30/20 GHz bands for both uplinks and downlinks).

3) The downlink band 18.82-18.92 GHz and corresponding uplink band 28.62-28.72 GHz, each one beginning 1.28 GHz below the top edge of the 30/20 GHz bands for both uplinks and downlinks. This band was considered because the band 18.82-18.92 GHz is used for wireless LAN systems in the fixed service, and cannot, therefore, shared as easily with FSS systems having larger numbers of earth stations.

The first alternative would seem ideal from a Canadian domestic perspective, but given that such an arrangement would have to be adopted globally, it would have the same difficulty as the higher band 17.9-18.4 GHz, because the band 17.3-18.1 GHz is planned in Appendix 30A for Region 1 BSS feeder links. The second of the above alternatives may have serious sharing problems with fixed systems in that portion of the 18 GHz band.

The third alternative in the 18 GHz band is planned for the fixed service and was recently channelized for wireless LAN systems. The band will consist of ten RF channels each 10 MHz wide over the band 18.82-18.92 GHz. These systems will be used mainly in buildings with a small coordination range, but there may be many of them. For this reason, the band may not be useful for GSO VSAT systems, but may be useful for non-GSO MSS gateway systems having relatively few large steerable earth stations that could be located outside of urban areas.

Proposed Canadian Table

It is proposed that in the bands 18.8-19.7 GHz and 28.5-29.5 GHz the following footnote be added:

18.8-19.7 GHz	FIXED FIXED-SATELLITE (space-to-Earth) **C020G**

C020G Non-geostationary mobile-satellite systems that operate in frequency bands below 3 GHz and use fixed-satellite bands for their feeder links shall use the bands 18.82-18.92 GHz in the space-to-Earth direction and 28.62-28.72 GHz in the Earth-to-space direction for those feeder links, unless otherwise agreed with the Department. In those bands the provisions of Radio Regulation 2613 (mod WARC-92) do not apply in the coordination of Canadian geostationary fixed-satellite networks.

3.10 . 19.7-20.2 GHz

Existing Canadian Allocations

The current Canadian Table allocates the band 19.7-20.2 GHz to the FSS (space-to-Earth) on a primary basis, and to the MSS (space-to-Earth) on a secondary basis. This is the same as the world-wide ITU allocation, except that the ITU Table includes footnote 873, an in-country footnote allocating the band also to the fixed and mobile services but is explicit in not limiting the e.i.r.p. from space stations in the fixed-satellite service.

19.7-20.2 GHz	FIXED-SATELLITE (space-to-Earth) Mobile-Satellite (space-to-Earth) ~~873~~

WARC-92 Decision

The Conference considered in detail Canadian proposals to allocate spectrum to the multipurpose-satellite service in the 24 and 27 GHz bands, and proposals of the USA and Mexico to allocate spectrum to the general-satellite service in the 19.7-20.2 GHz and 29.5-30 GHz bands. These allocation proposals were to accommodate the applications discussed above in Section 4.0 of Annex B.

The Conference concluded that a new service definition was not necessary to implement the satellite systems which Canada, the USA and Mexico described in support of their proposals. Instead, the Conference decided to upgrade the secondary mobile-satellite service to primary status in the band, over the full 500 MHz bands 19.7-20.2 GHz and

29.5-30 GHz in Region 2 and over the 100 MHz bands 20.1-20.2 GHz and 29.9-30 GHz in Regions 1 and 3. In addition, it approved five footnotes (873A through 873E) specifying how the band was to be used, and modified 873 to exclude the MSS as well as the FSS from e.i.r.p. limitations arising from fixed and mobile allocations in certain countries. These new and modified footnotes are as follows:

873 *Additional Allocation*: in Afghanistan,...and Zaire the band 19.7-21.2 GHz is also allocated to the fixed and mobile services on a primary basis. This additional use shall not impose any limitation on the power flux-density of space stations in the fixed-satellite service in the band 19.7-21.2 GHz and of space stations in the mobile-satellite service in the band 19.7-20.2 GHz where such allocation to the mobile-satellite service is on a primary basis in the latter band.

873A In order to facilitate interregional coordination between networks in the mobile-satellite service and fixed-satellite services, carriers in the mobile-satellite service that are most susceptible to interference shall, to the extent practicable, be located in the higher parts of the bands 19.7-20.2 GHz and 29.5-30 GHz.

873B In the bands 19.7-20.2 GHz and 29.5-30 GHz in Region 2, and in the bands 20.1-20.2 GHz and 29.9-30 GHz in Regions 1 and 3, networks which are in both the fixed-satellite service and the mobile-satellite service may include links between stations at specified or unspecified points or while in motion, through one or more satellites for point-to-point and point-to-multipoint communications.

873C In the bands 19.7-20 2 GHz and 29.5-30 GHz, the provisions of No. 953 do not apply with respect to the mobile-satellite service.

873D The allocation to the mobile-satellite service is intended for use by networks which use narrow spot-beam antennas and other advanced technology at the space stations. Administrations operating systems in the mobile-satellite service in the band 19.7-20.1 GHz in Region 2 and 20.1-20.2 GHz shall take all practicable steps to ensure continued availability of these bands for administrations operating fixed and mobile systems in accordance with the provisions of No. 873.

873E The use of the bands 19.7-20.1 GHz and 29.5-29.9 GHz by the mobile-satellite service in Region 2 is limited to satellite networks which are both in the fixed-satellite service and in the mobile-satellite service as described in No. 873B.

The Conference also approved Recommendation 719 (COM 4/D), requesting that the CCIR study the technical characteristics of such systems, the compatibility between FSS and MSS applications in the

bands, and the spectrum and orbit efficiency of these systems.

Discussion

The Conference decisions enable systems being planned in Canada (and in the USA) to be coordinated and put into service and should, therefore be included in the Canadian Table without change. Any change to the regulations in the Canadian Table only would create the international coordination problems discussed in Section 3.0 of Annex A.

Proposed Canadian Table

It is proposed that the Canadian Table, for the band 19.7-20.2 GHz, be as follows:

19.7-20.2 GHz	FIXED-SATELLITE (space-to-Earth) ~~Mobile-Satellite (space-to-Earth)~~ **MOBILE-SATELLITE (space-to-Earth)** ~~873~~ **873A 873B 873C 873D 873E**

where the new footnotes are as described above.

3.11 . 21.2-23.6 GHz

This section of this document, by exception, does not discuss all allocations within a band, but only one service within a given frequency range, namely the mobile service in the range 21.2-23.6 GHz. (A more detailed discussion of allocation changes in the 22.5-23 GHz portion of that range is presented in Section 3.12 below.)

Existing Canadian Allocations

Currently, the complete 21.2-23.6 GHz frequency range is allocated on a primary basis to the mobile service, on a co-primary basis with the fixed service, and with other services over part of the band. In the 22.0-22.5 GHz portion, the aeronautical mobile service is excluded. This allocation is the same as that in the ITU Table.

WARC-92 Activity

The Conference made no changes to the mobile service in this frequency range, although it did delete the broadcasting-satellite service and associated Footnote 877 from the band 22.5-23 GHz.

Discussion

As discussed in Section 3.0 of Annex B, the mobile service is not used as such in this frequency range in Canada, and it is not expected that there will be requirements for the service in Canada in the foreseeable future, given Canadian policy of licensing transportable line-of-sight radio systems in the fixed service rather than in the mobile service. Furthermore, as discussed in Section 1.0 of Annex B, it is expected that there will be increasing requirements for fixed systems in this frequency

range.

Proposed Canadian Table

For the above reasons, it is proposed that for the 21.2-23.6 GHz frequency range, the status of the mobile service, or the mobile excepting aeronautical mobile service in the band 22-22.5 GHz, be reduced from primary to secondary. For the bands 21.2-22.5 GHz and 23.55-23.6 GHz, the proposed Canadian Table entry is as follows:

21.2-21.4 GHz	EARTH EXPLORATION-SATELLITE (passive) FIXED ~~MOBILE~~ Mobile SPACE RESEARCH (passive)
21.4-22 GHz	FIXED ~~MOBILE~~ Mobile
22-22.21 GHz	FIXED Mobile except aeronautical mobile 874
22.21-22.5 GHz	EARTH EXPLORATION-SATELLITE (passive) FIXED ~~MOBILE except aeronautical mobile~~ Mobile except aeronautical mobile RADIO ASTRONOMY SPACE RESEARCH (passive)
23.55-23.6 GHz	FIXED ~~MOBILE~~ Mobile

It is proposed that the mobile service be reduced to secondary status in the 22.5-23.55 GHz band as well, as discussed in the following section.

3.12 22.5-23.55 GHz

Existing Canadian Allocations

Currently, the band 22.5-23.55 GHz is divided into three sub-bands: 22.5-22.55 GHz, 22.55-23 GHz, and 23-23.55 GHz. The fixed and mobile services are allocated on a primary basis throughout the full 1.05 GHz wide band, the broadcasting-satellite service is allocated on a primary basis in the lower 500 MHz (22.5-23.0 GHz), subject to Article 14 through Footnote 877, and the inter-satellite service is allocated on a primary basis in the top 1 GHz (22.55-23.55 GHz). Note that there are intentional 50 MHz guard bands between the inter-satellite service allocation and the passive allocations below 22.5 GHz and above 23.6 GHz.

22.5-22.55 GHz	FIXED MOBILE BROADCASTING-SATELLITE 877 ~~878~~
22.55-23 GHz	FIXED MOBILE BROADCASTING-SATELLITE 877 INTER-SATELLITE ~~878~~ 879
23-23.55 GHz	FIXED MOBILE INTER-SATELLITE 879

Note that Footnote 878 was not included, as it is an in-country footnote that does not affect Canada.

WARC-92 Decision

The Conference allocated spectrum to the broadcasting-satellite service in the 17.3-17.8 GHz band in Region 2, and in the 21.4-22 GHz band in Regions 1 and 3 (see Section 6.0 of Annex B, and Sections 3.6 and 3.7 above). That decision, in part, led to the removal of the broadcasting-satellite service from the band 22.5-23 GHz, and to the consequential deletion of Footnote 877.

Discussion

Canada proposed to WARC-92 that the band 17.3-17.8 GHz be allocated to the broadcasting-satellite service instead of the band 22.5-23 GHz; thus the service could be deleted from the Canadian Table in the 22.5-23 GHz band. (See also Section 3.0 of Annex A). A major effect of this change is to make the band more amenable for fixed service use. Another change in this band reduced the status of the mobile service from primary to secondary, as discussed in Sections 3.0 of Annex B and 3.11 above.

Proposed Canadian Table

It is proposed that the broadcasting-satellite service be deleted from this band, and that the mobile service be reduced from primary to secondary status (see Section 3.11). With these changes, the Canadian Table in this band would read as follows:

22.5-22.55 GHz	FIXED ~~MOBILE~~ Mobile
22.55-23.55 GHz	FIXED ~~MOBILE~~ INTER-SATELLITE Mobile 879

Note that the broadcasting-satellite service is deleted from the 22.55-23 GHz band in the ITU Region 2 Table and is, therefore, proposed for deletion from the Canadian Table.

3.13 24.25-25.25 GHz

Existing Canadian Allocations

Currently, the band 24.25-25.25 GHz is allocated exclusively to the radionavigation service. This was also the exclusive allocation in the ITU Table prior to WARC-92. The band was unused in Canada, and used by only a few administrations globally, although preliminary work was underway in Canada to use the band for ASDE. (See Section 8.0 of Annex B).

24.25-25.25 GHz	RADIONAVIGATION

WARC-92 Decision

There were several changes made in this band by the Conference. The band was seen by the Conference as a relatively unused band, into which a number of allocations could be made if spectrum could not be found for

them in other portions of the 20 to 30 GHz frequency range. These included:

- o allocation to the fixed service over the complete band in Regions 1 and 3, as compensation to users of that service for losing the band 21.4-22 GHz to the broadcasting-satellite service;
- o allocation to the inter-satellite service on a primary basis globally, over the 300 MHz-wide band 24.45-24.75 GHz, with one of the presumed applications being inter-satellite links between space stations of LEO mobile-satellite networks;
- o allocation to feeder links for broadcasting-satellite systems in the upper 500 MHz of the band in Regions 2 and 3. (Canada had initially proposed the band 21.4-22.2 GHz for this application.)
- o allocation of the band 24.65-24.75 GHz to the radiolocation-satellite service in the Earth-to-space direction.

The radionavigation service was retained in the lower 400 MHz of the band, ie. only 40 % of the pre-WARC bandwidth, but with priority over the inter-satellite service in the upper 50 % of that 400 MHz band through footnote 882E:

882E The inter-satellite service shall not claim protection from harmful interference from airport surface detection equipment stations of the radionavigation service.

The WARC specified that feeder links to broadcasting-satellite systems have priority over other uses of the fixed-satellite (Earth-to-space) allocation in the band 24.75-25.25 GHz, through Footnote 882G:

882G In the band 24.75-25.25 GHz, feeder links to stations of the broadcasting-satellite service shall have priority over other uses of the fixed-satellite service (Earth-to-space). Such other users shall protect and shall not claim protection from existing and future operating feeder-link networks of such broadcasting satellite stations.

Discussion

All of the allocation changes in the 24.25-25.25 GHz band in Region 2 were to accommodate new requirements of space services. The allocation of the 24.75-25.25 GHz band to the fixed-satellite service, in particular, is consistent with Canadian objectives at the WARC in that Canada had initially made a similar proposal in the 22 GHz band but accepted the 24 GHz alternative to achieve consensus at the Conference.

The new ITU allocations to the inter-satellite and radiolocation-satellite

services are not based on Canadian proposals to the Conference, although Canadian applications in these services may emerge. Discussion of possible differences between the Canadian Table and the ITU Table in Section 3.0 of Annex A is particularly applicable here, because the new allocations are all to space services. The conclusions drawn from the above are that the 24.25-25.25 GHz band entry in the Canadian Table should be the same as those of the WARC, the only difference being the addition of a proposed footnote C020A to the band 24.75-25.25 GHz. (See Sections 7.1 of Annex B and 3.2 above).

One area where the Conference decisions differed from the Canadian proposals is that the radionavigation service band in the ITU Table is now 400 MHz wide, rather than 500 MHz proposed by Canada. It would be very difficult to adopt a bandwidth wider than 400 MHz in the Canadian Table, as indicated in Section 4.0 of Annex A. For this reason, the alternative band 15.7-16.2 GHz is being proposed for ASDE radionavigation use through Footnote C020D (See Section 3.5 above).

Proposed Canadian Table

Based on the above information, it is proposed that the Canadian Table entry for the band 24.25-25.25 GHz are as follows:

24.25-24.45 GHz	RADIONAVIGATION
24.45-24.65 GHz	RADIONAVIGATION **INTER-SATELLITE 882E**
24.65-24.75 GHz	**INTER-SATELLITE** **RADIOLOCATION-SATELLITE** **(Earth-to-space)**
24.75-25.25 GHz	**FIXED-SATELLITE** **(Earth-to-space) 882G** C020A

Footnotes 882E and 882G are reproduced in the previous Section, and C020A in Section 3.2 above. Note the proposal that the radionavigation service be deleted from the band 24.65-25.25 GHz.

3.14 25.25-27.0 GHz

Existing Canadian Allocations

Currently the band 25.25-27.0 GHz is allocated to the fixed and mobile services on a shared primary basis, and to the earth exploration-satellite (space-to-space) and the standard frequency and time signal-satellite (Earth-to-space) services on a shared secondary basis. These are the same services that were allocated in the ITU Table on a world-wide basis before WARC-92.

25.25-27 GHz	FIXED MOBILE Earth Exploration-Satellite (space-to-space) Standard Frequency and Time Signal-Satellite (Earth-to-space)

WARC-92 Decision

It was concluded by the Conference that the band 25.25-27.5 GHz should be used for inter-satellite links between low-orbiting (LEO) satellites such as Space Station Freedom, and geostationary (GSO) data-relay satellites such as the Tracking and Data Relay Satellite System (TDRSS) of NASA/USA, and for short (30 to 40 miles) links between low-orbiting satellites. It is envisaged that this band will be used in conjunction with the inter-satellite band 22.55-23.55 GHz to provide wide-band links to and from LEO spacecraft. The only constraint placed on use of the inter-satellite allocation is that it be used only for scientific, industrial, and medical applications, ie. not for inter-satellite links between communications or broadcasting satellites. This was specified through the following footnote:

881A Use of the 25.25-27.5 GHz band by the inter-satellite service is limited to space research and Earth exploration-satellite applications, and also transmissions of data originating from industrial and medical activities in space.

A second related consequential action taken by the Conference was to delete the secondary Earth exploration-satellite (space-to-space) allocation. Rather than deleting it entirely, however, the Conference simply modified its directionality constraint from (space-to-space) to (space-to-Earth).

Discussion

Canada was in agreement at the WARC that the band 25.25-27.5 GHz should be used for data links between scientific satellites, and was willing to extend this use to industrial and medical applications but not to communications satellites since other bands were allocated for that purpose. Canada had proposed a new service definition, the "Space

Communication" service, for this purpose, and proposed that this new service be allocated spectrum in the 25.25-27.5 GHz band. The Canadian proposal was not accepted per se, but discussion of it resulted in footnote 881A above. The decisions of the Conference, then, were not identical to but were consistent with Canadian proposals to the Conference in this band. An additional provision in the Conference Final Acts relating to these allocations is that the power flux-density limits in Article 28 pertaining to the 17.7-19.7 GHz band were extended to inter-satellite networks in the band 25.25-27.5 GHz.

In considering the WARC decisions in this band, the constraints and limitations incurred in modifying worldwide space service allocations in a national allocation table, as discussed in Sections 1.0 and 3.0 of Annex A, should be taken into account.

Proposed Canadian Table

For reasons discussed above, it is proposed that the Canadian Table in this band be the same as that in the WARC-92 Final Acts, that is:

25.25-27 GHz	FIXED MOBILE **INTER-SATELLITE 881A** Earth Exploration-Satellite **(space-to-Earth)** Standard Frequency and Time Signal-Satellite (Earth-to-space)

3.15 . 27.0-27.5 GHz

Existing Canadian Allocations

The current Canadian allocations in this band are the same as those in the ITU Table for Regions 2 and 3 before WARC-92, as follows:

27-27.5 GHz	FIXED MOBILE FIXED-SATELLITE (Earth-to-space) Earth Exploration-Satellite (space-to-space)

It should be noted that the fixed-satellite (Earth-to-space) allocation in this band had been added by WARC-79 in Regions 2 and 3 to accommodate feeder links for broadcasting-satellite systems in the 22.5-23 GHz band without unbalancing the 2.5 GHz-wide fixed-satellite uplink and downlink

allocations in the bands 27.5-30 GHz and 17.7-20.2 GHz,respectively.

