CHAPTER 2

Mobile, mobile-satellite and space science services

(WRC-03 agenda items 1.3, 1.5, 1.6, 1.11, 1.12, 1.16, 1.20, 1.31, 1.33, 1.38)

CONTENTS

2.1 Agenda item 1.3

"to consider identification of globally/regionally harmonized bands, to the extent practicable, for the implementation of future advanced solutions to meet the needs of public protection agencies, including those dealing with emergency situations and disaster relief, and to make regulatory provisions, as necessary, taking into account Resolution **645 (WRC-2000)**"

2.1.1 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

2.1.1.1 Introduction to public protection and disaster relief

WRC-2000 considered the benefits of globally/regionally harmonized frequency bands for future advanced solutions for public protection and disaster relief (PPDR) and an increasing need for interoperability and inter-working between security and emergency networks, both nationally and for cross-border operations, in emergency situations and disaster relief. Resolution **645 (WRC-2000)** invited the ITU-R to study the identification of possible harmonized bands for future advanced solutions for PPDR and the development of a resolution identifying the technical and operational basis for global cross-border circulation of radiocommunication equipment in emergency and disaster relief situations.

Terminology for public protection and for disaster relief

There are terminology differences between administrations and regions in the scope and specific meaning of PPDR. For the purpose of discussing this agenda item, the following terms have been taken from draft new Report ITU-R M.[PPDR]:

Public protection radiocommunication: Radiocommunication used by responsible agencies and organizations dealing with maintenance of law and order, protection of life and property, and emergency situations.

Disaster relief radiocommunication: Radiocommunication used by agencies and organizations dealing with a serious disruption of the functioning of society, posing a significant, widespread threat to human life, health, property or the environment, whether caused by accident, nature or human activity, and whether developing suddenly or as a result of complex, long-term processes.

2.1.1.2 Spectrum vision for public protection and disaster relief applications

2.1.1.2.1 Administrations' views on public protection and disaster relief

There are a number of views concerning the focus and treatment of public protection versus disaster relief within this agenda item. Administrations have different amounts of overlap between the jurisdiction and responsibilities of their agencies and organizations. Therefore, the view(s) of some administrations is that public protection and disaster relief should be treated separately for this agenda item since they each have unique requirements. The views of others are that they can be considered together because the same agencies are involved to a large extent in both activities.

View A:

Public protection, including those dealing with disaster relief

Many administrations interpret the agenda item literally as focusing on the identification of spectrum for public protection agencies. Public protection activities are related to day-to-day activities and are planned and conducted within national borders. However, public protection agencies are also likely to participate in disaster relief activities and will usually be the first responders on the scene in a disaster relief event. While acknowledging that planning for public protection is a national responsibility, many administrations see significant long-term benefits in harmonization of spectrum for public protection, viz., increased spectrum efficiencies, reducing the need for periodic band replanning as systems are replaced, reducing the consequent disruption to other spectrum users, better economies of scale, market stimulation and focus for manufacturers and a favourable basis upon which interoperability and operational efficiency will evolve. Identification of spectrum in the Radio Regulations, similar to what has been done for IMT-2000, is intended to send a message to manufacturers on where to focus future equipment development. Harmonization of public protection will also help in meeting the needs of disaster relief.

View B:

Separation of public protection from disaster relief

A number of administrations believe that some aspects of disaster relief activities, by their nature, have different requirements regarding spectrum availability. It is recognized that public protection agencies and organizations will be the first on the scene in a disaster relief event. Moreover, it is generally acknowledged that public protection activities are routine day-to-day operations and are conducted for the most part within respective national borders using public protection assets of the nation. Therefore, some administrations view spectrum planning for these agencies and organizations as a national matter. Furthermore, it is recognized by some that harmonized spectrum for national public protection could benefit from economies of scale but this does not require provision in the Radio Regulations. On the other hand, disaster relief activities may involve an international relief effort from other administrations. Hence, spectrum requirements for these activities are not needed on a continuous daily basis and are not as easily quantifiable but may require immediate and potentially dramatic increase in spectrum access in response to a disaster. Therefore, consideration for globally harmonized spectrum for disaster relief activities is supported. Furthermore, some administrations are of the opinion that commercially operated systems using spectrum already identified may play a role in disaster relief support. For these reasons, these administrations believe that public protection and disaster relief require separation in the consideration of this agenda item.

2.1.1.2.2 Aspects of the use of disaster relief radiocommunication

In their disaster relief activities, international humanitarian organizations, such as the International Committee of the Red Cross, the International Federation of Red Cross and Red Crescent Societies and United Nation agencies, rely heavily on extensive private HF and VHF/UHF radio and satellite networks, especially where normal telecommunication services are interrupted, overloaded or unavailable. For efficient and autonomous conduct of their humanitarian activities, it is crucial for these organizations to be able to operate their own wireless networks independent from networks operated by governments or government agencies.

The use of radiocommunication services in the context of international humanitarian assistance is facilitated by the *Working Group on Emergency Telecommunications (WGET), which is also known as the Reference Group on Telecommunications of the Inter-agency Standing Committee on Humanitarian Affairs (IASC).*

Emergency management agencies and relief organizations use Amateur Service for assistance in emergency communications during disasters. Likewise, mobile-satellite communications, with their reliable, transportable terminals are used in emergency and disaster communications. In the future, other developing systems such as High Altitude Platform Stations (HAPS) may also play an important role in providing communications capabilities over a relatively large area for complementing PPDR communications.

It should also be noted that the Telecommunication Development Bureau (BDT) of ITU has recently published a handbook on disaster communications. While taking into account all telecommunication networks and services the handbook draws attention to the special capabilities of radiocommunication services. The handbook is in three parts; Part 1 provides a framework for policy-makers and planners, Part 2 is intended for those with operational responsibilities in disaster communications, while Part 3 covers technical matters.

It should be further noted commercial mobile systems are readily available and can be deployed rapidly in a disaster situation. By the year 2010, more than 1.7 billion mobile subscribers are anticipated. This will allow a large number of people in the world to be engaged in PPDR reporting activities.

The capabilities of these other radio systems to provide alternative communications should be considered.

2.1.1.2.3 Existing frequency bands designated for PPDR within countries

Based upon an ITU-R survey of PPDR communications conducted in the 2000-2003 study period from over 40 ITU members and international organizations, the summarized comments noted that existing bands in use are as follows:

a) There is little uniformity as regards the frequency bands that are used for PPDR use in different countries.

b) While in most countries the bands used for public protection are the same as those used for disaster relief, in some countries separate bands are used.

c) Many administrations have designated one or more frequency bands for narrow-band PPDR operations. It should be noted that only particular sub-bands of the frequency ranges or parts thereof listed below are utilized in an exclusive manner for PPDR radiocommunications: 3-30, 68-88, 138-144, 148-174, 380-400 MHz (including CEPT designation of 380-385/390-395 MHz), 400-430, 440-470,764-776,794-806, and 806-869 MHz (including CITEL designation of 821-824/866-869 MHz). One administration has designated PPDR spectrum for wideband and broadband applications.

2.1.1.2.4 Views on spectrum harmonization for PPDR

In the responses to the ITU-R survey of PPDR communications, a number of administrations have supported in principle the idea of providing harmonized frequency bands on a national and international level. Some of these views are as follows:

a) With regard to disaster relief, a number of countries prefer to have a common band so that use in all places is possible during the disaster. It is believed that relief teams can be much more effective if their systems operate on a common frequency band and the equipment used is based upon recognized radio compatibility characteristics and standards, and conform to common air-interface standards.

b) A number of countries have indicated the following needs and benefits of global/regional harmonization:

   i) Identification of sufficient harmonized spectrum for PPDR is a key public policy need.

   ii) Regional/global spectrum harmonization enhances cross-border coordination and assistance for a proper multinational response to a large disaster (such as large-scale earthquake and flood), crime or emergency incident, by facilitating radiocommunication between the dispatched teams and accepting agencies.

iii) Spectrum harmonization could reinforce the benefits of open standards, open technologies and radio compatibility and will help to reduce the cost of product development which may result in lower prices for PPDR users.

iv) Harmonization of spectrum could also facilitate interoperability between public protection and disaster relief agencies and organizations and provide a competitive market place.

c) Some administrations have noted that a limited extent of regional harmonization exists already and that activities are under way to further this harmonization.

d) Some administrations have questioned the need for further global/regional harmonization.

2.1.1.2.5 Future advanced solutions for PPDR

Radiocommunication in support of PPDR activities cover a range of radiocommunication services such as fixed, mobile, amateur and satellite. Typically, narrow-band technologies are used for PPDR radiocommunication within the terrestrial mobile service, while wideband and broadband technologies are finding PPDR applications within all services.

Narrow-band digital networks have been and will be introduced in an increasing number of countries while wideband and broadband technologies for PPDR are being developed. Reference to these technologies is starting to appear in regional standardization bodies.

The three radiocommunication scenarios, that is narrow-band, wideband and broadband, will develop to operate in an integrated manner to serve different needs in term of functionalities and geographic coverage for PPDR applications. Detailed information on the envisioned applications can be found in draft new Report ITU-R M.[PPDR]. In summary, the current understandings of these scenarios as they relate to PPDR are as follows:

a) Narrow-band

To provide PPDR narrow-band applications, the trend is to implement wide area networks including digital trunked radio networks providing digital voice and low speed data applications (e.g. pre-defined status messages, data transmissions of forms and messages, access to databases). Report ITU-R M.2014 lists a number of technologies, with typical channel bandwidths up to 25 kHz, that are currently used to deliver narrow-band PPDR applications.

b) Wideband

It is expected that the wideband technologies will carry data rates of several hundred kilobits per second (e.g. in the range of 384-500 kbit/s). Since it is expected that networks and future technologies may require higher data rates, a whole new class of applications including: wireless transmission of large blocks of data, video and Internet protocol-based connections in mobile PPDR communications systems may be introduced.

Systems for wideband applications to support PPDR activities are under development in various standards organizations. Many of these developments are referenced in Reports ITU-R M.2014, M.1457, and M.1073, with channel bandwidths dependent on the use of spectrally efficient technologies.

c) Broadband

Broadband technology could be seen as a natural evolutionary trend from wideband. Broadband applications enable an entirely new level of functionality with additional capacity to support higher speed data and higher resolution images.

Systems for broadband applications to support PPDR activities could typically be tailored to service localized areas (1 km^2 or less) providing voice, high speed data, high quality digital real time video and multimedia (indicative data rates in range of 1-100 Mbit/s) with channel bandwidths dependant on use of spectrally efficient technologies. Examples of possible applications are described in more detail in draft new Report ITU-R M.[PPDR].

Finally, it should be noted that various standards organizations are studying requirements for broadband PPDR applications. Report ITU-R M.2014 lists some of these activities, including Project MESA.

2.1.1.2.6 Interoperability techniques and technology solutions for PPDR

Interoperability techniques and advanced technologies may assist in providing support for bandwidth and interoperability. The variety of interoperability techniques and advanced technologies currently available may satisfy some PPDR requirements. Spectrum harmonization combined with these interoperability techniques and future advanced technologies may lessen the amount of global/regional spectrum as required by individual administrations for implementing their domestic PPDR applications. A few of these interoperability techniques and advanced technology solutions are detailed in draft new Report ITU-R M.[PPDR].

Some PPDR agencies and amateur radio groups use HF narrow-band systems including the use of data modes of operation as well as voice. Other technologies such as digital voice, high-speed data and video are in early implementations either using terrestrial or satellite network services.

2.1.1.3 Technical and operational issues

In order to provide effective communications, PPDR agencies and organizations need to fulfil a set of objectives and requirements that include interoperability, reliability, functionality, security in operations and fast call set-up[1] in each area of operation. Considering that the radiocommunication needs of PPDR agencies and organizations are growing, future advanced solutions used by PPDR agencies and organizations will require higher data rates, real-time video and multimedia. Draft new Report ITU-R M.[PPDR] among other items, defines objectives and requirements for the implementation of advanced solutions to meet the future needs of PPDR agencies and organizations. It provides a set of objectives, describes envisioned applications and the system design characteristics to be considered in order to satisfy the operational needs of PPDR agencies and organizations.

The requirements for PPDR radiocommunication should take into account the operating environments applicable to PPDR applications. User requirements are expected to lead to future advanced solutions for PPDR. The eventual accessibility of PPDR applications will also depend on various factors. These include cost, national regulations and laws, the nature of the PPDR mandate and the needs of the area to be served.

Radiocommunication in support of PPDR activities aim to achieve general objectives within the context of the maintenance of law and order, protection of life and property, response to emergency and disaster situations and coordinated rescue and relief operations. In addition, radiocommunication in support of PPDR operations aim to achieve operational objectives such as enabling communications management to be controlled (fully or in part) by PPDR agencies and organizations, in particular, for instant/dynamic reconfiguration changes, dispatch group (talk group) configuration, guaranteed access including priority levels and pre-emption (to over ride other users). It is important that communications through the system/network or those that are independent of the network such as Direct Mode Operation (DMO), simplex radio and push to talk are also available.

[1] Fast call set-up indicates reducing the response time to access the particular network.

Radiocommunication in support of PPDR activities needs to be available to support highly reliable operations on a continuous basis (i.e. 24 hours × 365 days/year). Providing coverage of the relevant jurisdiction and/or operation of the PPDR agency or organization whether it be national, provincial/state or at the local level is extremely important. PPDR radiocommunication is also usually required to provide reliable indoor and outdoor coverage of remote areas, and coverage of underground or inaccessible areas (e.g. tunnels, building basements).

The ITU-R survey also revealed concerns by administrations about appropriate levels of interference protection, the free circulation of equipment for international disaster relief, and logistic planning and preparedness.

2.1.1.4 Relevant ITU studies

Relevant Recommendations ITU-R: F.1105, M.1036 and DNR ITU-R M.[DR.RCIRC].

DN Report ITU-R M.[PPDR] "Objectives and requirements for PPDR radiocommunication", Recommendation ITU-D 13, "Effective utilization of the amateur services in disaster mitigation and relief operations" and the ITU "Disaster communications handbook for developing countries" also related to this matter.

2.1.2 Analysis of the results of studies

Studies have been undertaken in the ITU-R and the results of these studies are contained in draft new Report ITU-R M.[PPDR]. An understanding of the technical and operational issues impacting PPDR agencies and organizations has been achieved, as reflected in previous sections. However, it is the view of some administrations that further studies are required, particularly in the areas of the promotion of interoperability, regional/global roaming, equipment sharing, streamlined coordination, and economies of scale.

2.1.2.1 Agreements on PPDR radiocommunication

Many countries have formal or informal agreements with neighbouring countries concerning use of frequency bands designated for PPDR. Many countries have also signed the ITU/UN International Convention on the Provision of Telecommunications Resources for Disaster Mitigation and Relief Operation (the Tampere Convention). This framework covers the trans-border use of radiocommunication by all partners in international humanitarian assistance. Other agreements which are also relevant include ERC Decision (96) 01 regarding the harmonized frequency bands for emergency services, CITEL PCC.III/Resolution 28 (VI-96) recommendation regarding the harmonized frequency bands for public protection and IARU Memorandum of Understanding with the UN Office for the Coordination of Humanitarian Affairs (OCHA) concerning communications for disaster relief.

2.1.2.2 Spectrum requirements for PPDR

2.1.2.2.1 Objectives

The ITU-R has progressed work on the studies seeking to identify globally/regionally harmonized bands for the implementation of future advanced solutions to meet the needs of public protection agencies, including those dealing with emergency situations and disaster relief. Specifically, the ITU-R has progressed on the studies of the requirements for PPDR, contained in Annex 1 of draft new Report ITU-R M.[PPDR], which will assist in determining spectrum requirements for PPDR.

Many administrations see significant benefits for identifying harmonized spectrum for PPDR applications. These benefits could include among others, economies of scale, consolidation of duplicated infrastructure, improved spectrum efficiency, potential for interoperability, and improved operational effectiveness. These administrations envision basing their domestic planning on the internationally harmonized bands. It is believed that identifying harmonized spectrum will provide advice to manufacturers for design purposes. The amount to be identified should be based on the highest demand, most dense/urban environment. Within the globally/regionally harmonized band(s), administrations would be flexible in the amount of spectrum they want to use domestically. The identification of spectrum is viewed as providing a long-term migration opportunity to accommodate future operational needs. In this respect, globally/regionally harmonized band(s) could also support international disaster relief, however, the amount of spectrum identified is not intended to represent the amount of spectrum that should be harmonized internationally for this aspect.

The objective for other administrations is to identify globally/regionally harmonized spectrum to assist and promote interoperability of equipment internationally. This would facilitate cross-border public protection operations and effective international response to emergency and disaster relief situations when required. However, when public protection assets are invited across borders, only an agreement between those administrations involved is required. The focus therefore, should be placed on the spectrum requirements for international public protection and disaster relief. Further studies may be required to define these international spectrum requirements.

2.1.2.2.2 Methodologies for estimating PPDR spectrum needs

Administrations have used various methodologies to estimate the spectrum requirements for PPDR to the year 2010. Some administrations have used the generic methodology given in Recommendation ITU-R M.1390. This methodology and its variants are described in greater detail in Annex 4 of the draft new Report ITU-R M.[PPDR]. Other administrations have chosen alternative methodologies as described below.

2.1.2.2.2.1 Methodology based on Recommendation ITU-R M.1390

Some administrations used the generic methodology given in Recommendation ITU-R M.1390. This methodology was developed to calculate spectrum requirements for IMT-2000 and it can be used for any land mobile application by selection of appropriate input data. For these studies, the values for the input parameters were chosen to reflect the particular terrestrial mobile PPDR applications envisioned around the year 2010. Some administrations also chose to use a variant of this methodology to represent a generic city analysis.

Validity of Recommendation ITU-R M.1390 methodology for PPDR applications

A study of the validity of the results predicted by this methodology was done by inputting the parameters of a working narrow-band PPDR system into the calculator and confirming that the amount of spectrum it predicted was the same as that actually used by the system. This is particularly important in relation to the selection of the most sensitive parameters, including cell radius/frequency reuse and the number of users. Although not validated by actual measurement, the model is appropriate for estimating the wideband and broadband requirements as long as the input parameters are carefully considered and applied.

Sensitivity/parametric analysis

A sensitivity analysis of the result of spectrum calculations has been made. Considering the highest demand, most dense/urban environment the statistical analysis yielded a probable maximum upper limit of 200 MHz (narrow-band: 40 MHz, wideband: 90 MHz, broadband: 70 MHz).

2.1.2.2.2.2 Other methodologies

Other administrations have chosen alternative methodologies in their estimation. These alternative methodologies include an open and deliberative rulemaking process involving an ongoing and evolving monitoring and assessment of service needs and the consideration of input from public protection agencies and organizations, related associations, equipment manufacturers, and others based on domestic needs. This process also includes determining the availability of frequencies and sharing study with other systems.

2.1.2.3 Summary of the studies for PPDR spectrum required by the year 2010

A summary of the results of spectrum estimates for various PPDR radiocommunication applications (narrow-band, wideband, broadband), is given below in Table 2.1-1. Some administrations are of the view that further studies should address in detail differences in public protection and disaster relief spectrum requirements, including those of many developing countries, for national and international operations, in urban and rural areas, and should take into account capabilities of existing systems. It is envisioned that advanced solutions will be developed to serve different needs in terms of functionalities and geographic coverage for these scenarios.

NOTE – This table has been developed by ITU-R based on contributions provided by member administrations and discussions in the ITU-R meetings.

TABLE 2.1-1

Results of spectrum estimates for PPDR radiocommunication scenarios*

Location	Methodology used	Spectrum estimates			Total
		Narrow-band	Wideband	Broadband	
Large City A, Asia Pacific (High Demand, Urban Environment, Low PPDR Density)	Rec. ITU-R M.1390	52 MHz	3 MHz	48 MHz	103 MHz
Large City B, Asia Pacific (High Demand, Urban Environment, Low PPDR Density)	Rec. ITU-R M.1390	24 MHz	5 MHz	32 MHz	61 MHz
Large City, Asia Pacific (High Demand, Urban Environment, High PPDR Density)	Rec. ITU-R M.1390	40 MHz	70 MHz	60 MHz	170 MHz
Large City, America (High Demand, Urban Environment, Low PPDR Density)	Rec. ITU-R M.1390	46 MHz	39 MHz	50 MHz	136 MHz
Large City, Europe (High Demand, Urban Environment, Low PPDR Density)	Other	17 MHz	33 MHz**	-	-
Medium City, Europe (High Demand, Urban Environment, Low PPDR Density)	Rec. ITU-R M.1390	21 MHz	22 MHz	39 MHz	82 MHz
Medium City, Europe (Medium Demand, Urban Environment, Low PPDR Density)	Rec. ITU-R M.1390	12 MHz	11 MHz	39 MHz	62 MHz
Industrial District, Europe (Medium Demand, Suburban Environment, Low PPDR	Rec. ITU-R M.1390	3 MHz	3 MHz	39 MHz	45 MHz

Density)					
Asia Pacific	Other	15 MHz***	-	-	-
North America***	Other	35 MHz	12 MHz	50 MHz	97 MHz

* These estimates are from individual administrations.

** The estimate is based on a particular scenario.

*** The data reflects the current allocation(s) for one administration.

There are several reasons for the wide range of spectrum estimates in Table 2.1-1. First, the studies done in obtaining these results showed that the spectrum estimates are very sensitive to the density and the penetration rates assumed. Second, the spectrum calculations, while representative, cover different operating scenarios. For example, one administration based its spectrum estimates on the most dense/urban environment. Another administration chose to examine the amount of spectrum required in a typical medium sized city.

Many administrations do not envisage having physically separate networks supporting both domestic public protection and disaster relief activities. Therefore, the results incorporate both public protection and disaster relief spectrum requirements. Other countries may decide to calculate separate public protection and disaster relief spectrum requirements.

An analysis was performed to provide a generic example of the relationship between the different PPDR user categories and demographic population density in urban areas. This approach shows the optimum PPDR spectrum requirement based on demographics and population. That is, the amount of PPDR spectrum requirement based on the normalized number of PPDR users in a city based on its demographics and population size. This analysis assumed a non-uniform frequency reuse pattern that did not reuse frequencies in the suburban areas immediately adjacent to the urban area.

The analysis concluded that most urban areas had a central urban core with a dense population. The suburban ring around the urban core contained about the same amount of population, but was about 5 to 20 times the area of the urban core. A summary of the results of spectrum estimates for this analysis is provided in Table 2.1-2. (See Annex 4 of draft new Report ITU-R M.[PPDR] for greater detail.)

TABLE 2.1-2

Results of spectrum estimates for PPDR from a generic city analysis

	Medium city (Pop. = approx. 2.5 Million)		**Large city (Pop. = approx. 8.0 Million)**	
	PPDR user density		**PPDR user density**	
	Low	High	Low	High
Narrow-band	31 MHz	44 MHz	48 MHz	67 MHz
Wideband	25 MHz	34 MHz	38 MHz	52 MHz

Based on the data from Tables 2.1-1 and 2.1-2, Table 2.1-3 shows a range of spectrum estimates for similar scenarios.[2]

TABLE 2.1-3

Estimate of spectrum required for PPDR to the year 2010

	Medium city (Pop. = approx. 2.5 Million)		**Large city (Pop. = approx. 8.0 Million)**	
	PPDR user density		**PPDR user density**	
	Low	High	Low	High
Narrow-band	12 to 31 MHz	44 MHz*	17 to 52 MHz	40 to 67 MHz
Wideband	up to 25 MHz	34 MHz*	up to 38 MHz	52 to 70 MHz
Broadband	39 MHz	-	up to 50 MHz	60 MHz
* The results were obtained from the generic city analysis only.				

The spectrum estimates in Tables 2.1-1 and 2.1-2 do not necessarily imply a need for a single contiguous block of spectrum to accommodate all applications. It may be necessary to accommodate the requirements for the various applications (narrow-band, wideband and broadband) across a number of bands. However, to achieve economies of scale, the amount of contiguous spectrum in each category (narrow-band, wideband and broadband) should be maximized to the extent possible.

The results in Tables 2.1-1 and 2.1-2 include both the current spectrum use and the estimates for the future. The spectrum estimates provided for all three categories (narrow-band, wideband and broadband) may be reduced due to a variety of inherent network designs such as cellular architecture patterns (e.g. the cell radius and trunking efficiencies), and other technologies (Annex 5 of draft new Report ITU-R M.[PPDR]).

Considering the potential for new technologies such as IMT-2000 and systems beyond and Intelligent Transportation Systems (ITS) that may support or supplement advanced PPDR applications, the spectrum estimates may also be reduced. Although commercial systems may serve as a complement to dedicated systems in support of PPDR, such use would be in response to market demands.

The use of radiocommunication services such as the fixed service, the mobile-satellite service and the amateur service may supplement PPDR operations, which may impact the amount of spectrum needed for PPDR situations. Administrations can then take this into account when deciding their own domestic arrangements. In the future, advanced technology solutions such as HAPS and RNSS systems could provide additional capabilities, even in times of disasters due to their inherent invulnerability to natural and man-made disasters.

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[2] It is anticipated that work will continue to progress in the ITU-R to determine an estimate of the spectrum required to the year 2010 and beyond. Therefore, administrations are strongly encouraged to submit proposals to the CPM meeting with the proposed amount of spectrum required to satisfy the agenda item. The ITU-R has not yet reconciled the estimates prepared by a number of administrations to arrive at a consensus estimate.

2.1.2.4 Candidate bands

In response to the ITU-R survey, a list of potential candidate bands has been prepared. This list is attached as Annex 2.1-1.

While considering the list of candidate bands, the conference may take into account the following aspects:

1) To the extent possible, the candidate band(s) identified for use by PPDR applications could be identified from among the bands currently allocated to the fixed, mobile or mobile satellite service regionally/globally on primary or secondary basis.

2) If, however, the identified candidate bands for global/regional harmonization are not allocated to the mobile service on primary basis or is currently allocated to mobile service on a secondary basis, then a change to the Table of Frequency Allocations may need to be considered by the Conference.

3) The specific needs, especially of developing countries, for PPDR applications including interoperability of systems and services, technical and operational assistance and system availability should be met.

4) The needs of individual administrations for flexibility in applying future advanced solutions:

   a) to determine, at the national level, how much spectrum to make available to PPDR applications;

   b) to develop transitional plans appropriate to national situations and requirements;

   c) to continue the operation of all services with allocations in accordance with the Radio Regulations as required to satisfy national needs.

5) The standards and conditions of use applied to PPDR applications need to be in accordance with the relevant ITU-R Recommendations on technical and operational standards.

6) The study of suitable candidate bands for spectrum harmonization for PPDR should consider individual administration's current and planned uses of bands under consideration.

2.1.3 Methods to satisfy the agenda item and their advantages and disadvantages

With regard to the identification of globally/regionally harmonized spectrum for future advanced solutions to meet the needs of PPDR, there are several methods to satisfy agenda item 1.3.

2.1.3.1 Method A

The conference could consider listing global or regional bands for PPDR through footnotes in RR Article **5**.

Advantages:

- A footnote in the Table of Frequency Allocations would emphasize the use of these frequencies for public protection and disaster relief and could therefore, facilitate the global use of these bands for public protection and disaster relief without preventing administrations from using other bands for this purpose or to use these bands for other purposes, if they wish.
- The language used in the example footnotes would provide administrations with flexibility in making their specific allocations and the timing of the allocations.

Disadvantage:

This regulatory format for public protection and disaster relief systems compared to other mobile systems or radio services that are not footnoted in the RR could be misinterpreted as giving a different regulatory status to public protection and disaster relief compared with other uses.

2.1.3.2 Method B

The conference could consider a new Resolution or Recommendation. An example of such a Resolution is contained in Annex 2.1-2.

