PCC.III/REC. 35 (IX-97)

LOCAL MULTIPOINT DISTRIBUTION/COMMUNICATION SYSTEMS (LMDS/LMCS) OPERATING AT FREQUENCIES AROUND 27 GHZ.

The Ninth Meeting of the Permanent Consultative Committee III: Radiocommunications,

CONSIDERING:

1. That a Working Group was established at the Fifth Meeting of the Permanent Consultative Committee III in August 1996 to study the various aspects of the implementation of LMDS/LMCS in the Americas and that the terms of reference of this Working Group include the preparation of guidelines needed for the implementation of LMDS/LMCS in the Americas (see Resolution PCC.III/RES.35 (V-96));

2. That the implementation of wide band LMDS/LMCS can offer alternate multimedia distribution including video, telephone and data to residential and business subscribers;

3. The need to ensure that there is an opportunity for these new systems in the Americas taking into account efficient use of the frequency spectrum and sharing of the bands among services allocated on a co-primary basis;

4. That the LMDS/LMCS are point-to-multipoint systems of the fixed service;

5. That, in the Radio Regulations, there are shared allocations to the fixed service in the frequency bands 25.25-29.50 GHz and 31.0-31.3 GHz that can be considered for such wideband implementations of the LMDS/LMCS;

6. That the United States has identified spectrum in the 27.50-28.35 GHz, 29.10-29.25 GHz and 31.0-31.3 GHz ranges; that Canada has identified spectrum in the 25.35-28.35 GHz range; and that some other Region 2 administrations have identified similar frequency ranges for the operation of their LMDS/LMCS and that licensing activities are underway;

7. That studies within one administration indicate that frequency sharing of the band 25.25-27.50 GHz between the high density point-to-multipoint LMDS/LMCS and data relay and proximity operation communications systems of the inter-satellite service is not achievable pursuant to the provisions of S 21.2 of the Radio Regulations;

8. That a study done by another administration and described in a document submitted to one of the meetings of ITU-R Ad Hoc Group 7B/9D concludes that sharing between LMDS/LMCS considered in the study and data relay satellites is feasible;

9. That after exhaustive study, a joint government and industry Negotiated Rulemaking Committee in the United States determined that in the frequency range 27.5-29.5 GHz co-frequency sharing between point-to-multipoint LMDS/LMCS and the fixed satellite service (FSS) is not possible;

10. That the aforementioned Negotiated Rulemaking Committee also determined that sharing was possible between LMDS/LMCS hub-to-subscriber links and NGSO/MSS feeder links in the band 29.10-29.25 GHz under rules adopted by the United States;

11. That the deployment of LMDS/LMCS may be global in extent.

RECOGNIZING:

That the LMDS/LMCS Working Group is studying the various aspects of the implementation of LMDS/LMCS around 27 GHz in the Americas;

That in view of the limited studies identified in the "considering" 5 and 6 above, additional studies should be undertaken with a view to establishing international sharing criteria among services with allocations on a co-primary basis;

That there are advantages to be gained by having information regarding LMDS/LMCS technologies and implementation strategies available for use by the member countries of CITEL,

BEARING IN MIND:

That studies are in progress by a Correspondence Group of Working Parties 7B and 9D, within the ITU-R, with a view to establishing international sharing criteria between the inter-satellite service supporting the data relay and proximity operation communication systems and the fixed service supporting LMDS/LMCS operations in the frequency band 25.25-27.50 GHz;

That some administrations have recognised the need for a minimum of 1 GHz bandwidth for a single LMDS/LMCS network,

RECOMMENDS:

1. That CITEL administrations consider the harmonization of spectrum usage for LMDS/LMCS around 27 GHz, taking into account the aforementioned compatibility studies between radio services which share the use of the bands on a co-primary basis;

2. That CITEL administrations submit information regarding the implementation progress of LMDS/LMCS around 27 GHz in their countries;

3. That CITEL administrations take part in the studies within CITEL and within the aforementioned Correspondence Group that are in progress for establishing international criteria for sharing between LMDS/LMCS and the global operations of the inter-satellite service in the bands below 27.5 GHz which share the use of the bands on a co-primary basis;

4. That CITEL administrations contemplating near term implementation of wideband LMDS/LMCS, consider initial deployment of these systems in the band 27.50-28.35 GHz;

5. That CITEL administrations requiring, in the near term, bandwidth additional to the band 27.50-28.35 GHz:

   a) may consider the options described in Annexes 1 and 2 adopted by certain administrations,

   b) take into account sharing issues between LMDS/LMCS and the inter-satellite services in frequencies below 27.5 GHz as discussed in Annex 3, and

   c) be mindful of the sharing constrains between point-to-multipoint LMDS/LMCS and FSS systems

ANNEX 1

SOURCE: Canada

TITLE: **Local Multipoint Communication Systems (LMCS)**

1.0 Introduction

Canadians are currently serviced by two local distribution networks providing a range of broadcast and telecommunications services to consumer and business clients; the local cable TV network and the local telephone network. With advancements in technologies used by industry to deliver their services as well as continual change in the regulatory framework, it is expected that each will be able to provide the others core services, thereby offering a full range of services to consumers on a competitive basis.