WARC-92 Decision

The Conference added the inter-satellite allocation, including Footnote 881A, in this band to complete its allocation of the service over the full 25.25-27.5 GHz band, as discussed above in Section 3.14. Other changes made by the WARC in the band are:

- o the secondary Earth exploration-satellite (space-to-space) service was deleted, rather than changing its direction constraint to (space-to-Earth) as was done in the lower 25.25-27.0 GHz band;

- o the fixed-satellite (Earth-to-space) service was not deleted, as had been proposed by several administrations including Canada; rather, Footnote 881B was added so that Radio Regulation 2613 did not give an FSS network any advantage over a non-geostationary inter-satellite network for coordination purposes under Article 11 of the Regulations. Footnote 881B is as follows:

881B Space services using non-geostationary satellites operating in the inter-satellite service in the band 27-27.5 GHz band are exempt from the provisions of No. 2613.

Discussion

The addition of the inter-satellite service and Footnote 881A is discussed above in Section 3.14; inclusion of the service with the footnote in this band completes that change, and should be done for the reasons outlined above. The deletion of the secondary Earth exploration-satellite (space-to-space) service in the band is simply consequential to the primary inter-satellite allocation through Footnote 881A.

The retention of the fixed-satellite service with 881B added was a compromise at the WARC between those who wished to operate inter-satellite networks in the band without the need to coordinate with GSO fixed-satellite networks and those who wished to retain the FSS allocation. It should be noted that the band is no longer a prime band for BSS feeder-link systems, because that requirement can be met through allocations at 17 GHz, 18 GHz, and at 25 GHz (see Section 7.1 of Annex B). The elimination of 881B from the Canadian Table would not change the way in which a hypothetical Canadian FSS network in the band could be coordinated internationally. (See Section 3.0 of Annex A). Nor would elimination of the service and the footnote change the way FSS systems were implemented in the band by other administrations. Thus it would seem that to include the service in the band with 881B would provide the most flexibility in the use the band at a later date if the need arose, without imposing constraints on use of the band for scientific satellite programs.

Proposed Canadian Table

For the reasons discussed above, it is proposed that for this band, the Canadian Table be the same as the new ITU Table, as follows:

27-27.5 GHz	FIXED MOBILE FIXED-SATELLITE (Earth-to-space) **INTER-SATELLITE 881A 881B**

3.16 . 27.5-29.5 GHz

Existing Canadian Allocations

The current Canadian allocations in the 27.5-29.5 GHz band are the same as those of the ITU Table before WARC-92 on a world-wide basis, as follows:

27.5-29.5 GHz	FIXED MOBILE FIXED-SATELLITE (Earth-to-space)

WARC-92 Decision

The Conference made three additions to the world-wide ITU Table for this band:

1. Footnotes 882A and 882B were added to permit satellite operators to implement narrow-band space-to-Earth beacons in the Earth-to-space fixed-satellite band for rain attenuation measurements in their network on a real-time basis. These are:

882A *Additional Allocation*: the bands 27.500-27.501 GHz and 29.999-30.000 GHz are also allocated to the fixed-satellite service (space-to-Earth) on a primary basis for the beacon transmissions intended for up link power control.

Such space-to-Earth transmissions shall not exceed an equivalent isotropically radiated power (e.i.r.p.) of +10 dBW in the direction of adjacent satellites on the geostationary orbit. In the band 27.500-27.501 GHz, such space-to-Earth transmissions shall not produce a power flux-density in excess of the values in No. 2578 on the Earth's surface.

882B *Additional allocation*: the band 27.501-29.999 GHz is also allocated to the fixed-satellite service (space-to-Earth) on a

secondary basis for beacon transmissions intended for up link power control.

2. The earth exploration-satellite (Earth-to-space) service was added in the bands 28.5-29.5 GHz and 29.5-30 GHz on a secondary basis, subject to the constraints of footnote 882C:

882C In the band 28.5-30 GHz, the earth exploration-satellite service is limited to the transfer of data between stations and not to the primary collection of information by means of active or passive sensors.

3. The following footnote was added to band 27.5-30 GHz to specify that the primary fixed-satellite (Earth-to-space) allocation could be used for feeder links for the broadcasting-satellite service:

882D The band 27.5-30 GHz may be used by the fixed-satellite service (Earth-to-space) for the provision of feeder links for the broadcasting-satellite service.

Discussion

The first item above (the accommodation of space-to-Earth beacons to measure rain attenuation on a real-time basis for power-control purposes) was based in part on a Canadian proposal. Canada had proposed to the Conference a variation of footnote 882A. Footnote 882B was based on an alternative proposal from the USA, and the Conference decided to adopt both approaches because they are complementary. Adopting both approaches in the Canadian Table would give Canadian satellite-system manufacturers and operators maximum flexibility in the design and operation of their systems. In contrast, eliminating one or the other in the Canadian Table would not prevent either method being used by other administrations in arcs of the GSO of interest to Canada (see Sections 3.0 and 4.0 of Annex A, and Section 2.0 of Annex B). Thus it would seem advantageous to Canada that both 882A and 882B be included in the Canadian Table.

With respect to the secondary Earth-to-space earth exploration-satellite allocation, further constrained by Footnote 882C, there is some doubt about the usefulness and the necessity of the allocation. If, as stated in 882C, the allocation is to be used only for Earth-to-space feeder links to earth exploration-satellite space stations, that portion of the earth exploration-satellite system can be coordinated and notified within the fixed-satellite service, in accordance with the ITU definition of that service in Radio Regulation 22 (Orb-88). Furthermore, the fixed-satellite (Earth-to-space) service is allocated on a primary basis throughout this band. Thus it would seem that any potential Canadian user of this band for feeder links to an earth exploration-satellite space station should coordinate and notify his network as a fixed-satellite network with primary status rather than as an earth exploration-satellite network with

secondary status. Thus, the secondary allocation serves no useful purpose and need not be included in the Canadian Table.

In respect of Footnote 882D, there is some doubt again of the usefulness and necessity of the footnote. Again, according to the definition of the fixed-satellite service in Radio Regulation 22, that service can be used to provide "feeder links for other space radiocommunication services", including the broadcasting-satellite service. Thus 882D need not be included in the Canadian Table. Note that a similar footnote 858 is omitted from the Canadian Table in the 14-14.5 GHz band for the same reason. These omissions do not in any way prevent these bands being used for broadcasting-satellite feeder links although, as discussed in Section 7.0 of Annex B, they can best be provided in the Canadian context in the 17 GHz, 18 GHz, and 25 GHz bands.

Proposed Canadian Table

For the reasons discussed above, it is proposed that the Canadian Table entry for the band 27.5-29.5 GHz be as follows:

27.5-**28.5** GHz	FIXED MOBILE FIXED-SATELLITE (Earth-to-space) ~~**882D**~~ **882A 882B**
28.5-29.5 GHz	FIXED MOBILE FIXED-SATELLITE (Earth-to-space) ~~**882D**~~ ~~**Earth-Exploration-Satellite (Earth-to-space) 882C**~~ **882A 882B C020G**

It should be noted that with the proposed changes, there would be no need to sub-divide the band 27.5-29.5 GHz into its two components; it was done here because it is sub-divided in the Final Acts of WARC-92, and the earth exploration-satellite allocation is only in the upper portion of the ITU Table. Note also the proposed addition of Canadian Footnote C020G to regulate to the extent possible the implementation of feeder links of non-GSO mobile-satellite networks. (See Sections 3.9 above and 5.2 of Annex B).

3.17 . . 29.5-30 GHz

Existing Canadian Allocations

Currently the band 29.5-30 GHz is allocated to the fixed-satellite and the mobile-satellite services, with the addition of Footnote 882, as follows:

29.5-30 GHz	FIXED-SATELLITE (Earth-to-space) Mobile-Satellite (Earth-to-space) 882 ~~883~~	

882 The band 29.5-30 GHz may also be used for space-to-space links in the earth exploration-satellite service for telemetry, tracking, and control purposes, on a secondary basis.

These allocations are the same as the world-wide pre-WARC-92 in the ITU Table, but without in-country footnote 883 which allows fixed and mobile services on a secondary basis.

WARC-92 Decision

The Conference raised the status of the mobile-satellite service from secondary to primary throughout the band 29.5-30 GHz in Region 2, (but only in the band 29.9-30 GHz in Regions 1 and 3) to complement a similar change in the band 19.7-20.2 GHz. (See Sections 3.10 above and 4.0 of Annex B). Footnotes 873A, 873B, 873C, and 873E were added to this band, as they were to the 19.7-20 2 GHz band, to specify how the mobile-satellite service is to be used. (See Section 3.10 for the text of these footnotes.) In addition:

- Footnotes 882A and 882B were added to accommodate space-to-Earth beacons in the fixed-satellite service for uplink power control to overcome rain attenuation (see Section 3.16);
- additional countries in Region 3 added their names to Footnote 883;
- the earth exploration-satellite service (Earth-to-space) was added on a secondary basis, as it was in the band 28.5-29.5 GHz, and Footnote 882C was added to limit the use of that service (see Section 3.16); and
- Footnote 882D was added in this band as well to specify that the fixed-satellite service could be used for broadcasting-satellite feeder links (see Section 3.16).

Discussion

The Conference made several changes in this band, as noted above; each of the changes is related to changes made in lower bands, and their disposition in this band is related to that in the lower bands, as follows:

- the change in status of the mobile-satellite service from secondary to primary, and the addition of Footnotes 873A, 873B, 873C, and 873E should be made in the Canadian Table as well, as it was in the 19.7-20.2 GHz band (see Section 3.10 above and 4.0 of

Annex B for a detailed discussion of the reasons for this change);

- o Footnotes 882A and 882B should be added to accommodate beacons for uplink power control (see Section 3.16). The primary beacon allocation at 30 GHz in No. 882A may be required in some applications of multipurpose satellite systems in the band;
- o there is no reason to add Footnote 883 to the Canadian Table, as there was not following WARC-79 when it was first added the ITU Table;
- o there is no reason to add the secondary earth exploration-satellite service and associated Footnote 882C in this band, for the same reasons that there is no reason to add the allocation in 28.5-29.5 GHz band; basically that reason is that the primary fixed-satellite service can be used for any application allowed under 882C (see Section 3.16 for further discussion); and
- o there is no reason to add Footnote 882D to the band, for the same reason for not adding it to the band 27.5-29.5 GHz (see Sections 3.16 above and 7.0 of Annex B for further information).

Proposed Canadian Table

For the reasons discussed above and in previous sections, it is proposed that the Canadian Table entry for this band read follows:

29.5-30 GHz	FIXED-SATELLITE (Earth-to-space) ~~**882D**~~ **MOBILE-SATELLITE (Earth-to-space)** ~~**Earth Exploration-Satellite (Earth-to-space)**~~ ~~**882C**~~ **873A 873B 873C 873E** 882 **882A 882B** ~~883~~

3.18 . 31.8-32.3 GHz

Existing Canadian Allocations

The band 31.8-32.3 GHz is divided into two sub-bands 31.8-32 GHz and 32-32.3 GHz in both the current Canadian Table and the ITU Table before WARC-92. The lower sub-band is allocated to the radionavigation and the space research services with primary and secondary status, respectively. The upper sub-band is allocated to these services and also to the inter-satellite service. Note that the radionavigation service extends over the range 31.8 to 33.4 GHz, and the inter-satellite service extends over the range 32 to 33 GHz. Footnote 893 confers certain rights to the radionavigation service over the co-primary inter-satellite service, vis:

893 In designing systems for the inter-satellite and radionavigation

services in the band 32-33 GHz, administrations shall take all necessary measures to prevent harmful interference between the two services, bearing in mind the safety aspects of the radionavigation service (see Recommendation 707).

There were three in-country footnotes to this band in the pre-WARC ITU Table, which were not included in the Canadian Table. These were Footnotes 890 and 891, which allocated the band to the scientific satellite services on a primary basis in certain countries including the USA, and Footnote 892 which allocated the band 31.8-33.8 GHz for downlink fixed-satellite service in Japan, subject to Article 14.

The current Canadian Table entry for this band is as follows:

31.8-32 GHz	RADIONAVIGATION Space Research ~~890~~ ~~891~~ ~~892~~
32-32.3 GHz	RADIONAVIGATION INTER-SATELLITE Space Research ~~890~~ ~~891~~ ~~892~~ 893

WARC-92 Decision

The Conference raised the status of the space research service from secondary to primary, and specified that it should be used for space-to-Earth transmissions from deep space, defined in Regulation 169 (Orb-88) to be beyond 2 x 10^6 kilometres. As a consequence, the secondary space research allocation and Footnotes 890 and 891 were deleted. In addition, Footnote 893 was modified to include the space research service in the same way as the inter-satellite service, viz:

Mod 893 In designing systems for the inter-satellite and radionavigation services in the band 32-33 GHz, **and for the space research service (deep space) in the band 31.8-32.3 GHz,** administrations shall take all necessary measures to prevent harmful interference between the two services, bearing in mind the safety aspects of the radionavigation service (see Recommendation **707**).

Discussion

Canada did not object to the above changes during the WARC, subject to the proviso that the radionavigation service have no lesser a status respect to other primary services in the band than it had prior to the Conference, since the allocation may be used for Airport Surface Detection Equipment (ASDE) in the future (see Section 8.0 of Annex B). These concerns were

fully met with the above modification to Footnote 893; thus, the new ITU allocations in the band can be accepted, with the omission of in-country Footnote 892 as before.

Proposed Canadian Table

As discussed above, it is proposed that the Canadian Table entry for this band be the same as the world-wide allocations agreed to at WARC-92, but without the in-country Footnote 892, as follows:

31.8-32 GHz	RADIONAVIGATION **SPACE RESEARCH (deep space)** **(space-to-Earth)** ~~892~~ **893**
32-32.3 GHz	RADIONAVIGATION INTER-SATELLITE **SPACE RESEARCH (deep space)** **(space-to-Earth)** ~~892~~ **893**

3.19 . 34.2-35.2 GHz

Existing Canadian Allocations

Current Canadian allocations in this band are to the radiolocation and to the space research services. The radiolocation allocation is on a primary basis throughout the band 33.4 to 36 GHz. These allocations are the same as the pre-WARC-92 ITU allocations except for the omission of in-country Footnotes 894, 895, and 896.

34.2-34.7 GHz	RADIOLOCATION Space Research ~~895~~ ~~896~~ ~~894~~

WARC-92 Decision

The Conference upgraded the status of the space research service in the band 34.2-34.7 GHz, from secondary to primary, and specified that it should be used for deep space application (beyond 2 x 10^6 kilometres; see Section 3.18 above) in an Earth-to-space direction. (This band is the counterpart of the deep space space-to-Earth allocation in the band 31.8-32.3 GHz.) As a consequence, Footnotes 895 and 896 were deleted from the band.

Footnote 895 was also deleted in the adjacent band 34.7-35.2 GHz. In

addition, the list of countries in the Footnote 896 was changed in the band 34.7-35.2 GHz, although this does not affect Canadian use of the band.

Discussion

Canada had no objection to the above changes at the WARC, and may in fact use the upgraded space research allocation in co-operative multi-national space programs.

Proposed Canadian Table

It is proposed that the Canadian Table entry for the band 34.2-34.7 GHz be modified to correspond with the new ITU Table at the WARC, but with the omission of in-country Footnote 984 as before:

34.2-**34.7** GHz	
	RADIOLOCATION **SPACE RESEARCH (deep space)** **(Earth-to-space)**
	~~894~~

3.20 . . 37-40.5 GHz

In this section, a series of bands from 37 GHz to 40.5 GHz are considered together, because the changes to the allocations in the bands in this range are interrelated and all pertain to scientific space applications, although not all for the same application.

Existing Canadian Allocations

Currently there are allocations to the fixed and mobile services throughout the 37-40.5 GHz frequency range in the Canadian Table, augmented by allocations to the fixed-satellite service over the 37.5-40.5 GHz frequency range, and to the mobile-satellite service in the 39.5-40.5 GHz band, as follows:

37-37.5 GHz	
	FIXED MOBILE

and

37.5-39.5 GHz	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE
39.5-40.5 GHz	FIXED FIXED-SATELLITE (space-to-Earth) C21 MOBILE MOBILE-satellite (space-to-Earth) C21

In the upper 1 GHz portion of this frequency range, satellite systems are limited by footnote C21 to those of the Government of Canada, as follows:

C21 The allocations to the fixed-satellite and mobile-satellite services or a portion of these allocations will be designated for the exclusive use of the Government of Canada.

WARC-92 Decision

WARC-92 made six changes relating to the frequency range 37 to 40.5 GHz, all on a world-wide basis:

- the space research (space-to-Earth) service was added in the band 37-38 GHz (the corresponding uplink is the new allocation in the 40-40.5 GHz band; see below);
- the earth exploration-satellite (space-to-Earth) service was added throughout the band 37.5-40.5 GHz;
- the space research (Earth-to-space) service was added in the band 40-40.5 GHz. As noted above, this allocation is intended to be used in conjunction with the new downlink allocation in the 37-38 GHz band;
- the earth exploration (Earth-to-space) service was added in the same 40-40.5 GHz band, without the addition of a corresponding primary downlink allocation in the 30 to 40 GHz range, but with a secondary allocation throughout the band 37.5-40.5 GHz (see above);
- transmissions from space stations in the above new allocations in the entire 37.0-40.5 GHz band are subject to the same power flux-density limits of Article 28 as the fixed-satellite service in the 17.7-19.7 GHz band; and
- in-country Footnote 899, relating to the fixed-satellite (Earth-to-space) service in the band 37-39 GHz in Japan, was deleted.

Discussion

Canada has no immediate need for the above new allocations, other than perhaps through the possible participation of the Canadian Space Agency in international space programs such as the exploration of the Moon and Mars. However, it was determined at WARC-92 that existing and planned terrestrial services could share the band with the proposed new space services as long as the power flux-density limits of Regulation 2578 of Article 28 applied to the new allocations. That constraint was included in the Radio Regulations, and so sharing arrangements are possible between the services now allocated in the new ITU Table as described above.

Proposed Canadian Table

Based on the above, it is proposed that the Canadian Table entry for the frequency range 37-40.5 GHz be the same as that adopted by WARC-92, with the addition of Footnote C21 as before, as follows:

37-37.5 GHz	FIXED MOBILE **SPACE RESEARCH (space-to-Earth)**
37.5-**38** GHz	FIXED MOBILE FIXED-SATELLITE (space-to-Earth) **SPACE RESEARCH (space-to-Earth)** **Earth Exploration Satellite (space-to-Earth)**
38-39.5 GHz	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE **Earth Exploration-Satellite (space-to-Earth)**
39.5-**40** GHz	FIXED FIXED-SATELLITE (space-to-Earth) C21 MOBILE MOBILE-SATELLITE (space-to-Earth) C21 **Earth Exploration-Satellite (space-to-Earth)**

and

40-40.5 GHz	FIXED FIXED-SATELLITE (space-to-Earth) C21 MOBILE MOBILE-SATELLITE (space-to-Earth) C21 **EARTH EXPLORATION-SATELLITE (Earth-to-space)** **SPACE RESEARCH (Earth-to-space)** **Earth Exploration-Satellite (space-to-Earth)**

3.21 . . . 74-84 GHz

Existing Canadian Allocations

Current Canadian allocations in the frequency range 74 to 84 GHz are the same as those in the pre-WARC-92 ITU Table, as follows:

74-75.5 GHz	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE
75.5-76 GHz	AMATEUR AMATEUR-SATELLITE
76-81 GHz	RADIOLOCATION Amateur Amateur-Satellite 912
81-84 GHz	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE MOBILE-SATELLITE(space-to-Earth)

where Footnote 912 specifies an additional primary allocation, as follows:

912 In the band 78-79 GHz radars located on space stations may be operated on a primary basis in the earth exploration-satellite service and the space research service.