Advantages:

- Globally/regionally harmonized bands could be listed in a new WRC Resolution or Recommendation, without any specific identification in a footnote to the Radio Regulations.
- Different options of possible candidate bands for terrestrial public protection and disaster relief can be given in this new WRC Resolution or Recommendation.
- This method avoids misinterpretation of the regulatory status of PPDR compared with other uses in the identified band(s) by disassociating any additional spectrum identification for PPDR from the Table of Frequency Allocations.
- Different Regional proposals intended to cover the whole scope of frequency bands options with the possibility of prioritization for one or other of the bands can be noted in the text of a Resolution or Recommendation.
- Follows the approach of avoiding inclusion into the Radio Regulations of complex footnotes (as envisioned by Method **A**) for specific systems, but rather more broadly for services or applications and allows for important explanations in the Resolution or Recommendation text.

Disadvantages:

- There is the danger that the Resolution or Recommendation, if not referenced in a footnote, would be disregarded by administrations. Although it is not unique, it may be questioned whether a Resolution or Recommendation, which address a harmonization matter, is appropriate without any reference in RR Article **5**.

2.1.3.3 Method C

The conference could consider listing global or regional bands for PPDR through footnotes in RR Article **5**, with an appropriate reference to a resolution or recommendation, such as, the example given in Annex 2.1-2.

Advantages:

- A footnote in the Table of Frequency Allocations would emphasize the use of these frequencies for public protection and disaster relief and could therefore, facilitate the global use of these bands for public protection and disaster relief without preventing administrations from using other bands for this purpose or to use these bands for other purposes, if they wish.
- The language used in the example footnotes would provide administrations with flexibility in making their specific allocations and the timing of the allocations.
- This method allows important explanations to be included in the Resolution or Recommendation text.

Disadvantage:

This regulatory format for public protection and disaster relief systems compared to other mobile systems or radio services that are not footnoted in the RR could be misinterpreted as giving a different regulatory status to public protection and disaster relief compared with other systems.

2.1.3.4 Method D

No identification of global/regionally harmonized bands for PPDR but the conference could consider a new Resolution or Recommendation inviting ITU-R to conduct studies for the development of a Resolution identifying frequency bands that could be used on a global/regional basis for disaster relief operations.

Advantage:

Afford further time to address the spectrum needs for international disaster relief operations, which by some administrations is considered to be the only relevant issue of this agenda item.

Disadvantage:

This method does not respond to the need to provide globally/regionally harmonized bands for public protection.

2.1.4 Regulatory and procedural considerations

2.1.4.1 Identification of bands

For Method **A**, an example of the required footnotes could be structured as follows:

ADD

5.XXX *(Global bands for public protection and disaster relief using terrestrial services)*: The bands [...] may be used for future advanced solutions to meet the needs of public protection and disaster relief applications, on a worldwide basis, by administrations wishing to use them for such applications. Such use does not preclude the use of these bands by any application in services to which these bands are allocated and does not establish priority in the Radio Regulations. Such use also does not preclude the use of any other frequencies for public protection and disaster relief applications in accordance with the Radio Regulations.

ADD

5.YYY *(Regional bands for public protection and disaster relief using terrestrial services)*: In [Region XYZ/countries...], the bands [...] may be used for future advanced solutions to meet the needs of public protection and disaster relief applications by administrations wishing to use them for such applications. Such use does not preclude the use of these bands by any application in services to which these bands are allocated and does not establish priority in the Radio Regulations. Such use also does not preclude the use of any other frequencies for public protection and disaster relief applications in accordance with the Radio Regulations.

*****

For Method **B**, an example of a Resolution or Recommendation is provided in Annex 2.1-2.

For Method **C**, the required footnotes could be structured as the example for Method **A** with an additional sentence as follows: "The usage of these bands for public protection and disaster relief should be in accordance with Resolution **[PPDR 2.1-1]**."

For Method **D**, an example of a Resolution is provided in Annex 2.1-3.

2.1.4.2 Global cross-border circulation of radiocommunication equipment in emergency and disaster relief situations

Resolution **645** also invited the ITU-R *"to conduct studies for the development of a resolution identifying the technical and operational basis for global cross-border circulation of radiocommunication equipment in emergency and disaster relief situations,"*

In response, DNR ITU-R M.[DR.CIRC] has been developed. A possible regulatory option to encourage circulation of equipment as follows:

Draft a Resolution based on DNR ITU-R M.[DR.CIRC] "Global cross-border circulation of radiocommunication equipment in emergency and disaster relief situations". The Tampere Convention on the Provision of Telecommunications Resources for Disaster Mitigation and Relief Operations, an international treaty deposited with the United Nations Secretary-General (ICET-98, Tampere 1998) and related United Nations General Assembly Resolutions and Reports are also relevant in this regard.

ANNEX 2.1-1

Candidate bands

NOTE – This table of candidate bands has been developed by ITU-R based on contributions provided by member administrations and discussions in the ITU-R meetings. The allocation to various services indicated in the table refers to allocation on a primary basis only. Advantages and disadvantages for each candidate band for PPDR use are also listed.

Frequency band	Comments
3-30 MHz **Footnotes:** **5.132 5.149**	The band is allocated on a primary basis to several services including FS and MS. **Advantages:** • Some administrations currently use various frequencies in this band for narrow-band PPDR applications. • Good propagation in open plains or dense vegetation. • Valuable band to be kept for existing PPDR usages, i.e. humanitarian aid and disaster management. • Supports communication over short distances using near vertical incidence skywave and longer skywave paths. • Generally, some administrations use parts of these bands for government radiocommunication systems that may be suitable for PPDR applications. **Disadvantages:** • Extensive usage in this band by various services to which the band is allocated is resulting in overcrowding. • A number of sub-bands within the 3-30 MHz band are allocated globally to the aeronautical mobile (R) and the maritime mobile services. • Relatively large antennas are required. • Interference from short and long distances can be a problem. • Some administrations use parts of these bands for government radiocommunication systems that are predominantly for non-PPDR applications.

68-74.8 and 75.2-88 MHz **Footnotes:** **5.149 5.174 5.175 5.176 5.177 5.179 5.182 5.183 5.184 5.185 5.187 5.188 5.190**	The band 68-74.8 MHz is allocated on a primary basis to FS and MS in Regions 1 and 3. In Region 2, parts of this band are allocated on a primary basis to BS, FS, MS and RAS. Parts of the frequency band 75.2-88 MHz are allocated on a primary basis to FS, MS, and BS. **Advantages:** • Parts of this band are allocated to mobile services on a global or regional basis. • Various frequencies in this band are used for narrow-band PPDR applications. • Propagation in this band provides good coverage in rural and forest areas. **Disadvantages:** • Various services have allocation in this band and extensively use it. • Some administrations use parts of this band for BS (allocated on a primary basis). (It is expected that these services will be removed in the long term following conversion to digital transmission.) • There is some susceptibility to man-made noise in and around towns in this band. • Relatively large antennas are required.
138-144 MHz and 148-174 MHz **Footnotes:** **5.207 5.210 5.211 5.212 5.213 5.214**	Parts of these bands are allocated on a primary basis to FS, MS, MMS, MSS, RLS, RNSS, RAS, AMS and SRS. **Advantages:** • Good propagation to provide cost-effective coverage in rural areas. • The band 148-174 MHz is also used by maritime mobile and aeronautical mobile services for distress purposes and has the potential to provide interoperability with maritime and aeronautical communications, if needed. • In many administrations, equipment is available to support existing widely used narrow-band PPDR applications in the band 148-174 MHz. • Generally, some administrations use parts of these bands for government radiocommunication systems that may be suitable for PPDR applications. **Disadvantages:** • One administration uses the band 137-144 MHz for broadcasting services. That administration has decided that no new assignments will be made to broadcasting services in this band and expects that these services will be removed in the long term following their conversion to digital transmission. • Many CEPT administrations use the band 138-144 MHz extensively for non-PPDR government services. • Extensively used by existing services resulting in overcrowding in most cities. • Some administrations use parts of these bands for government radiocommunication systems that are predominantly for non-PPDR applications.
380-399.9 MHz **Footnotes:** **5.208A 5.209 5.220 5.222 5.224A 5.224B 5.254 5.255**	The band is allocated on a primary basis to FS and MS. **Advantages:** • Propagation in this band is suitable for cost-effective wider area coverage including both urban and rural areas. • This band is currently used or is intended to be used for narrow-band PPDR applications by many administrations in Europe and Asia. • The designation of the band 380-385/390-395 MHz for emergency services in Europe in accordance with ERC Decision (96) 01 has provided possibilities for

	interoperability, harmonized and efficient use of common spectrum with wide equipment availability. It is also noted that ERC Decision (96) 01 under *considering i)* that among NATO member administrations, there is an agreement between military and the civil authorities to accommodate the emergency services in Military frequency bands subject to certain conditions such as sharing. • In Europe, administrations use parts of these bands extensively and exclusively for government radiocommunications. • The band 385-390/395-399.9 MHz is being considered by the CEPT as a possible candidate band for PPDR harmonization noting that further negotiations with NATO member administrations are still necessary. **Disadvantages:** • This band is allocated to FS and MS and used extensively for these services. • National frequency allocations of some east European administrations do not allow them to implement ERC Decision (96) 01 since this band is used by different categories of users by these administrations. • This band is used by non-PPDR government services by some administrations in Region 2 and Region 3 and access to this band is required for interoperability among such services.
	• Some administrations use parts of these bands extensively and exclusively for government radiocommunications.
406.1-430 MHz and 440-470 MHz **Footnotes:** **5.209 5.138 5.149 5.261 5.262 5.266 5.267 5.268 5.269 5.270 5.271 5.272 5.273 5.274 5.275 5.276 5.277 5.278 5.279 5.280 5.281 5.282 5.283 5.284 5.285 5.286 5.286A 5.286B 5.286C 5.286D 5.286E 5.287 5.288 5.289 5.290**	These bands are allocated to several services including fixed, mobile, radiolocation, mobile-satellite, radio astronomy and space research services. **Advantages:** • Propagation in these bands is suitable for cost-effective wider area coverage including both urban and rural areas. • Widely used leading to wide availability of equipment. • Some administrations use parts of these bands for narrow-band PPDR applications. • Some administrations use parts of the 450-470 MHz band for existing commercial cellular systems which may be suitable for narrow-band PPDR applications. **Disadvantages:** • These bands are allocated to several radio services and are used extensively for these services and such use will continue. • These bands are widely used by civil PMR systems and therefore parts may not be available for PPDR. • Some administrations use parts of the band 420-450 MHz for high power radiolocation radars. • Some administrations use parts of the band 420-430 MHz for government services. • Some European administrations use the 440-470 MHz band extensively for civil systems and non-PPDR government applications. • Some administrations use parts of this band for existing commercial mobile systems.
746-806 MHz **Footnotes:**	The band is allocated to BS, FS and MS. **Advantages:** • In some administrations, parts of this band are currently being used for

5.149 5.291A 5.294 5.293 5.296 5.300 5.302 5.304 5.306 5.309 5.311 5.312 5.314 5.315 5.316	narrow-band PPDR applications. • One administration in Region 2 has designated 24 MHz of spectrum in the band 764-776 MHz paired with 794-806 MHz for both narrow-band and wideband public protection use. Several technical and regulatory provisions have been adopted by this administration to foster the deployment of advanced technologies. • The transition from analogue to more efficient digital television provides an opportune time to consider planning for reallocation of spectrum in this band for PPDR services. • Propagation in this band is suitable for cost-effective wider area coverage. **Disadvantages:** • Availability of this band for PPDR is dependent on transition of existing analogue broadcast operations to digital, for which there is no definite future date. • During the period of transition from analogue to digital transmissions for television services (expected to be long term), additional spectrum will be required for simulcasting analogue as well as digital television services.
	• Some administrations use parts of this band extensively for broadcasting and associated usages (e.g. wireless microphones, etc.). • Some administrations use parts of this band for government radiocommunications. • In Regions 1 and 3 BS usage of this band may be affected by decisions taken at RRC-04/05.
806-824 MHz and 851-869 MHz **Footnotes:** **5.293 5.309 5.311 5.312 5.314 5.315 5.316 5.319 5.321 5.319 5.323 5.317 5.317A 5.318 5.149 5.305 5.306 5.307 5.311 5.320 5.317A 5.319 5.321**	The band is allocated to FS, MS and BS. **Advantages:** • This band currently supports narrow-band PPDR applications. Both analogue and digital narrow-band products are readily available. • Propagation in this band is suitable for cost-effective wide-area coverage. • In Region 2, most administrations have designated the bands 821-824/866-869 MHz for public protection applications according to CITEL PCC.III/ Resolution 28 (VI-96) and do not mandate any specific technology in this band. This has provided possibilities for interoperability, harmonized and efficient use of common spectrum. • In Regions 2 and 3, portions of the 806-821/851-866 MHz band are also used for PPDR applications. • Some administrations use parts of this band for existing commercial cellular systems which could support PPDR applications. **Disadvantages:** • The band is allocated to FS, MS and BS and used extensively for these services. • Use of this band is dependent on existing analogue broadcast operations. • Incompatibility with GSM usage by some administrations may require additional filtering. • One administration uses a large part of this band for public telecom system. • In Europe, the band 862-870 MHz is widely used for short-range devices on an unlicensed basis. • Many administrations use parts of this band extensively for broadcasting and associated usages (e.g. wireless microphones, etc.).

	• Many European administrations use parts of this band for non-PPDR government usage. • Some administrations use parts of these bands exclusively and extensively for government radiocommunications. • Some administrations use parts of this band for existing commercial cellular systems.
870-876 MHz and 915-921 MHz **Footnotes:** **5.149 5.150 5.305 5.306 5.307 5.311 5.317 5.317A 5.318 5.319 5.320 5.323 5.325 5.326**	The band is allocated on a primary basis to BS, FS and MS. **Advantages:** • This band currently supports narrow-band applications. Both analogue and digital narrow-band products are readily available. • Propagation in this band is suitable for cost-effective wide area coverage including urban areas. • In Europe the bands 870-876 MHz paired with 915-921 MHz are identified for digital public trunking systems in accordance with ERC Decision (96) 04. However a review is being discussed.
	• Some administrations use parts of this band for existing commercial cellular systems (including IMT-2000), which may support or supplement PPDR applications. **Disadvantages:** • Many administrations use this band for public mobile telecom services. • Some administrations use parts of this band for existing commercial cellular systems (including IMT-2000). • Some administrations use the band 915-921 MHz for RLS on a primary basis. • The band 902-928 MHz is used for ISM applications in Region 2 countries.
4 400-4 900 MHz **Footnotes:** **5.149 5.339 5.441 5.442 5.443**	The band is allocated on a primary basis to FS, MS and FSS. **Advantages:** • Parts of this band are allocated to mobile services on a global or regional basis. • Sufficient bandwidth to support broadband applications. • Propagation is appropriate for short-range broadband systems. • Propagation provides capability for significant frequency reuse. **Disadvantages:** • No experience to date in using this band for land mobile applications. • Some administrations use this band or parts of this band extensively for non-PPDR government radiocommunication applications.

4 900-4 990 MHz **Footnotes:** **5.149 5.339 5.443**	The band is allocated on a primary basis to FS and MS. **Advantages:** • Technology/components are readily available in this band from RLANs. • Propagation is appropriate for short-range broadband systems. • Propagation provides capability for significant frequency reuse. • One administration has designated the 4 940-4 990 MHz band to be used in support of PPDR applications. **Disadvantages:** • Parts of this band are used extensively for radio astronomy. • One administration will use this band for wireless access by public telecom service providers.
5 850-5 925 MHz **Footnotes:** **5.150**	The band is allocated on primary basis to FS, FSS and MS. **Advantages:** • This band is also intended for use by TICS. • Technology/components are readily available in this band from RLANs. • Sufficient bandwidth to support broadband applications. • Propagation is appropriate for short-range broadband systems. • Propagation provides capability for significant frequency reuse.
	Disadvantages: • Parts of this band are used for ISM applications and for short-range devices. • Some administrations in Region 2 use parts of this band, either exclusively or heavily, for radiolocation. • In some administrations parts of this band are used extensively and exclusively for non-PPDR government radiocommunications. • One administration in Region 2 uses parts of this band for VSAT deployment.

ANNEX 2.1-2

Example of a RESOLUTION [PPDR 2.1-1] (WRC-03)

NOTE - This Resolution could also be redrafted as a recommendation, as appropriate.

Public Protection and Disaster Relief

The World Radiocommunication Conference (Geneva, 2003),

considering

a) the growing telecommunication needs of public agencies and organizations dealing with law and order, disaster relief and emergency response;

b) that future advanced solutions used by such public protection and disaster relief agencies and organizations will require high data rates;

c) that there is a need for interoperability and interworking between public protection and disaster relief (PPDR) networks, both nationally and for cross-border operations, in emergency situations and disaster relief;

d) the importance of the needs of public protection agencies and organizations, including those dealing with emergency situations and disaster relief for:

i) maintenance of law and order;

ii) emergency and disaster response;

iii) protection of life and property;

e) that the provision of appropriate spectrum resources to PPDR is becoming increasingly important to the maintenance of a stable and prosperous society;

f) that current PPDR applications are mostly narrow-band, including voice and low data-rate applications, typically in channel bandwidths of 25 kHz or less;

g) that although there will continue to be narrow-band requirements, many future applications will be wideband (indicative data rates in the range of 384-500 kbit/s) and/or broadband (indicative data rates in the range of 1-100 Mbit/s) with channel bandwidths dependent on the use of spectrally efficient technologies;

h) that new technologies for wideband and broadband PPDR applications are being developed in various standards organizations: in particular, a joint standardization programme (known as Mobility for Emergency and Safety Applications (MESA)) between ETSI and TIA has commenced for broadband PPDR;

i) that there is potential for new technologies such as IMT-2000 and systems beyond IMT-2000 and Intelligent Transportation Systems (ITS) which may support or supplement advanced PPDR applications;

j) that commercial systems may serve as a complement to dedicated systems in support of PPDR and that such complementary use would be in response to market demands;

k) that Resolution 98 (Minneapolis, 1998) of the Plenipotentiary Conference urges Member States to facilitate use of telecommunications for the safety and security of humanitarian personnel,

recognizing

a) the importance of interoperability in the provision of spectrum for public protection and disaster relief;

b) the benefits of globally and regionally harmonized frequency bands, such as:

i) increased potential for interoperability;

ii) a broader manufacturing base and increased volume of equipment resulting in economies of scale and expanded availability of equipment;

iii) improved spectrum management and planning;

iv) enhanced cross-border coordination;

v) improved cross-border circulation of equipment;

c) that spectrum planning for PPDR is done at the national level, taking into account the need for interoperability and benefits of harmonization with neighbouring administrations;

d) the increased benefits of cooperation between countries for the provision of effective and appropriate humanitarian assistance during disasters;

e) the special needs of developing countries, taking into account the ITU-D Handbook on disaster relief;

f) the needs of countries, particularly for developing countries, for low-cost communications equipment for public protection and disaster relief agencies and organizations;

g) that spectrum and innovative spectrum management may be required for the implementation of future advanced solutions;

h) that the trend is to increase the use of technologies based on Internet protocols;

i) that currently some bands or parts thereof below 1 GHz have been designated for exclusive use for public protection and disaster relief, specifically:

- some administrations in Region 2 have designated the bands 821-824/866-869 MHz for public protection and disaster relief use;
- harmonization, to some extent, has been achieved by some administrations in Region 1 by designating the frequency bands 380-385/390-395 MHz for emergency services;
- some administrations in Region 3 are using, plan to use, or have identified parts of the frequency bands 68-88 MHz, 138-144 MHz, 148-174 MHz, 380-399.9 MHz, 406.1-430 MHz, 440-502 MHz, 746-806 MHz, 806-824 MHz and 851-869 MHz for PPDR applications,

noting

a) that many administrations use frequency bands below 1 GHz for narrow-band PPDR applications;

b) applications requiring large coverage areas and providing good signal availability would generally be accommodated in lower frequency bands;

c) applications requiring wider bandwidths would generally be accommodated in progressively higher bands;

d) that PPDR agencies and organizations have a minimum set of requirements, including but not limited to, interoperability, secure and reliable communications, sufficient capacity to respond to emergencies, priority access in use of non-dedicated systems, fast response times, ability to handle multiple group calls and ability to cover large areas;

e) that in most administrations, PPDR applications are provided at several levels, from national down to local, and cooperation between the levels is a domestic matter which harmonized spectrum and interoperability could facilitate;

f) that, while harmonization may be one method of realizing the benefits stated above, in some countries multiple frequency bands can be a component of meeting the communication needs in disaster situations,

resolves

1 to urge administrations to use globally and regionally harmonized bands for PPDR, to the maximum extent possible*;*

2 to provide flexibility for disaster relief agencies and organizations by indicating that the identification of bands specifically for PPDR does not preclude the use of these bands by any application in services to which these bands are allocated and does not preclude the use of any other frequencies for disaster relief applications in accordance with the Radio Regulations;

3 to urge administrations, in emergency and disaster relief situations, to satisfy temporary needs for frequencies in addition to what may be normally provided for in agreements with neighbouring administrations;

4 to urge administrations to encourage PPDR agencies and organizations to utilize both existing and new technologies and solutions (satellite and terrestrial), to the extent practicable, to satisfy PPDR interoperability requirements and to further the goals of public protection and disaster relief;

5 that administrations should encourage agencies and organizations to use advanced wireless solutions for providing complementary support to PPDR agencies and organizations*,

recommends

1 that as necessary, administrations continue to work closely with their public protection and disaster relief community to further refine the identification of future spectrum requirements and possible methods to meet these requirements;

2 that administrations encourage PPDR agencies and organizations to utilize relevant ITU-R Recommendations in planning and implementing spectrum, technology and systems for public protection and disaster relief,

invites ITU-R

to conduct appropriate technical studies in support of the implementation of PPDR applications in the identified bands.

ANNEX 2.1-3

Example of a RESOLUTION [PP AND DR 2.1-2] (WRC-03)

NOTE - This Resolution could also be redrafted as a recommendation, as appropriate.

Public Protection and Disaster Relief

The World Radiocommunication Conference (Geneva, 2003),

considering

a) the growing telecommunication needs of public agencies and organizations dealing with law and order, disaster relief, emergency response and protection of life and property;

b) that there is a need for interoperability and interworking between public protection and disaster relief networks for international and cross-border operations in emergency situations;

c) that organizations, including commercial entities, are involved in providing solutions for disaster relief activities through special programmes;

d) that some features supporting public protection and disaster relief activities use commercially operated systems;

* Some administrations believe that IMT-2000 and ITS are examples of such advanced wireless solutions.

e) that commercially operated systems are already capable of partially fulfilling the needs of public protection and disaster relief, and the development of functions which will fulfil such needs is continuing;

f) that current public protection and disaster relief applications are mostly narrow-band, including voice and low data-rate applications, typically in channel bandwidths of 25 kHz or less;

g) that although there will continue to be narrow-band requirements, many future applications will be wideband (indicative data rates in the range of 384-500 kbit/s) and/or broadband (indicative data rates in the range of 1-100 Mbit/s) with channel bandwidths dependent on the use of spectrally efficient technologies;

h) that new technologies for wideband and broadband public protection and disaster relief applications are being developed in various standards organizations;

i) that there is potential for new technologies such as IMT-2000 and systems beyond IMT-2000 and Intelligent Transportation Systems (ITS) which may support or supplement advanced public protection and disaster relief applications;

j) that Resolution [36 (Rev. Marrakesh, 2002) of the Plenipotentiary Conference] urges Member States to facilitate the use of telecommunications for the safety and security of humanitarian personnel,

recognizing

a) that public protection activities are day-to-day operations and are conducted for the most part within respective national borders using public protection assets of the nation and, as such, spectrum planning is a national matter;

b) the importance of international and cross-border interoperability in the provision of spectrum for disaster relief;

c) that spectrum planning for public protection and disaster relief is done at the national level, taking into account the need for cooperation with other administrations;

d) the special needs of developing countries, taking into account the ITU-D Handbook on disaster relief;

e) the needs of countries, particularly for developing countries, for low-cost communications equipment for public protection and disaster relief agencies and organizations;

f) that the trend is to increase the use of technologies based on Internet protocols,

noting

a) that many administrations use frequency bands below 1 GHz for narrow-band public protection and disaster relief applications;

b) that public protection and disaster relief agencies and organizations have a minimum set of requirements, including, but not limited to, interoperability, secure and reliable communications, sufficient capacity to respond to emergencies, priority access in use of non-dedicated voice and data systems, fast response times, ability to handle multiple group calls and ability to cover large areas;

c) that the identification of multiple frequency bands and use of innovative technologies can help to meet the communication needs in public protection and disaster relief situations,

resolves

1 to urge administrations to encourage public protection and disaster relief agencies and organizations to utilize both existing and new technologies and solutions (satellite and terrestrial), to

the extent practicable, to satisfy public protection and disaster relief interoperability requirements and to further the goals of public protection and disaster relief;

2 that administrations encourage agencies and organizations to use advanced wireless solutions for public protection and disaster relief operations*,

invites ITU-R

1 to conduct studies, as a matter of urgency, for the development of a resolution identifying frequency bands that could be used on a global/regional basis for disaster relief operations, taking into account existing services in these bands;

2 to conduct studies for the development of an ITU-R Recommendation on technologies to take advantages of multiple frequency bands,

instructs the Director of the Radiocommunication Bureau

to report on the results of these studies to WRC-07,

urges administrations

to participate actively in the aforementioned studies by submitting contributions to ITU-R,

recommends

that WRC-07 consider, to the extent practicable, the identification in a resolution of globally/regionally harmonized frequency bands for disaster relief.

#########

2.2 Agenda item 1.5

"to consider, in accordance with Resolution **736 (WRC-2000)**, regulatory provisions and spectrum requirements for new and additional allocations to the mobile, fixed, Earth exploration-satellite and space research services, and to review the status of the radiolocation service in the frequency range 5 150-5 725 MHz, with a view to upgrading it, taking into account the results of ITU-R studies."

2.2.1 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

2.2.1.1 WAS including radio local area networks (RLANs) in the mobile service

The term "Wireless Access Systems (WAS)" describes an untethered radiocommunication system, which is usually deployed in geographically limited areas (this is not a regulatory definition for WAS including RLANs). A global mobile allocation for WAS including RLANs would support the trend that people want to use the same services everywhere. Broadband RLANs are a subset of these systems and are described in the guidelines found in Recommendation ITU-R M.1450. Office or indoor environments generally have low e.i.r.p.s and very small radio cells on the order of 30-metre radius or less. Outdoor environments generally use higher e.i.r.p.s and have larger cell radius.

* Some administrations believe that IMT-2000 and ITS are examples of such advanced wireless solutions.

Typical applications include public and private wireless access offered in homes, schools, hospitals, hotels, conference centres, airports, shopping centres, etc. These types of systems may thus be considered to fall into the ITU-R categories nomadic wireless access (NWA) or mobile wireless access (MWA). Also, administrations, through national rules and policies, may choose to either license these devices or to exempt these devices from licensing.

Several administrations have started to implement WAS in this frequency band, such as 5 150-5 350 MHz in some Region 2 and Region 3 countries and 5 150-5 350 MHz and 5 470-5 725 MHz in some Region 1 and Region 3 countries. Such systems are currently operated under No. **4.4**. There is some limited operational experience of sharing between these systems and other services allocated in these bands.

Sufficient spectrum, among other factors, is a necessary condition to allow satisfactory performance in the presence of other uncoordinated users and is one of the key conditions for market acceptance for these kind of systems.

Studies show that a spectrum requirement consistent with the bands covered by Resolution **736**, *resolves* 1, is justifiable. (See PDNR M.[METHOD.NWA.SPECTRUM]).

2.2.1.2 FWA applications in the fixed service

FWA is the wireless access application in which the location of the end-user termination and the network access point to be connected are fixed and are generally characterized as systems comprised of a base station and a number of remote stations located at users' premises within the service coverage or "cell". In a cell, all the remote stations communicate to the base station only during the assigned time slot, in the case of TDMA, or accessible timings, in the case of Carrier Sense Multiple Access (CSMA), which means only one station is emitting transmit power at any instantaneous time within a cell or sector. Employment of directive antennas at both base and remote stations will enable to reduce emissions to high elevation angles.