Local Multipoint Communication Systems (LMCS) is a broadband wireless telecommunications common carrier service in the 28 GHz range, which operates similar to a cellular network, will be capable of carrying basic and advanced communication services such as "wireless" cable TV, Internet access, video teleconferencing and various other multimedia and broadcasting services. These entirely new, independent, local networks for telecommunications services will be fully competitive with existing networks.

It is the intention of the Canadian government to encourage the establishment of this third local distribution network for broadcasting and telecommunication services, thereby offering alternative choices to Canadian consumers. To this end, the announcement of the policy and authorisation procedures for LMCS was initiated.

2.0 Background

On December 24, 1994, Industry Canada issued Gazette Notice DGTP-013-94 entitled ***Proposed Spectrum Policy to Accommodate Microwave Radio Systems, Including Local Wideband Distribution and Advanced Communication Satellites in Certain Bands Above 20 GHz*** which invited comments on a number of issues relating to frequency bands 22, 28 and 38 GHz, including the types of radio system applications in the areas of satellite and terrestrial microwave communications including LMCS.

In response to this notice, twenty-five submissions were received which were later refined to thirteen. Some of the key points that prevailed in the consultation process included:

i. LMCS technologies and services may evolve considerably over the next few years;

ii. the use of the 27-28 GHz band, with expansion below 27 GHz, was the preferred spectral option;

iii. - 1 GHz of spectrum is required for initial deployment of an LMCS system; and,

iv. the introduction of LMCS in Canada is expected to bring manufacturing and systems development opportunities.

3.0 Spectrum Allocation for LMCS in the 28 GHz Band

The spectrum designated for LMCS applications is essentially for high capacity multipoint communications systems having unidirectional and/or bi-directional transmission coverage over local areas providing wide access to residential and business customers. Within the spectrum allocation of 25.35-28.35 GHz, six frequency blocks of 500 MHz were created to allow authorised entities to provide service in local areas and support the spectrum requirements of more than one service provider.

The frequency plan and block availability adopted for LMCS is as follows:

Block A	500 MHz	27.85-28.35 GHz
Block B	500 MHz	27.35-27.85 GHz
Block C (reserved)	500 MHz	26.85-27.35 GHz
Block D (reserved)	500 MHz	26.35-26.85 GHz
Block E (reserved)	500 MHz	25.85-26.35 GHz
Block F (reserved)	500 MHz	25.35-25.85 GHz

Industry Canada made spectrum blocks A and B available for authorisation through a comparative selection and authorisation process . Spectrum blocks C, D, E and F are presently available for LMCS experimentation on a first-come, first-served basis. The latter blocks will subsequently be authorised for commercial use, commencing no earlier than 18 months and no later than 36 months after the completion of authorisation of blocks A and B which took place October 29th, 1996.

4.0 Service Areas

Industry Canada defined sixty-six (66) service areas in which spectrum blocks A and B were available for authorisation. Applicants who were interested in providing service to areas not defined could do so but had to include with their submission, a detailed

description of the proposed service area(s). These areas could not include any portion of the aforementioned sixty-six (66) service areas but had to lie entirely outside of the boundaries of those designated.

5.0 Eligibility

An entity was eligible to provide LMCS service at 28 GHz for blocks A and B as part of this call for applications if the entity, including its affiliates[1], was not:

i. a telecommunication common carrier which provides local exchange telephone service anywhere in Canada; or
ii. licensed to carry on a cable distribution undertaking under the Broadcasting Act anywhere in Canada.

6.0 Companies Awarded LMCS Licenses

The criteria for the awarding of LMCS licences, included: competitive strategy, innovation, economic benefits as well as research and development, coverage and demonstrated competencies. On October 29, 1996, three licenses of the thirteen received, were awarded 1 GHz of spectrum for 33 markets each to CellularVision Canada Ltd., and MaxLink Communications and a similar license for service in 127 small communities to Regional Vision Inc. to ensure that the expanding Information Highway continues to reach Canada's remote communities. Successful applicants' business plans have indicated that some services will be up and running by the end of 1997.