WARC-92 Decision

The Conference added the space research (space-to-Earth) service on a secondary basis over the 10 GHz-wide band 74-84 GHz.

Discussion

There are no immediate plans to use this new allocation in Canada; it may be used in the future as part of international cooperative space programs. Given that the allocation has a secondary status, it is not considered that it would hinder any future Canadian use of the band for existing services.

Proposed Canadian Table

For the reasons given above, it is proposed that the Canadian Table entry for the frequency range 74-84 GHz be the same as the WARC-92 ITU Table, as follows:

74-75.5 GHz	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE **Space Research (space-to-Earth)**
75.5-76 GHz	AMATEUR AMATEUR-SATELLITE **Space Research (space-to-Earth)**
76-81 GHz	RADIOLOCATION Amateur Amateur-Satellite **Space Research (space-to-Earth)** 912
81-84 GHz	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE MOBILE-SATELLITE (space-to-Earth) **Space Research (space-to-Earth)**

3.22 . . 151-164 GHz

Existing Canadian Allocations

Current Canadian allocations in the band 151-164 GHz are the same as those in the pre-WARC-92 ITU Table, as follows:

151-164 GHz	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE

WARC-92 Decision

The Conference added the allocation Earth exploration-satellite (passive) on a primary basis throughout the band 156-158 GHz. This required that the band be divided into the three sub-bands 151-156 GHz, 156-158 GHz, and 158-164 GHz.

Discussion

Information available at the WARC suggested that as a result of this allocation, the band would be used to measure atmospheric and environmental conditions. Canada may participate in future cooperative programs of that nature. Furthermore, it is not anticipated that this band will be required for existing services in the 156-158 GHz band in the foreseeable future.

Proposed Canadian Table

For the reasons given above, it is proposed that the Canadian Table be the same as the ITU Table for this band, that is:

151-**156** GHz	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE
156-158 GHz	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE **EARTH EXPLORATION-satellite (passive)**
158-164 GHz	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE

General Considerations Relating to the Allocation of Spectrum Above 3 GHz

1.0 Introduction

This Annex discusses a number of principles governing the allocation of spectrum to radiocommunication services in Canada, and presented in the Canadian Table of Frequency Allocations. While the allocations shown in the Canadian Table correspond very closely to those designated for Region 2 (the Americas) in Article 8 of the ITU Radio Regulations, there are differences which reflect the fact that Canadian use of the spectrum is not, and need not always, be identical with that agreed to internationally. This Annex discusses the flexibility available to Canada in adopting allocations different from those to which it agreed for Region 2.

2.0 Flexibility in Definition of Radiocommunication Services

Radiocommunication services are listed and defined in Section III of Article 1 of the ITU Radio Regulations. Allocation of spectrum to those services is specified in Article 8 of the Radio Regulations. As stated above, the Canadian Allocation Table is a variation of the Article 8 ITU allocation table for Region 2, with additions or deletions that reflect Canadian use of the spectrum.

A subject that needs to be addressed at this point is whether the Canadian Allocation Table might include radio services, with accompanying definitions, that are different from those in the ITU Radio Regulations. The subject is raised here because Canada made proposals for two new radio services, the multipurpose-satellite service and the space-communications service, in its proposals to WARC-92, with associated proposals for the allocation of spectrum in bands above 3 GHz that are discussed in this document, and has submitted contributions to the ITU Voluntary Group of Experts suggesting other new radio service definitions and allocation of spectrum to those services in bands above 3 GHz. As an example, the Canadian Table might specify allocations to the multipurpose-satellite service (or another name with a similar definition) in the 20 to 30 GHz frequency range, even though the service is not defined by the ITU. Thus the subject should be addressed and resolved as a precursor to consideration of the allocations themselves.

There may be certain advantages and simplifications in our Canadian domestic management of the radio spectrum by following this route, the same advantages that initiated the Canadian proposals for adoption of such proposals by the ITU. However, the use of definitions that had no status or recognition internationally would lead to confusion, delay, and possibly misunderstanding when attempting to coordinate and notify these systems internationally, either through the IFRB of the ITU or bilaterally with our neighbours. For this reason, **no radiocommunication services other than those in Article 1 of the ITU Regulations are considered for the allocation of spectrum in the Canadian Table.**

3.0 Flexibility in Allocations to Terrestrial Services

Bands considered in this section are those which have not been allocated by the ITU to space or satellite services. The question addressed is whether and under what conditions could a block of spectrum be allocated in the Canadian Table to a set of terrestrial services different from those in the ITU Table. Such a deviation could consist either of the deletion of a service, the addition of a service, or some combination of the two.

A basic technical factor relating to this question is that propagation above 3 GHz approximates line-of-sight, as distinct from multi-hop long-distance propagation at lower frequencies. Because of this, deviations from the ITU in the use of a band from need only be agreed among immediate neighbours, (ie. with the United States, with France (St. Pierre and Miquelon) and with Denmark (Greenland) in Canada's case. Tropospheric scattering, refraction, and ducting of microwaves increase propagation distances beyond pure line-of-sight, but are not expected to increase the number of neighbours that would need to be consulted for coordination purposes.

Most of the changes to the Canadian Table proposed in the main document consist of deletions from the ITU Table. This type of change includes, for example, deletion of the mobile service from some SHF bands. This does not, of course, create notification problems for Canada; however, Canada remains obligated to respect networks in the territories of our neighbours that are in conformity with the ITU Table.

The addition in any band of a service that is not in the ITU Table is a different proposition, though. There are fewer examples of this type in the main document. (One such example is use of the 16 GHz band for radionavigation in a band allocated to a similar but different service, radiolocation.) Changes of this nature will need to be agreed to with our immediate neighbours at the time that systems are coordinated and implemented.

4.0 Flexibility in Allocations to Space Services

There is less flexibility in changing allocations to space services in the Canadian Table because, above 3 GHz, interference to and from satellite systems can occur over a much wider geographical area than that between terrestrial systems. When a Canadian satellite system is placed in geostationary orbit, it must be coordinated with similar systems of several other countries. For instance, a Canadian fixed-satellite system with highly-directive beams that are intended to limit coverage to Canadian territory must be coordinated with similar systems of Mexico, the USA and, possibly, with those of Central and South American countries. Mobile satellites operating at UHF frequencies but with feeder links above 3 GHz have to be coordinated with similar systems serving a large portion of the globe. Thus, international coordination is a necessity when considering what frequency bands Canadian geostationary satellite systems will use.

The coordination of systems and prior international agreement on the frequency bands they will use is even more necessary in the case of non-geostationary systems, which may cause interference or be subject to interference world-wide. This pertains to Canadian systems such as Radarsat and to other systems in various space services in which Canadian companies, agencies, etc. might participate.

The above is a brief description the interference that Canadian satellite systems might cause to, or receive from, systems of other administrations. These potential interference conditions must be resolved prior to system implementation, usually using ITU international coordination procedures such

as those in Article 11 of the Radio Regulations. This can only be done if the systems to be coordinated are in conformity with other parts of the Radio Regulations, including Article 8.

Based on these considerations, it can be concluded that:

1. It is not advisable for Canada to allocate frequency bands in the Canadian Table to any space service that has not been allocated in Region 2 by the ITU. Otherwise, it would not be possible to coordinate such a system and it could only operate on a non-interfering basis and could not claim any rights for protection under the terms of international arrangements on spectrum sharing.

2. Omitting a Region 2 space service allocation from the Canadian Table would prevent the band from being used for that service in Canada, but would not prevent other administrations using the band for that space service and causing internationally agreed-to levels of interference into Canadian terrestrial systems in the same band.

In summary, the allocations to space services in the Canadian Table should as much as possible be the same as those for Region 2 in the ITU Table. Any deviations should only be introduced for very good reasons, fully recognizing that successful international coordination remains a prerequisite to implementation.

There can be other forms of deviations from general ITU "practices", resulting from the promulgation of Canadian spectrum utilization policies which, while being within the constraints of the ITU allocation table for Region 2, are adopted to make the utilization of the spectrum and orbit resources available to Canada more efficient from a Canadian perspective. Those policies may be aimed at increasing the utilization of available spectrum and orbit resources by Canadian space services, or at improving spectrum sharing between space and terrestrial services. Examples of such policies include the pairing of the fixed-satellite bands at 14 GHz and at 11 GHz in Sections 3.2 and 3.4 of the main document, and the constraints placed on the use of broadcasting-satellite feeder links in Sections 3.3, 3.6, 3.7, 3.8 and 3.13 of the main document.

5.0 Flexibility in Allocations to Terrestrial Services in Bands Shared with Space Services

In Section 2.0 of this Annex, consideration was given to including in the Canadian Table terrestrial allocations different from those in the ITU Table in bands allocated only to terrestrial services. The essential feature of such deviations is that the interference between networks is localized, so that interference considerations between services need be resolved only between Canada and its immediate neighbours.

In bands shared between space and terrestrial services, the situation is not localized, because of possible interference between a Canadian terrestrial network and a satellite network of another administration. There are internationally agreed interference and sensitivity limitations on both terrestrial and satellite networks in Articles 27 and 28 of the Radio Regulations and, in some cases, extensions to these constraints in CCIR Recommendations. Any additional terrestrial service allocations in the Canadian Table would have to respect these agreements; otherwise there could be coordination problems between a Canadian terrestrial network and a space network of another administration, and the Radio Regulations would be invoked in the resolution of any problem.

5.0 Concluding Notes

This Annex discusses the background, constraints, regulatory environment and other factors pertaining to for the more detailed review of the spectrum requirements of each radiocommunication service in Annex B, and of the allocation of frequency bands in the main document to meet those requirements. These factors form part of the rationale for the proposals presented in the main document.

Trends and Spectrum Requirements of Specific Services

Introduction

This Annex provides information on the characteristics of systems in each of the radio services that might be affected by changes to the Canadian Table of Frequency Allocations in the 3 to 160 GHz band. The spectrum requirements of these services, and the possibility of their sharing a given band with other radio services, are discussed. This information is used as background information for the main document in considering the allocation of spectrum to services in different bands in the 3 to 160 GHz range. No frequency allocation proposal is presented as such in this Annex.

1.0 The Fixed Service

The use of the fixed service is provided here, not because allocation changes to the fixed services per se are being considered, except in one relatively small band 17.7-17.8 GHz, but because there may be significant changes to the allocation of other services that share or might share spectrum with the fixed service. In some cases, new services are being considered in a band; in other cases, removal of existing shared services is being considered to increase the availability of the band to the fixed service.

Fixed systems are implemented in many frequency bands both above and below 1 GHz. An initial measure of the usage above 1 GHz can be obtained by considering the number of frequency assignments in the frequency ranges 1-3 GHz, 3-10 GHz, and above 10 GHz. Because of increased demands on use of the spectrum in the 1 to 3 GHz band for new mobile and broadcasting applications, possibly including the use of satellites, fixed systems may have to be accommodated instead in higher frequency bands. This requirement may be met in the heavily-used 3 to 10 GHz frequency range, or in bands above 10 GHz where a different set of constraints such as path attenuation during rain and equipment costs and availability may be the dominant factors.The current number of assignments in these three frequency ranges, a measure of the usage of the bands, is indicated in Table B1-1.

Table B1-1
Number of Fixed Assignments in Canada

Frequency Range	General Fixed Use	Carriage of TV and audio	Totals
1 to 3 GHz	8,500	100	8,600
3 to 10 GHz	20,100	2,700	22,800
Above 10 GHz	1,400	13,400 *	14,800
Totals	30,000	16,200	46,200

* Includes 12,800 assignments in the 12 GHz VHCM band.

As indicated, if we exclude the specialized VHCM assignments, a high percentage (60 %) of all fixed system assignments in Canada are for general use in the 3-10 GHz band. Also, 25 % of all assignments are for general use in the 1-3 GHz band, and only 4 % are for general use above 10 GHz. (Only 32 % of all fixed assignments are above 10 GHz, and of these almost all are for broadcasting use in the band 12.7-13.2 GHz.) In summary, there are comparatively few fixed systems above 15 GHz in Canada at this time.

Changes are proposed in the main document, and in the document on "proposed spectrum utilization for certain services above 1 GHz", in anticipation of the following:

- o some bands in the 1-3 GHz range may be re-allocated from the fixed service to other services, requiring those fixed traffic requirements to be met at higher frequencies, putting additional requirements on bands above 3 GHz either directly or as a result of more than one set of re-assignments;

- o the increasing implementation of LANs and FPLMTS/PCS systems and their interconnection amongst each other and with the PSTN may require new short-haul high-capacity digital radio systems; these can be implemented in bands above 10 GHz without the need to coordinate with existing long-haul systems; and

- o digital radio equipment is widely used in some other countries, and is becoming available at reasonable cost, in the bands 17.7-19.7 GHz and 21.2-23.6 GHz.

Major differences in propagation conditions above 10 GHz, compared with those below 10 GHz (particularly those in the 1 to 3 GHz range), may result in the need for new infrastructures with different hop lengths if networks are converted to these new bands.

In summary, the fixed bands above 10 GHz are only lightly used in Canada (except for the 12.7-13.2 GHz band), but this trend is expected to change in the next decade as congestion in lower bands forces use of higher bands, and as reliable equipment becomes available at reasonable cost. Growth is expected in the bands 14.5-14.8 GHz, 17.7-19.7 GHz, and 21.2-23.6 GHz.

2.0 Fixed-Satellite Service

In this section, fixed-satellite spectrum and orbit requirements to meet the needs of both domestic and international networks are considered. Fixed-satellite spectrum requirements for systems associated with other services are treated separately in this Annex, as follows:

- o feeder links for mobile-satellite networks, both in geostationary and in non-geostationary orbits such as low-Earth orbit (LEO), in Section 5.0 below;

- o feeder links for television broadcasting-satellite systems in Section 7.1 below; and

- o feeder links for digital sound broadcasting-satellite systems in Section 7.2 below.

Also, the use of the 20 GHz and 30 GHz bands for multi-purpose fixed-satellite and mobile-satellite systems are discussed separately in Section 4.0 of this Annex.

The spectrum requirements of Canadian domestic satellite systems, including those of North American sub-Regional systems, may be the same as, or different from, those used for international systems on a global basis. It is assumed that complete frequency reuse will continue to be possible between these systems, because they are implemented in different geostationary orbital positions. In such orbits, isolation of space stations of the different networks is possible because of earth station antenna discrimination. (This frequency reuse capability may not be available when one or the other system uses a non-geostationary orbit, such as that of low-earth-orbit (LEO) mobile-satellite systems.)

Canadian domestic use of the geostationary orbit has been between 104°W and 118.7°W. Intelsat satellites used by Teleglobe are located either over the Atlantic Ocean no further west than 53°W, or over the Pacific at about 180°W. These practices are expected to continue with perhaps small changes. This large separation enables independent consideration of the spectrum requirements of international and Canadian domestic geostationary networks.

2.1 Domestic and Sub-Regional Commercial Fixed-Satellite Systems

The estimate here of Canadian domestic fixed-satellite spectrum/orbit requirements is a result of analyses carried out within the Department. It is based on information made available recently to the Department, and on information made available to the CRTC. These requirements are stated in terms of 36 MHz-wide RF channels in the 3.7-4.2 GHz and 5.925-6.425 GHz bands (6/4 GHz C-band), and of 27 MHz-wide RF channels in the bands 11.7-12.2 GHz and 14.0-14.5 GHz (14/12 GHz Ku-band).

In general, when different forecasts of growth of a service are available, and both can be substantiated using different technical, economic, and demographic assumptions, the larger growth-rate assumption is used to estimate spectrum and orbit requirements, unless this approach were to severely curtail the accommodation other services. To do otherwise, such as basing the allocation of spectrum on medium-term most-likely requirements, may result in a shortage of available spectrum/orbit resource in the medium to longer term, and so that approach is avoided.

Bands in both the 3.5 to 7.075 GHz and 10.7 to 14.5 GHz ranges are considered together here, since satellite capacity at C-band is in part exchangeable with capacity at Ku-band. (Current ANIK satellites use both bands to meet user requirements.) Proceeding in this manner, analyses indicate the following RF channel requirements:

Table B2-1
Fixed-Satellite RF Channel Requirements

Frequency Band	Year		
	1990	2000	2010
6/4 GHz Band	47	67	83
14/12 GHz Band	85	118	137
Totals	132	185	220

These estimates are based on the delivery of analogue NTSC television signals using frequency-modulation. Recently, development has been initiated of a more spectrum-efficient digital encoding and multiplexing technique using video compression that may allow four to eight times as many

television programs to be delivered per unit of RF bandwidth. This means that the number of RF channels required for television delivery could be reduced.

Moreover, the associated costs of delivery of a television program by satellite may also be significantly reduced by the utilization of this technique. Because of this, the medium to long term effect of advances in video encoding on the need for spectrum and orbit resources may be the cost-effective transmission of significantly more programming in the available spectrum. Thus the introduction of digital encoding and transmission may be associated with several mitigating factors in terms of spectrum and orbit requirements. Consequently, no reduction in the long-term estimated number of RF channels required for television delivery has been assumed at this time.

Twenty-four 36 MHz-wide transponders can be implemented in the currently-used 500 MHz-wide 6/4 GHz C-band, and thirty-two 27 MHz-wide transponders in the current 500 MHz-wide 14/12 GHz Ku-band, using ANIK-E-type satellites. The number of such satellites and corresponding orbital positions required to meet Canadian domestic FSS requirements is projected to be as follows:

Table B2-2

Number of Orbit Positions Required to Meet Estimated FSS Requirements in Currently Used 6/4 GHz and 14/12 GHz Bands

Year of Requirement	1990	2000	2010
Positions Required at 6/4 GHz	2	3	4
Positions Required at 14/12 GHz	3	4	5

There are four dual-band geostationary orbit positions available for Canadian use in the 1988 Canada/USA/Mexico Arrangement to share the use of the geostationary orbit (see Annex C). Two of these locations are currently occupied by ANIK-E dual-band satellites, and the other two are occupied by older single-band ANIK-C and ANIK-D satellites. This corresponds closely to the above estimates for the 1990-2000 period. These estimates indicate that additional spectrum/orbit availability may be required in the decade 2000-2010 in the 14/12 GHz band, and in the decade 2010-2020 in the 6/4 GHz band.