2.2.1.3 Earth exploration-satellite service (active)

Active sensing is the measurement on board a spacecraft of signals transmitted by the sensor and then reflected, refracted or scattered by the Earth's surface or its atmosphere.

Three basic types of active sensors are addressed herein and will also be collectively referred to as spaceborne active sensors:

1) Radar scatterometers are useful for determining the roughness of large objects such as ocean waves.
2) Radio altimeters are used to determine the height of the Earth's land and ocean surfaces.
3) Imaging radars (synthetic aperture radars) are used to produce high resolution images of land and ocean surfaces.

A need has been identified to expand the bandwidth available for spaceborne altimeters and for spaceborne synthetic aperture radars (SARs) operating in EESS (active) in the 5 250-5 460 MHz band from 210 MHz to 320 MHz (5 250-5 570 MHz) in order to satisfy a requirement for the altimeter height measurements with a standard deviation of 1 to 2.5 centimetres and a SAR requirement for measurements with enhanced ground resolution of 1 metre.

The current spaceborne altimeter uses 320 MHz between 5 140 and 5 460 MHz. The use of a 320 MHz band around 5.3 GHz is essential to provide continuous measurements of the topography of the ocean surface with an unprecedented accuracy (1 to 2.5 cm) that requires simultaneous use of large bandwidths (320 MHz) around 14 GHz and 5 GHz to estimate ionospheric delay. High quality data have been collected, allowing scientists to give new significant insights into the following areas: global and regional ocean circulation, intra-seasonal to inter-annual ocean changes, mean sea level monitoring, tides, etc. Direct applications are now foreseen in the understanding of ocean coupling with the atmosphere and so in the prediction of climatic changes.

Recent El Niño monitoring and forecasting using spaceborne altimeter data highlights the essential contribution of such a mission. There are also numerous operational applications that are being developed for marine related activities, which will enable sea state forecasting in the same way that meteorologists forecast the atmosphere today.

Spaceborne SARs remote sensing technology make it possible to acquire global-scale data sets that provide unique information about the Earth's continually changing surface characteristics. A SAR mission is essential to routinely provide valuable information about the dynamic characteristics of our planet, along with broad scientific, environmental preservation, operational, and commercial utility.

The SAR imaging system is capable of addressing a wide range of Earth science SAR measurement objectives such as surface deformation, environmental management objectives such as rapid response to oil spills, operational objectives such as ice navigation, plus a broad range of commercial applications such as mapping, surveillance, forestry, agriculture, resource exploration, and land use and urban planning. The wideband SAR with a 300 MHz bandwidth, provides a higher resolution, in order to provide opportunities for additional commercial applications, such as high-resolution surface mapping and co-registration with electro-optical sensor data. For instance, it will be possible to precisely map the boundary of oil spills with the wideband SAR and compare this data with electro-optical sensor data, both of 1 m resolution.

2.2.1.4 Radiolocation service

There are numerous radar types, accomplishing various missions, operating within the radiolocation service throughout the range 5 250-5 850 MHz. There is a need for wider bandwidth to pick smaller and less reflective targets out of background clutter. DNR M.[8B-CHAR] gives the technical characteristics for several representative types of radars that can be used to assess the compatibility between radiolocation radars and systems of other services.

To provide the same regulatory protection through the whole tuning range, an upgrade of the radiolocation allocation in the band 5 350-5 650 MHz would be necessary. Noting the increased sharing requirements through the whole spectrum to accommodate all services proposed, the upgrade may also be necessary to safeguard the operation of the radars for the future.

2.2.1.5 Relevant ITU-R Recommendations

The following Recommendations are based on the results of the ITU-R studies:

Recommendations ITU-R M.1454, S.1426, S.1427, F.1399, F.1400, F.1401, F.1490, F.1499, F.1508 , SA.1166, SA.1280, M.1450, M.1461, M.1313, M.1372, DNR F.[FWA5GHz-EESS], DNR SA.[Document 7/46], DNR M.[8B-CHAR], PDNR M.[METHOD.NWA.SPECTRUM], PDNR M.[WAS5GHz EXPANSION-EESS], PDNR M.[8A-9B.RLAN.DFS].

2.2.2 Analysis of the results of studies

2.2.2.1 Resolution 736 (WRC-2000), *resolves* 1

"allocation of frequencies to the mobile service in the bands 5 150-5 350 MHz and 5 470-5 725 MHz for the implementation of WAS including RLANs."

2.2.2.1.1 Sharing between MS for WAS including RLANs and MSS feeder links in the band 5 150-5 250 MHz

Regulatory means to ensure the protection of non-GSO MSS Feeder Links from RLAN transmissions are found in Section 2.3 of this Report.

2.2.2.1.2 Sharing between MS (RLAN) and EESS (active)

Band 5 250-5 350 MHz

DNR SA.[7/46] concludes that sharing between these services is feasible with the characteristics such as those listed below applied to WAS including RLANs in the mobile service:

- Indoor deployment (giving an additional attenuation with respect to outdoor systems).
- Mean e.i.r.p. limit of 200 mW with transmit power control (TPC) to ensure a mitigation factor of at least 3 dB (or 100 mW if power control is not used).
- Randomized channel selection function, such as dynamic frequency selection (DFS)[3], associated with the channel selection mechanism to provide a uniform loading of the Wireless LAN channels across the available bandwidth in the 5 GHz range (the assumptions made in the study for a total of 330 MHz give a density of 440 transmitters per 20 MHz channel in the SAR footprint).

Further studies have shown that the mitigation factor of DFS is reduced according to the available bandwidth. For example, in the case of 20 MHz channel WAS including RLANs operating in a 200 MHz bandwidth, a reduction in the mean e.i.r.p. limit of 1.9 dB would be required to protect the EESS (active).

Furthermore, it may be noted that the above characteristics need to include a power density limit in order to protect EESS (active) from WAS transmitters that choose to use a narrower bandwidth than assumed in the studies. For example, the mean e.i.r.p. limit of 200 mW would correspond to a 10 dBm/MHz e.i.r.p. spectral density limit.

Concerns have been expressed by an administration that the characteristics listed above may not be adequate to ensure protection of the EESS (active).

Some administrations are of the view that these characteristics are the set of operational limits, which are currently agreed in ITU-R to meet the EESS protection criteria.

Some administrations are of the view that the above characteristics are the only set of limits, which meet the EESS protection criteria.

The combined technical constraints given below are an example of constraints that are under study:

1) wireless access systems including RLANs operating in the band 5 250-5 350 MHz should be limited to:
   a) a maximum transmitter power of 250 mW (24 dBm) or 11 + 10 log B dBm per transmitter, whichever power is less. (B is the 99% power bandwidth in MHz.);
   b) a maximum e.i.r.p. of 1.0 Watt (0 dBW) or -13 +10 log B dBW per transmitter, whichever power is less.

[3] Dynamic Frequency Selection (DFS) is a general term used in this Report to describe a mitigation technique that allows, amongst other functions, detection and avoidance of co-channel interference with respect to radar systems.

2) the e.i.r.p. spectral density of the emission of WAS including RLAN transmitters operating outdoors should not exceed the following values for the elevation angle θ above the local horizontal plane (of the Earth):

−13 dB(W/MHz)	for	$0° \leq \theta < 8°$
−13 – 0.716 (θ – 8) dB(W/MHz)	for	$8° \leq \theta < 40°$
−35.9 – 1.222 (θ – 40) dB(W/MHz)	for	$40° \leq \theta \leq 45°$
−42 dB(W/MHz)	for	$\theta > 45°$

Some ITU-R studies have shown that this alternative set of constraints is sufficient to protect the EESS (active) and may be practical to implement.

Some other ITU-R studies have shown that this alternative set of constraints is not adequate to protect the EESS (active), also in view of the absence of DFS and TPC interference mitigation techniques. Furthermore, another study has shown that this e.i.r.p. mask limitation may not be practically applicable to mobile devices operating on a license exempt basis.

Band 5 470-5 570 MHz

In parallel to the allocation to WAS including RLAN, the band 5 470-5 570 MHz is also being considered under *resolves* 3 of Resolution 736 for allocation to EES/SR (active) services.

Some studies have shown that sharing is possible between the mobile and EES/SR (active) services, subject to appropriate measures. In particular, studies have shown that sharing between WAS including RLAN in the mobile service and EES scatterometers/altimeters is feasible in the band 5 470-5 570 MHz. It is expected that the additional allocation for EES/SR (active) services considered under *resolves* 3 would also be used to provide additional bandwidth for wideband SARs. If this band were only used by such wideband sensors a more favourable sharing scenario would result (5 dB relaxation of the interference threshold). It is important to note that both services are seeking new allocations within this band and it may be necessary for each new service to accept necessary constraints. The two sets of constraints that could be applied are given below (see Section 2.2.4.1, **5.WAS3**):

First set of limits:

– in the band 5 470-5 725 MHz, the indoor and outdoor use of WAS including RLANs shall be restricted to a maximum mean e.i.r.p.[5] of 1 W and a mean e.i.r.p. density limit no greater than 50 mW in any 1 MHz;

– in the bands 5 470-5 725 MHz, WAS including RLANs shall implement TPC to ensure a mitigation factor of at least 3 dB on the average output power of the devices. If TPC is not implemented, the power limitations given above shall be reduced by 3 dB;

– in the bands 5 250-5 350 and 5 470-5 725 MHz, WAS including RLANs shall implement mitigation techniques such as DFS to avoid co-channel operation with other terrestrial systems, notably radar systems (see PDNR M.[8A-9B.RLAN.DFS]). The devices shall also be designed to ensure a near uniform spread of the loading across the available spectrum of the devices to improve the sharing with satellite services.

Second set of limits:

5 "Mean power" refers here to the e.i.r.p. during the transmission burst which corresponds to the highest power, if power control is implemented.

1) that wireless access systems including RLANs operating in the band 5 470-5 570 MHz be limited to:

   a) a maximum transmitter power of 250 mW (24 dBm) or 11 +10 log B dBm per transmitter, whichever power is less. (B is the 99% power bandwidth in MHz.);

   b) a maximum e.i.r.p. of 1.0 Watt (0dBW) or -13 +10 log B dBW per transmitter, whichever power is less.

2) the e.i.r.p. spectral density of the emission of a wireless access system including RLAN transmitter operating outdoors in the band 5470-5570 MHz should not exceed the following values for the elevation angle θ above the local horizontal plane (of the Earth):

−13 dB(W/MHz)	for	$0° \leq \theta < 8°$
−13 – 0.716 (θ – 8) dB(W/MHz)	for	$8° \leq \theta < 40°$
−35.9 – 1.222 (θ – 40) dB(W/MHz)	for	$40° \leq \theta \leq 45°$
−42 dB(W/MHz)	for	$\theta > 45°$

3) In the band 5 470-5 570 MHz, wireless access systems including RLANs shall implement mitigation techniques including dynamic frequency selection (DFS) and automatic transmit power control (ATPC).

Further studies are ongoing to identify these constraints (see values contained in Recommendations ITU-R SA.1166, PDNR M.[WAS5GHz-EXPANSION-EESS]).

2.2.2.1.3 Sharing between MS for WAS including RLANs and RDS

No administrations have expressed any current or planned aeronautical radionavigation usage of the band 5 150-5 250 MHz.

The high RF level, radar density, and the sensitivity of radar in conjunction with the expected high density of WAS including RLANs would, in general, not enable WAS including RLANs and radar to operate satisfactorily on a co-channel basis in the absence of mitigation techniques.

It is noted that in the band 5 600 - 5 650 MHz, ground-based radars used for meteorological purposes are authorized to operate on a equal basis with stations of the maritime radionavigation service, per RR 5.452.

DFS is a method, which should enable co-existence in this band between WAS including RLANs and radars. TPC is another method, which could also provide additional mitigation.

The specification of the detection criteria for the DFS must take into account the characteristics of the various radar systems operation in the 5 GHz bands as given in DNR M.[8B-CHAR].

Feasibility studies indicate that WAS including RLANs require a suitable DFS mechanism. The performance of DFS depends upon detecting the use of a certain channel by radiodetermination systems and stopping WAS including RLANs operation in this RF channel in short time so that harmful interference is not received by the radiodetermination system(s). In this case it is recommended that WAS including RLANs should be introduced in the bands shared by radars, only if the WAS including RLANs are capable of detecting and avoiding the radiodetermination systems, which could be interfered by WAS including RLANs. In the case that all WAS channels are occupied by RDS system emissions above the required DFS detection threshold, DFS must ensure that the WAS systems do not transmit until channels are clear of RDS system emissions due to RDS systems vacating the area or ceasing transmissions.

WAS including RLANs need to take into account spurious emission from radars. Measured radar emission spectra show spurious emissions that are suppressed to about –42/–62 dB relative to the radar fundamental emission level in a 20 MHz bandwidth. In measurement made from hilltop over a two week period near some major metropolitan areas of the United States, relatively high spurious emission peak levels have been observed in a large portion of the 5 GHz radiodetermination spectrum.

Analysis and simulation on the efficacy of one simplified method of co-channel interference detection and avoidance known as DFS shows that in most cases the DFS detection threshold will be exceeded and therefore radars will be detected by WAS including RLANs under these conditions. Certain types of low power radar systems may receive some interference from WAS.

Further studies are ongoing in ITU-R on DFS and final results are expected before WRC-03.

Administrations may require testing to confirm the ability of interference avoidance mechanisms (e.g. DFS) to detect the radar types in this band.

In addition, WAS including RLANs will have to accept interference from radiodetermination systems.

Provided an appropriate interference mitigation mechanism is implemented, WAS including RLANs may be able to share this band with the RDS. ITU-R concluded that the same sharing conditions apply to the bands 5 250-5 350 MHz and 5 470-5 725 MHz. One administration is of the view that studies are still ongoing in the ITU-R, therefore, it is premature, at this point, to conclude that the same sharing conditions apply to the bands 5 250-5 350 MHz and 5 470-5 725 MHz.

2.2.2.1.4 Sharing between mobile and amateur, and amateur satellite service

No contribution analysing this sharing situation has been received.

2.2.2.2 Resolution 736 (WRC-2000), *resolves* 2

"a possible allocation in Region 3 to the fixed service in the band 5 250-5 350 MHz, while fully protecting the worldwide Earth exploration-satellite (active) and space research (active) services."

2.2.2.2.1 Sharing between FS (FWA) and EESS (active)/SRS (active)

In the 5 250-5 350 MHz band, various types of spaceborne synthetic aperture radars (SAR), spaceborne radar altimeters and spaceborne scatterometers are operating in the EESS (active)/SRS (active). An analysis for frequency sharing with FWA is provided in Annex 1 to DNR F.[FWA5GHz-EESS]. For the SAR, three types of spaceborne active sensors were identified and the most vulnerable one was used in the sharing analysis. The interference from FWA to the sensor should be controlled below the threshold level, i.e. $I/N < -6$ dB. This threshold level corresponds to −132 dB(W/20 MHz) at the receiver input of the sensor which is located 400 km above the Earth's surface and equipped with an antenna of 42.7 dBi gain towards the Earth.

This requirement imposes an e.i.r.p. restriction on FWA operations. The analysis indicates that the total e.i.r.p. of signals transmitted towards the satellite from all the FWA stations located within its footprint of 220 km^2 area needs to be less than −7.6 dB(W/20 MHz) including surface scattering effects in order to satisfy this requirement.

The analysis also showed that the interfering signals into altimeter and scatterometer receivers from FWA systems do not cause serious interruptions to these operations. Since SAR is the most sensitive against the interference from FWA, altimeter and scatterometer receivers are considered protected if SAR receivers are protected.

The total e.i.r.p. from the FWA system towards the SAR depends on transmitter power, antenna gain patterns, cell size, employment of sector antennas, frequency reuse scheme, antenna elevation angle, etc. of the FWA systems. Annex 1 to DNR F.[FWA5GHz-EESS] includes an analysis to clarify the relationship among these factors and could be used to ensure the above conditions. For FWA systems in which both the base station and remote stations transmit signals with 2 W e.i.r.p. with other parameters used in DNR F.[FWA5GHz-EESS], the maximum density of 23 FWA base stations should be allowed within an EESS SAR foot print in the case of no use of sector antennas. Administrative measures for both base and remote stations, such as license-based operation, would be required in order to control deployment density of FWA systems and thus satisfy the above condition. The main factor to be taken into consideration is the elevation angle of the FWA transmitters.

With these requirements on the FWA systems, the EESS/SRS spaceborne active sensors are protected and the sharing is feasible.

Regarding the interference from EESS/SRS to FWA, FWA systems will need to tolerate short interruptions (0.5-10 seconds) from SAR and scatterometer systems during the satellites fly over the FWA cells (once in several days).

With these constraints to FWA system deployment and operations, EESS (active)/SRS (active) and FWA in FS are considered compatible.

A study indicates that it is difficult for FWA and other WAS including RLANs to share the same frequency at the same location. Even if RLANs are operated within FWA cells, most of them would use frequency channels different from the FWA system due to RLANs CSMA/CD and DFS capabilities. Therefore, there will not be combined interference into EESS/SRS satellites from FWA and RLAN at the same frequency from the same location.

2.2.2.2.2 Sharing between FS (FWA) and RLS

Various radiolocation radar systems are operated and planned in the band 5 250-5 350 MHz. Characteristics of these systems are described in DNR M.[8B-CHAR]. When an FWA system and a radar station share the same frequency band, a certain geographical separation is necessary between FWA cells and the radar location to secure the operation of both services.

The separation distance is determined by the interference from the FWA system into the radar receiver. Criterion of I/N = –6 dB could be used for judging whether the degradation is significant or not. The interference from the radar into the FWA receiver will be higher than the other direction in terms of level. However, with signal processing schemes such as FEC employed in the FWA system, the effect of the interference could be lowered to the level that the FWA system can continue its operation. The separation distance could be shortened if the locations of FWA stations are selected so that the interference signals towards the radar are reduced due to geographical shielding effects. Other interference mitigation techniques, e.g. antenna beam tilting or offset, polarization discrimination, frequency offset, transmit timing control, etc. could also reduce the separation distance.

An example study, in which FWA stations are located at 20 m height and the radar station at 100 m height, shows that the necessary separation distance is 70-76 km depending on the geographical shielding effect.

If the radar is of a moving nature, e.g. a ship-based radar or an airborne radar, the area in which the operation of a FWA system is allowed needs to be determined examining the effect of the exclusion zone that also moves with the radar. Protection of the radar operation would need to be confirmed by national administrative procedures to allow the operation of the FWA system. Frequency sharing between the radiolocation service and the fixed service is feasible as long as the operation of the radiolocation service is secured by administrative confirmation.

2.2.2.2.3 Sharing between FS (FWA) and MS (WAS including RLANs)

As explained in subsection 2.2.2.2.1, an ITU-R study has shown that it is difficult for FWA and RLANs to share the same frequency at the same location. When an FWA system and RLANs are operated in the adjacent areas at the same frequency, the interference from RLANs into the FWA system would be more significant than the other direction. According to this study based on the assumption of indoor RLAN deployment, operation of indoor RLANs will not be significantly affected if the RLANs are operated outside the FWA cells, or at locations more than about 1 km away from the nearest FWA base station, while an RLAN operated at the same frequency within 3 km of an FWA base station may affect the operation of the FWA base station. When there are multiple interfering RLANs observed by the FWA base station, the separation distance required will be greater.

2.2.2.3 Resolution 736 (WRC-2000), *resolves* 3

"additional primary allocations for the Earth exploration-satellite service (active) and space research service (active) in the frequency range 5 460-5 570 MHz."

ITU-R developed technical characteristics and performance and interference criteria for active spaceborne sensors. Similarly, technical characteristics and performance and interference criteria were developed for radiolocation/radionavigation radars. In order to ensure compatibility, sensor designs need to respect the interference criteria established for radiolocation systems in the frequency range between 1 and 10 GHz and to select design parameters to mitigate potential interference from terrestrial radars to the sensors (as detailed in Recommendation ITU-R SA.1280).

Spaceborne altimeters have operated in the 5 140-5 460 MHz band. Spaceborne scatterometers and spaceborne synthetic aperture radars have operated in the band 5 250-5 350 MHz. Operational experience gained over a period of more than 20 years shows that active spaceborne sensors and radionavigation and radiolocation systems have operated in common frequency bands with no record of identified instances of harmful interference to either the active spaceborne sensors or to the radionavigation and radiolocation systems.

Wideband signal altimeters and SARs are the type of spaceborne active sensors that are expected to operate in the band 5 460-5 570 MHz.

2.2.2.3.1 Sharing between EESS (active) and ARNS in the band 5 460-5 470 MHz

An analysis assessing potential interference from spaceborne altimeters into airborne weather radars operating in the aeronautical radionavigation service in the band 5 460-5 470 MHz has been performed. The results of this analysis indicate that spaceborne altimeters will not cause undue degradation to the performance of aeronautical radionavigation service systems.

An analysis assessing potential interference from airborne weather radars into spaceborne altimeters has been performed and the results indicate that spaceborne altimeters can operate in the presence of emissions from airborne weather radars operating in the aeronautical radionavigation service. Thus, it may be concluded that spaceborne altimeters and aeronautical radionavigation service systems are compatible.

An analysis assessing potential interference from spaceborne SARs into airborne weather radars operating in the aeronautical radionavigation service has been performed. The results of this analysis indicate that spaceborne SARs will not cause undue degradation to the performance of the aeronautical radionavigation service systems for the most likely case of side-lobe to side-lobe antenna coupling. The mainbeam to side-lobe coupling event duration is only 0.25-0.5 seconds as the spacecraft passes by.

An analysis assessing interference from airborne weather radars into spaceborne SARs has been performed and the results indicate that spaceborne SARs can operate in the presence of emissions from airborne weather radars operating in the aeronautical radionavigation service for the likely case of side-lobe to side-lobe coupling. The side-lobe to main-lobe coupling event lasts only 0.25-0.5 seconds as the spacecraft passes by. The SAR would point at a specific location no more than once in several days. Based on the analysis performed, it can be concluded that spaceborne SARs and airborne weather radars are compatible in the 5 460-5 470 MHz band.

2.2.2.3.2 Sharing between EESS (active) and MRNS service in the band 5 470-5 570 MHz

A study has been performed on sharing between altimeters and SARs and the maritime radionavigation service. It is concluded from this study that the radars can suffer interference from spaceborne altimeters and SARs but that the length of the interference is of the order of a few seconds when the maritime radionavigation radar enters the main lobe of the spaceborne altimeter or SAR. This kind of configuration has been statistically estimated for such kind of radar over a complete altimeter cycle (less than ten days). The total of interference events can then be considered as negligible.

The same study also concluded that the altimeter or SAR would not suffer from interference due to maritime radionavigation radars.

Altimeters and SARs operating in the band 5 460-5 570 MHz can operate satisfactorily without causing harmful interference to maritime radionavigation radars and without suffering harmful interference from them.

2.2.2.3.3 Sharing between EESS (active) and MS (RLANs) service in the 5 470-5 570 MHz band

See section 2.2.2.1.2.

2.2.2.3.4 Sharing between EESS (active) and RLS in the band 5 460-5 570 MHz

See section 2.2.2.4.1.

2.2.2.4 Resolution 736 (WRC-2000), *resolves* 4

"a review, with a view to upgrading, of the status of frequency allocations to the radiolocation service in the frequency range 5 350-5 650 MHz."

2.2.2.4.1 Sharing between EESS (active) and RLS in the bands 5 350-5 460 MHz and 5 460-5 570 MHz

Spaceborne altimeters have operated in the 5 140-5 460 MHz band. Spaceborne scatterometers and spaceborne synthetic aperture radars have operated in the band 5 250-5 350 MHz. Operational experience gained over a period of more than 20 years shows that active spaceborne sensors and radionavigation and radiolocation systems have operated in common frequency bands with no record of identified instances of harmful interference to either the active spaceborne sensors or to the radionavigation and radiolocation systems. This successful sharing has been based upon sensor employment of mitigation techniques found in Recommendation ITU-R SA.1280. In order to ensure continued compatibility, sensor designs need to respect the interference criteria established for radiolocation systems in the frequency range between 1 and 10 GHz and to select design parameters to mitigate potential interference from terrestrial radars to the sensors (as detailed in Recommendation ITU-R SA.1280).

5 350-5 460 MHz band

The ITU-R has examined the feasibility of operation of altimeters and SARs in 5 350-5 470 MHz bands. Studies indicate that compatibility exists in the 5 350-5 460 MHz band with both radiolocation systems and aeronautical radionavigation systems.

The ITU-R has determined that, for the sensors and radiolocation/radionavigation systems that have been analysed, compatibility exists in the band 5 350-5 460 MHz.

5 460-5 570 MHz band

For radiolocation systems in the band 5 460-5 570 MHz with characteristics similar to those in the band 5 250-5 460 MHz, the conclusion that active spaceborne sensors and radiolocation systems are compatible also applies to this band.

2.2.2.4.2 Sharing between RLS and ARNS in the 5 350-5 470 MHz band, RNS in the 5 460-5 470 MHz band and MRNS in the 5 470-5 650 MHz band

Operational experience gained over a period of more than 20 years shows that radionavigation and radiolocation systems have operated in common frequency bands with no record of identified instances of harmful interference to the radionavigation or radiolocation systems. To provide the same regulatory protection through the whole tuning range an upgrade of the radiolocation allocation in the bands 5 350-5 650 MHz is necessary. Noting the increased sharing requirements through the whole spectrum to accommodate all services proposed, the upgrade is also necessary to safeguard the operation of the radars for the future.

These radars are compatible for several reasons such as pulse discrimination capability within radar systems as well as the scanning of the antenna beams, which limits main-beam couplings.

2.2.2.4.3 Sharing between MS (RLAN) and RLS in the 5 470-5 650 MHz band

See section 2.2.2.1.3.

2.2.3 Methods to satisfy the agenda item and their advantages and disadvantages

Many of the issues being dealt with under this agenda item are inter-related. Therefore it is important to consider the allocations being sought in the 5 150-5 725 MHz together, balancing the needs of all services under consideration.

2.2.3.1 Resolution 736 (WRC-2000), *resolves* 1

Studies conducted within ITU-R have identified that mitigation techniques such as DFS and TPC need to be implemented as a minimum requirement to achieve interference mitigation in the bands 5 250-5 350 and 5 470-5 725 MHz.

For the 5 150-5 350 and 5 470-5 725 MHz bands, the following methods should be considered:

2.2.3.1.1 Method A

Propose a primary global allocation to the mobile service in the bands 5 150-5 350 MHz and 5 470-5 725 MHz limited to WAS including RLANs with appropriate footnotes and/or Resolutions to ensure protection of the existing services. These footnotes and/or Resolutions should incorporate technical requirements ensuring the above protection including mitigation techniques which are still under study within ITU-R. In addition WAS including RLANs, are proposed to not claim protection from the RDS, EESS (active), SRS (active) and from MSS feeder links in the relevant bands.

Advantages:

- Sufficient spectrum to implement WAS including RLANs is provided to meet the requirement based on the studies (see Section 2.2.1.1) while safeguarding the interests of the RDS, FSS, EESS and SRS through the implementation of mitigation techniques such as DFS and TPC, and appropriate operational restrictions and technical limits.
- A sufficient amount of spectrum allocated to the mobile service for the use of WAS including RLANs will enable channel spreading across the bands concerned and facilitate sharing with all space services.

- The mobile service for the use of WAS including RLANs would be protected from other possible future allocations in the concerned bands.

Disadvantages:

- May constrain future development of radiodetermination systems in these bands.
- There is no definition of WAS or RLANs, in the Radio Regulations.
- In the band 5 470-5 570 MHz, additional constraints may need to be placed on EESS (active) for which an allocation is being considered.

2.2.3.1.2 Method B

Propose a secondary global allocation to the mobile service in the bands 5 150-5 350 MHz and 5 470-5 725 MHz limited to WAS including RLANs with appropriate footnotes and/or Resolutions to ensure protection of the existing services. These footnotes and/or Resolutions should incorporate technical requirements ensuring the above protection including mitigation techniques.