7.0 Technical and Operational Requirements for LMCS

The technology to be implemented will depend on the system design and the telecommunications and broadcasting services to be carried. Industry Canada has not mandated technical requirements except to facilitate coordination between LMCS and between LMCS and inter-satellite links where they share spectrum. For such coordination Industry Canada has established the technical criteria established below. Further, Industry Canada has not mandated the types of services to be carried by LMCS providers other than the proposed system must be a high capacity, broadband multipoint system.
Fixed satellite earth stations may have access to the 27.5-28.35 GHz frequency range outside LMCS market areas subject to spectrum sharing conditions.

ITU Requirements (25.25-27.5 GHz)

[1] affiliate is defined in the same general manner as in subsection 35(3) of the Telecommunications Act; viz. a person who controls the entity, or who is controlled by the entity or by any person who controls the entity."

In the ITU Radio Regulations the band 25.25-27.5 GHz is allocated on a co-primary basis to Fixed (FS), Mobile and Inter-Satellite (IS) services. The current ITU regulations applicable to this band for the fixed service are as follows:

2504A (WARC 92) As far as practicable, sites for transmitting stations, in the fixed or mobile service, employing maximum values of equivalent isotropic radiated power (e.i.r.p) density exceeding 24 dBW in any 1 MHz band in the band 25.25-27.5 GHz should be selected so that the direction of maximum radiation of any antenna will be at least 1.5^{o} away from the geostationary-satellite orbit, taking into account the effect of atmospheric refraction[1].

2504A.1 (WARC 92) [1] The provisions, of No. 2504A shall apply until such time as the CCIR has made a recommendation on the e.i.r.p. density limits which should apply in the band.

2505 Paragraph 3. (1) The maximum equivalent isotropically radiated power (e.i.r.p) of a station in the fixed or mobile service shall not exceed +55 dBW.

2508 (4) The power delivered by a transmitter to the antenna of a station in the fixed or mobile service in frequency bands above 10 GHz shall not exceed +10 dBW.

The above regulations were based on the use of these bands by point-to-point systems in the fixed service. Since the band can also be used for high density point-to-multipoint systems, the following measures are needed to comply with the intent of these regulations.

Application of RR 2504A

It should be noted that this Radio Regulation (RR) is under review with a view to ensure protection to Inter-satellite Data Relay Satellite (DRS) systems, operating on the geostationary orbit (GSO), and to consider the need to increase the e.i.r.p. of point-to-point FS systems beyond 24 dBW/MHz under rain conditions. There is no specific consideration given at this time to develop separate regulations for LMCS type applications.

Subscriber Transmitter and E.I.R.P Power Limits

The limits given above also apply to the subscriber transmitters including the need to assess the impact of aggregate interference at the DRS satellite locations. The information available to date for the transmissions from subscriber stations is very limited. Many different scenarios are considered for the transmissions from subscribers

depending on the nature of the application. Therefore it will be up to the operator to ensure that their implementations meet the above criteria.

Power Flux Density (pfd) Limits for the Inter-Satellite Service

ITU RR 2578 specifies the pfd limits for the band 25.25-27.5 GHz for emissions from spacecraft in the inter-satellite service. These limits are as follows:

2578 The power flux-density at the Earth's surface produced by emissions from a space station, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, shall not exceed the following values:

> -115 dB(W/m^2) in any 1 MHz band for angles of arrival between 0 and 5 degrees above the horizontal plane;
>
> -115 + 0.5 (^{a}-5) dB(W/m^2) in any 1 MHz band for angles of arrival (in degrees) between 5 and 25 degrees above the horizontal plane;
>
> -105 dB(W/m^2) in any 1 MHz band for angles of arrival between 25 and 90 degrees above the horizontal plane.

These limits relate to the power flux-density that would be obtained under assumed free-space propagation conditions. The LMCS operators should consider the above pfd values from inter-satellite systems in their system design.

Coordination Considerations

The following requirements should facilitate inter-system coordination of LMCS systems, and should allow compatibility with inter-satellite applications in the band 25.5-27.5 GHz. These requirements are based on current information available on LMCS technology.

1. Frequency tolerance for LMCS equipment should be 0.001% or better.

2. Minimum spectral efficiency should be 1 bit/sec/Hz.

3. Only orthogonally polarised signals (i.e. horizontal or vertical) should be employed in order to benefit from cross-polar isolation and to maximise frequency re-use.