A number of options have been considered to meet the above-estimated long-term additional spectrum/orbit requirements, beyond that used by the current ANIK-E-type satellites at the four orbit positions 107.3°W, 111.1°W, 114.9°W, and 118.7°W. These include the following:

1. increasing the number of orbit positions in the currently-used bands, a difficult option to implement unless orbital separations between satellites can be significantly reduced, since the geostationary orbit is expected to continue be heavily used by Mexican and American satellites as well;

2. use of additional spectrum in the 14/12 GHz range, specifically the uplink band 13.75-14.0 GHz and a corresponding 250 MHz-wide downlink band in the 10.7-11.7 GHz range, to increase the 14/12 GHz bandwidth by up to 50 % and thereby increasing the period over which four orbit locations in the 14/12 GHz range will be adequate;

3. use of additional spectrum in the 6/4 GHz range, specifically a portion of the band 3.5-3.7 GHz in the downlink direction and a portion of either the band 5.85-5.925 GHz or the band 6.425-6.725 GHz in the uplink direction, thereby increasing the period over which four orbit locations in the 6/4 GHz range will be adequate;

4. use of the allotment-plan bands at either 13/11 GHz, (ie. 12.75-13.25 GHz uplink and 10.7-10.95 GHz and 11.2-11.45 GHz downlink), or at 6/4 GHz, (ie. 6.725-7.025 GHz uplink and 4.5-4.8 GHz downlink), or both (As indicated in Annex D, Canada has 3 orbit positions in the plan, and the use of these positions can be engineered to meet Canadian requirements at the time the system is coordinated.); and

5. use of spectrum above 15 GHz, such as the 2.5 GHz wide bands 17.7-20.2 GHz for the downlink and 27.5-30 GHz for the uplink.

In considering these alternatives, the requirements of mobile-satellite feeder links, broadcasting-satellite feeder links, and multipurpose (fixed-satellite and mobile-satellite) satellite systems need to be taken into account. (See sections 4.0, 5.0, and 7.0 of this Annex for consideration of these requirements.)

The frequency bands at 8/7 GHz (7.9-8.4 GHz uplink and 7.25 7.75 GHz downlink) and at 31/21 GHz (30-31 GHz uplink and 20.2-21.2 GHz downlink) are not included in the above list of alternatives for commercial systems, as these bands are used for government systems in Canada and other countries, as indicated by Canadian footnotes C5 and C21 in the current Table.

2.2 International Commercial Fixed-Satellite Systems

International fixed-satellite systems considered here include those of Intelsat and of other potential systems such as SovCanStar. Teleglobe is the operator of Intelsat earth stations in Canada, and provides access in Canada to the Intelsat network. SovCanStar is an organization owned jointly by Canadian and Russian interests to develop a satellite system for communication between Russia and Canada and other countries. It is assumed here that complete frequency reuse is possible among these systems, because of their well-separated geostationary orbit locations. Thus no spectrum-sharing considerations between the two networks need be taken into account in assessing their respective requirements. Detailed information on the spectrum and orbit requirements of these networks for the next two decades is not available in as much detail as that for the Canadian domestic requirements discussed in Section 2.1 of this Annex. They must, however, use world-wide allocations, as distinct from allocations such as the band 11.7-12.2 GHz, which are available to the Fixed-Satellite Service (FSS) in Region 2 only.

Intelsat systems are planned in consultation with its Signatories, including Teleglobe, the Canadian Signatory. These systems have to date used the same 6/4 GHz bands (5.925-6.425 uplinks and 3.7-4.2 GHz downlinks) as the ANIK system, and the 14/11 GHz band with the same uplink band 14.0-14.5 GHz but different downlink bands 10.95-11.2 GHz and 11.45-11.7 GHz.

The opportunity for use of additional spectrum below 10 GHz for such international systems is limited because the allotment-plan bands 4.5-4.8 GHz and 6.725-7.025 GHz are limited to national and sub-regional systems. FSS use of the band 3.4-3.7 GHz is also limited because of its use by some countries for radiolocation systems.

In the 10 to 15 GHz range, the additional uplink band 13.75-14 GHz allocated at WARC-92 increases the available bandwidth of international systems to 750 MHz, with a contiguous 13.75-14.5 GHz uplink band on a world-wide basis. Unplanned downlinks are allocated on a world-wide basis at 10.95-11.2 GHz and 11.45-11.7 GHz. Additionally, a 250 MHz wide band 12.5-12.75 GHz is allocated to the FSS in Regions 1 and 3, and the 500 MHz wide band 11.7-12.2 GHz is allocated in Region 2, but use of this band is limited by ITU Radio Regulation 839 to national and sub-regional systems. The exact eventual frequency plan for these international systems in the 10 to 15 GHz range has not yet been established; however, because of Radio Regulation 855A, international business networks using VSATs are expected to utilize the band 14.0-14.5 GHz rather than 13.75-14.0 GHz for their uplinks.

Beyond this 250 MHz expansion, which would provide a 25 % increase in the available spectrum below 15 GHz outside of the Allotment Plan, international FSS network expansion is expected to take place in the 30/20 GHz band, ie. in the downlink band 17.7-20.2 GHz and the uplink band 27.5-30 GHz. From a Canadian perspective, these bands may be used for business communications, possibly using VSATs, between North America and Europe and among Pacific rim countries. For these applications, satellites are expected to be located at about 50°W to serve both North America and Europe, and at about 180°W to serve both the Asian and North American portions of the Pacific rim. At these GSO locations they are not expected to interfere with, or be interfered by, Canadian use of the 19.7-20.2 GHz and 29.5-30 GHz bands for multipurpose networks (ie. combined FSS and MSS use, as described in Section 4.0 of this Annex) in the 107.3°W to 118.7°W arc.

At this time, the SovCanStar system is the other international fixed-satellite system with Canadian involvement. As currently understood, it will consist of two satellites, one at about 14°W and the other at about 160°W. It will be used for telephony, business communications and television distribution, and will operate in the 14/11 GHz band, the same bands as the current 14/11 GHz Intelsat satellites. There are no indications that implementation of this system would use of the spectrum in a way that would require any change to the Canadian Table of Frequency Allocations.

3.0 The Mobile Service

The mobile service is allocated in the ITU table of frequency allocations in almost every band allocated to the fixed service. The Canadian table is similar in most bands. There are several reasons for reviewing this practice, particularly in the bands above 10 GHz:

1) In many parts of the world, microwave radio links are said to be in the mobile service if they are installed on a temporary basis, or if they are transportable to some degree. In Canada, however, such systems are licensed as fixed systems unless they are truly mobile in the sense that they can operate while moving or at unspecified halts. Thus, there is no need in Canada to assign temporary microwave links in the mobile service.

2) There are no current assignments for mobile applications in Canada above 10 GHz, in part because of the severe shadowing caused by buildings and the small effective area of low-gain omnidirectional antennas at these frequencies, both of which tend to increase the required transmitter power of a mobile system.

However, it is anticipated that there will be mobile application developments using high-gain antennas in the upper SHF and EHF frequency ranges. These include:

- o Intelligent Vehicle Highway Systems (IVHS). For example, the band 63-64 GHz is being considered by developers of IVHS for transmissions from road to vehicle and between vehicles;

- o the mobile component of a radio LAN network to serve a building or complex of buildings. Radio LAN systems are being developed in such bands as 18 GHz, primarily to connect personal computers and other office equipment without the need for cabling. If such systems were to have an extensive mobile personal communications component, there may be a need for assignments and hence allocations in the mobile service; and

- o terrestrial personal communications systems (PCS) that are complementary to mobile-satellite systems in similar bands.

It would, therefore, seem more appropriate to allocate the mobile service in those bands where these applications are apt to be developed, and where it will be possible to share such systems with other users, rather than in all the bands above 10 GHz where the mobile service is allocated internationally.

4.0 Multipurpose Satellite Systems in the 30/20 GHz Band

In this section the requirements for composite fixed-satellite and mobile-satellite systems in the 20 to 30 GHz frequency range are discussed. These requirements are considered separately from the more conventional fixed-satellite requirements discussed in section 2.0 of this Annex, because of the need to implement hybrid systems that would carry both fixed-satellite and mobile-satellite traffic, and traffic that could variously be considered as being either of one or the other mode. Meeting this requirement with a single flexible system that handle both modes, particularly to meet emerging personal communications requirements, is seen as a cost-effective approach. The allocation of spectrum and orbit resources necessary for its development is therefore appropriate.Work is underway at the Communications Research Centre (CRC) of the Department to implement an experimental multipurpose satellite system in the 30 and 20 GHz bands as a first step in the application of new satellite technologies to meet personal and business communications requirements. This experimental system is expected to have switching and remodulation capabilities on the spacecraft that will enable new types of network topologies to complement the availability of smaller earth terminals at these higher frequencies.

It is anticipated that the use of the 30/20 GHz band will evolve in a way similar to that of the 14/12 GHz band in the 1970's and 1980's. With such developments, three different bands will be available: 6/4 GHz, 14/12 GHz and 30/20 GHz. Each of the three bands is expected to be used where it will be most cost-effective to do so. As presently understood, the 30/20 GHz band would be most suitable for applications requiring very small transportable or mobile terminals and large bandwidths, ie. personal communications applications in an ISDN environment. The band may also be best suited for some VSAT-type business communications applications. In general, the development and use of this band may somewhat ease the demands placed on the lower 6/4 GHz and 14/12 GHz fixed-satellite bands and mobile-satellite bands below 3 GHz. However, the magnitude of this effect on spectrum requirements at lower frequencies cannot be predicted at this time, because a portion of the services to be provided at 30/20 GHz may be new, and not yet offered at the lower frequencies. Since the magnitude of the transfer of traffic to higher bands is unknown, a conservative frequency-management approach would assume that the spectrum and orbit requirements currently foreseen at the lower 6/4 GHz and 14/12 GHz bands for existing applications will persist and that the 30/20 GHz band would

be used to accommodate new applications.

5.0 Feeder links for Mobile-Satellite Systems below 3 GHz

In considering mobile-satellite feeder links, three possible mobile-satellite system configurations need to be taken into account:

i) geostationary mobile-satellite systems operating in the 1 to 3 GHz frequency range;

ii) non-geostationary mobile-satellite systems operating in the 1 to 3 GHz frequency range; and

iii) non-geostationary mobile-satellite systems operating in the frequency range below 1 GHz.

Feeder link allocation requirements for each type of mobile-satellite system are considered separately, because their respective feeder-link system characteristics are quite distinct. In this discussion, "mobile-satellite systems" refers to all systems in the bands allocated to the mobile-satellite service (MSS), the aeronautical mobile-satellite service (AMSS), the maritime mobile-satellite service (MMSS) and the land mobile-satellite service (LMSS); "non-geostationary systems" refers to systems in highly elliptical orbits (HEO), in low Earth orbit (LEO) (in the order of 1,000 km altitude) and in mid Earth orbit (MEO) (in the order of 10,000 km altitude).

It should be also noted that the FSS spectrum requirements considered in this section are separate from, and in addition to, those considered in Section 2.0 of this Annex.

5.1 Feeder links for Geostationary Mobile Satellite Systems

Radio Regulation No. 27, which defines the mobile-satellite service, also states that the MSS may also include the feeder links necessary for its operation (ie. feeder links for MSS can use the bands allocated to the MSS). However, No. 726A, approved at WARC-MOB-87 and modified at WARC-92 to include additional bands, states that the bands 1525-1544 MHz, 1545-1559 MHz, 1626.5-1645.5 MHz, and 1646.5-1660.5 MHz should not be used for MSS feeder links. This was an opportune decision because these bands are, or will soon be, heavily used by planned mobile-satellite systems. Accommodation of MSS feeder links in higher SHF or EHF frequency bands increases the availability of the UHF bands for their basic mobile-satellite use. It would seem judicious that Radio Regulation No. 726A be extended to include other mobile-satellite frequency bands in the 1 to 3 GHz range.

In reviewing the requirements for feeder links in the SHF (3 to 30 GHz) fixed-satellite bands for UHF (300 to 3,000 MHz) geostationary mobile satellites, the requirements of global systems such as those of Inmarsat must be distinguished from of Canadian and sub-regional systems such as MSAT. This distinction is made because the feeder-link frequency bands used by one and the other are different. Canadian spectrum policy can to a considerable extent determine how fixed-satellite spectrum and orbit resources available to Canada should be used for feeder-links of Canadian mobile-satellite systems, but would have much less influence on the frequency bands and system characteristics chosen by a global operator such as Inmarsat.

5.1.1 Feeder Links for Canadian Geostationary MSS Systems

The first-generation Canadian GSO mobile satellite, MSAT, to be launched in early 1994, will use the bands 13.0-13.15 GHz and 13.2-13.25 GHz for its uplinks, and 10.7-10.95 GHz for its downlinks, at the orbit location 106.5°W. This is in accordance with Canadian spectrum utilization policies SP 10.7 GHz and SP 12.7 GHz, both dated January 1991. Furthermore, this use is consistent with the fixed-satellite allotment plan in Appendix 30B of the Radio Regulations, in which MSAT appears as an existing system. MSAT plans to use the same frequency plan as the satellite of the American Mobile Satellite Consortium (AMSC), in part so that each satellite could provide back-up capacity for the other in the event of a catastrophic failure of one of them. Feeder links of the AMSC satellite will use the USA allotment of the Appendix 30B plan. A 200 MHz-wide feeder link bandwidth is required in order to keep the cost of this first-generation mobile-satellite system at an affordable level, ie: (1) using only one polarization in the 13/11 GHz bands, and (2) translating the full mobile-satellite L-band spectrum for each of the five L-band antenna beams into different portions of the feeder-link band. In developing spectrum utilization policies SP 10.7 GHz and SP 12.7 GHz, full consideration was given to the need to share the spectrum between mobile-satellite feeder-link earth stations and fixed systems in the 13 and 11 GHz bands, and to the need to coordinate these systems at the time of implementation.

Based on the requirements of the first-generation MSAT system, it is possible to project those of a next-generation system. It is anticipated that MSAT's successor will use a portion of the additional mobile-satellite bands that were allocated in the 1-3 GHz frequency range at WARC-92, although the details of their utilization are subject to spectrum-policy decisions that are discussed in the companion review of frequency allocations in the 1 to 3 GHz band. It is also anticipated that the next generation system may utilize a larger number of antenna beams in the 1 to 3 GHz range, as was suggested in some of the earlier designs for the first-generation MSAT. In any case, it is anticipated that an increase in effective feeder-link *bandwidth* will be required. The question is whether an additional amount of *spectrum* will be required, and if so wherefrom, or alternatively whether advances in efficient spectrum utilization techniques can be used to increase sufficiently the capacity of the existing bands.

The utilization efficiency of the currently-allocated bands (13.0-13.15 GHz, 13.2-13.25 GHz and 10.7-10.95 GHz) can be improved to respond to larger feeder-link bandwidth requirements in a number of ways, including but not limited to the following techniques:

- using two orthogonal polarizations, either vertical and horizontal, or right and left circular, to double the effective bandwidth, and capacity, available in a given band;
- using multiple spot beams at 13/11 GHz as well as at UHF, and complete the communication paths between different UHF beams via some other network or facility, either within the same satellite network or otherwise. This may be feasible if a large portion of the mobile-satellite traffic is intra-beam traffic; actual operating experience with the first-generation MSAT may provide this information;
- using such techniques as the filtering and switching of signals or their demodulation, switching and remodulation on-board the spacecraft to reduce the amount of bandwidth that need be transmitted in the feeder links. This approach was considered too expensive for the first-generation MSAT, but should be reconsidered for successor systems, taking advantage of the on-board signal-processing capability currently being developed for applications in the 30/20 GHz band (see Section 4.0 of this Annex);

and/or

- o using two separate spacecraft to meet the overall Canadian GSO mobile-satellite requirement, at orbit locations that are sufficiently far apart to permit frequency reuse in the 13/11 GHz band, and yet are close enough to be simultaneously visible by mobile-satellite terminals at UHF. Orbit positions 106.5°W (or 107.3°W) and 111.1°W are possibilities that could be considered; these positions all correspond to Canadian allotments or existing-system plan entry in the ITU fixed-satellite allotment plan of Appendix 30B.

A second possibility is to use some other uplink/downlink pair of fixed-satellite bands for mobile-satellite feeder-links. In considering an alternative band-pair, a number of guidelines should be observed to ensure that:

i) the ability to use wider bandwidths be provided, to ease the accommodation of a presumed increase in mobile-satellite traffic over a wider UHF mobile-satellite bandwidth and possibly with a larger number of UHF antenna beams;

ii) use of the conventional fixed-satellite 6/4 GHz or 14/12 GHz bands (see Section 2.0 of this Annex) be avoided, so as not to restrict the development of the FSS; and

iii) sharing with terrestrial systems be feasible, since all bands except the currently used 14/12 GHz band discussed above and the 30/20 GHz band discussed in Section 4.0 of this Annex are shared on a co-primary basis by the FSS and the fixed service.

Applying these guidelines and other regulatory constraints on a band-by-band basis, the following considerations are noted:

1) the 3.7-4.2 GHz and 11.7-12.2 GHz downlink bands and the 5.925-6.425 GHz and 14.0-14.5 GHz uplink bands should not be used, because they are fully required for conventional FSS in the limited number of GSO orbit locations available to Canada under the 1988 Canada/USA/Mexico trilateral orbit-use arrangement (see Annex C and Section 2.0 of this Annex);

2) the 13.75-14.0 GHz uplink band is not suitable because of earth-terminal antenna diameter and EIRP constraints in RR No. 855A, and because the available 250 MHz bandwidth is not significantly more than that currently available in the 13/11 GHz band;

3) the 6.425-6.725 GHz and 6.725-7.025 GHz uplink bands (an allotment-plan band) each have significant terrestrial fixed systems operating on a co-primary basis, and each can only offer 250 MHz of bandwidth, not significantly more than that available in the 13/11 GHz band. There is no contiguous 500 MHz downlink band associated with these uplink bands. The downlink pair associated with the band 6.725-7.025 GHz is the band 4.5-4.8 GHz. The band 6.425-6.725 GHz might be paired with the 10.95-11.2 GHz downlink band, but with similar bandwidth and satellite/terrestrial sharing problems as use of the 10.7-10.95 GHz band would entail;

4) in the 19.7-20.2 GHz and 29.5-30 GHz bands that are being developed separately for flexible multipurpose FSS/MSS use (see Section 4.0 of this Annex), spectrum sharing

by such a system and a mobile-satellite feeder-link system may present problems, especially if the GSO locations used by both systems are limited to those designated for Canada in the 1988 trilateral orbit-use arrangement discussed in Annex C, in order to keep open the option of implementing large multi-band spacecraft offering significant economies of scale; and

5) the 17.8-19.7 GHz downlink band and the corresponding 27.5-29.5 GHz uplink band have significantly greater bandwidth, a ten-fold increase over the current 200 MHz bandwidth assignment. The current terrestrial fixed use of these bands in Canada is not considered so extensive that satellite-terrestrial coordination is seen as a significant problem. One potential problem is that while systems in these bands are not yet fully developed. However, this may not be the case by the time the next-generation geostationary mobile-satellite system is required.