Advantages:

- This method provides an allocation for the mobile service.
- This method provides regulatory recognition for WAS including RLANs.
- Protection of the existing primary services is maintained through the implementation of appropriate operational restrictions, technical limits and mitigation techniques and furthermore, WAS including RLANs, could not claim protection from these services.
- A sufficient amount of spectrum allocated to the mobile service for the use of WAS including RLANs will enable channel spreading across the bands concerned and facilitate sharing with space services.

Disadvantages:

- This method may discourage the development of WAS including RLANs relative to a primary allocation.
- While providing secondary regulatory status, the mobile service would have no protection from new primary services in the band.
- New types of systems operating on primary basis may later set additional limits for WAS including RLANs.
- If placing limits on secondary services is not permissible, then this method would not ensure protection of the primary services.
- There is no definition of WAS including RLANs in the Radio Regulations.

2.2.3.1.3 Method C

No global allocation for the mobile service.

Advantages:

- Existing situation for current systems is maintained.
- Afford further time to address sharing issues if studies are not complete regarding the necessary technical limits, operational constraints and mitigation techniques to protect the existing primary services.

Disadvantages:

- No regulatory or allocation status is given to the mobile service.

- This method does not respond to the need to provide globally harmonized spectrum for WAS including RLANs as stated in *considering* a) of Resolution **736 (WRC-2000)**. Furthermore, some administrations are of the view that by not providing the allocation needed for WAS, including RLANs, this method may encourage operation under No. **4.4**, administrations may permit licence-exempt use without the benefit of mitigation techniques specified by ITU, and interference may result from aggregate effects from a large number of devices for which no single administration is responsible, remedial action could therefore be difficult to achieve, particularly in the case of satellite systems.

2.2.3.1.4 Method D

Propose a primary global allocation to the mobile service in the bands 5 150-5 350 MHz limited to WAS including RLANs with appropriate footnotes and/or Resolutions to ensure protection of the existing services. These footnotes and/or Resolutions should incorporate technical requirements ensuring the above protection including mitigation techniques, which are still under study within ITU-R. In addition WAS including RLANs are proposed to not claim protection from the RDS, EESS (active), SRS (active) and from MSS feeder links in the relevant bands.

Propose a resolution to continue consideration of the 5 470-5 725 MHz band for WRC-07. Unresolved issues of Resolution 736 could also be included in this resolution.

Advantages:

- Some spectrum to begin initial implementation of WAS including RLANs is provided while safeguarding the interests of the RDS, FSS, EESS and SRS through the implementation of mitigation techniques such as DFS and TPC, and appropriate operational restrictions and technical limits are defined in footnotes and/or Resolutions incorporating technical requirements ensuring the above.
- Would allow additional time to confirm the effectiveness of the proposed interference mitigation technique (DFS) to ensure protection of existing services.

Disadvantages:

- This method does not fully respond to the need for globally harmonized spectrum for WAS including RLANs (i.e. it excludes the 5 470-5 725 MHz band) as stated in *considering a)* of Resolution 736 (WRC-2000).
- Given that only 200 MHz is proposed, this method may limit the full deployment of WAS including RLANs, e.g. through insufficient spectrum for dense deployments, lack of channels for functionality of DFS and possible restriction to indoor use only in the band 5 150-5 350 MHz, in some or all countries depending on the decisions of WRC-03.
- Although there are some administrations who consider that the same sharing conditions between WAS including RLAN and radiodetermination systems apply in the 5 250-5 350 and 5 470-5 725 MHz bands, this method treats the two bands differently.
- Some administrations are of the view that by not providing the allocation needed for WAS, including RLANs, in the band 5 470-5 725 MHz, this method may encourage operation under No. 4.4. In 5 470-5 725 MHz, administrations may permit licence-exempt use without the benefit of mitigation techniques specified by ITU.
- This method will increase the loading of devices across the band 5 150-5 350 MHz and therefore may increase the aggregate interference to the existing services (FSS and, depending on the DFS mitigation factor, EESS) in this band.
- There is no definition of WAS or RLANs, in the Radio Regulations.

- If an allocation to the space science services is provided for in the 5 470-5 570 MHz band at WRC-03, this may prejudice a possible allocation to the mobile service in the band 5 470-5 725 MHz at WRC-07 noting that ITU-R studies have shown that sharing between WAS including RLANs and the EESS is only feasible with constraints on both services.

2.2.3.2 Resolution 736 (WRC-2000), *resolves* 2

2.2.3.2.1 Method A

Propose a primary allocation to the fixed service in Region 3 in the band 5 250-5 350 MHz. The use should be limited to FWA systems subject to the compliance with draft new Recommendation F.[FWA5GHz-EESS]. In addition FWA are proposed to not claim protection from the RDS, EES (active), and SR (active) services, although EES (active) and SR (active) are not subject to 5.43A. Future system implementation in the RDS, EES (active) and SR (active) services should not require more restrictive sharing conditions on FWA.

Advantage:

Spectrum will be available to FWA systems. If an allocation is also provided to the MS in *resolves* 1, flexibility will be provided for each administration in Region 3 to select mobile WAS and/or FWA.

Disadvantage:

Some technical or operational arrangements at the national level may be necessary, if this band is used also for wireless access systems including RLANs in the mobile service, because it is difficult for FWA and wireless access systems including RLANs to operate on a co-frequency, co-location basis.

2.2.3.2.2 Method B

Propose a primary allocation to the fixed service for specific countries in Region 3 in the band 5 250-5 350 MHz. The use should be limited to FWA systems subject to the compliance with draft new Recommendation F.[FWA5GHz-EESS]. In addition FWA are proposed to not claim protection from the RDS, EES (active), and SR (active) services, although EES (active) and SR (active) are not subject to 5.43A. Future system implementation in the RDS, EES (active) and SR (active) services should not require more restrictive sharing conditions on FWA.

Advantage:

This method would allow the implementation of FWA systems in specific countries in Region 3 with minimum interference potential to the existing services due to the limited usage in terms of geographical areas.

Disadvantage:

Some technical or operational arrangements at the national level may be necessary, especially if this band is used also for wireless access systems including RLANs in the mobile service, because it is difficult for FWA and wireless access systems including RLANs to operate on a co-frequency, co-location basis. This disadvantage is, however, limited to the countries in the footnote.

2.2.3.2.3 Method C

Propose a secondary allocation to the fixed service in Region 3 in the band 5 250-5 350 MHz. The use should be limited to FWA systems subject to the compliance with draft new Recommendation F.[FWA5GHz-EESS].

Advantage:

- This method provides an allocation for the fixed service.

Disadvantage:

This method may discourage the development of FWA systems.

2.2.3.2.4 Method D

No allocation for the fixed service.

Advantage:

Existing situation for current systems is maintained.

Disadvantages:

- This method does not respond to the need to provide spectrum in Region 3 for fixed wireless access systems as stated in *considering b)* of Resolution **736 (WRC-2000)**.
- Some administrations are of the view that by not providing the allocation needed for FWA, this method may encourage operation under No. **4.4** by individual administrations and interference may result from aggregate effects from a large number of devices for which no single administration is responsible. Remedial action could therefore be difficult to achieve, particularly with respect to protection of satellite systems.

2.2.3.3 Resolution 736 (WRC-2000), *resolves* 3

2.2.3.3.1 Method A

Propose a primary allocation for the Earth exploration-satellite (active) and space research (active) services in the frequency band 5 460-5 570 MHz since compatibility exists with the radiolocation and the radionavigation services. To ensure successful sharing with existing radiodetermination services, design constraints and mitigation techniques in Recommendation ITU-R SA.1280 should be taken into account.

In addition, it should be noted that WRC-03 will consider the allocation of frequencies to the mobile service in the bands 5 150-5 350 MHz and 5 470-5 725 MHz for the implementation of wireless access systems including RLANs, hence the compatibility between the EESS and wireless access systems will also need to be considered.

Advantages:

- It would provide sufficient contiguous spectrum for deployment of high resolution sensors, given the current primary allocation to the EESS (active) in the adjacent band 5 250-5 460 MHz.
- Future wideband sensors would not be required to operate under No. **4.4**.

Disadvantages:

- Constraints may need to be placed on wireless access systems including RLAN for which the mobile allocation is being considered.
- If Method D is selected under *resolves* **1**, an allocation to the space science services in the band 5 470-5 570 MHz at WRC-03 may prejudice a possible allocation to the mobile service in the band 5 470-5 725 MHz at WRC-07, noting that ITU-R studies have shown that sharing between WAS including RLANs and the EESS is only feasible with constraints on both services.

2.2.3.3.2 Method B

No allocation for EESS in the band 5 460-5 570 MHz.

Advantages:

- The existing situation for current primary services is maintained.
- If Method D is selected under *resolves* **1** and no EESS allocation is provided, this will not prejudice a possible allocation to the mobile service in the band 5 470-5 725 MHz at WRC-07, noting that ITU-R studies have shown that sharing between WAS including RLANs and the EESS is only feasible with constraints on both services.

Disadvantages:

- Does not fulfil the requirement to extend the EESS allocation.
- Some administrations are of the view that by not providing allocation needed for EESS (active)/SRS (active), this method may encourage operation under No. **4.4**.

2.2.3.4 Resolution 736 (WRC-2000), *resolves* 4

2.2.3.4.1 Method A

Upgrade the radiolocation service to primary in the band 5 350-5 650 MHz. In addition, a provision could be considered that the radiolocation service should not claim protection from the existing primary radionavigation service, except as per 5.452.

Advantages:

- Provides primary allocation to the radiolocation service at frequencies in the vicinity of 5 GHz as needed to meet radar operation requirements while protecting the radionavigation service.
- The radiolocation service has a primary allocation in the band 5 350-5 650 MHz without constraints to the existing primary EESS allocation.
- The continued interference-free operation of the radiolocation service is ensured.
- Regarding the proposed primary allocation to the mobile service in the band 5 470-5 650 MHz the upgrade of the radiolocation service to primary status is a consequential change to allow restrictions to be imposed on the primary mobile service like DFS.
- Provides a primary allocation to the radiolocation service, contiguous with existing 5 250-5 350 MHz and 5 650-5 850 MHz bands, with sufficient bandwidth to meet current and future requirements for radiolocation.

Disadvantages:

- The mobile service will be required to protect, and not claim protection from the radiolocation service.
- This method may restrict certain applications in the mobile service.

2.2.3.4.2 Method B

Upgrade the radiolocation service in the band 5 350-5 470 MHz to primary status. No upgrade for the radiolocation service in the band 5 470-5 650 MHz.

Advantages:

- The existing situation for current systems in 5 470-5 650 MHz is maintained.

- Provides primary allocation to the radiolocation service at frequencies in the vicinity of 5 GHz as needed to meet radar operation requirements while protecting the radionavigation service.

Disadvantages:

- Does not fulfil the requirements of *resolves* **4** for the upgrade of the radiolocation service in the band 5 470-5 650 MHz.
- Does not provide appropriate protection of radiolocation systems to meet the changes in requirements, missions, and technology that are driving a need for wider bandwidth to pick smaller and less reflective targets out of background clutter.
- While maintaining secondary regulatory status, the radiolocation service would have no protection from new primary or secondary services in the band.

2.2.4 Regulatory and procedural considerations

2.2.4.1 Resolution 736 (WRC-2000), *resolves* 1

Methods A and B

Studies for allocations to the mobile service in the bands 5 150-5 350 MHz and 5 470-5 725 MHz have been limited to WAS including RLANs type devices only. Any allocation to the mobile service should be limited to WAS including RLANs only.

Due to the sharing with existing services in the bands 5 150-5 350 MHz and 5 470-5 725 MHz, technical limits and mitigation techniques will need to be applied to the mobile service. These constraints are seen as necessary requirements to any mobile allocations for WAS including RLANs.

If Method A or B is utilized under § 2.2.4.1 then a footnote should be added (No. **5.WAS1, 5.WAS2** and **5.WAS3**) to permit the mobile service to operate in the bands 5 150-5 350 MHz and 5 470-5 725 MHz. Examples of such footnotes for individual bands are as follows:

5 150-5 250 MHz

ADD

5.WAS1 Use of the 5 150-5 250 MHz band by the mobile service is limited to those applications described in Recommendation ITU-R M.1450-1 for WAS, including RLANs, which will be operated in accordance with the conditions below:

– in the 5 150-5 250 MHz band, the use of WAS, including RLANs, shall be restricted to indoor use with a mean e.i.r.p. limit of 200 mW and a mean[4] e.i.r.p. density limit no greater than 10 mW in any 1 MHz band.

Some administrations are of the view that the following text should also be included in the above footnote:

> WAS, including RLANs, must neither cause harmful interference to, nor claim protection from, nor otherwise impose constraints on operation or development of the existing services.

*****

Conditions related to the protection of the FSS service in this band are found in Recommendations ITU-R M.1454, S.1426 and S.1427.

Any footnote developed under WRC-03 Agenda item 1.5 must be reconciled with those suggested under WRC-03 Agenda item 1.6 that are shown in section 2.3 of this CPM Report.

5 250-5 350 MHz

ADD

5.WAS2 Use of the 5 250-5 350 MHz band by the mobile service is limited to those applications described in Recommendation ITU-R M.1450-1 for WAS, including RLANs, which will be operated in accordance with the conditions below:

Some administrations are of the view that the following text should also be included in the above footnote:

> WAS, including RLANs, must neither cause harmful interference to, nor claim protection from, nor otherwise impose constraints on operation or development of the existing services.

*****

Examples of conditions, as discussed in details in § 2.2.2.1.2 (EESS) and § 2.2.2.1.3 (RDS) are given below:

First set of limits:

– in the 5 250-5 350 MHz band, the use of WAS, including RLANs, shall be restricted to indoor use with a mean e.i.r.p.[4] limit of 200 mW and a mean e.i.r.p. density limit no greater than 10 mW in any 1 MHz band;

– in the band 5 250-5 350 MHz, WAS, including RLANs, shall implement transmitter power control (TPC) to ensure a mitigation factor of at least 3 dB on the average output power. If TPC is not implemented, the power limits given above shall be reduced by 3 dB;

– in the bands 5 250-5 350 and 5 470-5 725 MHz, WAS, including RLANs, shall implement mitigation techniques such as DFS to avoid co-channel operation with other terrestrial systems, notably radar systems (see PDNR ITU-R M.[8A-9B.RLAN.DFS]). The devices shall also be designed to ensure a near uniform spread of the loading of the devices across the available spectrum to improve the sharing with satellite services.

Second set of limits:

1) that wireless access systems, including RLANs, operating in the band 5 250-5 350 MHz be limited to:

   a) a maximum transmitter power of 250 mW (24 dBm) or 11 +10 log B dBm per transmitter, whichever value is lower (B is the 99% power bandwidth in MHz);

   b) a maximum e.i.r.p. of 1.0 Watt (0 dBW) or –13 +10 log B dBW per transmitter, whichever value is lower;

2) the e.i.r.p. spectral density of the emission of a wireless access system, including RLAN, transmitter operating outdoors should not exceed the following values for the elevation angle θ above the local horizontal plane of the Earth:

-13 dB(W/MHz)	for	$0° \leq \theta < 8°$
$-13 - 0.716 (\theta - 8)$ dB(W/MHz)	for	$8° \leq \theta < 40°$
$-35.9 - 1.222 (\theta - 40)$ dB(W/MHz)	for	$40° \leq \theta \leq 45°$
-42 dB(W/MHz)	for	$\theta > 45°$

[4] "Mean power" refers here to the e.i.r.p. during the transmission burst which corresponds to the highest power, if power control is implemented.

3) mitigation techniques such as DFS shall be implemented to address potential interference to radars operating in 5 250-5 350 MHz (under study in ITU-R, see PDNR ITU-R M.[8A-9B.RLAN.DFS]

5 470-5 725 MHz

ADD

5.WAS3 Use of the 5 470-5 725 MHz band by the mobile service is limited to those applications described in Recommendation ITU-R M.1450-1 for wireless access systems, including RLANs, which will be operated in accordance with the conditions below.

Some administrations are of the view that the following text should also be included in the above footnote:

> WAS, including RLANs, must neither cause harmful interference to, nor claim protection from, nor otherwise impose constraints on operation or development of the existing services.

*****

Examples of conditions, as discussed in detail in § 2.2.2.1.2 (EESS) and § 2.2.2.1.3 (RDS) are given below:

First set of limits:

– in the band 5 470-5 725 MHz, the indoor and outdoor use of WAS, including RLANs, shall be restricted to a mean e.i.r.p.[5] limit of 1 W and a mean e.i.r.p. density limit no greater than 50 mW in any 1 MHz;

– in the band 5 470-5 725 MHz, WAS, including RLANs, shall implement transmitter power control (TPC) to ensure a mitigation factor of at least 3 dB on the average output power of the devices. If TPC is not implemented, the power limits given above shall be reduced by 3 dB;

– in the bands 5 250-5 350 and 5 470-5 725 MHz, WAS, including RLANs, shall implement mitigation techniques such as DFS to avoid co-channel operation with other terrestrial systems, notably radar systems (see PDNR ITU-R M.[8A-9B.RLAN.DFS]). The devices shall also be designed to ensure a near uniform spread of the loading across the available spectrum of the devices to improve the sharing with satellite services.

Second set of limits:

1) that wireless access systems, including RLANs, operating in the band 5 470-5 570 MHz be limited to:

   a) a maximum transmitter power of 250 mW (24 dBm) or 11 +10 log B dBm per transmitter, whichever value is lower (B is the 99% power bandwidth in MHz);

   b) a maximum e.i.r.p. of 1.0 Watt (0 dBW) or –13 +10 log B dBW per transmitter, whichever value is lower;

2) the e.i.r.p. spectral density of the emission of a wireless access system, including RLAN, transmitter operating outdoors in the band 5 470-5 570 MHz should not exceed the following values for the elevation angle θ above the local horizontal plane of the Earth:

   –13 dB(W/MHz) for $0° \leq \theta < 8°$

[5] "Mean power" refers here to the e.i.r.p. during the transmission burst which corresponds to the highest power, if power control is implemented.

$-13 - 0.716 (\theta - 8)$ dB(W/MHz)	for	8° ≤	$\theta < 40°$
$-35.9 - 1.222 (\theta - 40)$ dB(W/MHz)	for	40° ≤	$\theta \leq 45°$
-42 dB(W/MHz)	for		$\theta > 45°$

3) wireless access systems, including RLANs, operating in the bands 5 570-5 725 MHz be limited to a maximum e.i.r.p. of 1.0 Watt (0 dBW) or –13 + 10 log B dBW per transmitter, whichever value is lower;

4) in the band 5 470-5 725 MHz, wireless access systems including RLANs shall implement mitigation techniques including dynamic frequency selection (DFS) and automatic transmit power control (TPC).

With respect to all bands listed above:

Methods A and D

In addition, WAS, including RLANs, in the mobile service must not claim protection from the existing primary services and RDS. This point should be included in the footnote. If appropriate limits and mitigation techniques are implemented (e.g. DFS, TPC), then the provisions of No. **5.43A** may not be necessary.

One administration is of the view that the following footnote should be applied:

ADD

5.WAS4 Stations in the mobile service shall not cause interference to and must accept interference from stations in the radiolocation, Earth exploration-satellite and space research (active) services. Mobile devices utilizing these bands shall operate only if equipped with an automated interference mitigation technique that meets the minimum standards as defined in Resolution [to be developed]. Technical requirements for DFS include adherence to the following criteria:

1) DFS detection threshold of –67 dBm.

2) DFS integration period of less than 1 microsecond.

3) Channel move time of 10 seconds.

4) Channel availability check time of 60 seconds.

5) Channel non-occupancy period of 30 minutes.

Method B

The footnotes described above are equally applicable to Method B noting if only a secondary allocation to EESS were to be granted, or if the radiolocation service is not upgraded to primary, some administrations suggested that the following text is also required in the relevant footnotes:

WAS including RLANs must neither cause harmful interference to, nor claim protection from, nor otherwise impose constraints on operation or development of the existing services.

NOTE – For a number of countries there is already a primary allocation to the mobile service by No. **5.447**.

2.2.4.2 Resolution 736 (WRC-2000), *resolves* 2

Any allocation to the FS in the bands 5 250-5 350 MHz for Region 3 should be limited to fixed WAS only.

If Method A or C is used under section 2.2.4.2, then the following example footnote (No. **5.FWA1**) could be used:

ADD

5.FWA1 The use of the frequency band 5 250-5 350 MHz by the fixed service is permitted in Region 3 only for fixed wireless access systems subject to compliance with DNR ITU-R F.[FWA5GHz-EESS]. In addition, FWA shall not claim protection from the RDS, EESS (active), and SRS (active), although EESS (active) and SRS (active) are not subject to No. **5.43A**. Future system implementation in the RDS, EESS (active) and SRS (active) services shall not require more restrictive sharing conditions on FWA.

*****

If Method B is used under section 2.2.4.2 then the following example footnote (No. **5.FWA2**) could be used:

ADD

5.FWA2 *Additional allocation:* The band 5 250-5 350 MHz is also allocated to the fixed service on a primary basis in the following countries in Region 3 [name of countries]. The use of this band by the fixed service is permitted only for fixed wireless access systems subject to compliance with draft new Recommendation F.[FWA5GHz-EESS]. In addition FWA shall not claim protection from the RDS, EESS (active), and SRS (active), although EESS (active) and SRS (active) are not subject to 5.43A. Future system implementation in the RDS, EESS (active) and SRS (active) services shall not require more restrictive sharing conditions on FWA.

*****

2.2.4.3 Resolution 736 (WRC-2000), *resolves* 3

Since the sharing situation between EESS (active) and the RNS in the bands 5 350-5 460 MHz and 5 460-5 570 MHz are identical, an extension of the application of No. **5.448B** would be required up to 5 570 MHz. Such a modified footnote could be as the following example:

MOD

5.448B The earth exploration-satellite (active) service operating in the band 5 350-~~5 460~~5 570 MHz shall not cause harmful interference to, or constrain the use and development of, the ~~aeronautical~~ radionavigation service.

*****

Regarding the sharing between EESS (active) and the RLS, it should be noted that consideration is being given to the proposed upgrade of the RLS in the band 5 350-5 650 MHz under *resolves* **4** of Resolution **736**.

A possible extension of No. **5.448A** above 5 350 MHz is not required, because it would give a more favourable status to a former secondary service (i.e. radiolocation in case of a successful upgrade) vis-à-vis an already primary service in the 5 350-5 460 MHz band (i.e. EESS).

Furthermore, since the sharing situation between the EESS (active) and the RLS is similar below and above 5 350 MHz, WRC-03 could also consider the ~~deletion~~suppression of No. **5.448A**, since the conclusion on the operational experience and sharing situation between the EESS (active) and the RLS stated above applies equally to the band 5 250-5 350 MHz. Removal of No. **5.448A** would give EESS (active) a more favourable regulatory status without constraining the development and deployment of the radiolocation service.

2.2.4.4 Resolution 736 (WRC-2000), *resolves* 4

Sharing between the RLS and the EESS (active)/SRS (active)

Since the sharing situation in the bands above and below 5 460 MHz is identical, no specific footnote is required which would put any constraints on the development and deployment of either of the two services in the band 5 460-5 570 MHz.

The text given in § 2.2.4.3 with respect to No. **5.448A** also applies here.

Sharing between RLS and RNS

The conference should consider a footnote to provide protection of current and future safety-of-life systems in the RNS from the RLS in the 5 350-5 650 MHz band.

#########

2.3 Agenda item 1.6

"to consider regulatory measures to protect feeder links (Earth-to-space) for the mobile-satellite service which operate in the band 5 150-5 250 MHz, taking into account the latest ITU-R Recommendations (for example, Recommendations ITU-R S.1426, ITU-R S.1427 and ITU-R M.1454)"

2.3.1 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

2.3.1.1 Summary of ITU-R Recommendations on this topic

This agenda item addresses the provision of regulatory measures to protect MSS feeder links operating in the band 5 150-5 250 MHz, in view of the use of this band by RLAN applications. It has to be noted that a possible new allocation to the mobile service in this band for RLAN applications is dealt with under WRC-03 agenda item 1.5.

If additional bands are made available for RLANs at WRC-03 under agenda item 1.5, the aggregate effect of RLAN transmissions on the non-GSO MSS feeder links will be mitigated by the spread of the RLAN devices over a larger amount of spectrum.

This sharing between RLANs and MSS feeder links was studied in ITU-R leading to the development of Recommendations ITU-R M.1454, S.1427 and S.1426 defining the operational restrictions for RLANs and protection measures of the MSS feeder links. These Recommendations provide guidance on e.i.r.p. density, operational restrictions, pfd levels and the methodology for assessing interference from RLANs into non-GSO MSS feeder links.

Recommendation ITU-R M.1454 *recommends*:

1) administrations should ensure that the mean e.i.r.p. density limit of RLANs or other wireless access transmitter devices operating in the band 5 150-5 250 MHz should be no greater than 10 mW in any 1 MHz (or equivalently 0.04 mW in any 4 kHz) per transmitter (Notes 1, 2 and 3);

2) administrations should take measures to ensure that RLANs or other wireless access transmitters are operated indoors in the bands 5 150-5 250 MHz;

3) for the protection of MSS feeder links, the pfd level of total RLAN interference observed at the victim satellite receiver, for satellites using full earth coverage antennas, should be no greater than the pfd levels specified in Recommendation ITU-R S.1426. A lower pfd level should be used as a trigger for administrations to take actions to protect non-GSO MSS feeder links from aggregate RLAN interference (Notes 4 and 5);

4) administrations should consider the implementation of mitigation techniques to further reduce interference into FSS systems from RLANs (see Note 6).

Note 4: details *recommends* 3, proposing, on a provisional basis, a pfd trigger level 3 dB below that in draft new Recommendation ITU-R S.1426, further study being required.

Recommendation ITU-R S.1426 *recommends*:

1) RLANs sharing the same frequency bands with non-GSO feeder links in the FSS should be designed in such a manner that their aggregate RLAN power flux-density be limited to $-148 - 20 \log_{10}(h_{SAT}/1\,414)$ dB(W/(m^2 · 4 kHz)), at the FSS satellite orbit for spacecraft using full earth coverage receive antennas and where h_{SAT} is the altitude of the satellite (km).

Note 1: details the meaning of the term "aggregate": the interference to the satellite receiving beam is to be calculated from all of the RLANs within the field of view of the non-GSO satellite receiving beam.

Note 2: indicates the need of further studies for non-GSO spacecraft with multiple narrow spot beams.

Recommendation ITU-R S.1427 *recommends*:

1) the assessment of interference from RLAN emissions to non-GSO MSS satellite feeder-link receivers, operating in the band 5 150-5 250 MHz, should be based on the increase ($\Delta T_{satellite}$) in satellite noise temperature ($T_{satellite}$);

2) in order to ensure adequate protection for the non-GSO MSS feeder links from RLAN emissions in the band 5 150-5 250 MHz the aggregate $\Delta T_{satellite}/T_{satellite}$ should be no more than 3%.

Note 1 indicates the need for further studies to evaluate the impact of long-term interference due to RLANs into the non-GSO MSS feeder links in terms of the reduction in non-GSO MSS system capacity, and sets a provisional tolerable reduction in capacity of 1%.

Note 2 is identical to Note 1 to Recommendation ITU-R S.1426 given above.

2.3.1.2 Summary of technical and operational studies

Studies in progress concerning building entry (or shielding) loss indicate an average building shielding loss of 15 dB at frequencies near 5 GHz. There are substantial variations in this loss value with respect not only to building type and construction, but also as a function of propagation path elevation and azimuth and floor level, as also evident in more extensive data collected at lower frequencies. Existing sharing studies make use of a more conservative average loss value of 10 dB.

There is a possibility that RLAN transmitters could proliferate until a critical point where the aggregate interference to a MSS feeder link could reach the pfd levels of Recommendation ITU-R S.1426. This assumption leads to further discussions on how to insert a reference to this latter Recommendation in the RR (Note 4 of Recommendation ITU-R M.1454), if possible or necessary.