4. In addition to accounting for aggregate levels, the maximum e.i.r.p density for a single station shall not exceed -52 dBW/Hz, except in cases of hub-to-hub interconnection which will be considered on a case by case basis.

5. Inter-system coordination within the same area and with the adjacent areas is the responsibility of the LMCS operators.

6. Coordination of LMCS systems in the border area will be required with the terrestrial systems in the U.S. There is no existing coordination agreement with the U.S. at this time for this frequency band. Until such time as an agreement is developed, Industry Canada will coordinate any systems located within 60 km of the border. This distance is currently used for the coordination of fixed systems in the 23 GHz band.

The above technical requirements are subject to change in accordance with future changes to the ITU recommendations and radio regulations, as well as any additional information from LMCS operators and equipment manufacturers.

ANNEX 2

Source: United States of America
Title: Use of the 27.5-31.3 GHz Band in the USA

Taking into account the results of WRC-95, and extensive deliberations in the U.S., the United States Federal Communications Commission ("FCC or Commission") adopted a final plan on July 17, 1996 as issued in its First report and Order to Redesignate the 27.5 GHz-29.5 GHz Frequency band for the domestic use as shown below. This spectrum segmentation plan was designated to provide spectrum for all of the competing services seeking to use these bands in the United States. On March 11, 1997, the FCC adopted a plan designating the 31.0-31.3 GHz band additionally for LMDS as issued in its Second Report and Order.

Band 27.5-30.0 GHz and 31.0-31.3 GHz

27.5 GHz 28.35 28.6 29.1 29.25 29.5 30 31 31.3

LMDS fss[1] 850 MHz	GSO FSS ngso fss 250 MHz	NGSO FSS gso fss 500 MHz	MSS FL& LMDS (H) 150MHz	MSS FL& GSO FSS 250 MHz	GSO FSS ngso fss 500 MHz		LMDS[2] (H) (S) 300 MHz

1. Lower case indicates licensing is on a non-interference, non-protected basis.
2. 31.0-31.075 GHz – LMDS shared with existing users (75 MHz).
   31.075-31.225 GHz – LMDS primarily protected basis (150 MHz).
   31.255-31.3 GHz – LMDS shared with existing users (75 MHz).

   LMDS: Local Multipoint Distribution Service; (H) indicates Hub-to-subscriber link (S) indicates Subscriber-to-Hub link; FL: Feeder link.

   The plan adopted by the FCC designates co-frequency sharing in band segments where the commission and the parties have concluded it is feasible. The FCC concluded that adoption of this band promotes spectrum efficiency and facilitates the deployment of diverse, interactive, competitive services for consumers.

1. The band segmentation plan will be implemented through appropriate changes in part 25 and Part 101 of FCC rules. Discrete spectrum bands were designated for specific types of systems. Services designated for domestic licensing priority are specified in capital letters in the graphic depiction of the band plan. These services have licensing priority vis-à-vis any other type of service allocated domestically or internationally in the band. Lower case letters indicate services in a particular band segment which also have licensing priority vis-à-vis any third service allocated domestically or internationally in the band, but have no licensing priority over the service in capital letters in the band segment and must operate on a non-interference basis and must accept interference vis-à-vis that service. Services designated with two priority users have equal licensing rights based on the sharing principles adopted for that particular band segment.

2. Primary LMDS Spectrum

The FCC designated 1300 MHz of spectrum for LMDS systems in three non-contiguous segments. At 27.5-28.35 GHz, 850 MHz for LMDS was designated on a primary basis. GSO/FSS or NGSO/FSS systems will be permitted on a non-interference basis to the LMDS systems in the 850 MHz band segment, for the purpose of providing limited gateway-type services. Another 150 MHz of spectrum at 29.1-29.25 GHz was designated for LMDS transmissions, in the hub-to-subscriber direction, on a co-primary basis with NGSO/MSS feeder links. The commission subsequently adopted in its Second Report and Order an additional 300 MHz at 31.0-31.3 GHz for LMDS use.

3. Primary GSO/FSS Spectrum

The FCC designated 750 MHz of exclusive primary spectrum for GSO/FSS systems, in two non-continuous segments at 28.35-28.60 GHz and 29.5-30.0 GHz. NGSO/FSS systems will have secondary status in these segments. They also designated GSO/FSS use for 250 MHz on a co-primary basis with NGSO/MSS feeder links at 29.25-29.5 GHz.