In summary, it would seem that the two viable long-term feeder link alternatives for Canadian domestic GSO UHF mobile satellite networks are the currently designated bands at 13 and 11 GHz, or the use of wider bandwidths at 28 GHz and 18 GHz. Both of these alternatives have advantages and disadvantages, with the choice between the two partly dependent on technology that is not yet fully developed and requirements that are not yet quantified.

5.1.2 Feeder Links for International Geostationary Systems

The designation of spectrum on a global or Regional basis within the FSS for feeder links of geostationary mobile satellites was on the agenda of WARC-92, but no action was taken. The reason why the matter had been raised and included on the WARC agenda is reportedly that some difficulties had been experienced in coordinating Inmarsat assignments under Article 11 of the Radio Regulations. The feeder links of these systems are in C-band below 3.7 GHz for the downlink and above 6.425 GHz for the uplink.

One of the reasons why no such designation was decided at WARC-92 is simply that there is no global space-to-Earth fixed-satellite allocation below 15 GHz that is not either part of the Appendix 30B allotment plan or heavily used by existing fixed-satellite networks in some part of the world. In such a situation, recognizing that any Canadian spectrum policy decision taken in isolation (ie. without a corresponding ITU decision) would not likely influence the frequency selection process of a geostationary global system such as that of Inmarsat, the designation of feeder-link spectrum for such international systems is not pursued in this review.

5.1.3 Feeder Links for Ka-Band Mobile-Satellite Systems

Mobile-satellite systems are being developed in the 20 GHz to 30 GHz range as part of a multipurpose FSS/MSS system (see Section 4.0 of this Annex). It is expected that such systems could accommodate any feeder links to the mobile-satellite portion of the system within the service band or in adjacent portions of the 30/20 GHz band, ie. that separate feeder-link bands would not be required.

5.2 Feeder Links for Non-Geostationary Systems

There are two distinct classes of non-geostationary mobile-satellite systems being developed consistent

with WARC-92 provisions: 1) the so-called "Big LEO" systems in the 1 to 3 GHz band, including those that plan to use mid-altitude circular orbits and those with elliptical orbits, and 2) the so-called "Little LEO" systems below 1 GHz. These two different classes of systems have different service applications and topologies. Since they also meet their feeder-link requirements differently, they are considered separately here.

5.2.1 Feeder Links for "Big LEO" Mobile-Satellite Systems

A number of new bands in the 1 to 3 GHz range were allocated to the MSS by WARC-92, and are being considered in other countries in the design of non-GSO "Big LEO" MSS systems. Because of the heavy utilization of these bands by several services, it is good spectrum management practice to implement MSS feeder links in FSS bands above 3 GHz (WARC-MOB-87 had approved Footnote 726A for this reason). However, since FSS bands below 14.5 GHz are heavily used by GSO FSS networks, and since the feeder links of LEO mobile satellites may not be easily coordinated with GSO FSS networks, the relatively unused FSS Ka-band (17.7-20.2 GHz and 27.5-30.0 GHz) is being considered in the design of these feeder links.

A related spectrum policy question is how to manage the long-term use of the Ka-band in such a way that these feeder link systems can be implemented without causing frequency sharing problems with possible future GSO systems, and with the new generation of GSO Ka-band systems discussed in section 4.0 of this Annex. Use of FSS bands by non-GEO networks such a these feeder links is subject to Radio Regulation 2613, as modified by WARC-92, which states that GSO fixed satellite networks have priority over non-GSO networks, that non-GSO space stations and associated earth stations shall reduce their emissions to a negligible level whenever there is insufficient angular separation between the satellites to otherwise avoid unacceptable interference between them. There are four modes of interference that have to be taken into account if spectrum is to be shared between a GSO and a non-GSO fixed-satellite network (a Big-LEO feeder-link network in this case). These are:

1) interference in the Earth-to-space direction from the GSO network's earth station transmitter into the non-GSO network's space station receivers;

2) interference in the Earth-to-space direction from the non-GSO network's earth station transmitter into the GSO network's space station receiver;

3) interference in the space-to-Earth direction from the non-GSO network's space station transmitter into the GSO network's earth station receiver; and

4) interference in the space-to-Earth direction from the GSO network's space station transmitter into the non-GSO network's earth station receiver.

In addressing these four interference modes, it is assumed that the GSO network and the non-GSO network are operating in the same space-to-Earth or Earth-to-space direction. Otherwise, the network operating in the reverse direction would have to operate on a non-interference basis, because spectrum is not allocated in both uplink and downlink at Ka-band, except explicitly for BSS feeder links in the 17.7-18.4 GHz band.

This sharing problem is being considered by CCIR Study Group 4, and recommendations on sharing by the two application within the FSS may result from these considerations. Some general conclusions can be arrived at, however, without having the results of that detailed study:

1) The interference between a GSO and a LEO network sharing the same frequency band would not be a steady-state problem, as it would be between say two GSO networks, but rather would be a series of regular short-term bursts of interference. Sharing arrangements may or may not allow increased levels of interference due to their short duration, probably measured in seconds.

2) Such short-term interference would be experienced when both the LEO satellite and the GSO satellite were in the same direction as seen from either the LEO earth station or the GSO earth station involved in the interference mode under consideration, ie. one of the four described above. Sharing may be possible, either because the EIRPs and receiver sensitivities are such that interference levels are acceptable in both networks (an unlikely event), or more likely because the LEO network is operated in such a way that communication through that network is avoided during those short periods. This may be possible either by interrupting user messages through the LEO network during these intervals, or by communicating through another satellite of the LEO constellation. The ability do adapt in this way may be dependant on the particular characteristics of the different LEO satellite systems, and on the type of service provided by the LEO network.

3) If sharing as discussed in (2) above is not possible, then one possible way of accommodating both types of network would be to have them operate in separate frequency bands. This may require a spectrum-policy decision whereby a particular FSS band or pair of uplink/downlink bands is designated as the band or bands to be used by non-GSO networks, and that RR 2613 would not apply regarding Canadian GSO FSS networks in this band or bands. The frequency band or bands to be used in this manner have not considered in detail, but based on the discussions in Section 5.1.1 of this Annex for GSO MSS feeder links, it would seem that such bands should be in the 17.8-19.7 GHz and/or 27.5-29.5 GHz ranges. The bandwidth of such bands should be as narrow as possible, probably in the tens of megahertz.

One additional factor to be taken into account in considering this third possibility is the amount of bandwidth required by the MSS networks, and whether different non-GSO MSS networks can share the same band. Whether the overall efficiency of the 30/20 GHz FSS band would be improved as a result of the designation of bands for non-GSO feeder links may depend on the necessary width of the designated band.

Another factor to be considered is the sharing of the non-GSO feeder links with terrestrial fixed systems. Coordination between these systems may be more difficult than between terrestrial fixed systems and GSO fixed-satellite systems, because the non-GSO earth station would have to be able to operate at all azimuths and elevation angles. Inter-service coordination may be eased, however, because the number of gateway earth stations in the non-GSO satellite system is expected to be small and be located away from urban centres. The question here is: if a non-GSO feeder link band were to be designated, what portion of the 17.7-19.7 GHz and 27.5-29.5 GHz bands would be the easiest to share with the fixed service? If a LEO-MSS feeder link band were to be so designated, it might be specified that Radio Regulation 2613 did not apply in that band. Such a provision would encourage LEO MSS system designers to avoid the regulatory problems associated with RR 2613 by using this band. Such a Canadian regulation would only apply to Canadian GSO satellites, but if LEO system designers were to start using these bands for their feeder links, the approach might gain wider acceptance.

5.2.2 Feeder links for "Little LEO" Mobile-Satellite Systems

The design approach being used for Little LEO systems does not use feeder links, but simply transmits to and from the central earth station on the same VHF bands used by the user terminals. If, however, a Little LEO system were to require feeder links, the considerations in Section 5.2.1 of this Annex would apply, with the exception that much narrower feeder-link bandwidths would be required, and thus could perhaps be accommodated at lower frequencies.

6.0 Television Broadcast in the Broadcasting-Satellite Service

There are at present no satellites in operation in Canada in bands allocated to the BSS, and no imminent plans for such systems. There are, however, television-distribution systems operating in the fixed-satellite 6/4 GHz C-band and the 14/12 GHz Ku-band. In some cases a very large number of TVRO terminals are being used to receive these signals, but from a regulatory perspective (under the Radiocommunication Act) these stations and networks are in the FSS. From the perspective of considering future Canadian use of the radio spectrum, it is assumed that true broadcasting-satellite systems will be implemented in the foreseeable future for the delivery of television programs.

A prime band for a broadcasting-satellite service in Canada is the 12.2-12.7 GHz band. As described in detail in Annex D, Canada has access to six orbit positions in the ITU 12 GHz broadcasting-satellite plan (Appendix 30 of the Radio Regulations) and associated feeder links in the 17 GHz band (Appendix 30A of the Radio Regulations). That plan is based on a total of 32 radio channels in the 500 MHz wide band, 16 in one polarization and 16 in the other. Each channel is planned to carry one NTSC analog frequency-modulated television signal, with a 24 MHz channel bandwidth. As specified in the plan, Canada can use all 32 channels in each of six orbit locations to serve one of six service areas, each approximately one-sixth of Canada in area. The plan specifies the assignments in enough detail to determine the aggregate carrier-to-interference ratio of each plan entry at specific test points, and the single-entry carrier-to-interference ratio of each plan entry into each other plan entry at these specified test points. These orbit positions and carrier-to-interference ratios are the core of the plan; within these constraints, an administration (Canada in this case) can use the plan with considerable flexibility to respond to its requirements at the time that its system is designed in detail.

There is thus considerable flexibility available in Canada for implementing a 12 GHz broadcasting-satellite system in accordance with that plan. The plan allows the number of satellite beams and service areas of a Canadian system to be chosen with few constraints. For instance, the plan can accommodate a number of configurations such as:

- a minimum-cost first-generation system located at 91°W, with a single Canada-wide beam transmitting up to 32 channels from that location;
- a similar low-cost initial system located at 91°W, with two half-Canada beams transmitting up to 16 channels into each beam;
- a larger twin-satellite system transmitting half-Canada beams from 129°W and 91°W, each one transmitting up to 32 separate channels into each service area;
- transmitting quarter-Canada beams (possibly similar to those of the ANIK-B satellite), with the two western beams transmitted from 129°W and the two eastern beams from 91°W, with up to 16 channels per beam;

- o transmitting Canada-wide beams from both 91°W and 129°W, providing up to 64 channels throughout Canada (this approach seems to be under consideration in system planning activities in the USA);

- o transmitting either up to 32 channels into quarter-Canada beams or 64 channels into half-Canada beams using orbit locations 139°W, 129°W, 91°W and 82°W;

- o transmitting 32 channels into each of six beams, using the six Canadian orbit locations in the plan, in the manner specified in the Plan; or

- o using these same six orbit locations and beams larger than those specified in the plan to provide more than 32 channels per service area. 64 to 96 channels per service area could be provided by making use of the full complement of Canadian resources in the plan if larger than one-sixth-Canada beams were acceptable and batteries were used to avoid outages due to early eclipses during the March and September equinoxes.

To implement any of the above scenarios other than the six-beam and six-satellite scenario of the plan, it would be necessary to use either the adjacent beams specified in the plan, the interim modification procedure associated with the plan, the permanent plan-modification procedure, or some combination of these three processes. The common thread constraining the implementation of these alternatives is that the interference into assignments of other administrations cannot be greater than that specified in the plan without their agreement. However, by taking advantage of improved spacecraft antennas to reduce interference into other non-adjacent service areas, and by using current low-noise receivers that permit lower satellite e.r.i.p.'s, (thus less interference into adjacent USA service areas), few difficulties are anticipated in being able to implement any of the above scenarios.

There is an additional element of flexibility in the Region 2 portion of the ITU 12 GHz plan that further increases its usefulness. That is that the system may be implemented with any signal format in place of the standard one, ie. that of analog frequency modulation with a 24 MHz signal bandwidth, again as long as the effective interference into other plan assignments is not greater than that which would be created when using the standard analog FM transmission format. This flexibility allows digital encoding and transmission using techniques such as 2-phase or 4-phase PSK to be used rather than the standard analog FM. Source encoding techniques such as MPEG (the Motion Picture Experts Group technique) enable an NTSC television signal to be represented by a digital bit-stream at a 5 to 6 Mbit/sec rate, and an HDTV signal to be represented by a bit stream of about 25 Mbits/sec. If 4-phase PSK were used to broadcast these signals, at a 1 bit/hertz density, one could broadcast 4 NTSC signals in one 24 MHz RF channel of the Appendix 30 plan, or 1 HDTV channel. Such techniques are being considered by Telesat for application in the 6/4 GHz and 14/12 GHz bands, and by Hughes (HCI) in their DirecTVsat program in the 12.2-12.7 GHz band.

Thus, by using available digital modulation and source encoding techniques, some 256 to 384 NTSC television programs or 64 to 96 wide-band HDTV programs could be broadcast into each of several service areas in Canada by using the spectrum/orbit resource already available to us in the ITU 12 GHz Appendix 30 plan. We would have to take full advantage of the flexibility embedded in that plan to do so, but that flexibility is there to be used.

When the 12 GHz band is fully utilized as described above, higher frequency bands would be required to meet additional requirements. It is assumed that the 12 GHz band would be fully utilized before the 17.3-17.8 GHz band is used, because of the additional rain attenuation, and hence the need for higher satellite e.r.i.p. levels, resulting in higher system costs at the higher frequency. No time

estimate is currently possible as to when the 17 GHz band would be required under these assumptions, given that there are currently no operational broadcasting-satellite systems in Canada, nor known planning activities underway to implement such a system in either the 12 GHz band or the 17 GHz band. Thus it can be expected that the 17 GHz band will not be required for several decades, given the availability and capacity of the 12 GHz band.

7.0 Feeder Links to Broadcasting-Satellite Systems

Feeder links to both television and sound broadcasting-satellite systems are considered here, but in separate sub-sections 7.1 and 7.2 of this Annex, because the spectrum-policy considerations relating to the two requirements, and the resulting proposed entries in the Canadian Table, are quite different.

7.1 Feeder Links to Television Broadcasting-Satellite Systems

In this section earth-to-space feeder-links to broadcasting-satellite systems for television broadcast are considered, concentrating on the provision of feeder links as required for broadcasting-satellite systems in the 12.2-12.7 GHz band and in the 17.3-17.8 GHz band.

Before WARC-92, the band 17.3-17.8 GHz was identified as the feeder-link band for broadcasting satellites using the 12.2-12.7 GHz band. This band was planned by the ITU for Region 2 in 1983; the resulting plan is in Appendix 30A of the Radio Regulations. Moreover, before WARC-92, the 22.5-23 GHz band was allocated in the ITU table to the BSS in Regions 2 and 3, and the FSS (Earth-to-space) was allocated on a primary basis in Regions 2 and 3 in the band 27.0-27.5 GHz. Although there was no specific designation in the ITU table that the 27 GHz band be used for BSS feeder links, the need for a feeder-link band separate from the general fixed-satellite uplink band 27.5-30 GHz was the principal reason for the ITU FSS allocation in the band 27-27.5 GHz in Regions 2 and 3 in 1979. Thus, before WARC-92 the 17.3-17.8 GHz band was officially the feeder link band for broadcasting satellites using the 12.2-12.7 GHz band, and 27.0-27.5 was informally considered to be the feeder-link band for broadcasting satellites using the band 22.5-23.0 GHz.

Several changes were made at WARC-92 to these BSS and associated feeder link allocations in Region 2, and other changes to the ITU allocation table that affected these allocations. These were:

- the BSS was added in the band 17.3-17.8 GHz, to begin in the year 2007, in the same band as the planned feeder links in Appendix 30A;
- conditions were specified governing the sharing between the feeder links of Appendix 30A and broadcasting-satellite systems operating within the new allocation;
- the broadcasting-satellite service was deleted from the band 22.5-23 GHz, in part as a consequence of the allocation at 17 GHz;
- the fixed-satellite (Earth-to-space) allocation in the band 17.3-18.1 GHz was extended to 18.4 GHz, and the requirement that the allocation be used only for BSS feeder links was extended to 18.4 GHz;
- the FSS was allocated on an exclusive basis in the band 24.75-25.25 GHz, with feeder links to broadcasting-satellites having priority over other fixed-satellite applications;

- a footnote was added stating that geostationary fixed-satellite assignments have no priority over non-geostationary inter-satellite assignments in the 27.0-27.5 GHz band; and

- a footnote was added stating that the fixed-satellite (Earth-to-space) allocation in the 27.5-30 GHz band can also be used for BSS feeder links.

There are a number of factors to consider in deciding how these allocations should be used. These are:

- in the long term, the 17.3-17.8 GHz band should not be used for both uplinks and downlinks in the same service area, because of the harmful interference from a transmitting feeder-link earth station into neighbouring BSS receiving terminals at unspecified locations;

- there is no serious space-station-to-space-station interference associated with dual-directional use of the 17 GHz band. (This was shown in Annex 2 to Part A of the Canadian Proposals to WARC-92.) Thus the 17 GHz band can be used for uplinks in one service area and downlinks in another, possibly with the need to address earth-station-to-earth-station sharing problems on a common border.

- the uplink band used at 18 GHz should be 17.9-18.4 GHz, to minimize any possible interference between uplink and downlink transmissions of different systems, ie. a maximum-width 100 MHz wide guard band 17.8-17.9 GHz should be used as such.

- even by using this 100 MHz guard band the feeder link 17.9-18.4 GHz should not be considered as an uplink associated with the 17.3-17.8 GHz downlink, because of the serious interference problems that would be experienced within a space station if this pair of uplink/downlink bands were chosen.

- the band 27.0-27.5 GHz cannot be considered in the long term as a BSS feeder-link band, because low-earth-orbit (LEO) scientific data-relay satellites are expected to be using this band in the near future, and it is not expected that these LEO systems could be successfully coordinated with geostationary BSS networks. The explicit removal by Footnote 881B of the priority given to geostationary systems through Regulation 2613 in this band by WARC-92 recognizes this difficulty.

- the 27.5-30 GHz fixed satellite (Earth-to-space) band should not be used for BSS feeder links when other bands are available, even though Footnote 882D agreed to by WARC-92 allows this, because this band will be required in the long term to be paired with the fixed-satellite (space-to-Earth) 17.7-20.2 GHz band.

The overall conclusion to be drawn from of these considerations is that the 24.75-25.25 GHz band is the only band available as a feeder-link band associated with the 17.3-17.8 GHz broadcasting-satellite band. Therefore, pairing this band with the 17.3-17.8 GHz BSS band should be considered.

If the 24.75-25.25 GHz band were to be used in this manner, the bands 17.3-17.8 GHz and 17.9-18.4 GHz would be available for use with the 12.2-12.7 GHz downlink. The spectrum policy question on this point is how these two bands should be used, because both are obviously not required at the same time. Factors to take into account in addressing this question are:

- it is unlikely that both the 12.2-12.7 GHz and the 17.3-17.8 GHz broadcasting-satellite bands will be required in Canada in the foreseeable future, given the capacity and flexibility of the 12 GHz plan for Canada (see Section 6.0 of this Annex).