In order to meaningfully insert pfd levels on the operation of RLANs such as those proposed in Recommendation ITU-R S.1426 in the Radio Regulations, two main issues are to be resolved:

- how to determine that the pfd levels have been reached or are close to being reached;
- what action to take when these pfd levels have been reached.

ITU-R discussions indicate that there may be technical challenges in measuring the aggregate interference level at the satellite. One possibility that has been suggested is to determine the pfd at the satellite by comparing the increase in noise level of an unoccupied satellite channel or in guardbands in the forward path, making the measurement at the Earth's surface. It has been recognized that it would be difficult to determine the source of small increases in the satellite uplink noise level because of the other sources of noise, such as intra-system and inter-system interference, which would have to be distinguished from the RLAN emissions. Such measurements could involve cooperative efforts between multiple non-GSO satellite operators. It has also been noted that the accuracy needed for assessing the levels in Recommendation ITU-R S.1426 may not be achieved by current high performance measurement tools.

There may be a need for administrations to be able to verify the results of such a measurement independently.

It appears also difficult to estimate the number of RLANs in use and to calculate the interference level. One way suggested to accomplish this would be to monitor the manufactured and deployed number of RLAN devices by the relevant RLAN manufacturers in each country of interest. One possibility would be for sellers of license-exempt radio devices to return numbers sold to their National Regulatory Authority on an annual basis, and that this data could be provided to the ITU Radiocommunication Bureau. Some administrations indicated that they would not monitor the number of equipments sold by multiple manufacturers into a global market, and that it would already be difficult to know how much equipment was actually in use. All this would lead to uncertainty sources in prediction.

Also, since RLAN interference into non-GSO MSS satellite receivers involves large areas that can encompass several countries, it would be difficult to apportion the number of RLANs between all the administrations involved. If this apportionment was possible to some extent, it would not provide neutral and equitable means to establish the responsibility of one or even a small group of administrations for the interference caused to the non-GSO MSS feeder links, as long as each administration would be only partly responsible for the aggregate interference, and it would be difficult to justify at what point the portion of responsibility is sufficient for it to be necessary for the administration to take corrective action. That is why the regulatory solutions would necessarily require the cooperation of all the administrations involved.

However, if the pfd level is approached, this would require a huge number of RLANs[6] to be in use and it is expected that there would be a general awareness of the RLAN deployment, thus supporting prediction models.

2.3.2 Analysis of the results of studies

The guidance provided in the three Recommendations described above is the result of ITU-R studies undertaken in ITU-R during the study period of 1998-2000. It was concluded that these measures were needed to protect the non-GSO MSS feeder links from interference caused by RLANs in the band 5 150-5 250 MHz.

The context of the sharing set by these three ITU-R Recommendations distinguishes two separate types of constraint, in order to support the protection of the non-GSO MSS feeder links:

- the emission and utilization limits of the RLANs, proposed by Recommendation ITU-R M.1454 *recommends* 1 and 2. This constitutes a first important step in providing protection for non-GSO MSS feeder links;

---

6 Calculations under different assumptions produce different numbers of RLAN devices necessary to reach the levels in Recommendation ITU-R S.1426. These numbers range from just under one million to tens of millions in the field of view of the MSS satellite, e.g. for LEO-F, 1/3 of the surface of the Earth.

- an aggregate pfd level due to emissions from RLANs in the footprint of each satellite receiver such as those proposed by Recommendations ITU-R S.1426 and M.1454, leading to ITU-R action for developing and adoption of regulatory solutions before the growth of RLANs in that region reaches the critical stage.

As discussed above, there may be difficulties in determining the level of interference and therefore to apply the second type of constraint.

2.3.3 Methods to satisfy the agenda item and their advantages and disadvantages

2.3.3.1 Method A

Insert the transmission limits and indoor usage restrictions (Rec. ITU-R M.1454) on the RLANs in the RR and add a Resolution inviting the continuation of work in the ITU on further regulatory and technical mechanisms to ensure that aggregate interference will not increase to a detrimental level.

Advantages:

- Setting limits on the RLAN transmitting power and indoor utilization is easy to implement and the control of these restrictions can be implemented by each administration.
- This solution provides a level of protection to the non-GSO MSS feeder links and encourages the continuation of ITU-R studies to address the issue of aggregate interference within a realistic time-frame.

Disadvantages:

In case of an explosive growth of RLANs, this solution may not offer sufficient protection to the non-GSO MSS community in the period between the identification of the excess aggregate interference into the non-GSO MSS satellite feeder links and the completion of the requested ITU-R studies.

2.3.3.2 Method B

Insert the transmission limits and indoor usage restrictions (Rec. ITU-R M.1454) on the RLANs in the RR, and insert an aggregate pfd level at the satellite receiver with an associated WRC Resolution that establishes actions to be taken if it is shown by administrations to be exceeded.

Advantages:

This solution provides an improved level of protection to the non-GSO MSS satellites from RLAN interference provided that it is possible to verify the compliance with the pfd level.

Disadvantages:

- For technical reasons, the measurement or calculation of a pfd level at a satellite receiver may be difficult and result in uncertainties. Furthermore, there is no generally accepted measurement procedure.
- The responsibility for ensuring compliance with aggregate pfd levels would not be with individual administrations but for a group of administrations in the coverage area, whose individual responsibility would be difficult to apportion in an equitable manner.
- It may not be possible for all administrations to check the measurements performed by the operators, therefore some administrations would not be able to verify the results obtained by those making measurements. The Radio Regulations texts are mandatory and thus it should be possible to check all the requirements in an unambiguous, neutral and reproducible manner, with recognized tools.

- In the case of an explosive growth of RLANs, this solution may not offer sufficient protection to the non-GSO MSS community in the period between the identification of the problem and its resolution.

2.3.4 Regulatory and procedural considerations

For both solutions, the Radio Regulations could be modified in one of two ways: direct incorporation or incorporation by reference.

2.3.4.1 Method A

Some possible modifications to the Radio Regulations are provided as examples for the two alternative incorporation methods with regard to the incorporation of the transmission and usage limits on RLANs in the Radio Regulations.

In addition, a Resolution related to further work on regulatory and technical mechanisms has to be developed in order to address the aggregate interference from RLANs. An example Resolution [RLAN 2.3-1] is given in Section 2.3.4.1.3.

2.3.4.1.1 Direct incorporation

Add the following to Article **5**:

ADD

5.447XX1 In the band 5 150-5 250 MHz, the mobile service for implementation of WAS, including RLANs, shall be operated in accordance with the following conditions:

i) deployment of WAS, including RLANs, shall be restricted to indoor use only;

ii) the maximum e.i.r.p. density of any WAS station, including RLAN stations, shall not exceed –20 dBW (10 mW) in any 1 MHz band (or equivalently –44 dBW (0.04 mW) in any 4 kHz band);

*****

2.3.4.1.2 Incorporation by reference

Add the following to Article **5**:

ADD

5.447XX2 In the band 5 150-5 250 MHz, the mobile service for implementation of WAS, including RLANs, shall be operated in accordance with *recommends* 1 and 2 of Recommendation ITU-R M.1454.

2.3.4.1.3 Example of a Resolution for Method A

RESOLUTION [RLAN 2.3-1] (WRC-03)

Provisions to protect feeder links of non-geostationary satellite systems in the mobile-satellite service in the 5 150-5 250 MHz band

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that the FSS (Earth-to-space) is allocated worldwide on a primary basis in the band 5 150-5 250 MHz, this allocation being limited to feeder links of non-geostationary-satellite systems in the mobile-satellite service (No. **5.447A**);

b) that the band 5 150-5 250 MHz is also allocated to the mobile service, on a primary basis, in some countries (No. **5.447**, WRC-2000)[7] subject to agreement obtained under **9.21**, and that this allocation is already planned for use by RLANs[8] in Europe on a co-primary basis;

c) that RLAN devices are planned to be distributed on an unlicensed basis and to comply with the restrictions stated in No. **5.447XX**;

d) that the interference from a single RLAN device complying with the operational restrictions above will not on its own cause any unacceptable increase in the noise level at the satellite;

e) that the MSS satellite receivers may experience an unacceptable effect due to the aggregate interference from these RLAN devices, especially in the case of a prolific growth in the number of these RLAN devices;

f) that the aggregate effect will be due to the global deployment of RLAN devices and that it may not be possible to apportion the cause of the effect between individual administrations,

recognizing

a) that a means is required to prevent the aggregate interference from the worldwide deployment of RLANs from becoming detrimental to the feeder links of non-geostationary-satellite systems in the mobile-satellite service;

b) that an aggregate pfd level has been developed in Recommendation ITU-R S.1426;

c) that there is a degree of uncertainty in the means to measure or calculate the aggregate pfd level specified in Recommendation ITU-R S.1426,

resolves to invite ITU-R

to continue work on regulatory and technical procedures in order to address the aggregate interference from a possible prolific growth in the number of RLAN devices.

2.3.4.2 Method B

Some possible modifications to the Radio Regulations are provided as examples for the two alternate incorporation methods.

2.3.4.2.1 Direct incorporation

Add the following to Article **5** (the following example uses the aggregate pfd levels contained in Recommendation ITU-R S.1426 and these values would need to be substituted if other pfd levels were adopted):

ADD

5.447XX3 In the band 5 150-5 250 MHz, the mobile service for implementation of WAS, including RLANs, shall be operated in accordance with the following conditions:

i) deployment of WAS, including RLANs, shall be restricted to indoor use only;

ii) the maximum e.i.r.p. density of any WAS stations, including RLAN stations, shall not exceed –20 dBW (10 mW) in any 1 MHz band (or equivalently –44 dBW (0.04 mW) in any 4 kHz band);

---

[7] This allocation may be changed to reflect the outcome of agenda item 1.5 and Resolution **736**.

[8] This term may have to be replaced by the appropriate terminology in the Radio Regulations and will need to take account of the outcome of agenda item 1.5.

iii) The following aggregate power flux-density limit due to the emissions of all WAS stations, including RLAN stations, within the satellite receiving beam at any non-GSO satellite that is operating in accordance with the Radio Regulations and in particular with Articles **5**, **9** and **11** thereof, shall be applied in accordance with the provisions of Resolution **[RLAN2.3-2]**:

$-124 - 20 \log 10 (\mathbf{h}_{SAT}/1\,414)$ dB(W/(m^2 · 1 MHz)), or equivalently:

$-148 - 20 \log 10 (\mathbf{h}_{SAT}/1\,414)$ dB(W/(m^2 · 4 kHz)), at the FSS satellite orbit and where $\mathbf{h}_{SAT}$ is the altitude of the satellite (km).

*****

The band 5 150-5 250 MHz is required for continued operation of feeder links of non-GSO MSS. This footnote would ensure protection to the operation of non-GSO MSS feeder links in accordance with the provisions of Recommendations ITU-R **S.1426**, **S.1427** and **M.1454**. The compliance with the aggregate pfd level is not subject to verification by BR, but rather is left to individual administrations and MSS operators per Resolution **[RLAN 2.3-2]**. The aggregate pfd levels are verified for non-GSO MSS feeder-link satellites that are in operation. Should the levels exceed or be close to exceeding the pfd levels contained in No. **5.447XX**, remedial actions could be taken at the next WRC.

2.3.4.2.2 Incorporation by reference

Add the following to Article **5** (if other pfd levels than those in Recommendation ITU-R S.1426 were selected, incorporation by reference of this solution would not be valid):

ADD

5.447XX4 In the band 5 150-5 250 MHz, the mobile service for implementation of WAS, including RLANs, shall be operated in accordance with *recommends* 1 and 2 of Recommendation ITU-R M.1454, and *recommends* 1 of Recommendation ITU-R S.1426 shall be applied in accordance with Resolution **[RLAN 2.3-2]**.

2.3.4.2.3 Example of a Resolution for Method B

RESOLUTION [RLAN 2.3-2] (WRC-03)

Determination of aggregate power flux-density levels caused by stations of the mobile service operating in the band 5 150-5 250 MHz at the orbit of non-GSO FSS satellites used for feeder links of the mobile-satellite service

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that this conference adopted an allocation of the band 5 150-5 250 MHz to the mobile service for wireless access systems (WAS), including radio local area networks (RLANs);

b) that FSS (Earth-to-space) is allocated worldwide on a primary basis in the band 5 150-5 250 MHz, this allocation being limited to feeder links of non-geostationary-satellite systems in the mobile-satellite service (No. **5.447A**);

c) that there is a need for continued operation of non-GSO FSS systems used for feeder links in the mobile-satellite service in this band;

d) that results of studies in ITU-R indicate that sharing in the band 5 150-5 250 MHz between wireless access systems, including RLANs, and the FSS is feasible under specified conditions;

e) that interference from a single wireless access system, including RLANs, within the footprint of the non-GSO FSS satellite, will not cause any perceivable increase in the noise level at the satellite;

f) that in many countries, these RLAN devices will operate on a non-licensed basis;

g) that very large numbers of wireless access system, including RLAN, transmitters are expected to be deployed in individual countries, and can result in global deployment of such devices;

h) that current non-GSO FSS systems employ large beams covering as much as one third of the Earth's surface to provide feeder links in the mobile-satellite service;

i) that the interference caused by very large numbers of transmitters in the mobile service which individually meet the emission limits contained in No. **5.447XX** can cause impairment to the non-GSO FSS feeder-link transmissions due to the aggregate level of interference at the satellite,

recognizing

a) that maximum power flux-density levels have been developed in Recommendations ITU-R **M.1454** and **S.1426** and have been incorporated in No. **5.447XX**;

b) the difficulty for the Radiocommunication Bureau to assess whether such levels have been exceeded due to the manner in which RLAN devices are deployed;

c) that means may exist to measure or calculate the aggregate power flux-density levels caused by very large numbers of wireless access system including RLAN, transmitters at the non-GSO FSS satellite used to provide feeder links in the mobile-satellite service to a precision sufficient for determining whether those in No. **5.447XX** have been or are close to being exceeded,

resolves

1 to encourage administrations, with the assistance of operators of non-GSO FSS systems providing feeder links in the mobile-satellite service, cooperate to determine the aggregate power flux-density levels caused by stations of the wireless access systems, including RLANs, in the mobile service using ITU-R Recommendations where appropriate;

2 that a future competent conference should review the findings made in *resolves* 1, with a view to taking appropriate action, including reviewing the allocation and/or emission limits contained in No. **5.447XX**, should the aggregate power flux-density limits be exceeded,

encourages

1 administrations to cooperate to the maximum extent practicable in tracking the number of mobile service transmitters deployed within the territory of their respective countries to facilitate the determination of the aggregate power flux-density levels at the satellite providing feeder links for non-geostationary-satellite systems in the mobile-satellite service;

2 administrations and operators to provide the results of their measurements and/or calculations made in accordance with *resolves* 1 to ITU-R in a timely manner,

invites ITU-R

to continue developing methods for calculating and measuring aggregate power flux-density levels at non-GSO FSS satellites caused by wireless access system, including RLAN, transmitters operating in the band 5 150-5 250 MHz.

#########

2.4 Agenda item 1.11

"to consider possible extension of the allocation to the mobile-satellite service (Earth-to-space) on a secondary basis in the band 14-14.5 GHz to permit operation of the aeronautical mobile-satellite service as stipulated in Resolution **216 (Rev.WRC-2000)**"

2.4.1 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

Relevant ITU-R Recommendations: S.728-1, RA.611, RA.769, RA.1513, SA.510, SA.1155, SA.1414; F.758, F.1094, F.1245 and DNR M.[AMSS].

2.4.1.1 Introduction

AMSS in the 14-14.5 GHz band is being proposed to meet a growing demand for two-way broadband communications by passengers and operators of commercial aircraft.

All or parts of the band 14-14.5 GHz are allocated on a primary basis to the FSS (Earth-to-space), RNS, and FS and MS (except aeronautical mobile service). Secondary services allocated in all or parts of the band include: MSS (Earth-to-space) (except AMSS), SRS, RAS, and RNSS. To achieve the objective of Resolution **216 (Rev.WRC-2000)**, studies were carried out to assess "the feasibility of sharing the band 14-14.5 GHz between the services referred to in *considering c)* and the aeronautical mobile-satellite service, with the latter service on a secondary basis." In addition, studies were carried out by the ITU-R with systems operating in secondary allocations in the band using available data as well as that obtained as a result of an Administrative Circular (CA/91).

Liaison statements among the concerned working parties exchanged information on the technical characteristics of the terminals of these services, as well as on analytical methodologies for, and results of, compatibility/sharing analyses. In addition, an Administrative Circular (CA/91) was sent by the Director of the BR requesting administrations to provide information on certain types of their use of the band 14-14.5 GHz, for which there were a limited number of replies.

2.4.1.2 Compatibility with services having primary allocations in the band 14-14.5 GHz

2.4.1.2.1 Fixed-satellite service (FSS) (14-14.5 GHz)

One central factor in the design of the planned AMSS network used for the FSS compatibility studies, is that the 14 GHz transmissions from the aircraft earth stations (AES) would be received by space station facilities that were coordinated with adjacent satellites. A second central design factor of the AMSS system is that the individual AES transmissions would be under the positive control of a network control and monitoring centre (NCMC), which would limit the aggregate off-axis, co-frequency, e.i.r.p. levels from multiple AES at adjacent satellites to (or below) those levels that have been accepted by other satellites, including, *inter alia*, effects of antenna pattern variations and pointing stability.

The AMSS networks will need rigorous protocols to control the operation of AES to be within the agreed limits. These controls include: entry of AES into the network; authorization for the AES to transmit; authorization to change transmit power/data rates and frequency assignment; and the ability to terminate AES transmissions. An NCMC must manage AES transmission levels within ranges both on an individual and on an aggregate (per transponder) basis.

Taking into account the planned AMSS networks in the 14-14.5 GHz band, studies were conducted to determine the feasibility of operating in the band on a secondary basis with the FSS.

The compatibility study with the FSS was begun by constructing a Monte Carlo simulation of a planned AMSS network, including the ability to evaluate the impact of transmissions from adding AES, and sources of random errors and inherent latencies for each co-frequency AES in the system. Running over 100 000 trials of the simulation determined that the NCMC could control the aggregate off-axis e.i.r.p. levels to those of Recommendation ITU-R S.728-1 for both 2º and 3º GSO satellite spacing to a 99.99% confidence level. This analysis verified that it was feasible to control the aggregate off-axis e.i.r.p. density levels from an AMSS network to be no greater than that of coordinated VSATs, as characterized in Recommendation ITU-R S.728-1.

Another study examined whether the cumulative interference from an AMSS network would cause harmful interference to non-GSO space station receivers.

2.4.1.2.2 Radionavigation service (RNS) (14-14.3 GHz)

There are no records in the ITU Master Register indicating use of the radionavigation allocation in the 14-14.3 GHz band by any administration. No additional information was obtained on radionavigation use of the band as a result of enquiries within the ITU-R and the BR Administrative Circular (CA/91). Consideration of compatibility matters has not revealed a problem in the use of this band by AMSS with respect to RNS.

2.4.1.2.3 Fixed service (FS) (14.4-14.5 GHz); (Regions 1 and 3: 14.3-14.4 GHz); (5.505: 14-14.3 GHz); (5.508: 14.25-14.3 GHz)

In the 14-14.5 GHz range, the FS is allocated on a primary basis in the band 14-14.3 GHz by No. **5.505**, in the band 14.25-14.3 GHz by No. **5.508**, in the band 14.3-14.4 GHz in Regions 1 and 3 and in the band 14.4-14.5 GHz in all three Regions.

Technical feasibility studies were performed by a number of administrations to determine whether planned AMSS networks could operate without causing harmful interference to the fixed service systems operating in the 14-14.5 GHz band.

These studies analysed the interference from planned AMSS networks by determining a pfd mask or e.i.r.p. mask that would not cause harmful interference to the systems in the FS. This was achieved by setting up a model of air traffic routes and fixed service receivers. The aggregate levels of interference into the fixed service networks due to emissions from planned AMSS networks were then calculated. The air traffic scenario was based upon the air traffic routes over the United Kingdom, Australia, France and Russia. Some studies used actual traffic routes with random variations in the time of arrival of the aircraft and deviation of the aircraft flight from the selected route. Other studies used worst-case scenarios in which deterministic air traffic routes were along the main beam region of the fixed service station. Aggregate levels of interference were calculated as a function of time and I/N exceedence curves were presented to describe the long-term and short-term levels of interference caused by the chosen air traffic scenario, pfd or e.i.r.p. mask and aircraft altitudes. As far as interference from the planned AMSS networks is concerned, it was agreed that the following interference assessment levels should apply:

- Long-term

  I/N = –20 dB to be exceeded for no more than 20% of time or an FDP (Fractional Degradation in Performance) not to exceed 1%.

- Short-term

A permissible interference level of –125 dB(W/MHz) not to be exceeded.

A pfd mask to protect the FS was developed on the basis of the assessment levels given above.

2.4.1.2.4 Mobile service (MS) (except aeronautical mobile) (14.4-14.5 GHz); (Regions 1 and 3: 14.3-14.4 GHz); (5.509: 14.25-14.3 GHz)

There are no records in the ITU Master Register indicating any use of the MS allocation in the band. No additional information was obtained on mobile service use of the band as a result of inquiries within the ITU-R, nor as a result of the BR Administrative Circular (CA/91).

However, based on information received in the course of conducting studies with the FS, it was learned that the band is used by some administrations for electronic news gathering (ENG) (the service is termed temporary-fixed by some administrations). Since ENG is considered by some administrations as a mobile service, and the system aspects of ENG are similar to those of the FS, the methodology recommended for AMSS studies with the FS was employed for such MS studies using ENG network characteristics.

2.4.1.3 Compatibility with services having secondary allocations in the band 14-14.5 GHz

2.4.1.3.1 Radio astronomy service (RAS) (14.47-14.5 GHz)

The RAS systems operate at relatively few sites around the world and uses antennas with a gain greater than 65 dBi. The radio astronomy observations in this band are important, but at some observatories, observations are carried out only for a small fraction of the time.

Sharing studies were performed using two alternative methodologies to determine if sharing between the RAS and the AMSS networks would be feasible in the 14-14.5 GHz band.

a) One study applied the Recommendation ITU-R RA.769 pfd level of –221 dB(W/(m^2 · Hz)) to the AES emissions and derived the required AES pfd values to protect the RAS receiver.

b) The second study used the simulation methodology developed for sharing studies between non-GSO satellite systems and the RAS. This methodology, developed in Recommendation ITU-R M.1583, consists in a division of the sky into cells of approximately equal solid angles and in calculation of the epfd generated by all aircraft for each cell, averaged over time slots of 2 000 seconds. This methodology also assumes worst-case assumptions for the AMSS interference environment. Temporal statistics are obtained by performing a sufficient number of trials, randomly changing the RA station antenna pointing direction within a cell and the position of aircraft from one trial to another. The study showed that, above a 5° elevation angle, the epfd limit of –303 dB(W/(m^2 · Hz)) (derived from Recommendation ITU-R RA.769 and the RAS antenna peak gain) was exceeded for less than 2% of the time (this criterion comes from Recommendation ITU-R RA.1513).

2.4.1.3.2 Space research service (SRS) (14-14.3 GHz) and (14.4-14.47 GHz)

Sharing studies were performed to determine if it is feasible for AES in the AMSS to share the 14-14.3 GHz and 14.4-14.47 GHz bands with the SRS on a secondary basis. Data relay satellite (DRS) networks use earth stations in the SRS at a very few sites in the world. These studies showed that the use of AMSS in this band is feasible.

2.4.1.3.3 Radionavigation-satellite service (RNSS) (14.3-14.4 GHz)

There are no records in the ITU Master Register indicating any use of the RNSS allocation in the 14.3-14.4 GHz band. Nor is there any record in any BR list of a prior Advance Publication Information (per No. **9.1**) by an administration for use of the band by RNSS. Nor was any information on proposed RNSS use of the band provided by administrations in response to the BR

Administrative Circular (CA/91). Consideration of sharing matters has not revealed a problem on the use of this band by AMSS with respect to the RNSS.

2.4.1.3.4 Mobile-satellite service (MSS) (except AMSS) (14.0-14.5 GHz)

MSS (except AMSS) systems, in the 14-14.5 GHz band, are operational in all three ITU Regions. Through the data reported in response to CA/91, it was learned that MSS use of the 14-14.5 GHz band requires that the MSS systems operate such that the aggregate, off-axis e.i.r.p. of all co-frequency transmissions is within the limits set by the administrations wherein these systems are employed. These limits have been based on the principles of, and closely related to, the limits developed during the adoption of Recommendation ITU-R S.728-1, as is appropriate for the satellite spacing environment. Since these existing MSS networks have a secondary status, they must accept interference from primary users of the band, but can claim protection against harmful interference from users of new secondary allocations, such as the AMSS.

A study was conducted to determine the ability of a planned AMSS network to share the band 14-14.5 GHz with an operational MSS network. The study concluded that sharing is feasible.

2.4.2 Analysis of the results of studies

On the basis of information available from the ITU-R studies, it has been demonstrated that it is feasible for appropriately designed AMSS networks to be operated on a secondary basis in the band 14-14.5 GHz without causing harmful interference to primary services in the band. Additional studies have shown the feasibility of AMSS sharing with services employing secondary allocations in the band.

2.4.2.1 Analysis of studies involving the primary allocations in the band

2.4.2.1.1 Fixed-satellite service

The studies show that an AMSS system operating on a secondary basis can compatibly operate with the FSS in the 14-14.5 GHz frequency band, provided aggregate co-frequency AES emissions in the direction of adjacent satellites are limited to levels that are equal to or less than the levels that have been accepted by other satellite networks. These conclusions apply equally to GSO and non-GSO FSS.

In addition, DNR ITU-R M.[AMSS] provides guidance to system designers and licensing administrations regarding technical and operating parameters of AMSS networks in the band 14-14.5 GHz needed to permit operation of AMSS networks with the FSS in the band.

2.4.2.1.2 Radionavigation service

Based on the information available, AMSS use of this band does not present any difficulty.

2.4.2.1.3 Fixed service

A general conclusion of the studies was that the dominant interference effect occurs as a result of an aircraft flying through the main beam of an FS antenna producing short-term interference and also significantly influencing the long-term FDP.

Results of the interference analyses have concluded that the following pfd mask applied to the AES of an AMSS network would adequately protect the fixed service networks in the band 14-14.5 GHz:

$$pfd = -132 + 0.5*\theta \quad dB(W/m^2) \text{ in 1 MHz} \quad \text{for } \theta \leq 40°$$

$$pfd = -112 \quad dB(W/m^2) \text{ in 1 MHz} \quad \text{for } 40 < \theta \leq 90°$$

Where θ is the angle of arrival, measured in degrees.

FS protection could also be ensured by a consistent e.i.r.p. mask, which can be derived for any given altitude from the above pfd mask using the conversion formula in Annex 2 of DNR ITU-R M.[AMSS]. Simplification of the resulting e.i.r.p. mask could also be considered.

2.4.2.1.4 Mobile service

Since there are no known mobile service systems using this allocation, a sharing analysis was accomplished employing characteristics of ENG systems that do use the allocation. These studies showed that the use of AMSS in this band is feasible, based on the information available.

2.4.2.2 Analysis of studies involving secondary allocations in the band

2.4.2.2.1 Radio astronomy service

Based on the studies described in § 2.4.1.3.1, both of which came to the same conclusion, it was concluded that sharing is feasible between the AMSS networks and the RAS in the 14-14.5 GHz band, provided that the following conditions are met:

1) AMSS Channels in the 14.47-14.5 GHz band

   a) AMSS stations do not transmit in the 14.47-14.5 GHz band within line-of-sight of radio astronomy stations operating within this band;

   or,

   b) if an AMSS operator intends to operate co-frequency within the visibility of the RA station, a specific agreement with the RA station will be needed to ensure that AMSS AES will meet the requirements of Recommendations ITU-R RA.769 and RA.1513 within the 14.47-14.5 GHz band during observations. When practicable, this may include advance information to AMSS operators regarding observation schedules.