4. Primary NGSO FSS Spectrum

Consistent with the U.S. position at the WRC-95, and its intention to continue to propose 500 MHz for NGSO/FSS at WRC-97, the FCC designated 500 MHz at 28.6-29.1 GHz for NGSO-FSS systems. The FCC believes designating 500 MHz is necessary to accommodate the worldwide demand for 28 GHz spectrum for NGSO/FSS systems.

5. Sharing in the 29.1-29.25 GHz band between NGSO/MSS feeder link earth stations and LMDS (150 MHz)

The FCC adopted sharing rules between LMDS hub-to-subscriber transmissions and NGSO/MSS feeder links in the 29.1-29.25 GHz band. These rules were based on rules agreed to at its Negotiated Rulemaking Committee (NRMC). Transmission of LMDS subscriber transceivers in this shared 150 MHz band segment was prohibited.

ANNEX 3

SOURCE: United States of America

TITLE: Usage of the Band 25.25 - 27.5 GHz by NASA and Other Space Agencies and Potential Sharing Issues

The 25.25 - 27.5 GHz band will be used by NASA and the other space agencies around the world for a variety of activities which cannot be accommodated in other frequency bands. The history of the allocation, which stretches back to 1985, includes the primary allocation to the Inter-Satellite Service made at WARC-92 and proposals to consider a primary allocation to Earth Exploration-Satellite Service at WARC-97. Current and planned usage of the band includes a wide range of missions by the United States, Japan, Russia and the European Space Agency.

The following sections of this paper address the allocation history and usage of the band 25.25 - 27.5 GHz as well as sharing analyses that have been conducted between the space science services and proposed Local Multipoint Communication/Distribution Services (LMCS/LMDS).

Allocation Status History

The frequency band 25.25 - 27.5 GHz is allocated worldwide in the ITU Radio Regulations to the fixed service, the mobile service, and the inter-satellite service on a primary basis as shown in Figure 1. The frequency band 27.0 - 27.5 GHz is also allocated, on a primary basis, to the fixed-satellite service in the Earth-to-space direction. Additionally, secondary allocations to the standard frequency and time signal-satellite service, in the Earth-to-space direction, and to the Earth exploration-satellite service (25.5 - 27.0 GHz), in the space-to-Earth direction, exist.

It should be noted that, in response to the worldwide need for more space-to-Earth bandwidth for environmental and Earth resources data (the band 8025 - 8400 MHz is already congested), the issue of the allocation to the Earth exploration-satellite service in the band 25.5 - 27.0 GHz has been placed on the agenda of WRC-97. The Space Frequency Coordination Group (SFCG), whose membership includes space agencies from North, Central and South America, as well as from other parts of the world, supports upgrading the EESS allocation from secondary to Primary in this band.

1992 Conference Actions

WARC-92 established provisional e.i.r.p. spectral density limits on the emissions of fixed and mobile stations in the 25.25-27.5 GHz band in the direction of the geostationary-satellite orbit in order to protect space stations on orbit. Comprehensive studies of the required e.i.r.p. spectral density limits had not been completed, so a provisional value was assigned pending further work and review by the then CCIR. A provisional power flux

density constraint was already in place in the then Article 28 of the Radio Regulations, to protect fixed and mobile systems from interference from space science service systems.[2]

Current and Planned Missions in Ka-band

The currently planned use of the 25.25-27.5 GHz band is presented in Figure 1. As can be seen, the entire band is used by the various data relay satellites (DRS) planned for the band, with different band segments planned for Proximity Operations and Earth exploration-satellite downlinks. These services are discussed below.

NASA's Tracking and Data Relay Satellite (TDRS) system has been used to relay data between user satellites and Earth using S-band and Ku-band frequencies since 1983. The TDRS H, I & J satellites, which are currently under contract and planned for launch starting in 1999, will provide these services in the 25.25 - 27.5 GHz band, as well as in the lower frequency bands, thereby increasing capacity and improving service. The TDRS channels are designed to support a maximum data rate of 800 Mbps in a 650 MHz bandwidth in order to accommodate wide-band sensor data. The need to support several of these channels within a given orbital area is foreseen, as well as the need to coordinate channel usage with other administration's relay systems.

The Data Relay Technology Satellite (DRTS) system from the National Space Development Agency of Japan (NASDA) will provide the same types of services, as will the TDRS. Japan has Advanced Published 5 orbital locations for its DRTS system. In addition, the ETS-VI/Kiku-6 satellite is currently in orbit and operating in this band.
The European Data Relay System (EDRS) system from the European Space Agency (ESA) will also provide data relay type services. Four EDRS satellites have been advanced published by ESA, with an early operational capability to be provided by the Artemis satellite.