- because the additional transmitted power required to overcome rain attenuation is considerably more at 17 GHz than at 12 GHz, increasing the costs of a 17 GHz system relative to a similar system at 12 GHz, it is expected that BSS systems would continue to be implemented at 12 GHz until that band is fully utilized; only then would additional requirements be met at 17 GHz.

- sharing of the 17.9-18.4 GHz band between broadcasting-satellite feeder links, fixed-satellite space-to Earth links, and terrestrial fixed systems, would place considerable additional constraints on fixed and fixed-satellite downlink systems, especially if the feeder links were to use transportable earth stations.

- if feeder links to 12 GHz broadcasting-satellite systems were to be implemented first in the 17.3-17.8 GHz band, and then changed at a later date to operate in the 17.9-18.4 GHz band, there would be lead-time required to implement this change of bands. Capital invested in 17.3-17.8 GHz equipment would have to be amortized; the fixed and fixed-satellite systems would have to be modified as required to adapt them to the new sharing environment; and 12 GHz broadcasting-satellite space stations using the new uplink frequencies would have to be implemented. These considerations suggest that the decision to use the 18 GHz band rather than the 17 GHz for the feeder links of a next-generation 12 GHz broadcasting-satellite system may have to be made as early as 10 years before the 17 GHz feeder-link band becomes unavailable because of its use for downlinks.

Spectrum allocations and footnotes based on this information are discussed in the main document. At this point, it may be concluded that the 24.75-25.25 GHz band should be considered as an uplink for 17 GHz broadcasting-satellite systems, that the 17.3-17.8 GHz and 17.9-18.4 GHz bands could possibly accommodate feeder-link bands for 12 GHz BSS systems, and that a number of factors need be taken into account in determining which, or whether both, of these bands should be made available in Canada for feeder links of 12 GHz BSS systems.

7.2 Feeder links to Sound Broadcasting-Satellite Systems

The BSS was allocated spectrum in the 40 MHz-wide band 1452-1492 MHz by WARC-92, though limited by Regulation 722A to digital audio broadcasting. Earth-to-space feeder links for such systems will be provided in fixed-satellite bands above 3 GHz. There was no consideration at WARC-92 of which fixed-satellite bands if any should be designated for sound BSS feeder-link use, although there were proposals on the subject from CEPT, the former USSR, and Canada. The stated reason for this absence of a decision was that there was no reason to discuss the matter until there was a decision on where (or whether) there should be an allocation for the BSS (sound) service, and the decision on that matter was made too late in the Conference to permit reconsidering the consequential feeder link requirements of these systems.

The bandwidth required for a Canadian sound BSS feeder-link system is not expected to be significantly greater than the available 40 MHz BSS allocation at 1.4 GHz, and may be less, since significant frequency reuse is not expected within a single spacecraft, and the 40 MHz bandwidth may

have to be shared among several systems. Use of multiple spot beams may result in a greater overall system effective bandwidth, but such a system is expected to utilize more than one spacecraft for weight and primary power considerations. The different spacecraft can be sufficiently separated in orbit to permit the reuse of the feeder-link spectrum, and yet be in the same field of view of a 1.4 GHz receiving terminal. Thus, an FSS bandwidth of the order of 40 to 50 MHz is seen as possibly being both necessary and sufficient for a future Canadian sound BSS system.

With this possible requirement, and lack of a WARC decision on the subject, consideration of the designation of FSS spectrum for BSS (sound) feeder links in Canada is reduced to choosing the most effective way of managing the fixed-satellite spectrum and orbit resources available for Canadian systems. (See Section 3.1 of Annex A for discussion of this matter in general terms, and Annex C for a description of available Canadian fixed-satellite spectrum/orbit resources). This leaves us with two basic alternatives:

1. make no designation within the FSS, which could result in designers of sound BSS systems choosing any FSS (uplink) band available at the time; or

2. designate a particular FSS (uplink) band for sound BSS feeder links and specify the sharing conditions in this band between such feeder links and other FSS uses.

Two advantages and one disadvantage have been invoked relative to the making of such a designation. The advantages are:

1. the broadcasting community would know which band to use in the planning and development of sound BSS systems, including the ITU's own sound BSS planning activities included in Resolution 528 (COM 4/W of the WARC-92 Final Acts); and

2. a designation and consequential use of a relatively narrow band in an appropriate part of the spectrum would avoid assignments to BSS (sound) feeder links within the much wider (500 MHz or more) FSS bands, and thus avoid reducing the usefulness of these bands for their intended wideband applications.

The only disadvantage attributed to the making of such a designation is that it may reduce the FSS's flexibility to respond to situations not currently anticipated.

Since the advantages of proceeding immediately with a designation seem to predominate, it would seem useful and appropriate to review the various FSS uplink bands to determine whether any of these bands would technically meet the BSS requirement while, at the same time, have a minimal impact on their future planned or potential use by the services already allocated or suited to them. The various alternatives are the following:

- the band 5850-5925 MHz, a natural space-to-Earth extension to the 5925-6425 MHz band, might be paired with the band 3625-3700 MHz if, in fact, that band becomes available for an augmented 6/4 GHz ANIK system;

- the band 5925-6425 MHz is paired with the band 3700-4200 MHz, is already fully used by ANIK-D and ANIK-E systems and is included in the 1988 CAN/USA/Mexico orbital arrangement;

- the band 6425-6725 MHz could either be paired with the band 3400-3700 MHz to

meet additional FSS wideband requirements in the future, or paired with the 10.95-11.2 GHz downlink band (a somewhat unusual but feasible arrangement with the potential to increase the available FSS spectrum/orbit resource in the long term);

- o the band 6725-7025 MHz is officially paired with the band 4500-4800 MHz in the Appendix 30B FSS Plan. This band could be used for BSS (sound) feeder links, as is the 13 GHz Appendix 30B allotment for the feeder links of MSAT at 106.5°W (as discussed in Section 5.1.1 of this Annex). However, the band may also be needed in the future to augment the 6/4 GHz band by 300 MHz;

- o the band 7025-7075 GHz can meet the sound BSS requirements, and does not have an obvious use in the development of FSS networks, since it is isolated above the 6725-7025 MHz uplink band of the allotment-plan, and does not have a corresponding downlink band above the 4500-4800 MHz downlink band of the allotment plan;

- o the band 7900-8400 MHz is used in conjunction with the downlink band 7250-7750 MHz and is reserved for government use through Footnote C5;

- o the band 12.75-13.25 GHz is officially paired in the Appendix 30B plan with the 11 GHz band and is currently used for MSAT feeder links and may possibly, in the long term, be used by the FSS at other orbit locations;

- o the band 13.75-14 GHz is a candidate for pairing with the band 11.45-11.7 GHz in one of the proposals for changes to the Canadian Table. Both bands are a natural extension to the current 14/12 GHz bands;

- o the band 14.0-14.5 GHz is heavily used by ANIK-C and ANIK-E systems, in conformity with the Can/USA/Mex arrangement, and is therefore unavailable for sound BSS feeder links;

- o the band 14.5-14.8 GHz is not allocated to the fixed-satellite service in the Canadian Table because it is required for terrestrial applications that cannot share with the FSS;

- o the bands 17.3-17.8 GHz, 17.9-18.4 GHz and 24.75-25.25 GHz are fully required for feeder-links to BSS systems for television delivery, as discussed in Section 7.1 of this Annex;

- o the bands 27.5-29.5 GHz and 29.5-30 GHz are expected to be used with the bands 17.7-19.7 GHz and 19.7-20.2 GHz respectively. In particular, the bands 19.7-20.2 GHz and 29.5-30 GHz are anticipated to be used for the multipurpose satellite systems described in section 4.0 above; and

- o the band 30-31 GHz is used with the band 20.2-21.2 GHz and is reserved for government systems through Footnote C21.

This is a complete list of FSS Earth-to-space bands below 31 GHz, except for the band 17.8-17.9 GHz. Each of the bands other than the band 7025-7075 MHz is considerably wider than that required for BSS (sound) feeder links, and is associated with a corresponding FSS downlink band. Thus, their use for narrow-band feeder links should be avoided if possible.

The only other FSS uplink band below 31 GHz that is not otherwise useful for either general wide-band FSS application or BSS (television) feeder-links is the band 17.8-17.9 GHz, part of the 17.3-18.4 GHz band between the identified feeder-link bands 17.3-17.8 GHz and 17.9-18.4 GHz. This is a possible alternate to the 7025-7075 MHz band, but the reverse-band sharing problems that would be encountered at 17.8 GHz with FSS or BSS downlinks would seem to make the band less attractive for BSS (sound) feeder links than the 7 GHz band, and its use would rule out the possibility in the long term of a multiband broadcasting-satellite spacecraft. In both the 7 GHz and 17.9 GHz bands, feeder links share with the fixed service on a co-primary basis.

8.0 Airport Surface Detection Equipment (ASDE) in the Radionavigation Service

Studies are underway in the Department of Transport leading to the development of a radar system for aircraft traffic management at large airports in Canada. The targeted traffic to be managed with this system is both aircraft on the ground on the various runways and taxiway of an airport, and in the air in the immediate vicinity of the airport. Without going into the design of such equipment, it can be said from a spectrum requirement perspective that such radars need to have an operating range of several kilometres in adverse (heavy rain) conditions with high reliability, and need to have a range resolution of a few metres. The required *range and reliability* in heavy rain conditions determines the radar pulse e.r.i.p., a parameter that would necessarily increase with increasing frequency due to the increase in rain attenuation with increasing frequency for a given rate of rainfall.A separate parameter, the *range resolution,* is dependant on the radar pulse duration, which is inversely proportional to the necessary bandwidth of the radar transmission. Bandwidths in the order of 400 MHz to 600 MHz are expected to be necessary to achieve the necessary range resolution.

Such equipment should have the protection of the safety-of-life regulation 953 of the Radio Regulations. To appreciate this, one need only consider that such equipment is designed to aid in the avoidance of collisions of large passenger-carrying aircraft on taxiways and runways, or in the immediate airspace, of airports such as the Pearson airport at Toronto.

Prior to WARC-92, a prime band being considered for such systems was the band 24.25-25.25 GHz. That band was allocated to the radionavigation service on a world-wide basis. The band is being used for developmental ASDE systems in Japan, and was being considered for similar use in Canada.

Another band being considered for ASDE is the band 31.8-33.4 GHz. Prior to WARC-92, that band was shared on a co-primary basis only with the inter-satellite service in the band 32.0-33.0 GHz, and on a secondary basis with the space research service in the band 31.8-32.3 GHz. In considering the sharing between systems of the radionavigation and inter-satellite services, ITU regulation 893 requires that the safety aspects of the radionavigation service be taken into account; that footnote, combined with Radio Regulation 953 (see previous paragraph), puts the onus on the inter-satellite network to protect, and accept interference from, the radionavigation network in an agreed manner.

At WARC-92, the ITU took the following decisions related to this topic:

- in Region 2, the spectrum available to the radionavigation service in the 25 GHz band was reduced to 400 MHz (24.25-24.65 GHz), and the top 200 MHz (24.45-24.65 GHz) was also allocated on a co-primary basis to the inter-satellite service. However, regulation 882E was added to this 24.45-24.65 GHz band stating that systems in the inter-satellite service cannot claim harmful interference from ASDE systems in the radionavigation service, ie. inter-satellite systems are secondary

to such applications in the radionavigation service.

- o the space research service was raised from secondary to primary status in the band 31.8-32.3 GHz. However, this service in this band was included in RR 893 in the same way that the inter-satellite service is specified in the band 32.0-33.0 GHz. Thus the onus is on the user of the space research service to protect and not claim harmful interference from safety-of-life equipment, ie. ASDE, in the band, similar to a user of the inter-satellite service.

In summary, the 32 GHz band has adequate protection and bandwidth, as it had before the Conference. The 24 GHz band has adequate protection in its allocated band, but that band has been reduced from 1000 MHz to 400 MHz.

It is not evident whether the 24 GHz band has enough bandwidth to implement the ASDE radars with sufficient range resolution to do the required task. Furthermore, the rain attenuation may be a significant cost and/or reliability factor in the implementation of such systems at 32 GHz. For these reasons an alternate band being considered for implementation of high-resolution ASDE systems is the band 15.7-16.2 GHz. This band is the bottom 500 MHz of the 1600 MHz-wide radiolocation band (15.7 GHz to 17.3 GHz). Note that the radiolocation and radionavigation services are very similar, radars being employed in both cases, the only difference being the application of those radars. In the US domestic allocation table, ASDE systems are permitted in this band through US footnote G59, which states that ASDE systems are permitted on an equal basis with military systems. Similar use could be considered in Canada, either through a Canadian domestic footnote or a co-primary allocation to the radionavigation service in the Canadian table.

9.0 The Radiolocation Service

No changes to allocations to the radiolocation service were made by WARC-92, and no changes to the spectrum requirements of the radiolocation service in Canada are anticipated. The only effect to radiolocation allocations that might come from this spectrum policy review above 3 GHz is a possible sharing with, or replacement by, the radionavigation service in the 15.7-16.2 GHz band. (See Section 8.0 of this Annex.)

10.0 The Inter-Satellite Service

There are two distinct applications of the inter-satellite service considered in this review:

- i) its application by communications satellite networks to provide links between satellites in the FSS or the MSS. In some cases, these communications satellites are in the GSO orbits, in other cases they are in non-GSO orbits (probably but not necessarily in LEO orbits), and

- ii) its application by scientific satellite systems to provide links for data transmission between scientific low-earth-orbit (LEO) satellites (or those in other non-GSO orbits) and GSO data-relay satellites, to be then transmitted to or from Earth through fixed-satellite links.

These two types of applications are similar in that they both involve communications paths between

satellites. However, characteristics such as the orbits involved and the necessary interference protection of the signals involved are quite different. Different bands were allocated and different sharing conditions agreed to for the different applications at WARC-92. The two different applications are considered below in Sections 10.1 and 10.2 respectively.

10.1 Communications Satellite Applications

At WARC-79, the bands 22.55-23.55 GHz and 32-33 GHz were allocated on a primary basis to the inter-satellite service. It was anticipated at that time that inter-satellite links would be implemented in these bands between geostationary fixed satellites to add flexibility in the implementation of complex fixed-satellite networks, particularly those involving inter-continental paths that might otherwise require two-hop routes using Intelsat satellites. No such systems have in fact been implemented in these bands. Planners of such systems now indicate that if such links are implemented on satellite systems it is much more likely that higher frequencies, at 60 GHz or higher, would be used. In this environment the 23 GHz band is being used for a very different application involving LEO scientific satellites (see Section 10.2 of this Annex).

A different requirement for inter-satellite links was discussed at WARC-92: the need for inter-satellite links to provide connecting paths between LEO mobile satellites such as those of the Iridium/Motorola system. The original proposal, made by the USA, was that a 300 MHz wide inter-satellite band be allocated to meet this requirement in the band 21.7-22 GHz. Because of the characteristics of such LEO/MSS systems, this allocation would have to be on a global basis. LEO/MSS inter-satellite links could not use the same spectrum as HDTV/BSS systems, and the 22.4-23.0 GHz band was already allocated to the BSS in Regions 1 and 3. Because of that decision, it was necessary to find another band to satisfy the LEO/MSS inter-satellite requirement. The band agreed to by the Conference was the band 24.45-24.75 GHz, shared with the radionavigation service (see Section 8.0 of this Annex) in the lower part of the band, and with the radiolocation-satellite service (see Section 13.0 of this Annex) in the upper portion of the band.

10.2 Scientific Satellite Applications

The inter-satellite service is used by space agencies, including the Canadian Space Agency, in international scientific space programs. Inter-satellite links are used to transmit information between LEO and GSO satellites, from one to another LEO satellite, and from one GSO satellite to another. The bands used for the first two of these three applications are the 22.55-23.55 GHz band discussed above in Section 10.1 of this Annex, and the 25.25-27.5 GHz band. Specifically, the 22.55-23.55 GHz band is intended to be used for transmission of data from geostationary relay satellites such as TDRSS to LEO satellites such as Space Station Freedom, but there is nothing in the Radio Regulations that makes this limitation official. The wider-bandwidth 25.25-27.5 GHz band is similarly intended to be used for transmission to the GSO satellites, probably to be further transmitted to the earth, and for relatively short range proximity links between LEO satellites, but again there is nothing in the Radio Regulations that restricts the allocation to such links.

There was an improvement in the status of the 23 GHz inter-satellite service at WARC-92 in that while it had already been allocated on a co-primary basis with the fixed and mobile services, the previously-allocated broadcasting-satellite service was removed (see Section 6.0 of this Annex). The power flux-density limitation of inter-satellite transmissions in this band and in the 25 GHz band was not changed; it is the same limit as that imposed on the FSS in the 17.7-19.7 GHz band, through

Radio Regulation 2578. That limit is imposed to protect terrestrial receiving fixed and mobile stations in the band.

The new primary inter-satellite service allocation in the band 25.25-27.5 GHz replaces the old secondary earth exploration-satellite allocation in the same band. It also shares the band on a co-primary basis with the fixed and mobile services. To enable sharing between services,inter-satellite transmission levels in this band also are also limited by the power flux-density limits of Radio Regulation 2578.In preparing proposals to WARC-92, Canada had agreed that the 25.25-27.5 GHz band should be used for inter-satellite links between scientific satellites. However, in those WARC preparations it was recognized that to simply allocate the band to the inter-satellite service without constraint may unnecessarily create difficult sharing problems, because the newly allocated inter-satellite service may be used by other applications in ways not compatible with the reason for the allocation. The Canadian alternative was to propose a new service to meet the inter-satellite needs of space agencies in the 25 GHz band, ie. the space communications service, and allocate the 25 GHz band to that service. This approach was not supported per se at the WARC, but the proposal did result in ITU footnote 881A that specifies that the inter-satellite service in the 25.25-27.5 GHz band be used only for space research, Earth exploration-satellite, industrial, and medical applications, ie. not for inter-satellite links between communications satellites. This designation met the spirit and perceived requirements expressed in Canada's proposed use of the band. It should be noted that there is no such constraint in the Radio Regulations in the companion band 22.55-23.55 GHz.

The 32.0-33.0 GHz band is also being considered for scientific-satellite applications, as the band to be used for inter-satellite communication between geostationary satellites such as TDRSS. In the TDRSS system, for instance, this GSO inter-satellite network is used to provide a global tracking network of LEO satellites operated from White Sands, New Mexico. Other space agencies such as ESA or NASDA may in the future set up similar geostationary networks, and share the band in view of the isolation afforded by the spacecraft's antenna discrimination.