2) AMSS channels in the 14-14.47 GHz band

   All AES transmitters on channels in the 14-14.47 GHz band, within line of sight of radio astronomy stations during radio astronomy observations have emissions in the band 14.47-14.5 GHz such that they meet the levels given in Recommendation ITU-R RA.769. Results from studies show that the following AES pfd levels in the band 14.47-14.5 GHz are sufficient, with some margin, to meet the RAS power flux-density levels in Recommendation ITU-R RA.769, i.e.:

$$pfd = -190 + 0.5*\theta \quad dB(W/m^2) \text{ in 150 kHz for } \theta \leq 10°$$

$$pfd = -185 \quad dB(W/m^2) \text{ in 150 kHz for } 10° < \theta \leq 90°$$

   Where θ is the angle of arrival, measured in degrees.

Such AES pfd levels in the band 14.47-14.5 GHz may be achieved by the AMSS operators through a combination of reduced AES signal power, sharp filtering, maintaining adequate frequency separation, or enhanced AES antenna performance.

2.4.2.2.2 Space research service

Based on the studies described in section 2.4.1.3.2, it was concluded that it is feasible for the AMSS to share with the space research service in the 14-14.3 GHz and 14.4-14.47 GHz bands, and that sharing can be accomplished through coordination as per RR Article **9**. It was determined that the main mechanism for interference occurs when an AES transmits in or near the main beam of the SRS antenna. In such a situation, coordination between the two networks is the most appropriate method for ensuring compatibility. The studies indicated that the coordination agreements between AMSS and space research networks can be developed based on controlling the emissions levels of the AES and, in severe cases, may require cessation of AES emissions in the frequency band used by the SRS networks when operating in the vicinity of the space research earth station. Specifics of the agreements will vary based on the characteristics of the individual SRS sites and the AMSS networks. Such emission restrictions are feasible for the AMSS.

2.4.2.2.3 Radionavigation-satellite service

Since there are no RNSS systems using, or proposing to use this secondary allocation, use of the band by AMSS is feasible.

2.4.2.2.4 Mobile-satellite service (except AMSS)

Analyses confirmed that interference protection margins make it feasible for AMSS and MSS (except AMSS) networks to share the band 14-14.5 GHz, both on a secondary basis, when they employ co-frequency transponders on adjacent satellites.

2.4.3 Methods to satisfy the agenda item and their advantages and disadvantages

Each of the regulatory and procedural alternatives that could be used for satisfying the agenda item to provide for the secondary AMSS allocation in the band 14-14.5 GHz requires removal from the existing MSS allocation of the phrase "*except aeronautical mobile-satellite*". Each alternative is presented below, along with the advantages and disadvantages of each.

The Arab Administrations stated their reservations with regard to all the methods proposed under this agenda item.

2.4.3.1 Method A

Remove the restriction **"*except aeronautical mobile-satellite*"** from the Table of Frequency Allocations in Article **5** for the MSS in the frequency band 14-14.5 GHz.

Under this option the phrase "*except aeronautical mobile-satellite*" would be removed from the secondary MSS allocation for 14-14.5 GHz in the Table of Frequency Allocations. No further modifications of the RR to protect other services from harmful interference would need to be incorporated.

Advantage:

Some administrations believe that compliance with the existing provisions of the RR would be sufficient. This is the simplest approach for satisfying the agenda item as the regulatory status of a secondary service and related procedures are well defined in the Radio Regulations. Since the service is to be secondary, it is obliged to protect all primary services and pre-existing systems of secondary services can claim protection from harmful interference, and also the AMSS must accept harmful interference from primary services and pre-existing secondary services.

Disadvantage:

The compatibility/sharing conditions that were identified by the ITU-R as contained in DNR ITU-R M.[AMSS] for protecting certain other services will not be explicitly referred to in the RR. In this case the application of DNR ITU-R M.[AMSS] and/or other criteria is left to administrations to satisfy the requirements to protect other services. Hence, some administrations believe that the protection of primary terrestrial and pre-existing systems of secondary services is not ensured as it may be difficult to detect and localize the interference source, and this may not allow administrations to intervene to make interferers cease their transmissions. Some administrations believe that even in the case where the interferer would be determined, it would be necessary to justify and negotiate the level of harmful interference.

2.4.3.2 Method B

Remove ***"except aeronautical mobile-satellite"*** from the Table of Frequency Allocations in Article **5** and add a footnote that incorporates by reference ITU-R Recommendation DNR ITU-R M.[AMSS].

Advantages:

Some administrations believe that this would ensure the appropriate protection of the fixed service and the radio astronomy service by enforcing the necessary limitations in the RR. For the convenience of licensing authorities, the compatibility/sharing conditions for protecting certain other services will be explicitly referenced and that this would be of assistance to administrations. Including limits in the RR identifies to AMSS operators clear operating guidelines relative to other services.

Disadvantages:

Some administrations believe that this might not be consistent with the principle that adding footnotes to the Radio Regulations or referring to additional ITU-R Recommendations in them should be avoided where possible, and that inclusion of limits in the RR for the protection of primary services from interference caused by the secondary service would not be consistent with the current status of secondary services and could be interpreted ambiguously by Administrations. Changes in Recommendations incorporated by reference into the RR must be approved by a competent WRC.

2.4.4 Regulatory and procedural considerations

In Method A, there are no consequential RR procedural changes or additions required. Existing regulatory procedures are adequate to deal with the modification to Article **5**. The modification is to remove the restriction "*except aeronautical mobile-satellite*" from the Table of Frequency Allocations in Article **5** for MSS in the frequency band 14-14.5 GHz.

In Method B, the modification is to remove the restriction "*except aeronautical mobile-satellite*" from the Table of Frequency Allocations in Article **5** for MSS in the frequency band 14-14.5 GHz and there would be regulatory or procedural changes required. This would be achieved by adding a footnote to Article **5** of the RR that incorporates by reference DNR ITU-R M.[AMSS], and by way of example, this footnote could read:

ADD

5.AMSS In the band 14-14.5 GHz, aircraft earth stations in the aeronautical mobile-satellite service shall operate in accordance with the provisions of Annex 1 of DNR ITU-R M.[AMSS]. The pfd limits in Annex 1 may be exceeded on the territory of any country whose administration has so agreed.

*****

It is worth noting that the latter sentence of this example footnote is consistent with No. **21.17**, which applies to pfd limits as described in Table 21-4.

Under Method B, even though the AMSS complies with the limits, in no way should it detract from being a secondary service, and therefore in the event it causes harmful interference, it will have to immediately eliminate the harmful interference.

For Methods A and B the case of the protection of other secondary services is addressed in DNR ITU-R M.[AMSS].

For Methods A and B in order to use AMSS on a secondary basis in the frequency band 14-14.5 GHz, a request for coordination of the AMSS network is to be submitted to the BR. Under Article 9, this leads to the publication of a Special Section of the BR International Frequency Information Circular (BR IFIC). This publication is to initiate the coordination procedure for the AMSS network where the class of station is matched for the space station and earth station, and the space station and earth station have the same category of allocation. This publication could take the form of a new AMSS network or the modification of an existing network to include the AMSS operations. Any earth station other than that published with the above-mentioned new Special Section (aeronautical mobile-satellite service with secondary allocation) must have the characteristics within the limits of those published by the Bureau or it should have to undergo the coordination procedure of Article 9. These actions could therefore be done within the existing procedures of the Radio Regulations.

With regard to the notification of earth stations pertaining to the AMSS, in addition to that included in the publication procedure referred to in the previous paragraph, some administrations were of the opinion that there would be three possible courses of action:

a) using the current provisions of Article 9 (No. 9.7 and other relevant provisions) or;

b) modifying the relevant part of the Rules of Procedure relating to No. 11.32 or;

c) a new provision (No. 9.7C), the wording of which would indicate that the required coordination needs to be effected by the administration responsible for the AMSS with respect to space services of other administrations whose services are likely to be affected. This coordination requirement should be identified by the Bureau and carried out by AMSS administrations using Appendix 8 criteria.

Under Methods A and B, WRC-03 may consider suppression of Resolution **216 (Rev.WRC-2000)**.

Some administrations are of the view that, in addition, since no further action by the Conference is needed to implement this proposal, it can be provisionally applied from the end of WRC-03 by including the appropriate provisions in Article 59. Such action will hasten the establishment of the aeronautical mobile-satellite service in this frequency band to meet the growing demand for broadband communications to provide data transmission service for aircraft.

Some other administrations are of the view that the decisions on the date of implementation is outside the mandate of CPM.

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2.5 Agenda item 1.12

"to consider allocations and regulatory issues related to the space science services in accordance with Resolution **723 (Rev.WRC-2000)** and to review all Earth exploration-satellite service and space research service allocations between 35 and 38 GHz, taking into account Resolution **730 (WRC-2000)**"

2.5.1 Resolution 723 (Rev.WRC-2000), *resolves* 1

"provision of up to 3 MHz of frequency spectrum for the implementation of telecommand links in the space research and space operations services in the frequency range 100 MHz to 1 GHz"

2.5.1.1 Summary of technical and operational studies, and relevant ITU-R Recommendations

Sharing scenarios from 100 MHz to 1 GHz have been considered. Recent detailed sharing studies have been conducted in the band 235-328.6 MHz.

Relevant Recommendations ITU-R: SA.363-5, SA.364-5, SA.609-1, SA.1017, SM.1448 and DNR SA.[Doc. 7/62].

2.5.1.2 Analysis of the results of studies

In the range between 100 MHz to 1 GHz, the SRS and SOS have a combined primary allocation of 3.9 MHz and a combined secondary allocation of 10.35 MHz in the space-to-Earth direction, but only a combined 2.4 MHz in the Earth-to-space direction for telecommand links.

Sharing conditions in the range 100 MHz to 1 GHz have not been agreed. However, to accommodate existing telecommand systems in certain countries where the band 257-262 MHz has already been used successfully for many years, it may be possible to identify 3 MHz within the band 257-262 MHz. Systems operating in accordance with the RR might experience occasional interference from other systems based on a coordination distance of the order of 400 km as derived from the aeronautical mobile case.

2.5.1.3 Methods to satisfy the agenda item and their advantages and disadvantages

2.5.1.3.1 Method A

No change.

Advantages:

No impact on existing systems operating in accordance with the RR.

Disadvantages:

Spectrum for telecommand links in the space research and space operations services in the frequency range 100 MHz to 1 GHz will not be provided, and the imbalance between space-to-Earth and Earth-to-space directions will continue to exist.

2.5.1.3.2 Method B

Consider the allocation of up to 3 MHz of spectrum for telecommand links (Earth-to-space) for the space research and space operations services in the 257-262 MHz band with conditions to minimize the possibility of interference to systems operating in accordance with the RR

Advantages:

- Provides up to 3 MHz of allocation in certain countries for telecommand links.
- The existing spectrum for the space-to-Earth and Earth-to-space directions will be balanced.

Disadvantages:

Occasional interference may occur to systems operating in accordance with the RR.

2.5.1.4 Regulatory and procedural considerations

Method A

None required.

Method B

The existing telecommand systems could be accommodated by the addition of a footnote to RR Article **5**. For example, the footnote could read:

ADD

5.XXX *Additional allocation:* In [countries], the band [257-262] MHz is also allocated to the space research and space operation services (Earth-to-space) on a primary basis. The coordination distance for earth stations of these services is 400 km.

2.5.2 Resolution 723 (Rev.WRC-2000), *resolves* 2

"to consider incorporating in the Table of Frequency Allocations the existing primary allocation to the space research service in the band 7 145-7 235 MHz under No. **5.460**"

2.5.2.1 Summary of technical and operational studies, and relevant ITU-R Recommendations

The 7 145-7 235 MHz band is allocated on a primary basis to the FS, the MS and by No. **5.460**, to the SRS (Earth-to-space), with a segment of the band restricted to deep space. The footnoted SRS primary allocation is subject to agreement obtained under No. **9.21**. The companion SRS downlink band, 8 400-8 500 MHz, is allocated on a primary basis in the Table of Frequency Allocations. This pair of bands is used on a worldwide basis for cross-support of near-Earth and deep space missions in accordance with international agreements concluded between a number of space agencies. The footnote calling for agreement under No. **9.21** was originally applied at WARC-71 because the coordination parameters necessary for earth station coordination were not agreed at that time. In the time since this footnote was adopted, RR Appendix **7** has been modified and now contains all of the necessary coordination parameters for transmitting earth stations for the space research service in the 7 145-7 235 MHz band. Therefore, the premise behind requiring agreement under No. **9.21** no longer exists.

Relevant Recommendations ITU-R: SA.609-1; SA.364-5; SA.1016 and SA.1157.

2.5.2.2 Analysis of the results of studies

Since WRC-2000 revised Appendix **7** to include space research station parameters and coordination methodologies for the 7 145-7 235 MHz band into the Radio Regulations and since coordination under No. **9.17** is mandatory, coordination under No. **9.21** is an additional burden on administrations, which is no longer necessary. Therefore, it is practicable, without affecting the protection afforded the fixed and mobile services, to provide a worldwide primary status in the band 7 145-7 235 MHz, while maintaining the restriction to deep space in the part of band 7 145-7 190 MHz.

Since the space research service allocation in the band 7 145-7 190 MHz is limited to deep space applications and the band 7 190-7 235 MHz is not used nor currently planned for use by GSO satellites in the space research service, there is no need to apply the provisions of No. **21.2** and Table **21-1** to the bands. Even in the unlikely case of a GSO SRS mission, there will be no requirement for orbital avoidance to be placed on terrestrial services. The provisions of No. **21.3** should be applied in the band 7 145-7 235 MHz to minimize the possibility of interference to space research satellites.

The appropriate provisions of Sections III and IV of Article **21** should be applied to SRS earth stations in the band 7 145-7 235 MHz to facilitate sharing with the fixed and mobile services.

2.5.2.3 Methods to satisfy the agenda item and their advantages and disadvantages

Method

In RR Article **5** add to the Table of Frequency Allocations a primary allocation to the SRS (Earth-to-space) in the bands 7 145-7 190 MHz (deep space) and 7 190-7 235 MHz. Modify No. **5.460** to delete the reference to No. **9.21** in the band 7 145-7 235 MHz. Retain the restriction to indicate that no emissions to deep space are permitted in the sub-band 7 190-7 235 MHz. Add to No. **5.460** the provision that GSO satellites in the SRS shall not claim protection from FS and MS, and No. **5.43A** does not apply.

Advantages:

- Satisfies *resolves* 2 of Resolution **723** with respect to deep space and non-deep space applications within the space research service.
- Eliminates the need for stations in the space research service to seek coordination under No. **9.21** prior to operation.
- Does not affect operating characteristics for transmit stations in the fixed and mobile services.
- Assures continued availability of access to these bands for space research.

Disadvantages:

None.

2.5.2.4 Regulatory and procedural considerations

Add to the Table of Frequency Allocations in RR Article **5** a primary allocation to the SRS (Earth-to-space) in the bands 7 145-7 190 MHz (deep space) and 7 190-7 235 MHz. No protection shall be claimed by SRS GSO satellites from FS and MS. Include the band 7 145-7 235 MHz in RR Table **21-2** and indicate that only Nos. **21.3** and **21.5** apply. The space research service allocation in the band 7 145-7 190 MHz will continue to be limited to the use of deep space applications.

Example of a possible modification to footnote No. 5.460

MOD

5.460 ~~*Additional allocation:* the band 7 145-7 235 MHz is also allocated to the space research (Earth-to-space) service on a primary basis, subject to agreement obtained under No. **9.21**.~~ The use of the band 7 145-7 190 MHz by the space research service (Earth-to-space) is restricted to deep space; no emissions to deep space shall be effected in the band 7 190-7 235 MHz. Geostationary satellites in the space research service operating in the band 7 190-7 235 MHz shall not claim protection from the fixed and mobile services and No. **5.43A** shall not apply.

Example of a possible addition to Table 21-2

Frequency band	Service	Limit as specified in Nos.
7 145-7 235 MHz	Space research	**21.3** and **21.5**

The appropriate provisions of Sections III and IV of RR Article **21** should be applied to space research service earth stations in the band 7 145-7 235 MHz to facilitate sharing with the fixed and mobile services.

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2.5.3 Resolution 723 (Rev.WRC-2000), *resolves* 3

"to review the allocations to the space research service (deep space) (space-to-Earth) and the inter satellite service, taking into account the coexistence of these two services in the frequency range 32-32.3 GHz, with a view to facilitating satisfactory operation of these services"

2.5.3.1 Summary of technical and operational studies, and relevant ITU-R Recommendations

The band 31.8-32.3 GHz is allocated worldwide to the SRS (deep space) (space-to-Earth) with the 32-32.3 GHz segment shared with the ISS on a primary basis. The FS and RNS are also allocated worldwide on a primary basis. No. **5.548** states that in designing systems for the 31.8-32.3 GHz band, including the 32-32.3 GHz segment shared between the inter-satellite and the SRS (deep space), administrations shall take all necessary measures to prevent harmful interference between the services.

Sharing studies concerning bands used for deep-space research, including sharing with the ISS in the 32 GHz band, are summarized in Recommendation ITU-R SA.1016. The feasibility of sharing was assessed for ISS systems using GSO-GSO links, GSO-non-GSO links and non-GSO-non-GSO links. In all three cases, it was concluded on the basis of an inability to satisfy the protection criteria of Recommendation ITU-R SA.1157 for practical ISS links employing transmitting antennas conforming to Recommendation ITU-R S.672, that sharing between the ISS and the SRS (deep space) (space-to-Earth) in the 32-32.3 GHz band (see section 2.5 of Annex 1 in Recommendation ITU-R SA.1016) is not feasible. Interference caused by ISS links were in excess of 55 dB greater than the protection criteria given in Recommendation ITU-R SA.1157 and no techniques were identified to mitigate against such an excessive amount of interference.

Relevant Recommendations ITU-R: SA.509; SA.1014; SA.1016; SA.1157; S.672 and S.1151.

2.5.3.2 Analysis of the results of studies

Studies summarized in Recommendation ITU-R SA.1016 have concluded that sharing between the SRS (deep space) (space-to-Earth) and the ISS in the 32-32.3 GHz band may not be practicable due to the onerous sharing conditions and the absence of practical mitigation techniques. This conclusion is based on: interference to SRS (deep space) Earth stations that is in excess of 55 dB greater than the protection criteria given in Recommendation ITU-R SA.1157; and, the absence of practical mitigation techniques to reduce the interference to an acceptable level.

2.5.3.3 Methods to satisfy the agenda item and their advantages and disadvantages

Method

Delete the ISS allocation in the 32-32.3 GHz band.

Advantages:

Deletion of the allocation would ensure the reception of deep-space transmissions at the SRS deep-space earth stations without unacceptable interference.

Disadvantages:

The existing ISS allocation bandwidth of 1 000 MHz will be reduced to 700 MHz.

2.5.3.4 Regulatory and procedural considerations

Delete the ISS allocation in the 32-32.3 GHz band in RR Article **5**. Also, consequential revisions to No. **5.548** are required. Note that there is also a country footnote, No. **5.547C**, that may be affected by the decisions of the conference.

#########

2.5.4 Resolution 723 (Rev.WRC-2000), *resolves* 4

"to review existing allocations to space science services near 15 GHz and 26 GHz, with a view to accommodating wideband space-to-Earth space research applications"

2.5.4.1 Summary of technical and operational studies, and relevant ITU-R Recommendations

An allocation is needed to support planned high data rate space research missions requiring large bandwidths for high capacity transmission links. Satellites for these missions will carry telescopes and/or other passive instruments to measure phenomenon such as the Earth's magnetosphere and solar flares.

An ITU-R study considered the spectrum requirements associated with the current plans of international space agencies to implement high data rate space research missions with data rate requirements up to 1 Gbps or higher. These missions will be limited in number with an estimated three to five satellites per year worldwide, and will generally be in polar or inclined equatorial orbit with some at geostationary altitudes, some in highly elliptical orbits, and still others at the L1 or L2 libration points. Frequency bands being considered include the 14.8-15.35 GHz band, which is currently allocated on a primary basis to the FS and the MS, and on a secondary basis to SRS, and the 25.5-27.0 GHz band which is allocated on a primary basis to the FS, ISS, MS and the EESS.

This ITU-R study concluded that each band has its own set of particular advantages for satisfying a broad range of stated future SRS mission requirements from the viewpoint of technical, schedule, and cost considerations. The 26 GHz band is most desirable for high data rate SRS missions operating in high inclination orbits due to the possible sharing of ground station resources with EESS missions operating in that band. Similarly, the 15 GHz band is most desirable for high data rate SRS missions operating in low-to-mid inclination orbits, geostationary orbits, and L1/L2 libration points due to the possible sharing of ground station resources located at low-to-mid latitude Deep Space Network and US National Radio Astronomy Observatory sites. Also, an existing data relay satellite network provides added flexibility to SRS missions by providing full coverage backup support in the 15 GHz band, and partial coverage backup support in the 26 GHz band. Where a 15 GHz infrastructure is not available, the 26 GHz could also be used for some of the above applications.

Studies have been performed in both bands 14.8-15.35 GHz and 25.5-27 GHz to evaluate the feasibility of using these bands for SRS (space-to-Earth) wideband applications.

Relevant ITU-R Recommendations: SA.364, F.758, SA.1024, SA.1155 and SA.1344.

The results of the sharing studies for the band 14.8-15.35 GHz may be found in DNR ITU-R SA.[15SHAR], and for the band 25.5-27.0 GHz may be found in DNR ITU-R SA.[26SHAR].

2.5.4.2 Analysis of the results of studies

2.5.4.2.1 Frequency band 14.8-15.35 GHz

Results of simulations of the probabilistic interference from SRS, based on assumed deployment of 24 satellites in geostationary orbit, into digital point-to-point FS systems show that the same pfd limits applicable in the band 10.7-11.7 GHz are necessary to protect the fixed service in the band 14.8-15.35 GHz. In any 1 MHz band, these limits are:

1)	–126	dB (W/m^2)	for	$0° < \delta \le 5°$
	–126 + (δ–5)/2	dB (W/m^2)	for	$5° < \delta \le 25°$
	–116	dB (W/m^2)	for	$25° < \delta \le 90°$

where δ is the angle of arrival above the horizontal plane (degrees).

These pfd limits should permit operation of the 400 Mbit/s space-to-Earth SRS links as required. However, as the fixed service has not been required to implement orbit avoidance in this band, some existing FS links could be adversely impacted with an I/N of up to +16 dB if antennas of these stations are aligned with specific SRS GSO orbit locations with co-channel emissions.

Results of simulation studies carried out by ITU-R of interference from SRS non-GSO satellite systems into FS P-P systems show that sharing between these services is feasible in the band 14.8-15.35 GHz using pfd limits 2 dB higher than those applicable to the band 10.7-11.7 GHz. In any 1 MHz band, these limits are:

2)	–124	dB (W/m^2)	for	$0° \leq \delta \leq 5°$
	–124 + (δ–5)/2	dB (W/m^2)	for	$5° < \delta \leq 25°$
	–114	dB (W/m^2)	for	$25° < \delta \leq 90°$

where δ is the angle of arrival above the horizontal plane (degrees).

The pfd limits in 1) and 2) above are applied to GSO and non-GSO satellites, respectively, under assumed free-space propagation conditions.

Protection of SRS receiving earth stations from the emissions of fixed systems with the characteristics given in Recommendation ITU-R F.758 may be realized at separation distances as small as 18 km to 30 km under favourable conditions and at distances from 160 km to greater than 300 km for less favourable conditions. These distances were determined for mode (1) propagation for an inland great-circle path over smooth Earth (zone A2) using the methodology in Appendix 7. These separation distances will decrease significantly when account is taken of such factors as frequency channelization plans, average antenna gains, varying elevation angles, natural site shielding, terrain clutter and other terrain features.

DNR ITU-R SA.[15SHAR] shows that an existing data relay satellite network would be protected from the emissions of the example low-orbiting satellites and geostationary satellites, and that the separation distance between a receiving geostationary data relay satellite and a transmitting geostationary SRS satellite could be as little as 12 km (equivalent to an orbital separation of less than 0.02 degrees). Additionally a minimum protection margin of +23 dB existed for the near-antipodal case of geostationary SRS satellite emissions in the direction of a receiving data relay satellite. Similar results were found for the case of a low-orbiting SRS satellite transmitting in the space-to-Earth direction that is located within the main beam of the receiving antenna of the data relay satellite. In this case, the margin of the interference with respect to the protection criteria given in Recommendation ITU-R SA.1155 was +22 dB.

There are no known SRS (passive) or EESS (passive) systems using the 15.20-15.35 GHz band under the provisions of No. **5.339**.

2.5.4.2.2 Frequency band 25.5-27 GHz

The existing pfd limits given in Table 21-4 for the band 25.5-27.0 GHz provide protection of P-P and P-MP fixed service systems from space-to-Earth emissions of low-orbiting satellites and geostationary satellites to receiving earth stations in the space research service. In any 1 MHz band, these limits are:

–115	dB(W/m^2)	for	$0° < \delta \leq 5°$
–115 + (δ – 5)/2	dB(W/m^2)	for	$5° < \delta \leq 25°$
–105	dB(W/m^2)	for	$25° < \delta \leq 90°$

where δ is the angle of arrival above the horizontal plane (degrees).

The pfd limits above are applied to GSO and non-GSO satellites under assumed free-space propagation conditions.

Protection of SRS receiving earth stations from the emissions of P-P and P-MP fixed systems with the characteristics given in Recommendation ITU-R F.758 may be realized at separation distances less than 20 km under favourable conditions. Separation distances less than 150 km for P-P systems and less than 65 km for P-MP for less favourable conditions may be required. These distances were determined for mode (1) propagation for an inland great-circle path over smooth Earth (zone A2). These separation distances will decrease significantly when account is taken of such factors as frequency channelization plans, average antenna gains, varying elevation angles, natural site shielding, terrain clutter and other terrain features. However, it is noted that the addition of an allocation to the SRS would introduce further constraints when coordinating with FS systems.

DNR ITU-R SA.[26SHAR] shows that data relay satellite networks operating in the ISS would be protected from the emissions of the example SRS low-orbiting satellites and geostationary satellites, and that the separation distance between a receiving geostationary data relay satellite and a transmitting geostationary SRS satellite could be as little as 7 km (equivalent to an orbital separation of less than 0.01 degrees). Additionally a minimum protection margin of +23.7 dB existed for the near-antipodal case of geostationary SRS satellite emissions in the direction of a receiving data relay satellite. Similar results were found for the case of a low-orbiting SRS satellite transmitting in the space-to-Earth direction that is located within the main beam of the receiving antenna of the data relay satellite. In this case, the margin of the interference with respect to the protection criteria given in Recommendation ITU-R SA.1155 was +22 dB.

In view of the envisaged use of the same infrastructure for EESS and SRS, it is expected that coordination between these two services will not result in any constraints for the EESS.

2.5.4.3 Methods to satisfy the agenda item and their advantages and disadvantages

2.5.4.3.1 Frequency band 14.8-15.35 GHz

2.5.4.3.1.1 Method A

Upgrade the allocation to the space research service in the band 14.8-15.35 GHz to primary with the space-to-Earth directional indicator. The SRS will be subject to the power flux-density limits given in 1) and 2) of § 2.5.4.2.1 for GSO and non-GSO satellites, respectively. Add space-to-space and Earth-to-space directional indicators to the existing secondary SRS allocation in the band 14.8-15.35 GHz.

Advantages:

- Provides a primary allocation to the SRS of 550 MHz for space-to-Earth wide band applications.
- Improving the status of SRS (space-to-Earth) protects the SRS from the results of possible future allocations.
- Maintains and enhances current infrastructure investments.

Disadvantages:

- The requirement to coordinate with a small number of SRS receiving earth stations imposes a new constraint on the development of the fixed service.
- The fixed service has not implemented orbital avoidance in this band since, currently, there are no requirements to share this band with a space service on a co-primary basis. Consequently, some existing FS links, if aligned with specific GSO orbit locations occupied by satellites with co-channel emissions, could be adversely impacted. For example, I/N values of up to +16 dB for boresight coupling may be experienced.