The **Satellite Networks Interoperability Panel** (SNIP), made up of representatives of NASA, ESA and NASDA, has developed an agreement to allow inter-operable cross-support of each other's spacecraft. The channelization scheme, which is essential for cross-support, covers most of the 25.25 - 27.5 GHz band and is given in Figure 1. Twenty-three (23) data relay satellite (DRS) orbital locations have been identified in the ITU for purposes of sharing analysis.

Russia, which currently uses S-band and Ku-band for DRS activities, has long term plans to use the Ka-band as well. This would permit them to transfer their wideband communications links from the interference-prone Ku-band to Ka-band. India, which has a very strong space research/Earth exploration-satellite program, may in the future use the Ka-band for DRS communications links.

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[2] In this paper, the term "space science services" includes, any or all of the following radio services; space research service, Earth exploration-satellite service, space operation service, and inter-satellite service when used for space science applications.

NASA is developing a **Proximity Operations Communication System** (POCS) to relay data, video and voice between orbiting vehicles operating within 50 km of the International Space Station. This system would be used to support activities ranging from simple telemetry to telerobotics color video. It will also have applications to low-orbit inter-vehicle communications, particularly during docking maneuvers. Figure 1 shows that two different bands will be used for POCS, one for transmit and one for receive. These bands are separated at the upper and lower edges of the 25.25-27.5 GHz band in order to avoid intra-system interference. All partners in the International Space Station (ISS) have indicated the need for such a system. This is the only band available to Space Research for these types of wideband services. The transmitting and receiving stations may be at any orientation to one another (above, below, in front, behind, etc.), and therefore the transmission path between the vehicles can appear at any angle from virtually any point on the Earth's surface. Unlike a satellite in geostationary orbit, a POCS receiver can be oriented at low elevation angles as viewed from any point on the Earth.

Intensive use of the 25.25-27.5 GHz band by administrations operating DRS systems will require careful coordination between the systems to maintain interference free links and interoperability, such as that which currently facilitates extensive use of S-band. This requires multiple wideband channels for flexibility of operations. This is one of the drivers which has resulted in international agreements among all DRS operators to access and use the full 25.25 - 27.5 GHz band.

Sharing Status

Until recently, it had long been accepted that space science service systems were compatible with fixed and mobile service systems, sharing the same frequency allocation, provided that appropriate technical sharing criteria could be agreed upon.

Since WARC-1992, certain fixed and mobile service systems have been proposed which present a different kind of sharing situation, one which could cause unacceptable levels of interference to the space science service systems. The characteristics of such systems which make them different from the traditional (shareable) terrestrial systems, are 1) a much greater population density, and 2) the lack of antenna discrimination at the central hub of each element (cell). LMCS/LMDS systems being proposed for broadband video/data distribution represent one of the new fixed service systems.

Sharing between fixed point-to-point service systems and space science service systems has recently been studied in ITU-R Joint Ad Hoc Working Party 7B/9D (JAH 7B/9D). The allocated frequency bands under consideration were 2025-2110 MHz, 2200-2290 MHz and 25.25-27.5 GHz. Unfortunately the work of JAH 7B/9D did not include study of point-to-multipoint LMCS/LMDS-like fixed service systems in the 25.25-27.5 GHz band.

Draft New Recommendation ITU-R F.[AD/9D], "Maximum Equivalent Isotropic Radiated Power of Transmitting Stations in the Fixed Service Operating in the Frequency Band 25.25-27.5 GHz Shared with the Inter-Satellite Service" was approved by JAH

7B/9D, at its October 1996 meeting and was submitted to the January 1997 Plenary meeting of Study Group 9. It was adopted by the Study Group for approval by correspondence. The draft new Recommendation (DNR) states that as far as practicable, the e.i.r.p. density of a fixed service station in the direction of the DRS orbital locations should not exceed +24 dBW in any one MHz band.