11.0 The Space Research Service

There were no allocations to the Space Research service at WARC-92 in the 3 GHz to 30 GHz frequency range, except indirectly through allocations to the inter-satellite service as explained in Section 10.2 of this Annex. In contrast, there were a number of new allocations to the space research service above 30 GHz, and a number of bands in which a secondary space research allocation was raised to primary status. These allocations to the space research service, all on a world-wide basis, and the constraints on the use of the allocation, are as follows:

31.8-32.3 GHz	space-to-Earth direction, for deep space use,
34.2-34.7 GHz	Earth-to-space direction, for deep space use,
37.0-38.0 GHz	space-to-Earth direction,
40.0-40.5 GHz	Earth-to-space direction,
74.0-84.0 GHz	space-to-Earth direction, secondary allocation.

Note that in some cases a space research band is allocated to be used for "deep space" applications only, ie. applications in which the satellite is more than two million kilometres from the Earth, while in other cases this constraint is not imposed.

Canada does not have any special requirements for the use of these allocations, other than possible Canadian Space Agency participation in international space programs in which the bands are used. At

the same time, any concerns of Canada regarding these allocations were met by the specified sharing conditions between the space research service and other services. Sharing with the fixed service at 37 GHz is acceptable because of the Article 28 power flux-density limits on the space service. Sharing with the radionavigation service at 32 GHz is acceptable of the sharing constraints placed on the inter-service by RR 893 were extended to the space research service as well, as discussed above in Section 9.0 of this Annex.

12.0 The Earth Exploration-Satellite Service

There were several allocations to the earth exploration-satellite service, apart from the inter-satellite allocation for earth-exploration applications in the 25.25-27.5 GHz band, most of them with a secondary status. These include:

25.5-27.0 GHz,	direction changed from space-to-space to space-to-Earth, secondary status,
28.5-30.0 GHz,	Earth-to-space direction, secondary status, constrained by RR 882C,
37.5-40.5 GHz,	space-to-Earth direction, secondary status,
74.0-84.0 GHz,	space-to-Earth direction, secondary status,
156-158 GHz,	passive use, no direction specified, primary status.

As in the case of space research allocations above 30 GHz, there are no immediate plans in Canada to use these allocations; long term use as presently anticipated would stem from Canadian participation in some international space program. At the same time, since the allocations are on a secondary basis (except for the passive allocation at 156 GHz), there is no reason to be concerned that use of these allocations would constrain the primary use of the bands by other services.

There is one exception to the above general conclusion, relating to the uplink allocation in the 28.5-30 GHz band constrained by the new footnote 882C. That footnote states that the service in the 28.5-30 GHz band can only be used for the (Earth-to-space) transfer of data between stations, and not for the primary collection of data by either active or passive means. This task could be accomplished equally well by a primary Earth-to-space link in the FSS in same band, and therefore the secondary allocation is not seen as being required.

13.0 The Radiolocation-Satellite Service

The radiolocation-satellite service was defined by WARC-92 as being "a radiodetermination-satellite service for the purpose of radiolocation" (RR 46A in Section III of Article 1). Feeder links for such systems may also be in bands allocated to the service. The USA proposed the definition, arguing that a specialization of the more general radiodetermination-satellite service is necessary for systems where safety-of-life aspects is not a factor. The Conference accepted the argument and the proposed definition.

Furthermore, the USA proposed that the new service be allocated 100 MHz of spectrum without directionality constraints in the band 24.55-24.65 GHz. Informal discussions at the WARC indicated that dual-direction operation similar to that being planned for one US LEO mobile-satellite system was the basis for the lack of directionality constraints in the proposal. No details of the applications to be made of the proposal were available, other than that it was presumed to be an EHF variant of the former GEOSTAR radiodetermination-satellite system that operated in the 1610-1626.5 MHz and

2483.5-2500 MHz bands.

At the WARC the band was shifted slightly upwards to 24.65-24.75 GHz, in part to accommodate the radionavigation service in the lower band 24.25-24.65 GHz without having to share a band between the two services, and allocated in Region 2 only rather than a world-wide allocation. Furthermore, it was allocated for uplink use only, without a corresponding downlink allocation. There were indications that a system using the radiolocation-satellite allocation at 24 GHz may use the FSS/MSS 19.7-20.2 GHz band.

There have been no requirements expressed in Canada for such an allocation. However, in the Final Acts of the WARC, the radiolocation-satellite service shares the band only with the inter-satellite service. As noted in Section 10.1 of this Annex, the new inter-satellite allocation in this band is primarily for links between LEO mobile-satellite systems.

14.0 Concluding Notes

Background information is provided in this Annex specific to each of the services that are considered for possible change in the allocation of spectrum to the service, and/or in a companion document concerning spectrum utilization policies relating to that service. No proposals as such are made in this annex. However, the public may wish to comment on information presented in this Annex and in Annexes A, C and D in addition to or as background information to comments on the allocation proposals presented in the main document.

Available Spectrum/Orbit Resources in the Fixed-Satellite Service for Canadian Domestic Systems

1.0 Introduction

This annex provides a record of the spectrum and orbit resources available to Canadian fixed-satellite users as a result of ITU decisions taken at WARC-92 and prior Conferences, and arrangements agreed to with Canada's North American neighbours. This information is background to consideration of spectrum and orbit requirements for the fixed-satellite service in Annex B, and allocations to the fixed-satellite service in the main document.

2.0 Bands Considered

Spectrum/orbit resources in both the 3 to 6 GHz and 10 to 15 GHz frequency ranges are discussed in this annex. The "conventional" bands 3.7-4.2 GHz, 5.925-6.425 GHz, 11.7-12.2 GHz, and 14-14.5 GHz are reviewed, as well as the "allotment" bands 4.5-4.8 GHz, 6.725-7.025 GHz, 10.7-10.95 GHz, 11.2-11.45 GHz, and 12.75-13.25 GHz. These bands are considered because Canada is party to treaties and less formal arrangements with other administrations on use of the geostationary orbit (GSO) in these bands. Other fixed-satellite service (FSS) bands are available in Canada, but without international arrangements governing the use of the GSO.

3.0 Background

The international agreements and arrangements referred to above are the 1988 Canada/USA/Mexico trilateral orbital arrangement for the conventional 6/4 GHz and 14/12 GHz bands, and the 1988 Space WARC Final Acts (now Appendix 30 B of the Radio Regulations) for the 13/11 GHz and upper 6/4 GHz allotment bands.

3.1 North American Orbital Arrangements Pertaining to Use of the Conventional 6/4 and 14/12 GHz Bands

The usual way of determining the orbit location of a fixed satellite, or the locations of the satellites of a multi-satellite system such as Telesat's ANIK-C, ANIK-D, or ANIK-E systems, is to simply choose available orbit locations on the GSO for which the inter-network interference is acceptably low, and to coordinate the satellites at these orbital locations through Article 11 of the Radio Regulations. This was the way in which the early ANIK-A satellite orbit locations were determined, for example. In the early 1980's, at the time that the Canadian ANIK-C and ANIK-D networks, the Mexican Morelos network, and a number of US domsat networks were being planned, it was recognized in each of the three administrations that the GSO resource available in North America would have to be managed more efficiently if these systems were all to be placed in orbit. It was agreed to do this in a two-stage process involving, first, choosing orbit positions of the satellites involved, taking into account the expected necessary orbital separations to result in a successful coordination of the systems involved, and then coordinating the satellites at these orbital positions at some later date. The resulting "orbital arrangement" was simply a list of which satellite would be coordinated at which orbital position later on.

The first Can/USA/Mex orbital arrangement was agreed to in 1982. This arrangement included orbital positions for two 6/4 GHz ANIK-D satellites, three 14/12 GHz ANIK-C satellites, the dual-band ANIK-B satellite, and two dual-band Morelos satellites. The ANIK-Cs were at 2.5° spacing, the ANIK-Ds at 3.5° and the dual-band Morelos satellites at 3°. Advantage was taken of the discrimination of the antennas on the Canadian and Mexican satellites to place these satellites closer to one another than the above values (eg. 2° only between Morelos-1 and ANIK-D-2, and 1° only between ANIK-C-3 and Morelos-2. Note that at the time of this trilateral arrangement, US domsats were at 4° spacing at 6/4 GHz and at 3° spacing at 14/12 GHz; the next year, 1983, the FCC required new US domsats to be at a 2° spacing at 14/12 GHz and at a 2.5° spacing at 6/4 GHz, the latter having since been reduced to 2°.

In 1987, Canada and Mexico both requested that this trilateral arrangement be reconsidered, because:

- Canada had a requirement for four dual-band orbit locations to accommodate the ANIK-E series of satellites, rather than the four 14/12 GHz positions and three 6/4 GHz positions of the 1982 arrangement, none of which could be used by dual-band satellites;
- Canada had a requirement for extended cross-border coverage (ECBC) of a few channels of its 14/12 GHz portion of the ANIK-E satellites; and
- Mexico had a requirement for three rather than two dual-band satellites.

These requirements were realized at a time when the required number of US domsat orbit locations was increasing rapidly. In 1985 prospective requirements for United States domestic FSS systems had increased to the point of saturating available orbit resources at 2° spacing for both the 14/12 GHz and 6/4 GHz bands outside of the Canada/Mexico orbital arc of the 1982 arrangement.

Canada and Mexico agreed that separations between their own satellites, or between their own and US satellites (situations in which no spacecraft-antenna discrimination is available) should not be less than 3°, and that the separation between Canadian and Mexican satellites should be not less than 2°. Smaller spacings had been accepted at 14/12 GHz in the 1982 arrangement, but the spacings considered in 1988 were governed by the spacings required by the 6/4 GHz portions of the planned dual-band systems.

After three meetings between representatives of the three administrations, an arrangement was agreed to which would accommodate four Canadian dual-band satellites and three Mexican dual-band satellites, with minimal loss of orbit availability for US domestic operators. (The arrangement is discussed in more detail in Section 4.0 of this Annex.) The arrangement was agreed to through an exchange of letters between senior officials of DOC, the FCC and Mexican authorities in September 1988.

3.2 ITU Planning of the Fixed-Satellite Allotment-Plan Bands

WARC-79 issued Resolution 3 of the Radio Regulations that requested that the ITU convene a WARC in the 1980s to plan the use of the geostationary orbit by certain (to be determined) space services and bands . The result was the two-session Conference, held in 1985 and 1988, respectively.

It was agreed at the first session, WARC-ORB-85, that the fixed-satellite service be planned at the second session (WARC-ORB-88) in the bands 4.5-4.8 GHz (for downlinks), 6.725-7.025 GHz (for

uplinks), 10.7-10.95 GHz and 11.2-11.45 GHz (for downlinks), and 12.75-13.25 GHz (for uplinks), a total bandwidth of 800 MHz in each direction. There was some confusion in the Report of the 1985 WARC to the 1988 WARC as to whether there should be exactly one or at least one allotment per administration in the Plan. Canada stated that its requirement was for three full-band allotments (knowing full well that there was sufficient orbit capacity available for a similar number of allotments throughout Region 2). However, the 1988 Conference determined that the Plan would accommodate only one allotment of 800 MHz per service area, independent of the availability of greater capacity in Region 2 (but not in Regions 1 and 3, especially Europe and Africa). In response to this Conference decision, Canada asked that its land mass be served from three separate satellites at different orbit positions, to provide an elevation angle of at least 10° at specified locations in the Arctic. The ensuing ITU response was positive and Canada obtained three full-band allotments to serve CANADA-WEST, CANADA-CENTRAL, and CANADA-EAST respectively. The ITU Plan with these Canadian allotments is in Appendix 30B of the Radio Regulations.

Existing systems were also accommodated in the Appendix 30B Plan. There were many "existing systems" of France, Russia, etc. in the Region 1 and 3 portion of the GSO, but the only "existing system" of interest to Canada in the Region 2 portion of the GSO was MSAT's feeder link system at 106.5° West in the 13 and 11 GHz bands. This system is included in Part B of the Plan with the other existing systems. Note that an "existing system" entry in Part B of the plan is valid for 20 years after the plan comes into effect, ie. until March 2010 in MSAT's case. After that date, a Canadian "existing system" at 106.5°W will lose that status.

4.0 Available Orbital Capacity

4.1 In the 6/4 GHz and 14/12 GHz Bands through the CAN/USA/MEX Arrangement

As indicated above, the orbital locations available to Canada in the conventional 6/4 GHz and 14/12 GHz bands, as agreed to in the 1988 Canada/USA/Mexico orbit-utilization arrangement, are 107.3°, 111.1°, 114.9° and 118.7°, ie. four positions with orbital separations of 3.8°. To secure this amount of orbital capacity in the highly-utilized portion of the GSO between 100°W and 120°W (as described in Section 3.1 of this Annex) it was necessary to maximize the utilization of the GSO by taking advantage of the geographical separation between Canada and Mexico. The consequential spacecraft-antenna discrimination between the domestic satellites of the two countries allowed Canadian and Mexican orbital separations of 1.9°. Accordingly, Mexican orbital positions in the arrangement were chosen to be 109.2°W, 113.0°W and 116.8°W. As part of the same arrangement the USA could locate 14/12 GHz satellites at 105°W and at 121°W (2.3° from the Canadian orbital positions at 107.3°W and 118.7°W), and satellites in either or both bands at 103°W and at 123°W. (The reason for the latter arrangement was that while a spacing of 2.3° was acceptable at 14/12 GHz --- a slight reduction from the 2.5° separation of the 1982 arrangement ---, it was not acceptable at 6/4 GHz.) The previously (1982) agreed orbit locations are indicated in Table C-1, and the new (1988) locations are indicated in Table C-2. Note that extensive transitional arrangements have been and continue to be a necessary part of the present (1988) arrangement, because of the significant differences between the 1982 and 1988 arrangements. These include agreements on time intervals for movements of satellites from the old to the new locations.

4.2 In the Upper 6/4 GHz and the 13/11 GHz Bands through the ITU Appendix 30B Allotment Plan

As indicated in Section 3.2 of this Annex, Canada obtained three allotments in the Appendix 30B Plan, each to serve one third of Canada's territory, and also retained the right to implement the "existing-system" feeder links for MSAT at 106.5°W. This happened just months after Canada had agreed to four orbital positions for the 6/4 GHz and 14/12 GHz ANIK satellites through the 1988 CAN/USA/MEX orbital-use arrangement. At the Conference, Canada succeeded in obtaining the 3 easternmost of the 4 CAN/USA/MEX positions for its CANADA-EAST, CANADA-CENTRAL, and CANADA-WEST allotments, ie. 107.3°W, 111.1°W, and 114.9°W. This was arranged so that, in combination, CAN/USA/MEX and allotment-plan positions would allow Canadian operators to implement large multi-band spacecraft if it were cost-effective to do so. Note that a major reason for the need for the 1988 re-drafting of the 1982 CAN/USA/MEX arrangement, from a Canadian perspective, was that in 1985 Telesat Canada had determined that dual-band spacecraft would be much less costly than smaller single-band spacecraft. Arranging that the Canadian allotment-plan orbital positions coincide with CAN/USA/MEX orbital positions provided the flexibility to implement large multi-band spacecraft. Canadian orbit locations at the different frequency bands of interest are shown in Figure C-1.

There are two potential FSS intra-service sharing problems associated with these allotment Plan entries that are not experienced when using bands not included in the Plan. These are:

i) each of the three Canadian Plan entries are for one third of Canada, for reasons explained above; the procedures associated with the Plan permit this to be modified only at the time that the allotments are converted to assignments; and

ii) systems implemented within the Plan must have a set of generalized parameters within specified constraints if the system is to be "in conformity with" the Plan; notification of the network is more difficult if it is not in conformity with the Plan.

At the time that Canadian satellite networks are implemented within the Plan, it may be more cost-effective either to use spacecraft with one-third-Canada beams as indicated in the Plan, or to implement three identical spacecraft with Canada-wide coverage. Similarly, it may be more cost-effective to implement the network using generalized parameters that are not in conformity with the Plan. In both cases, the question that would arise is whether the system that is not "in conformity" with the plan affects other entries in the Plan. There are specific levels of interference into other systems that have been agreed to in the Plan to determine whether another planned system can be considered as being affected. Fortunately, the three Canadian allotments are located in a portion of the GSO in which there are not a large number of allotments. The only other allotments that might possibly be affected by changes of Canadian assignments from that specified by the parameters of the Plan are the US allotment at 101°W, Ecuador's allotment at 104°W, the Jamaican allotment at 108.6°W, the Mexican allotment at 113°W, or allotments to French territories in the Caribbean and in the Pacific Ocean from 115.9°W. (See Table C-3 for details of the Plan in the 92°W to 130°W arc.) These allotments all have high C/I margins, at least 8 dB above the required 26 dB, and it may therefore be assumed that reasonable modifications of the Canadian allotments, including expansion to Canada-wide beams, would not affect other allotments and could be implemented without difficulty. There is no technical reason to prevent this from happening if required, though a favourable interpretation of the procedures in Appendix 30B by the IFRB would be required.

It may be noted in Figure C-1 that there are Canadian allotment-plan entries at 107.3°W, 111.1°W, and 114.9°W in the 1988 Can/USA/Mex orbital use arrangement, but no Canadian allotment at the most westerly 118.7°W location. At some time in the future, it may be desirable to implement identical multi-band Canadian domestic fixed-satellite systems at any of the four Canadian positions. Under the procedures of Appendix 30B, it would be possible to place a Canadian fixed-satellite in the fourth position for "additional use" if other allotments or assignments of the plan were not affected. This condition could, fortunately, be easily met since the GSO near 118.7°W is very lightly occupied, the only nearby allotments being that of French territories in the Caribbean and in the Pacific at 115.9°W, Mexico at 113°W, and SMO at 125.5°W.

5.0 Summary

As indicated in Figure C-1, Canada has access to the geostationary orbit at 107.3°W, 111.1°W, 114.9°W, and 118.7°W in the conventional 6/4 GHz and 14/12 GHz bands through the 1988 Canada/USA/Mexico trilateral orbit utilization arrangement, and in the upper 6/4 GHz and 13/11 GHz bands through the Appendix 30B allotment Plan. While Appendix 30B does not explicitly state that these orbit locations are available for Canadian domestic systems with Canada-wide beams, the technical characteristics of the plan itself, coupled with the text of the accompanying procedures, suggest that such an implementation would be possible. Assuming two times frequency re-use through a combination of spot beams and/or use of both polarizations, the above provides a total of:

(500 + 500 + 300 + 500) x 2 x 4 or 14,400 MHz

of bandwidth for Canadian domestic fixed-satellite use. This represents 7.2 times that used by a current-generation ANIK-E satellite. Detailed frequency assignment plans, including transponder bandwidths and the number of transponders, could be developed within this overall available bandwidth at the time that the systems are being designed in detail.