- Potential decrease in the operating margin of FS links due to interference from the emissions of geostationary and low-orbiting SRS satellites.
- For their own protection, new stations in the fixed service may be required to avoid pointing towards the GSO orbit.

2.5.4.3.1.2 Method B

Upgrade the allocation to the space research service in the band 14.8-15.35 GHz to primary but limit the applications to space-to-Earth non-GSO operation, subject to the second set of pfd limits given in § 2.5.4.2.1. Retain all other aspects of the SRS on a secondary basis.

Advantages:

- Provides a primary allocation to the SRS of 550 MHz for non-GSO space-to-Earth wide band applications.
- Improving the status of non-GSO SRS (space-to-Earth) protects the non-GSO SRS from the results of possible future allocations.
- Maintains and enhances current infrastructure investments.
- Obviates the need for the fixed service to avoid the GSO orbit.

Disadvantages:

- Does not provide a primary allocation status to SRS GSO operation.
- The requirement to coordinate with a small number of SRS receiving earth stations imposes a new constraint on the development of the fixed service.

2.5.4.3.1.3 Method C

No change to the Radio Regulations.

Advantages:

No impact on existing services.

Disadvantages:

Does not provide the desired level of protection to the SRS.

2.5.4.3.2 Frequency band 25.5-27 GHz

Method

Add a primary allocation to the SRS (space-to-Earth) in the Table of Frequency Allocations. Add the space research service (space-to-Earth) to No. **5.536A.** Add the SRS (space-to-Earth) to RR Table 21-4 for the band 25.5-27.0 GHz, subject to the pfd limits in § 2.5.4.2.2.

Advantages:

- Provides a primary allocation to the SRS of 1 500 MHz for space-to-Earth wide band applications.
- Limited impact on existing services using the band.

Disadvantages:

None in view of RR No. **5.536A**.

2.5.4.4 Regulatory and procedural considerations

2.5.4.4.1 Frequency band 14.8-15.35 GHz

Method A

In the band 14.8-15.35 GHz, add a primary allocation to the SRS (space-to-Earth) in the Table of Frequency Allocations. Add space-to-space and Earth-to-space directional indicators to the existing secondary allocation to the SRS in the band 14.8-15.35 GHz. Add the two sets of pfd limits detailed under § 2.5.4.2.1 to RR Table 21-4. The first set would be applicable to GSO SRS satellites and the second set would be applicable to non-GSO SRS satellites. Add characteristics of SRS earth stations to Table 8 of Appendix **7** for use in coordination.

Method B

In the band 14.8-15.35 GHz add a primary allocation to the SRS (space-to-Earth) limited to non-GSO applications in the Table of Frequency Allocations. Retain all other aspects of the SRS on a secondary basis in the Table of Frequency Allocations. Add the second set of pfd limits detailed under § 2.5.4.2.1 to RR Table 21-4 for non-GSO SRS (space-to-Earth). Add characteristics of non-GSO SRS earth stations to Table 8 of Appendix **7** for use in coordination.

Method C

None.

2.5.4.4.2 Frequency band 25.5-27 GHz

Method

Add a primary allocation in the band 25.5-27.0 GHz to the SRS (space-to-Earth) in the Table of Frequency Allocations. Amend No. **5.536A** to include SRS earth stations and associate the amended footnote with the SRS allocation in the Table of Frequency Allocations. Add SRS (space-to-Earth) to RR Table **21-4** in the band 25.5-27.0 GHz with the pfd values given in § 2.5.4.2.2.

NOTE - Consequential suppression of Resolution 723 could be considered by WRC-03 following successful conclusion of work on all the *resolves*.

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2.5.5 Review of all EESS and SRS allocations between 35 and 38 GHz, taking into account Resolution 730 (WRC-2000)

2.5.5.1 EESS (active) and SRS (active) in the band 35.5-36 GHz

Resolution **730 (WRC-2000)** *resolves*:

1 to invite ITU-R to study sharing between spaceborne precipitation radars and other services in the band 35.5-35.6 GHz;

2 to recommend that WRC-03 review the results of those studies and consider the removal of the restriction currently contained in No. **5.551A** on spaceborne precipitation radars operating in the Earth exploration-satellite service in the band 35.5-35.6 GHz.

2.5.5.1.1 Summary of technical and operational studies, and relevant ITU-R Recommendations

The band 35.5-36 GHz is allocated on the primary basis to the EESS (active) and SRS (active). Prior to WRC-97, precipitation radars in the EESS (active) operated on a primary basis in the band 35.5-35.6 GHz under the provisions of No. **S5.551 (SUP WRC-97)**. This 100 MHz band is used by precipitation radars located on spacecraft. WRC-97 decided to allocate the band 35.5-36 GHz to both the EESS (active) and SRS (active), but with the provisions contained in No. **5.551A**.

List of relevant Recommendations: ITU-R SA.577, SA.1166, DNR SA.[35GHz-EESS(active)] and DNR M.[8B-33GHz].

2.5.5.1.2 Analysis of the results of studies

ITU-R studies have shown that sharing between spaceborne active sensors and radiolocation systems in the band 35.5-36 GHz is feasible, as indicated in § 5.7.2.1 of Chapter 5 of the CPM-97 Report. The ITU-R, which studied compatibility between spaceborne active sensors and other services prior to WRC-97, noted that in the band 33.4-36 GHz, compatibility analysis between spaceborne altimeters and scatterometers, and terrestrial radars in the radiolocation service indicated that interference from these spaceborne active sensors into the radiolocation systems would not exceed the interference criteria for terrestrial radiolocation systems. The ITU-R also examined the compatibility between active sensors and radiolocation systems from the aspect of potential interference from these radiolocation systems into altimeters and scatterometers and concluded that interference into these sensors would not exceed their interference criteria. Based on these studies, CPM-97 concluded that compatibility between known spaceborne active sensors and radiolocation systems in the 33.4-36 GHz band existed and that an allocation of 500 MHz in this frequency range should be made. Therefore, there was no technical reason behind applying No. **5.551A** for the EESS (active) and SRS (active) in the 35.5-36 GHz band.

Since WRC-97 further studies have been undertaken in the ITU-R on sharing in the band 35.5-36 GHz between spaceborne synthetic aperture radars (SAR) and radiolocation systems, and spaceborne precipitation radars and radiolocation systems. These studies resulted in DNR ITU-R SA.[35GHz-EESS(active)] which concludes that sharing between all types of active spaceborne sensors and radiolocation systems is feasible provided that the pfd generated by any EESS/SRS (active) spaceborne sensor at the Earth's surface for angles greater than 0.8° from the beam centre does not exceed the limit of –73.3 dBW/m^2 in any 2 GHz band. ITU-R studies have shown there are no compatibility issues between spaceborne active sensors and systems in the fixed and MetAids service in the 35.5-36 GHz band.

2.5.5.1.3 Methods to satisfy the agenda item and their advantages and disadvantages

2.5.5.1.3.1 Method A

Delete the band 35.5-35.6 GHz from No. **5.551A**, which currently covers the entire band between 35.5-36 GHz. This would restore the regulatory situation that existed prior to WRC-97 in the band 35.5-35.6 GHz.

Advantages:

Systems in the EESS (active) and SRS (active) can again use 100 MHz (in the 35.5-35.6 GHz band) without the unnecessary constraints of No. **5.551A**.

Disadvantages:

This method maintains the unnecessary constraints of No. **5.551A** on the EESS (active) and SRS (active) in the 35.6-36 GHz band.

2.5.5.1.3.2 Method B

Replace No. **5.551A** with a footnote limiting the mean power flux-density at the Earth's surface from spaceborne active sensors operating in the EESS (active) and SRS (active) systems in the band 35.5-36 GHz, generated at an angle greater than 0.8 degrees from the beam center to –73.3 dBW/m^2 in any 2 GHz band.

Advantages:

- This would allow the deployment of current and planned EESS (active) and SRS (active) systems without undue constraint.
- This would ensure protection of other services to which this band is allocated.

Disadvantages:

Constraints may be placed on the future development of EESS (active) and SRS (active) in the 35.5-36 GHz band.

2.5.5.1.3.3 Method C

Suppress No. **5.551A**.

Advantages:

This would eliminate the restriction on the EESS (active) and SRS (active) in the entire 35.5-36 GHz band.

Disadvantages:

RLS systems and FS and MS systems in countries mentioned in No. **5.549** may not be protected from future EESS (active) or SRS (active) systems if those future systems use higher power levels than current and planned systems.

2.5.5.1.4 Regulatory and procedural considerations

Method A would require modification of No. **5.551A** to exclude the band 35.5-35.6 GHz, which was not subject to the unnecessary constraints prior to WRC-97.

Method B would require replacement of No. **5.551A** by a new footnote to limit the peak power emissions of EESS (active) and SRS (active) in the 35.5-36 GHz band, such as:

"**5.XXX** In the band 35.5-36.0 GHz, the mean power flux-density generated by any EESS/SRS (active) spaceborne sensor at the Earth's surface for any angle greater than 0.8 degrees from the beam centre shall not exceed -73.3 dB(W/m^2) in any 2 GHz band."

(NOTE - One administration sought to include additional words in this draft footnote advocating the removal of the right of protection for the EESS/SRS (active) from interference from the radiolocation service.)

Method C would require no additional regulatory provisions beyond simple suppression of No. **5.551A.**

NOTE - Consequential suppression of Resolution 730 could be considered by WRC-03.

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2.5.5.2 EESS (passive) in the band 36-37 GHz

2.5.5.2.1 Summary of technical and operational studies, and relevant ITU-R Recommendations

The band 36-37 GHz is allocated on a primary basis to the EESS (passive) and space research service (passive). The band is also allocated on a primary basis to the fixed and mobile services. The sub-band 36.43-36.5 GHz is also used by the radio astronomy service for spectral line observations as noted under No. **5.149**.

Relevant Recommendations ITU-R: SA.1029-1 and F.758-2.

2.5.5.2.2 Analysis of the results of studies

With respect to the EESS (passive) and SRS (passive) allocations in the band 36-37 GHz, data taken in this band contributes to the estimate of total vapour, total cloud liquid water, sea surface wind speed, sea surface temperature, sea ice extent, snow depth and soil moisture content. These parameters are derived from measurements near 7, 10.7, 18.7, 23.8, 50.3, 52.8 and 89 GHz in combination with measurements in the 36-37 GHz band. There have been no changes in the requirements for the passive sensing allocation in the 36-37 GHz band, nor have there been any changes in the sharing conditions in this band that would warrant any allocation changes to the EESS (passive) and SRS (passive).

However, the anticipated introduction of active systems into this band, without agreed sharing criteria between the active and passive services, could seriously jeopardize the success of these important scientific programmes, and consequently impact the measurements made in the bands 7, 10.7, 18.7, 23.8, 50.3, 52.8 and 89 GHz.

Based upon preliminary studies conducted so far, the deployment of a limited number of fixed stations operating at the maximum power given in Recommendation ITU-R F.758 may cause unacceptable interference to a passive sensor. Taking into account the scattering effect, the interference level may be increased. Land area measurements would be degraded rather than ocean measurements. If passive services were to be protected to the levels of Recommendation ITU-R SA.1029-1, in order to meet the data availability requirements specified in this Recommendation, it may be necessary to limit the deployment of the fixed and mobile services.

2.5.5.2.3 Methods to satisfy the agenda item and their advantages and disadvantages

2.5.5.2.3.1 Method A

Make no change to the RR and continue urgent sharing studies under normal ITU-R activities.

Advantages:

No impact on terrestrial services.

Disadvantages:

- Important scientific data from current space missions may be lost.
- Planning of future missions is inhibited by the lack of knowledge of terrestrial systems deployment, until ITU-R sharing studies are completed.

2.5.5.2.3.2 Method B

In order to protect the operation of EESS (passive) and space research service (passive) systems, urge administrations to limit the deployment of terrestrial service systems in the band 36-37 GHz and to define sharing criteria between the active and passive services in this band for possible inclusion in the Radio Regulations at the next WRC.

Advantages:

- Would provide a provisional operational environment to all services in the band until the time of establishment of appropriate sharing criteria between the active and passive services.

Disadvantages:

This may limit the deployment of fixed and mobile stations in this band.

2.5.5.2.4 Regulatory and procedural considerations

For **Method A**, no change to the RR would be needed.

For **Method B**, it may be necessary to develop a resolution in order to urge administrations to limit the deployment of active systems in the band 36-37 GHz and to define sharing criteria between active and passive service using this band, in time for WRC-07.

Example of a Resolution

ADD

Resolution XXX (WRC-03)

Use of the frequency band 36-37 GHz

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that the frequency band 36-37 GHz is allocated to the Earth exploration-satellite (passive) service and to the space research service (passive) on a primary basis;

b) that the frequency band 36-37 GHz is allocated to the fixed service and to the mobile service on a primary basis;

c) that the Earth exploration-satellite (passive) service protection criteria are contained in Recommendation ITU-R SA.1029;

d) that Recommendation ITU-R F.758-2 provides characteristics of FS point-to-multipoint systems operating in the band 36-37 GHz, but does not provide information on characteristics of FS point-to-point systems operating in this band;

e) that the band 36-37 GHz is not available for high-density applications in the fixed service (see No. **5.547**);

f) that the EESS (passive) operating in the band 36-37 GHz may be interfered by the emissions of systems of active services,

recognizing

1 that EESS (passive) systems may experience harmful interference if a high density of fixed-service stations is deployed in the band 36-37 GHz;

2 that sharing criteria between EESS (passive) and FS systems need to be defined in the band 36-37 GHz,

resolves

1 to invite ITU-R to conduct sharing analyses between passive services and the fixed and mobile services in the band 36-37 GHz in order to define appropriate sharing criteria;

2 to recommend that WRC-07 review the results of the studies and consider the inclusion of the sharing criteria within the RR,

urges administrations

1 to provide characteristics of active systems (fixed and mobile services) operating in the band 36-37 GHz;

2 to avoid deploying a high density of stations in the fixed and mobile services in the band 36-37 GHz.

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2.5.5.3 SRS (space-to-Earth) in the band 37-38 GHz

2.5.5.3.1 Summary of technical and operational studies, and relevant ITU-R Recommendations

The band 37-38 GHz is allocated on a primary basis to the SRS (space-to-Earth). The band is also allocated on a primary basis to the fixed and mobile services. The sub-band 37.5-38 GHz is also allocated on a primary basis to the fixed-satellite service (space-to-Earth).

Relevant Recommendations ITU-R: SA.1017, SA.1396 and SA.1344.

2.5.5.3.2 Analysis of the results of studies

With respect to the SRS (space-to-Earth) allocation in the band 37-38 GHz, there have been no changes in the requirements for this allocation, nor have there been any changes in the sharing conditions in this band that would warrant any allocation changes to the SRS (space-to-Earth). However, there are ongoing ITU-R studies examining the sharing situation between the SRS (space-to-Earth) and the FSS (space-to-Earth) with a view towards establishing appropriate sharing conditions between the two services in the 37.5-38 GHz band.

2.5.5.3.3 Methods to satisfy the agenda item and their advantages and disadvantages

Method

Make no change to the SRS (space-to-Earth) allocation in the band 37-38 GHz and continue studies under normal ITU-R activities.

Advantages:

- No impact on other services operating in the band.
- Allow administrations to get data from space research instruments operating in this band.

Disadvantages:

None.

2.5.5.3.4 Regulatory and procedural considerations

None.

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2.6 Agenda item 1.16

"to consider allocations on a worldwide basis for feeder links in bands around 1.4 GHz to the non-GSO MSS with service links operating below 1 GHz, taking into account the results of ITU-R studies conducted in response to Resolution **127 (Rev.WRC-2000)**, provided that due recognition is given to the passive services, taking into account No. **5.340**"

2.6.1 Uplink allocation in the band 1 390-1 393 MHz

Spectrum requirements

A total of 1.525 MHz (space-to-Earth) and 1.9 MHz (Earth-to-space) are presently allocated on a worldwide primary basis to the MSS below 1 GHz. In addition, 2 MHz (Earth-to-space) in Region 2 is allocated to the MSS below 1 GHz. Some individual countries have additional allocations (Earth-to-space) for the MSS below 1 GHz, appearing in footnotes. These bands are allocated and used for both MSS feeder links and service links. In the preparation of WRC-97 and WRC-2000 views were expressed that additional spectrum may be required for MSS feeder links to alleviate spectrum congestion in the service links. There are many non-GSO MSS networks at frequencies below l GHz at some state of coordination under No. **9.11A**, and also many non-GSO MSS networks at the advance publication stage. *Considering b)* of Resolution **214 (Rev.WRC-2000)** indicated that, "in order to meet projected MSS requirements below 1 GHz, a range of an additional 7 to 10 MHz will be required in the near future", although "a number of these systems may not be implemented for reasons not connected with spectrum availability".

During WRC-03 preparation, no evidence of spectrum congestion of MSS service links below 1 GHz has been shown in ITU-R. Furthermore, many administrations are of the opinion that the experience of MSS below 1 GHz has demonstrated that the growth of the traffic could be accommodated in the existing frequency bands without requirement for an additional allocation.

It has to be noted that several frequency bands are already allocated in upper frequency bands (for example 5 091-5 250 MHz) for non-GSO MSS feeder links and could provide an alternative solution for feeder links of MSS systems with service links below 1 GHz.

2.6.1.1 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

Relevant Recommendations: ITU-R SA.1029, F.1242 and RA.769.

2.6.1.1.1 EESS (passive)

Regarding the impact on EESS (passive), Recommendation ITU-R SA.1029 contains the acceptable interference levels and related data availability criteria to the bands 1 370-1 400 MHz and 1 400-1 427 MHz. The acceptable interference power is –171 dBW in a reference bandwidth of 27 MHz. Several ITU-R studies have shown that use of the band 1 390-1 393 MHz for MSS uplinks would, in the worst case, require out-of-band emission attenuation between 108 and 128 dB. A recent contribution submitted by two administrations to ITU-R containing a preliminary study indicated that by limiting MSS earth station antenna side-lobe e.i.r.p. and attenuating the unwanted emissions of the earth station transmitters by 110 dB, in the band 1 400-1 427 MHz, protection of EESS (passive) can be provided. Theoretical analysis indicates that reduction of out-of-band and spurious emissions beyond the typical ITU-R levels could be achieved to assist in protecting the sensitive science services in the band 1 400-1 427 MHz by an appropriate combination of modulation techniques, filters and amplifier design. However the additional tests and measurements of emissions from equipment having the characteristics, performance and reliability of equipment that would be used in operational MSS systems, taking into account effects such as long-term shift of oscillators and their phase noise, amplifier thermal noise, amplifier non-linearity, local oscillator phase noise and Doppler effects to achieve the required attenuation have not yet been carried out as required by Resolution 127. Without confirmation by the above tests and measurements, an allocation close to the passive band 1 400-1 427 MHz is not considered by ITU-R as allowing sufficient protection to the EESS (passive).

Further studies conducted within the ITU-R have shown that, even with very advanced design, the filter rejection capability of passive sensors is limited to around 80 dB for a spectral separation of 7 MHz whereas between 94 and 101 dB will be required. A further reduction of the sensor bandwidth caused by even more extensive filtering is not feasible. Results of a preliminary study recently contributed to ITU-R indicate that emission limits on NVNG MSS earth stations combined with the EESS (passive) filter rejection capabilities are able to provide the required protection to EESS (passive) from MSS feeder uplinks in the band 1 390-1 393 MHz. However, this conclusion was not agreed by any of the relevant ITU-R working parties. The current filter design would require a spectral separation of up to 20 MHz taking into account acceptable insertion loss and hardware complexity.

Another important consideration is the secondary allocation to EESS (passive) in the band 1 370-1 400 MHz under No. **5.339**. Use of this band is made under the current interference environment given the currently allocated services. Although having a secondary status, EESS (passive) plans continued use of the band, which should be taken into account. Operation of MSS feeder links in the band 1 390-1 393 MHz would cause a level of interference that would preclude passive sensor operations in the 1 370-1 400 MHz band in large areas where MSS earth stations are within the field of view of EESS (passive) sensors.

2.6.1.1.2 Radio astronomy service

Protection of the radio astronomy service (RAS) stations is an important consideration for the deployment of MSS feeder uplinks in the 1 390-1 393 MHz band. The 1 330-1 400 MHz band is used by the RAS for observations of the red-shifted hydrogen (HI) line and No. **5.149** urges administrations to take all practicable steps to protect the RAS from harmful interference. Loss of access to this band would prevent scientists from access to critical information through observations that are carried out at a number of radio astronomy stations worldwide. Detrimental interference to radio astronomy stations observing in the 1 330-1 400 MHz or 1 400-1 427 MHz bands from MSS uplink transmissions operating in the band 1 390-1 393 MHz can be prevented by a combination of geographic location, protection (i.e. exclusion) zones around radio astronomy stations, and appropriate attenuation of unwanted emissions which may be readily achievable for the limited number of MSS feeder-link stations that would be implemented. However, to date no technical studies have been carried out concerning required separation distances between potential locations of MSS feeder uplink stations operating in the band 1 390-1 393 MHz in relation to existing RAS stations observing in the bands 1 330-1 400 MHz or 1 400-1 427 MHz.

2.6.1.1.3 Radiolocation service and radionavigation service

The radiolocation service has a primary allocation in the band 1 350-1 400 MHz. Systems in the radionavigation service are also continuing to operate in several countries in all Regions. Coordination between terrestrial stations of the radiolocation service and a limited number of MSS feeder-link earth stations could be done by applying international coordination procedures.

2.6.1.1.4 Fixed service

The band 1 350-1 400 MHz is allocated in Region 1 to the FS. Coordination between FS terrestrial stations and MSS feeder-link earth stations could be done by applying international coordination procedures. The number of MSS feeder-link stations is small, which lessens the coordination effort required.

Two of the three FS channelling plans defined in this frequency band by Recommendation ITU-R F.1242 overlap with the potential candidate for an MSS frequency allocation. The first one is pairing the band 1 427-1 452 MHz with 1 492-1 517 MHz. The second one is based on the pairing of the band 1 375-1 400 MHz with 1 427-1 452 MHz, with a duplex spacing of 52 MHz.

For countries using this second frequency arrangement, it can be noted that the candidate frequencies for the MSS feeder links are not aligned. As a consequence, this will increase the coordination effort by requiring to take into account about twice as many FS stations (stations being interfered with being different from interfering stations) for the coordination as compared to a choice of the frequencies that align with the fixed service plan. A solution would be to select an allocation for MSS feeder links in line with the FS channel plan. This could in addition increase the frequency separation between the downlink and the passive allocations in the 1 400-1 427 MHz band.

2.6.1.2 Analysis of the results of studies

2.6.1.2.1 EESS (passive)

Studies within ITU-R concluded that use of the band 1 390-1 393 MHz for MSS uplinks would require out-of-band emission attenuation between 108 and 128 dB to be implemented by the MSS transmitter, which is practically very difficult to achieve. Regarding the EESS (passive) receiver, the required filter rejection of 94 to 101 dB on-board the passive sensor satellite cannot be met with a spectral separation of only 7 MHz. A further reduction of the sensor bandwidth caused by even more extensive filtering is not feasible because of sensitivity requirements. A spectral separation of up to 20 MHz would be required. Operations of passive sensors having a secondary allocation in the band 1 370-1 400 MHz would be precluded from continuing by an MSS allocation in the band 1 390-1 393 MHz in large areas where MSS earth stations are within the field of view of EESS (passive) sensors. These studies did not take into account any additional degradation of data availability due to MSS.

One preliminary study recently contributed to ITU-R has shown that taking into account data availability requirements can result in the proposed MSS feeder links protecting the EESS (passive), while providing a data availability that exceeds the current requirement of 0.99 and a possible requirement of 0.999. However, this conclusion was not agreed by any of the relevant ITU-R working parties.

2.6.1.2.2 Other services

ITU-R has concluded that a new allocation would result in additional coordination and/or establishment of exclusion zones with radio astronomy stations, radiolocation stations and fixed and mobile stations.

2.6.2 Downlink allocations in the band 1 429-1 432 MHz

2.6.2.1 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

Relevant Recommendations: ITU-R SA.1029, F.1242, RA.769 and RA.1513.

2.6.2.1.1 Earth exploration-satellite service (passive)

Regarding the impact on EESS (passive), Recommendation ITU-R SA.1029 contains the acceptable interference levels and related time excess criteria. The acceptable interference power is −171 dBW in a reference bandwidth of 27 MHz and the related time excess criteria is 0.99 to be distributed to all relevant services causing interference. Studies have shown that use of the band 1 429-1 432 MHz for MSS downlinks requires an out-of-band attenuation of up to 73 dB. A recent study proposes emission limits on MSS illumination and demonstrates that these proposed limits and the proposed attenuation of out-of-band and spurious emissions may protect EESS (passive). Further studies conducted within the ITU-R have shown that, even with very advanced design, the filter rejection capability of passive sensors is limited to around 40 dB for a spectral separation of 3 MHz whereas between 52 and 56 dB will be required. These study results were obtained for the case of main beam to main beam coupling, which rarely occurs during EESS data gathering operations but could occur during sensor system calibrations. Only at a spectral separation in excess of 6 MHz could the required rejection level be achieved based on acceptable insertion loss and filter complexity.

A recent preliminary study showed that, when the EESS sensor system antenna pointing as used in data gathering operations is taken into account, the protection criteria for EESS (passive) sensor systems is met with large positive margins using the filter performance of current sensor system receivers. However, this conclusion was not agreed by any of the relevant ITU-R working parties.

2.6.2.1.2 Radio astronomy service

Resolution **127 (WRC-2000)** focuses on the 1 429-1 432 MHz band as the candidate band to be allocated for space-to-Earth feeder links to the non-GSO MSS, with service links operating below 1 GHz. This band is very close to the 1 400-1 427 MHz exclusive passive band, used by the RAS for observations of the 1 420 MHz spectral line of neutral hydrogen. Recommendation ITU-R RA.769, Tables 1 and 2, list the detrimental interference levels for the RAS in the 1 400-1 427 MHz band. They are given as –180 dB(W/m^2) in the entire 27 MHz band (1 400-1 427 MHz) for continuum observations, and as –196 dB(W/m^2) in a 20 kHz band for spectral line observations.

Recommendation ITU-R RA.1513 specifies 2% of time as the maximum data loss allowable to the RAS in any one band from any one system, and 5% of time as the maximum total loss of data in any one band from all sources.

Studies have shown that to meet the RAS continuum observation protection criteria in the 1 400-1 427 MHz band an attenuation of 67 dB would be required for the unwanted emission of a single downlink transmitter providing –152 dB (W/(m^2 · 4 kHz)) in-band spectral power flux-density, under the assumption of a flat spectrum over the 27 MHz. In addition, in order to meet the RAS spectral line observation protection criteria in the 1 400-1 427 MHz band, spurious artefacts of this transmitter should be attenuated by 51 dB in any 20 kHz portion of the band.

In order to define limits on the aggregate interference from a non-GSO constellation into radio astronomy frequency bands, the epfd concept has been adopted by ITU-R. The methodology of the calculation is described in Recommendation ITU-R M.[NGSO/RA]. Based on the epfd concept, as defined in Article **22**, the requirements on the aggregate unwanted emissions of a non-GSO constellation into the band 1 400-1 427 MHz could be stated as:

1) An epfd limit of –243 dB(W/m^2) in 27 MHz for 98% of the time at each radio astronomy station for continuum observations.

2) An epfd limit of –259 dB(W/m^2) in 20 kHz for 98% of the time at each radio astronomy station for spectral line observations.

The above values are based on a main beam gain of 63 dBi, for a 100 m diameter radio astronomy antenna. When considering epfd levels for the largest radio astronomy antenna in use (305 m diameter), a main beam gain of 73 dBi should be used to calculate the epfd limit.