Annex 1 to DNR ITU-R F.[AD/9D] identifies how the value of +24 dBW/MHz was derived. The DRS protection criteria is given by Recommendation ITU-R SA.1155 and results in a maximum allowable fixed service (FS) e.i.r.p. in the direction of a DRS of 13.5 dBW/MHz. The interference criteria are not to be exceeded for more than 0.1% of the orbital period of the spacecraft being tracked by the DRS (user satellite). The probability of exceeding the 13.5 dBW/MHz limit is greatest for instances of main beam coupling between the highly directional DRS and FS antennas. The likelihood of main beam coupling depends upon the orbital characteristics of the user satellite, the number of FS stations and the azimuth pointing of the FS transmitter antenna. Simulations were run for various DRS orbital locations to determine the spatial distribution of interference received from a random deployment of point-to-point radio-relay stations near 1245 major cities of the world. Calculations were made that show that the probability of direct coupling from point-to-point FS stations is of the order of magnitude 10^{-5}. Based on these calculations, it was determined that an e.i.r.p. density limit of +24 dBW/MHz would be acceptable for the rare instance of main beam-to-main beam coupling. It was further determined that the low probability of occurrence results largely from the directional pointing of the high gain FS transmitting antenna (i.e., 40 dBi) assumed to be at a random azimuth angle uniformly distributed between 0 and 360 degrees.

It must be noted that for point-to-multipoint LMCS/LMDS hub transmissions, the transmitting antenna radiates energy omni-directionally in azimuth and would therefore be orders of magnitude more likely to result in direct coupling into the DRS at low elevation angles toward the orbit. Therefore, the considerations within JAH 7B/9D which resulted in an allowable e.i.r.p. density limit of +24 dBW/MHz for fixed service point-to-point systems, may not apply in the case of LMCS/LMDS systems and requires further study to examine the temporal and spatial interference aspects of such systems on space science service systems.

It must also be noted that the interference into space systems comes from the aggregation of emitters in the field of view of the space system antenna. The greatest contribution comes from the aggregation of emitters in the vicinity of the aim point of the satellite antenna beam. When the satellite beam is oriented toward the Earth's horizon, direct coupling can occur for a significant number of LMCS/LMDS emitters for service areas located near the edge of the space system's field of view. Particularly at low elevation angles, the satellite beam is large with respect to a given service area. The aggregation of interference can occur across multiple service areas, and even across service areas in neighboring administrations. Therefore, any sharing criteria which would be developed should be a practicable limit that can be applied on a per service area (or per square kilometer) basis while still providing sufficient protection from the aggregation of emitters within the space system antenna field of view.

It is further noted that the orbital geometry of POCS systems is significantly different from DRS systems and will lead to low elevation angles of arrival to the POCS receivers from virtually any point on Earth.

Technical Discussion

Several technical studies have been conducted on the impact of introducing LMCS/LMDS into the band 25.25-27.5 GHz, particularly on sharing with the space systems that will use the inter-satellite and Earth exploration-satellite service allocations. In the United States, the Federal Communications Commission (FCC) requested NASA to conduct one of these studies in seeking to alleviate the LMDS/FSS sharing problems at 28 GHz. NASA's answer to the FCC has also been provided to the international space community in response to SFCG Action Item 15/16 at SFCG-16 in Moscow, Russia, in September 1996. Another study was conducted in Canada concerning their Local Multipoint Communications Service (LMCS).

The FCC-requested study by NASA was comprehensive, using parameters and inputs from system operators and planners of the LMDS and space science. Sharing feasibility was assessed between LMDS systems and TDRS, ISS proximity operations and EESS downlinks. The results showed that sharing feasibility is significantly affected by the LMDS system characteristics, parameter selection and service area size. For 3 out of 4 proposed LMDS system types studied, the level of interference from hub-to-subscriber transmissions into both DRS and ISS POCS systems was found to be between 10 dB and 17 dB in excess of the ITU-R recommended allowable values (i.e. 10 - 17 dB negative margins). In the same 3 out of 4 LMDS system types, subscriber-to-hub transmissions resulted in levels of interference between 1 dB and 10 dB in excess of the ITU-R recommended allowable values into both DRS and POCS. The LMDS parameters for the four systems resulted in emissions towards the geostationary-satellite orbit that were all within the current limits given in RR Table S21-1 and Draft New Recommendation ITU-R F.[AD/9D] previously mentioned.

An Industry Canada input document to the June 1995 meeting of JAH 7B/9D examined LMCS type systems interfering with a data relay satellite (DRS) system and stated that sharing was feasible under most circumstances (negative margins, however, were calculated for elevation angles below 10 degrees for one of two LMCS systems examined). No action has been taken by the ITU-R on this study. Further, the study did not address the higher powered LMDS systems that are planned for operation in the United States in bands above 27.5 GHz.

The apparent conflicting results between these studies can be traced primarily to the specific LMCS/LMDS parameters that were examined. Further input is needed from LMCS/LMDS proponents on their planned implementation parameters to aid in refining the studies.