Table C-1

1982 Trilateral Orbital Arrangement
among Canada, the United States and Mexico

6/4 GHz Use	Orbital Position	4/12 GHz Use
USA	101.0° W	-
-	102.5° W	USA
Canada	104.5° W	-
-	105.0° W	USA
-	107.5° W	Canada
Canada	108.0° W	-
-	110.0° W	Canada
Canada	111.5° W	-
-	112.5° W	Canada
Mexico	113.5° W	Mexico
Mexico	116.5° W	Mexico
-	117.5° W	Canada
USA	119.5° W	-
-	120.0° W	USA
USA	122.0° W	USA

Table C-2

1988 Trilateral Orbital Arrangement
of Canada, The United States, and Mexico

6/4 GHz Use	Orbital Position	14/12 GHz Use
USA	103.0° W	USA
-	105.0° W	USA
Canada	107.3° W	Canada
Mexico	109.2° W	Mexico
Canada	111.1° W	Canada
Mexico	113.0° W	Mexico
Canada	114.9° W	Canada
Mexico	116.8° W	Mexico
Canada	118.7° W	Canada
-	121.0° W	USA
USA	123.0° W	USA

Table C-3

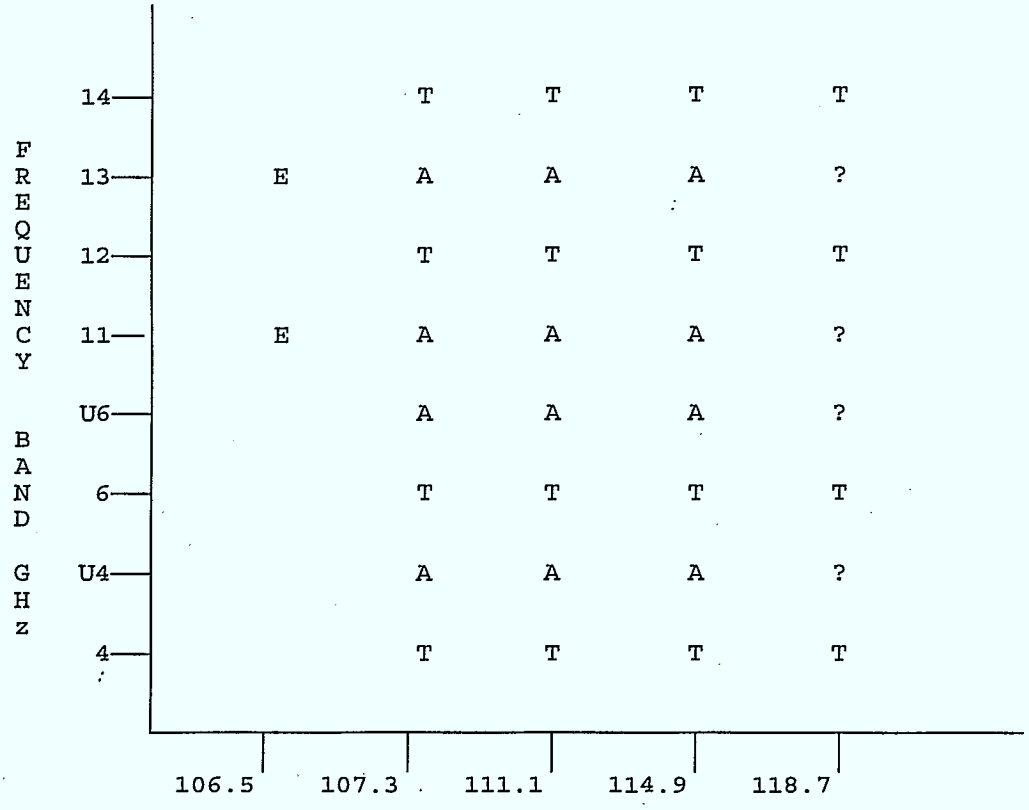
Allotment-Plan Entries
Between 92° West and 130° West

Orbit Position	Country	Service Area Long.	Lat.	C/I in dB 6/4	13/11
130.5°	WSLV, El Salvador	89° W	14° N	34.3	32.2
128.0°	WTON, Tonga	175° W	21° S	32.3	47.5
125.5°	WSMO, Samoa Islands	172° W	14° S	32.1	45.0
115.9°	WGDL, Guadeloupe	62° W	16° N	36.6	37.7
115.9°	WGUF, French Guiana	53° W	4° N	43.2	39.6
115.9°	WOCE, Tuamatu Archipelago	141° W	16° S	47.9	51.3
114.9°	**WCAN0WEST, Canada West**	**120° W**	**57° N**	**28.5**	**24.6**
113.0°	WMEX, Mexico	104° W	23° N	34.4	36.3
111.1°	**WCAN0CENT, Canada Central**	**96° W**	**51° N**	**27.3**	**24.5**
108.6°	WJMC, Jamaica	78° W	18° N	33.9	35.0
107.3°	**WCAN0EAST, Canada East**	**77° W**	**50° N**	**27.9**	**16.4**
106.5°	**WCANMSAT, an existing system in the 13/11 GHz plan only. -**			**15.6**	
104.0°	WEQA, Ecuador	83° W	1° S	40.7	40.7
101.0°	WUSA, United States CONUS	94° W	37° N	34.3	35.5
101.0°	WUSAVIPRT, Puerto Rico	65° W	18° N	31.0	37.7
98.2°	WABW, Dutch Antilles	69° W	12° N	29.8	33.8
96.0°	WCTR, Costa Rica	85° W	8° N	37.0	38.9
93.1°	WVCT, St. Vincent	61° W	13° N	31.2	34.2
92.0°	WHTI, Haiti	73° W	19° N	31.9	34.3

Note: The allotments between 92° W and 128° W are indicated, because any allotment may be moved for a variety of reasons, by up to 10°. For instance, the HTI allotment may be moved as far west as 102° West and the SLV allotment as far east as 120° West (see 5.3 of Appendix 30B). Thus any allotments outside the 92° W to 130° W arc would have no effect on the Canadian allotments or possible Canadian orbital use within the plan.

Figure C-1

GEOSTATIONARY ORBIT POSITIONS
AVAILABLE TO CANADIAN FSS OPERATORS



Legend:

E: Existing system location in the Allotment Plan
A: Allotment location in the Allotment Plan
(3 allotment positions)
T: Orbital location in the Trilateral Arrangement
(4 positions)
?: Location of a possible "Additional System"
in the Allotment Plan

Available Spectrum/Orbit Resources in the Broadcasting-Satellite Service for Canadian Domestic Systems in the ITU Region 2 Appendix 30 Plan

1.0 Introduction

This annex provides supplemental information in support of the review undertaken in Section 6.0 of Annex B of the amount of spectrum/orbit resource that is available to Canada in the 12.2-12.7 GHz band, in accordance with Appendix 30 of the Radio Regulations of the ITU. It discusses the number of 24 MHz-wide channels that could be utilized in various parts of Canada and estimates the number of television programs that could be broadcast into these areas by satellite in the 12 GHz band.

2.0 Background

The 12.2-12.7 GHz broadcasting-satellite band in ITU Region 2 (the Americas) was planned at a Regional Administrative Radio Conference (RARC) in 1983. RARC-83 completed the work of WARC-77, that had developed a similar plan for Region 1 in the 11.7-12.5 GHz band and for Region 3 in the 11.7-12.2 GHz band. The Regions 1 and 3 Plans were incorporated into the Radio Regulations as Appendix 30 by WARC-79. The first session of the Space WARC in 1985 (WARC-ORB-85) combined the results of the Final Acts of RARC-83 and Appendix 30 from WARC-79 to form an expanded Appendix 30 in the Final Acts of WARC-85; this expanded Appendix 30 became a part of the Radio Regulations in October 1986.

RARC-83 also planned the feeder links in the 17.3-17.8 GHz band to be used in conjunction with the 12 GHz BSS assignments of Appendix 30; this 17 GHz assignment Plan was included in the Final Acts of WARC-85, and was also incorporated into the Radio Regulations in 1986 in a new Appendix 30A. This annex does not consider the 17 GHz feeder-link band further, as it is concerned only with the capacity of Canada's 12 GHz assignments in Appendix 30.

The RARC-83 Region 2 portion of the Appendix 30 Plan is very different from the WARC-77 Regions 1 and 3 portion, in that it is

- a much higher capacity plan, assigning as many as 32 channels per service area where required, rather than the uniform 6 channels per service area of the WARC-77 Plan;
- much more flexible in how an assigned radio channel can be used. It is basically a performance-specification plan in that it is an agreement between administrations on the amount of interference or impairment that the assignment of one channel can impose on the assignment of another, rather than a design-specification plan that specifies how the assignments in the Plan should be used.
- is perhaps less flexible than the Regions 1 and 3 Plans in terms of being able to change the orbit location of a Plan assignment through the Plan-modification process. This is a by-product of the higher capacity of the Region 2 Plan.

Canada had advised the ITU before RARC-83 that its BSS requirements in the 12 GHz BSS band would total 32 RF channels in each of the following six service areas:

CAN-1	consisting of British Columbia, the Yukon, and the MacKenzie valley, ie. that part of Canada in the Pacific time zone;
CAN-2	Alberta, the western part of Saskatchewan, and the territories north of those areas, ie. that part of Canada in the Mountain time zone;
CAN-3	Manitoba and eastern Saskatchewan, and the territories north of those areas, ie. that part of Canada in the Central time zone;
CAN-4	Ontario and the territories north of Ontario;
CAN-5	Quebec and the territories north of Quebec, mainly Baffin Island; and
CAN-6	the Maritime area, ie. New Brunswick, Prince Edward Island, Nova Scotia, and Newfoundland including Labrador.

Canada foresaw in 1983 a long-term requirement of 32 NTSC television channels into each of these six service areas, but also an initial or short-term requirement to serve the country from either two or three locations. In the two-satellite scenario, areas CAN-1, CAN-2, and CAN-3 would be served from one orbit location and areas CAN-4, CAN-5, and CAN-6 from a second location. A three-satellite system would serve CAN-1 and CAN-2 from one location, CAN-3 and CAN-4 from a second, and CAN-5 and CAN-6 from a third. A Canadian objective was to have Plan-entries capable of accommodating both the initial and the eventual high-capacity requirement.

A second area of flexibility required of the Plan was that, although the Plan would be based on the transmission of analog FM modulated NTSC programs signals in a 24 MHz channel, the Plan should also accommodate either a number of audio FM signals multiplexed onto an RF carrier within a 24 MHz channel, or possibly the transmission of HDTV television signals.

3.0 The Plan

3.1 Canadian Orbit Assignments in the Plan

There are six Canadian orbit locations in the Plan, corresponding to the six service areas described above. In addition, in part to be able to accommodate early-generation systems serving the country from two or three orbit locations, the concept of "Service-Area Group" was approved by the RARC. The Canadian assignments in the Plan are:

ITU Group 10	CAN-1 and CAN-2	at 138° W
ITU Group 12	CAN-2, CAN-3 and CAN-4	at 129° W
ITU Group 13	CAN-3, CAN-4 and CAN-5	at 91° W
ITU Group 14	CAN-4, CAN-5 and CAN-6	at 82° W
-	CAN-2	at 72.5°W
-	CAN-6	at 70.5°W

This set of Plan-entries meets the long-term requirement for broadcasting 32 programs of analog FM modulated NTSC programs into each of the six service areas. Four of these orbit locations can serve the areas associated with them at a sufficient elevation angle, and yet also have eclipse times in September and March after 1 am in most cases so that less than full operation during eclipse would have a minimal effect. However, the eclipse time for CAN-6 at 70.5°W is somewhat earlier, beginning at about midnight in the Maritimes; that for CAN-2 area from 72.5°W is very early, about 9 pm, resulting in the need for batteries to operate through an eclipse from that position. (The 72.5° location was recognized as being our poorest and will probably be used last. The USA has a similar easterly location for the eastern USA at 61.5°W.)

With these groupings in the Plan, the three-location interim system referred to earlier could be implemented with CAN-1 and CAN-2 served from 138°W, CAN-3 and CAN-4 served from either 129°W or 91°W, and CAN-5 and CAN-6 served from 82°W. The two-location interim system could be implemented with CAN-1, CAN-2, and CAN-3 being served from either 138° or 129°, and with CAN-4, CAN-5, and CAN-6 served from either 91°W or 82°W. (Some of these accesses require the utilization of the regulatory Interim-System procedure of Resolution 42 of the Radio Regulations as well as the above service-area groupings; see Section 3.3 of this Annex.) As well, through that interim procedure an initial Canada-wide beam could be implemented from 91°W. Thus, for Canada the Plan has the flexibility to implement both interim cost-effective lower-capacity systems and a full-capacity system of 32 radio channels per service area.

Multiples of 32 radio channels can be used in any area of Canada if required, by transmitting into adjacent areas within the ITU Groups described above, or by enlarging the service areas through the Plan-modification procedure,(see Section 3.3 of this Annex), or by a combination of these two methods. By enlarging the service areas somewhat from the CAN-1, ... CAN-6 areas described earlier, it would be possible to provide at least 64 channels throughout the country, and up to 96 channels in some areas if so required.

3.2 Technical Characteristics of the Plan

The Plan is based on the transmission of analog NTSC television signals frequency-modulated within 24 MHz wide RF channels. There are 32 RF channels in the 500 MHz-wide 12.2 to 12.7 GHz band, with 16 carriers specified for transmission in the right-circular mode and another 16 in the left-circular mode.

The technical characteristics of the Plan, from the perspective of interference between BSS networks in the band, are as follows:

- there is a sufficient set of baseline technical parameters specified for the Plan entries that the single-entry carrier-to-interference ratio due to the interference from any one Plan entry into any other can be determined with an agreed-to set of interference equations. This includes interference from adjacent and second-adjacent assignments as well as co-channel assignments, and also takes into account interference between assignments in the corresponding uplink assignments. The only technical parameters unique to a particular assignment are its space-station or Earth station e.r.i.p. and, of course, the geometrical parameters of the uplink and downlink beams.

- there is a specification of when an assignment is "affected" by another assignment. (This is specified in Section 2 of Annex 1 of Appendix 30.)

- it is stated in Section 3.1 of Annex 5 of Appendix 30 that systems with other signal formats, etc. can be implemented, as long as the change does not increase the interference into other assignments in the Plan.

In combination, these three characteristics are those of a "performance specification" Plan, with all of the flexibility that implies, rather than a "design specification" Plan that attempts to freeze system design to 1983 technology through the Radio Regulations.

3.3 Regulatory Characteristics of the Plan

The regulatory articles associated with the Plan provide:

- the procedure in Article 5 for notifying an assignment without coordination of any form when the system's characteristics are identical with its Plan entry and the baseline set of Plan technical parameters;

- the concept discussed in Sections 2.0 and 3.1 of this Annex, that other systems can be implemented without seeking agreement of other administrations as long as the system does not cause more interference (or require more protection) than the associated baseline system;

- the mechanism in Article 4, to formally modify the assignment's characteristics, ie. its orbit location, beam characteristics, e.r.i.p. values. etc. if no other entry is "affected", or with permission of an administration whose Plan entry is deemed to be affected; and

- an "interim" modification procedure, specified in Resolution 42 of the Regulations, whereby an administration can formally replace for a specified period of time one or more Plan entries with one or more "interim" systems, as long as the interference into an assignment of another administration from the interim system or systems is not more than that which would have been caused by the Plan entry or entries which are "removed" temporarily. These interim systems must be operated at one of the orbit locations of the permanent systems that they replace on a temporary basis.

In combination, these procedures provide considerable flexibility in how the entries of the Plan discussed in Section 3.1 of this Annex can be used by Canadian operators.

4.0 Possible Utilization of the Plan in Canada

Since the 12 GHz Region 2 Plan was developed in 1983, four technical developments have changed the way in which the Plan is likely to be used:

- noise figures of in-the-home receivers home consumption have decreased significantly because of the availability of low-noise preamplifiers at 12 GHz, resulting in lower satellite e.r.i.p.'s necessary to achieve a given system performance; this results in a corresponding increase in flexibility to modify other characteristics of the system without "affecting" another Plan entry;

- a tendency to use smaller home antennas, which would counteract the improvements in noise figure mentioned above;

- the practice of using complex shaped-beam spacecraft antennas rather than the simple single-feed elliptical antenna used as a basis for development of the Plan. (The ANIK-E antennas are examples of such an antenna, as is the antenna pattern of CCIR SG-4 Recommendation 672, which is based in part on Canadian input to the CCIR.) Such antennas tend to reduce the interference to Plan entries other than those of immediate neighbours, and thus increase the flexibility available before other Plan entries are affected.

- there is a trend to transmission of television programs in BSS networks using digital transmission and extensive source encoding, rather than by analog FM transmission. Transmission rates in the order of 23 MB/s for HDTV programs and 4 to 6 MB/s for NTSC programs, using source encoding techniques such as MPEG, can be expected. This means that by using 2-phase or 4-phase psk systems, one or perhaps two HDTV programs or several NTSC programs could be transmitted over a 24 MHz-wide 12 GHz channel.

These technical innovations, combined with the flexibility of the 17/12 GHz Plan of Appendix 30 and 30A, mean that the 12.2-12.7 GHz band can be used cost-effectively in the provision of both interim and high-capacity BSS networks for the delivery of both NTSC or HDTV programming. With digital transmission and a source encoding technique such as MPEG, the delivery of 64 to 96 HDTV programs into each of several Canadian service areas seems possible at 12 GHz, or several times that number of NTSC programs, or some mixture of the two as specified by market forces.

DEPARTMENT OF COMMUNICATIONS

RADIOCOMMUNICATION ACT

NOTICE NO. DGTP-004-93

PROPOSED SPECTRUM ALLOCATIONS ABOVE 3 GHz

As a result of the 1992 World Administrative Radio Conference (WARC-92) a number of new frequency allocations were made which impact on existing radio spectrum users in the SHF and EHF frequency bands above 3 GHz.

To assist the Department in the revisions to the Canadian Table of Frequency Allocations for the range of frequencies from 3 to 164 GHz, a Proposals Paper is being released which provides background information on the frequency bands, the preparations for and the results of the Conference, and the proposed spectrum allocation changes to the Canadian Table. The paper also provides a summary of the spectrum and orbit resources available to Canada for the development of fixed-satellite and broadcasting-satellite services. In addition, at this time, any other issues related to the use of the radio spectrum above 3 GHz may be addressed.

Therefore, the Department of Communications invites interested and affected parties to provide their views and comments on these matters.

Copies of the Proposals Paper entitled Proposed Spectrum Allocations Above 3 GHz are available from Information Services, Department of Communications, 300 Slater Street, Ottawa, Ontario K1A 0C8, (Telephone (613) 990-4900) or from the Department's Regional Offices in Moncton, Montreal, Toronto, Winnipeg and Vancouver.

Submissions should be addressed to the Director General, Telecommunications Policy Branch, Department of Communications, 300 Slater Street, Ottawa, Ontario, K1A 0C8 to be received on or before October 1, 1993. All representations should cite the Canada Gazette Part I Notice publication date, title, and the Notice 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 the Department of Communications Library, 300 Slater Street, Ottawa and at the Regional Offices of the Department at Moncton, Montréal, Toronto, Winnipeg and Vancouver for a period of one year.

Also, 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, K1P 6A6 (Telephone (613) 234-8826). Reasonable costs of duplication will be charged.

Dated at Ottawa this 17th day of May, 1993

Paul Racine
Assistant Deputy Minister
Communications Policy