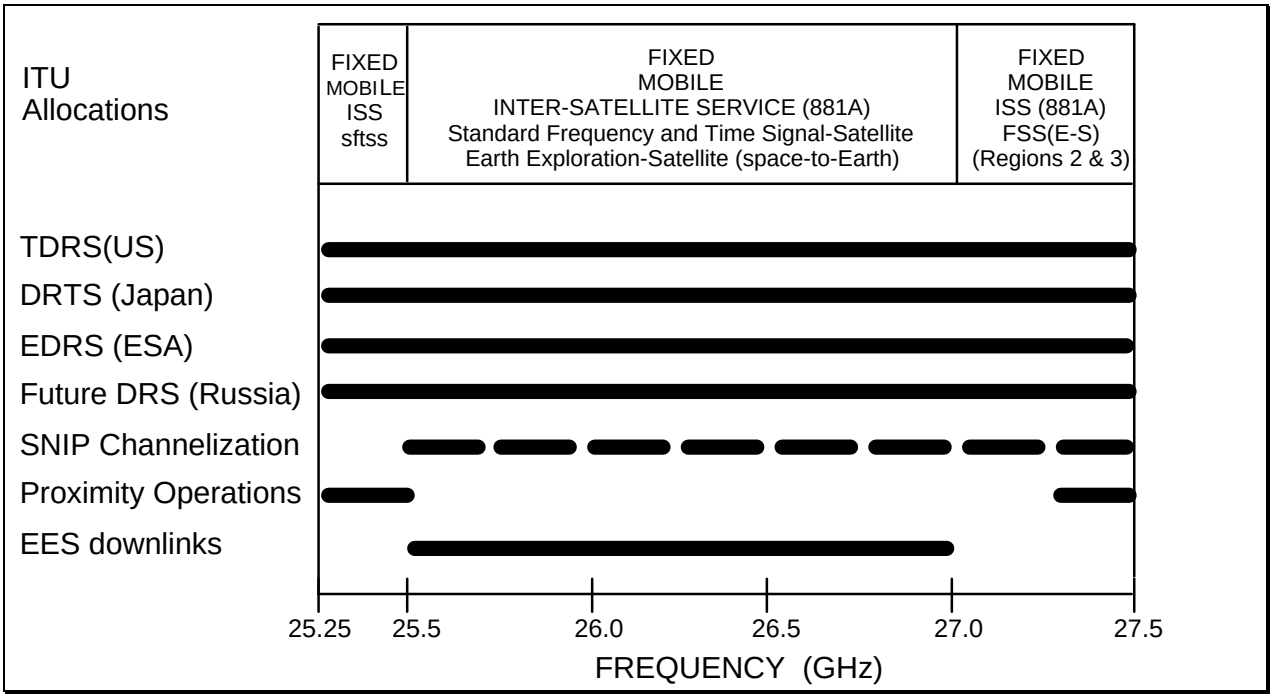
While studies to date have focused on potential LMCS/LMDS deployment in the United States and Canada, a similar interference environment would occur for deployment in Central and South America.

Summary

The 25.25-27.5 GHz band is extremely important for meeting the future requirements of space science services in support of the International Space Station and the next generation of Earth observing satellites. As inter-satellite data relay bandwidth requirements increase and as the increasing number of space systems, both government and commercial, continues to limit access to spectrum in lower frequency bands, the 25.25-27.5 GHz band will soon be the workhorse band for space agencies around the world.

Studies to date examining the feasibility of sharing in this band between space science services and LMCS/LMDS demonstrate that sharing feasibility is significantly affected by LMCS/LMDS system characteristics, parameter selection and service area size. To date, available sharing criteria within the ITU (i.e., RR Table S21-1 and DN Recommendation ITU-R F.[AD/9D]) have been developed only to address sharing with point-to-point fixed services and may not apply for point-to-multipoint services like LMCS/LMDS. Further study into the temporal and spatial characteristics of LMCS/LMDS interference, particularly for hub transmissions, is required to assess the suitability of applying these point-to-point criteria to point-to-multipoint systems. Work is need within the ITU-R to carry out these assessments and develop new criteria as needed to assure protection of co-primary space science services in the band.

Finally, any sharing criteria which may be developed should be a practicable limit that can be applied on a per service area (or per square kilometer) basis. This could enable flexible LMCS/LMDS deployment while ensuring protection of space science service systems.
CITEL members are encouraged to participate in further studies in the ITU-R on sharing issues in the 25.25-27.5 GHz band.



Note: RR 881A reads as follows:

> 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.

Figure 1. NASA and other Space Agencies operate throughout the 25.25-27.5 GHz Band