Studies show that these levels might be met using emerging technologies, but the use of such large attenuations is not customary and has not been demonstrated. Given the importance of this band for the passive services, Resolution **127** states that it is necessary to conduct additional tests and measurements on transmissions from systems having the characteristics, performance and reliability of equipment, that would be used in operational systems, to validate theoretical analyses, taking into account effects such as long-term shift of oscillators and their phase noise, amplifier thermal noise, amplifier non-linearity, local oscillator phase noise and Doppler effects, and that such tests should be completed prior to WRC-03. No such studies have been submitted to ITU-R.

2.6.2.1.3 Fixed and mobile services

The band 1 427-1 452 MHz is allocated in all Regions to both fixed service and mobile service (except aeronautical mobile in the band 1 427-1 429 MHz in all Regions and in the band 1 429-1 452 MHz in Region 1). However, No. **5.342** provides an additional allocation for aeronautical mobile service (limited to aeronautical telemetry) in eight Region 1 countries above 1 429 MHz.

Coordination between terrestrial stations of the fixed service and MSS feeder-link earth stations would require international coordination procedures. The number of MSS feeder-link stations is expected to be small which would reduce the coordination effort required.

Two of the three FS channelling plans defined in this frequency band by Recommendation ITU-R F.1242 overlap with the candidate MSS frequency bands considered under agenda item 1.16. The first one is pairing the band 1 427-1 452 MHz with 1 492-1 517 MHz. The second one is based on the pairing of the band 1 375-1 400 MHz with 1 427-1 452 MHz, with a duplex spacing of 52 MHz.

For countries using this second frequency arrangement, it can be noted that the candidate frequencies for the MSS feeder links are not aligned. As a consequence, this will increase the coordination effort by requiring to take into account about twice as many FS stations (stations being interfered with being different from interfering stations) for the coordination as compared to a choice of the frequencies that align with the fixed service plan. A solution would be to select an allocation for MSS feeder links in line with the FS channel plan. This could in addition increase the frequency separation between the downlink and the passive allocations in the 1 400-1 427 MHz band.

The band 1 427-1 452 MHz is of particular importance in many countries as this band is used intensively for low capacity long haul radio relays, including some security applications. The FS does not share this band with space services and has evolved its applications globally, primarily low cost rural, point-to-multipoint systems in developing and developed countries, without this constraint. Therefore, protection of fixed service in this frequency band needs particular attention. In addition, pfd limits are preferred for the non-GSO MSS feeder-link space segment to remove the need for any coordination with the fixed service.

Several administrations use the band 1 429-1 453 MHz for a digital cellular land mobile telecommunication system in the mobile service. The service needs to be protected from harmful interference caused by the proposed space-to-Earth feeder links of non-GSO MSS.

2.6.2.2 Analysis of the result of studies

2.6.2.2.1 Earth exploration-satellite service (passive)

Should an allocation be made, an out-of-band emission attenuation of 73 dB to be implemented by the MSS transmitter would be required to protect the EESS (passive). Regarding the EESS (passive) receiver, the required filter rejection of 52 to 56 dB on-board the passive sensor satellite cannot be met with a spectral separation of only 3 MHz. A further reduction of the sensor bandwidth caused by even more extensive filtering is not feasible because of sensitivity requirements. A spectral separation in excess of 6 MHz would be required.

2.6.2.2.2 Radio astronomy service

The following limits would ensure the protection of all but the most sensitive radio astronomy stations from unwanted emission of the non-GSO MSS feeder links space stations:

1) An epfd limit of -243 dB(W/m^2) in a 27 MHz bandwidth for 98% of the *time* at each radio astronomy station for continuum observation.

2) An epfd limit of -259 dB(W/m^2) in any 20 kHz bandwidth within the 1 400 MHz to 1 427 MHz band, for 98% of the *time* at each radio astronomy station for spectral line observation.

The above values are based on a main beam gain of 63 dBi, for a 100 m diameter radio astronomy antenna. When considering epfd levels for the largest radio astronomy antennas in use (305 m diameter), a main beam gain of 73 dBi should be used to calculate the epfd limit.

2.6.2.2.3 Fixed service

Results of sharing studies within ITU-R have concluded that the following pfd limits applied to non-GSO MSS feeder links should be adequate to protect the fixed service in the 1.4 GHz band:

–140	dB(W/m^2 in 1 MHz)	for	$\theta \leq 5°$
–140 + 0.5 (θ – 5)	dB(W/m^2 in 1 MHz)	for	$5° < \theta \leq 25°$
–130	dB(W/m^2 in 1 MHz)	for	$25° < \theta \leq 90°$

where:

θ: angle of arrival above the horizontal plane (degrees).

These pfd limits are to be applied under assumed free-space propagation conditions. Also, any new allocation should be aligned with a fixed service pairing arrangement in order to ease coordination.

2.6.3 Methods to satisfy the agenda item and their advantages and disadvantages

2.6.3.1 Method A1

Make an allocation to the MSS for feeder uplinks in the band 1 390-1 393 MHz with the necessary protection for currently allocated services.

Advantages:

Provides additional spectrum for feeder links for non-GSO MSS systems with service links below 1 GHz.

Disadvantages:

Protection of EESS (passive) in the band 1 400-1 427 MHz requires attenuation of unwanted emission levels of up to 128 dB on the MSS transmitter side. The possibility of achieving these high out-of-band attenuation levels has not yet been demonstrated. The EESS (passive) receiver may have to increase its band-pass filter rejection up to 101 dB, which is considered not feasible because of further reduction of available sensor bandwidth and insertion losses. A spectral separation of up to 20 MHz would be required. Use of the EESS (passive) secondary allocation in the band 1 370-1 400 MHz would be precluded due to in-band interference in large areas where MSS earth stations are within the field of view of EESS (passive) sensors. Sufficient geographical separation is required between MSS feeder-link earth stations and stations of other services (RAS, RLS, FS and MS). Continued access to the 1 330-1 400 MHz band by the RAS may be constrained, although further studies are required.

2.6.3.2 Method A2

Make no allocation to the MSS in the band 1 390-1 393 MHz.

Advantages:

No impact on existing services.

Disadvantages:

Does not provide any additional spectrum for feeder links for non-GSO MSS systems with service links below 1 GHz.

2.6.3.3 Method B1

Make an allocation to the MSS for feeder downlinks in the band 1 429-1 432 MHz with the necessary protection for currently allocated services (epfd limits for protection of the radio astronomy and pfd limits for the protection of fixed and mobile services).

Advantages:

Provides additional spectrum for feeder links for non-GSO MSS systems with service links below 1 GHz.

Disadvantages:

Protection of EESS (passive) in the band 1 400-1 427 MHz requires attenuation of unwanted emission levels of up to 73 dB on-board the MSS satellite or slightly lower levels if combined with limits on the MSS satellite e.i.r.p. In addition, the EESS (passive) receiver would have to increase its band-pass filter rejection up to 56 dB, to maintain protection during the rarely occurring case of main beam to main beam coupling. This level of filtering is considered not feasible because of further reduction of available sensor bandwidth and insertion losses. Protection of the RAS in the band 1 400-1 427 MHz requires attenuation of unwanted emission levels of up to 85 dB.

2.6.3.4 Method B2

Make no allocation to the MSS in the band 1 429-1 432 MHz.

Advantages:

No impact on existing services.

Disadvantages:

Does not provide any additional spectrum for feeder links for non-GSO MSS systems with service links below 1 GHz.

2.6.4 Regulatory and procedural considerations

Methods A1 and B1 would require modification of Article **5** for a new allocation.

Further modification of Articles **5** and/or **21** may be necessary to define pfd and epfd limits.

Unwanted emission levels may have to be specified for the MSS transmitters in appropriate footnotes of the Radio Regulations.

The conference may consider suppression of Resolution **127 (Rev.WRC-2000)**.

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2.7 Agenda item 1.20

"to consider additional allocations on a worldwide basis for the non-GSO MSS with service links operating below 1 GHz, in accordance with Resolution **214 (Rev.WRC-2000)**"

2.7.1 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

Spectrum requirements

A total of l.525 MHz (space-to-Earth) and l.9 MHz (Earth-to-space) are presently allocated on a worldwide primary basis to the MSS below l GHz and 300 kHz (Earth-to-space) is allocated for land MSS on a worldwide primary basis. An additional 151.5 MHz may be used subject to the agreement obtained under No. **9.21**, which would make it difficult. In addition, 2 MHz (Earth-to-space) in Region 2 is allocated to the MSS below 1 GHz. Some individual countries have additional allocations (Earth-to-space) for the MSS below l GHz, appearing in footnotes. These allocations are for both the MSS service links and feeder links.

There are many non-GSO MSS networks at frequencies below l GHz at some state of coordination under No. **9.11A**, and also many non-GSO MSS networks at the advance publication stage.

Considering b) of Resolution 214 (Rev.WRC-2000) indicated that, "in order to meet projected MSS requirements below 1 GHz, a range of an additional 7 to 10 MHz will be required in the near future" although "a number of these systems may not be implemented for reasons not connected with spectrum availability. During WRC-03 preparation, no evidence of spectrum congestion of MSS service links below 1 GHz has been shown in ITU-R. Furthermore, many administrations are of the opinion that the experience of MSS below 1 GHz has demonstrated that the growth of the traffic could be accommodated in the existing frequency bands without a requirement for an additional allocation.

2.7.1.1 Sharing between non-GSO MSS Earth-to-space links and the land mobile and the fixed services in the band 450-470 MHz

There are many kinds of terrestrial systems operating in the band 450-470 MHz which have varied technical and operational requirements (such as density distributions, necessary C/(N + I) ratios and antenna heights). Therefore, at this time, it might be difficult to provide single value protection or sharing criteria applicable to all such systems. ITU-R conducted sharing studies relevant to possible additional Earth-to-space allocations to the non-GSO MSS with a view on a variety of scenarios that were examined with differing technical characteristics for systems in the mobile service and for systems in the mobile-satellite service.

2.7.1.1.1 Sharing between non-GSO MSS Earth-to-space links and the land mobile service

Several studies have been carried out using the statistical simulation model in Recommendation ITU-R M.1039, Annex 3, to determine the probability of interference between narrow-band, FDMA non-GSO MSS Earth-to-space links and land mobile service in the bands 450-470 MHz. In most studies the non-GSO MSS systems have been modelled using MSS networks with 48 satellites, and in one study 81 satellites were used. Both of these MSS networks are defined in Recommendation ITU-R M.1184. The MES antenna heights used in the studies were 1.5 m and 3 m, and MES data rates used were up to 9.6 kbit/s. The mobile earth stations were uniformly distributed over the land area within the satellite beam (12 million km^2). Certain operational constraints, such as MES transmission duration and transmission duty cycle limitations were used for the non-GSO MSS networks in the studies.

The studies assumed the following characteristics for various land mobile systems:

- An analogue, frequency modulation system (or digitally modulated, binary-FSK system); a vertically polarized antenna having 0 dBi gain towards the satellite; 10 m^2 antenna height product; minimum received signal power assumed to be −140 dBW; and channel bandwidths of 6.25, 12.5 and 25.0 kHz.
- Analogue FM or digital modulation; 5 dBi antenna gain toward the horizon; 200 m antenna height resulting in an antenna height product of 600 m^2; C/(I + N) of 17 dB and channel bandwidths of 16 and 25 kHz.
- Digital modulation, 25 kHz channel spacing, 1.5 m mobile antenna height with 45 dBm transmitter power, and 50 m base station antenna height with 40 dBm transmitter power. The second system used digital modulation, 6.25 kHz channel spacing, 2 m mobile antenna height with a maximum of 38.5 dBm transmitter power, and 200 m base station antenna height with 48 dBm transmitter power. The analogue systems used 12.5 kHz channel spacing, 1.5 m mobile antenna height with 38 dBm transmitter power, and 50 m base station antenna height with 38 dBm transmitter power. The threshold of interference in both cases was a carrier-to-interference ratio less than 19 dB.

The different scenarios studied included MSS uplinks sharing with digital or analogue MS systems only. In addition two different scenarios of a mixed analogue/digital MS system environment were examined:

- a geographically mixed environment where analogue and digital MS systems operate in the same frequency band but in different geographical areas; and
- a mixed environment in different frequency band segments where analogue and digital MS systems in the same area operate in different parts of the frequency band shared with the MES uplinks.

For the range of parameters studied, the modelled probabilities of interference into a single terrestrial link were between 0.003% and 0.1%. The greatest probability of interference in the results (0.1%) may be viewed (for a 99% availability/1% unavailability MS channel) as a reduction of availability from 99% to 98.9% and a corresponding change in unavailability of 1% increased to only 1.1%. These studies did not address the network aspects of the land mobile service.

Further studies were performed using the analytical method in Annex 1 of Recommendation ITU-R M.1039 to estimate the probability of interference from the non-GSO MSS FDMA narrow-band uplinks into the MS mobile and base station receivers in the band 450-470 MHz. Applications of the MS systems support public safety and broadcast programme production. The non-GSO MSS network has Earth-to-space links from mobile earth stations with antenna heights of 1.5 m. The technical characteristics of the MS systems are those of systems operating in an Asian region. The antenna height of mobile stations is typically 1.5 m and the effective antenna heights of base stations vary from 37.5 m to 300 m. Due to the greater antenna height the base stations would suffer more serious interference than the mobile stations in most cases.

The calculation shows an interference probability of 19% to mobile wireless systems for broadcasting utilities, which is considered unacceptable.

It was found that the probabilities of interference depend in large measure on the assumed distribution of MES in the service area. In the above studies, the MES terminals are distributed in an area of 33 thousand km^2 considering the actual operation area.

Further consideration was made regarding low-power (1 mW) systems which are operated in the 450 MHz band in Region 3 for voice communication in construction sites, power plants, etc, where interference to the systems can endanger the users. Considering that the receiving signal level of the wireless systems is about –100 dBm and the transmitting power level of MSS earth stations is about 3 watts, separation distances required between two systems would be large. Thus co-frequency sharing with MSS systems is impractical.

None of the studies were conducted with the use of a dynamic channel activity assignment system (DCAAS), as described in Annex 4 of Recommendation ITU-R M.1039, in the MSS network. In an operational MSS system with DCAAS, used to detect and to avoid active MS channels, the probability of interference may be lower than the values calculated in this study. However, low power devices may be of insufficient power for detection by the satellite, thus rendering DCAAS ineffective.

2.7.1.1.2 Sharing studies between non-GSO MSS Earth-to-space links and the fixed service

Studies were not conducted to demonstrate that fixed service and non-GSO MSS Earth-to-space links can share the same frequency band in the frequency bands around 460 MHz.

2.7.2 Analysis of results of studies

Studies have been conducted by the ITU-R with respect to co-frequency sharing between narrow-band, FDMA MSS uplinks and mobile service systems. Some studies showed low probabilities of interference to the mobile service, but others for example where low power MS systems were used resulted in significantly higher interference probabilities. This difference is caused by the differing technical parameters of MS and MSS systems and the models used in the studies.

Sharing studies did not consider sharing between narrow-band, FDMA MSS uplinks and fixed service. In addition, there are other specific cases that have not been studied, such as the network aspects of the land mobile service.

2.7.3 Methods to satisfy the agenda item and their advantages and disadvantages

No additional allocation to accommodate the MSS below 1 GHz.

Advantage:

Fully protects the existing services below 1 GHz.

Disadvantage:

Does not provide additional MSS spectrum.

2.7.4 Regulatory and procedural considerations

With no additional allocations, no changes are required to the existing Article **5** of the Radio Regulations.

The Conference may consider the suppression of Resolution **214 (Rev.WRC-2000)**.

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2.8 Agenda item 1.31

"to consider the additional allocations to the mobile-satellite service in the 1-3 GHz band, in accordance with Resolutions **226 (WRC-2000)** and **227 (WRC-2000)**"

2.8.1 Resolution 226 (WRC-2000)

"Sharing studies for, and possible additional allocations to, the mobile-satellite service (space-to-Earth) in the 1-3 GHz range, including consideration of the band 1 518-1 525 MHz"

2.8.1.1 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

2.8.1.1.1 Sharing with aeronautical mobile telemetry (AMT) systems

Recommendation ITU-R M.1459 provides the framework for conducting sharing studies between aeronautical mobile telemetry systems and the mobile satellite service. Recommendation ITU-R M.1459 was approved in 2000 and contains the pfd values to protect AMT systems applicable to GSO MSS systems. Recommendation ITU-R M.1459 takes into account a range of AMT systems with different characteristics and considers a variety of sharing scenarios, including worst-case sharing scenarios, which resulted in very stringent protection criteria for AMT systems. Recommendation ITU-R M.1459 also defines a number of mitigation techniques that may facilitate sharing and acknowledges the need for further studies on this sharing matter.

The AMT systems considered in the Recommendation and operating in the 1 518-1 525 MHz band are representative of the systems operating in the USA. Flight testing in the USA is also performed on behalf of a number of other administrations. Flight testing carried out in the USA uses the band 1 435-1 525 MHz and has priority over other uses by the mobile service.

Recommendation ITU-R M.1459, *considering p*), states "that telemetry stations in the aeronautical mobile service have a wide range of characteristics and some may have less stringent protection criteria values than those contained in the recommends". AMT systems operating in the band 1 518-1 525 MHz in the countries listed in No. **5.342** significantly differ from the characteristics given in Recommendation ITU-R M.1459. The frequency band concerned is used for the radio links for transmitting command signals to deliver telemetry data from a test aircraft. The value of pfd equal to -140 dB(W/m^2) in a 4 kHz bandwidth should be considered as the permissible level of interference to protect the considered type of AMT systems operating in the band 1 518-1 525 MHz in the countries listed in No. **5.342**. This value of permissible pfd level is based on the results of theoretical and experimental studies.

Other studies submitted within the ITU-R addressed the implementation of particular interference mitigation techniques described in Recommendation ITU-R M.1459 that, if practical, would allow MSS systems to exceed the pfd levels in this Recommendation without causing harmful interference to the aeronautical mobile telemetry systems.

Relevant RR provisions: Nos. **5.342**, **5.343**, **5.344**, **5.348**, and **5.348A**.

2.8.1.1.2 Sharing with the fixed service

Regarding sharing with the fixed service, Recommendations ITU-R M.1141 and M.1142 contain coordination pfd threshold values applicable to non-GSO MSS and GSO MSS respectively.

Some administrations have deployed point-to-multipoint systems operating below 1 520 MHz. These systems are deployed over large areas and provide services to isolated and remote communities. These administrations believe that these systems may be impacted by interference from MSS, considering the engineering and economic challenges associated with their deployment scenario.

2.8.1.1.3 Sharing with the mobile service

ITU-R studies have been conducted regarding sharing between MSS and mobile systems that operate in Japan.

2.8.1.2 Analysis of the results of studies

Sharing studies have been conducted with regard to a possible MSS downlink allocation in Regions 1 and 3 in the band 1 518-1 525 MHz.

2.8.1.2.1 Sharing with AMT

Nos. **5.342** and **5.344** provide an allocation to AMT systems in this band in a number of countries. AMT systems operate in this band in a number of countries. A small number of these countries manufacture the majority of the world's aircraft.

Studies submitted to the ITU-R indicate that the pfd values in Recommendation ITU-R M.1459 are consistent with the characteristics of AMT systems operating in one country in Region 2. These pfd values are the following (in any 4 kHz):

-181.0 dB(W/m^2)	for $0° \le a \le 4°$
$-193.0 + 20 \log a$ dB(W/m^2)	for $4° < a \le 20°$
$-213.3 + 35.6 \log a$ dB(W/m^2)	for $20° < a \le 60°$
-150.0 dB(W/m^2)	for $60° < a \le 90°$

A number of studies have been considered with regard to these values. All studies have agreed that, if GSO MSS systems were limited to these values for a particular territory, operation of MSS systems within that territory would not be possible.

Another study submitted to the ITU-R provided a pfd level equal to -144.4 dB(W/m^2) in a 4 kHz bandwidth to be considered as the protection level for aeronautical telemetry systems operating in the band 1 518-1 525 MHz in the countries in Region 1, that is those listed in No. **5.342**. In this theoretical study the worst-case interference approach were used. As a result it leads to overestimation of the protection requirements of aeronautical telemetry systems. At next stage of this study the more realistic approach was implemented, involving experimental evaluation of protection requirements for the aeronautical mobile telemetry systems. The result of experimental study show that, for the protection of aeronautical telemetry systems operating in the band 1 518-1 525 MHz in the countries listed in No. **5.342**, a pfd level equal to –140 dB(W/m^2) in a 4 kHz bandwidth needs to be applied to the MSS systems in this band. This pfd level would allow co-coverage operation of many types of MSS systems. Studies submitted to ITU-R did not indicate any deployment of AMT systems in Region 3. From the above information, it is concluded with respect to AMT, that operation of MSS in the band 1 518-1 525 MHz in Regions 1 and 3 is technically feasible.

The sharing studies regarding AMT systems conforming to the characteristics of Recommendation ITU-R M.1459 present diverse and sometimes conflicting views, and these different views are discussed below.

a) Several administrations' view of the sharing studies

Studies submitted to the ITU-R indicate that, in the band 1 518-1 525 MHz, only one administration operates AMT systems with characteristics consistent with Recommendation ITU-R M.1459. Such AMT systems operate in the band 1 435-1 525 MHz in that administration.

Studies have shown that, if the pfd values given in Recommendation ITU-R M.1459 are applied throughout the USA (including Alaska, Hawaii and Puerto Rico), MSS operation from 30% of orbital locations is possible. This value increases to about 42% if the pfd values are limited to the continental USA only.

Recommendation ITU-R M.1459 states that the analysis leading to the pfd levels given in the Recommendation represents a worst-case scenario and a number of interference mitigation techniques are listed in Annex 2 of the Recommendation to enhance the sharing. Studies have explored some of these mitigation techniques and have shown that the Recommendation ITU-R M.1459 pfd levels could be relaxed significantly by implementation of these techniques while still maintaining sufficient protection of the AMT systems.

Studies have concluded that around 25 dB antenna discrimination is available from aeronautical telemetry stations with site diversity, i.e. with the implementation of site diversity, the pfd levels (in a 4 kHz bandwidth) of Recommendation ITU-R M.1459 can be relaxed for high elevation angles as shown below.

-181.0 dB(W/m^2)	for $0° \le a \le 4°$
$-190.75 + 2.44a$ dB(W/m^2)	for $4° < a \le 20°$
$-188.3 + 35.6 \log(a)$ dB(W/m^2)	for $20° < a \le 60°$
-125.0 dB(W/m^2)	for $60° < a \le 90°$

There would be no "keep-out" zones for aircraft using the AMT service because, at those satellite elevation angles at which site diversity is ineffective, the unmitigated pfd values of Recommendation ITU-R M.1459 are applied. This new set of pfd levels allows satisfactory non-co-coverage operation of GSO MSS satellites that are visible from AMT service areas at 15 degrees satellite elevation or more, without causing interference to the AMT service. These pfd levels would allow MSS operation from about 55% of GSO orbital locations if applied to continental USA. With these pfd levels, co-coverage sharing between AMT and MSS is also possible for GSO MSS satellites operating above 40 degrees elevation to low antenna gain mobile earth stations (MES). For MSS systems using high antenna gain MES, co-coverage operation at lower elevation angles would be possible. The studies have also shown that the MSS will have high service availability in the presence of interference from AMT systems.

Studies submitted to ITU-R provided extensive information on satellite antenna side lobe performance characteristics of currently operational and planned MSS systems. The studies showed that MSS systems are capable of providing antenna discrimination levels in the range of 20-25 dB. The studies also concluded that station keeping of MSS satellites would not adversely impact the sharing feasibility especially with those MSS systems implementing digital beam forming mechanism. Electronic beam steering by regular updates of the satellite beam coefficients allows MSS satellites to have high inclination angles while accurately maintaining the satellite footprint on the ground. This would ensure that MSS systems comply with the necessary pfd limits.

In another study the sharing scenario between the two services has been analysed, considering implementation of other mitigation techniques. This analysis has shown that MSS operation is potentially possible from all orbital locations if the following pfd values are applied to the USA (in a 4 kHz bandwidth):

-156 dB(W/m^2)	for	$0° \leq a \leq 4°$
$-156.4 + 0.111a$ dB(W/m^2)	for	$4° < a \leq 60°$
-150 dB(W/m^2)	for	$60° < a \leq 90°$

Applying these pfd values could reduce the available airspace at some AMT stations operating in the USA and this loss would have to be overcome by mitigation. As an example of one of the many mitigation techniques available, the criterion described in Recommendation ITU-R M.1459 can be met by increasing the AMT system carrier power by 1 dB. This figure reduces to 0.38 dB if there is no interference from fixed service stations to consider.

At some AMT stations where the receiving antenna points close to the geostationary arc for long periods, additional mitigation is required. An example of another mitigation technique is to use frequency avoidance. With this method, those AMT stations requiring additional mitigation would be assigned frequencies, which are not constrained by MSS operations. Of the total primary allocation to AMT systems, 7.8% would be constrained by MSS, leaving 92.2% of the available band for use in this mitigation technique.

In summary, an MSS allocation in the band 1 518-1 525 MHz is feasible, while protecting AMT systems. Without the use of any mitigation techniques by the AMT systems, the MSS would be able to use about 30% of the geostationary orbit. However, there are practical mitigation techniques that would lead to a more equitable sharing of the spectrum between AMT and MSS downlinks. The pfd values needed to protect AMT systems depend on the choice of mitigation techniques.

b) Another view of the sharing studies

Studies submitted to the ITU-R show, in accordance with Recommendation ITU-R M.1459, that GSO MSS and aeronautical mobile telemetry are fundamentally incompatible under co-coverage scenarios, and that sharing is not feasible without causing harmful interference to AMT operations. AMT systems use low-gain transmit antennas (~2 dBi) and high gain (30 dBi) receive antennas. GSO MSS satellites use extremely high gain (~40 dBi) downlink antennas and mobile earth stations use low-gain (~2 dBi) receive antennas. This fundamental asymmetry in the competing links precludes sharing if an MSS satellite is within line of sight of an AMT ground station and exceeds the protection levels in Recommendation ITU-R M.1459. Without meeting the protection levels in Recommendation ITU-R M.1459, GSO MSS satellites in Region 1 and 3 visible to AMT ground stations in Region 2 will interfere with AMT operations.

Some mitigation techniques proposed in the ITU-R studies impose impractical or unrealistic constraints on AMT. Using site diversity, for example, results in unacceptable "keep-out" zones within the test ranges. Some test ranges could become unusable in this band if GSO MSS satellites, operating at these frequencies and visible to the test ranges, are deployed. Relocation of flight test air space is not possible because the air space and spectrum in use at existing ranges is already congested. In addition, safety considerations, i.e. not flying over populated areas or in commercial airspace, prevent relocation of existing fight test air space. Indeed, harmful interference will occur for main lobe to main lobe conjunction between MSS satellites and AMT ground antennas, and for some main lobe to side lobe and side lobe to side lobe conjunctions. Specific scenarios will require further evaluation.

Other proposed mitigation techniques, such as the use of post-processing to recover lost data, are already in use. Error correction is currently used in the coding of digital flight test data prior to transmission, and proposed additional error correction will require increased spectrum, which is not available. In any event, the maximum performance advantage of such techniques is minimal (~5 dB) with respect to the overall interference deficit. Depending on modulation techniques and channel fading characteristics, the improvement would be less.

In addition, the sharing studies need to address other detailed technical issues that could impact sharing feasibility. For instance, more definitive information about MSS antenna side lobes and orbit station-keeping would be useful. It is noted that station keeping tolerances are already cited in the ITU Radio Regulations. The failure to address these issues underscores the incompleteness of existing sharing studies. Moreover, sharing studies have failed to address the escalating complexity of the "keep-out" zones that will result as additional MSS satellites are placed into orbit within view of AMT ground stations. The studies have not taken into account the aggregate effect of multiple MSS satellite systems with differing satellite designs. Finally, consideration of I/N margins, with respect to permissible levels used in sharing situations with other services, should be considered.

Range safety considerations are critical in the AMT context and must not be compromised by implementation of impractical sharing methods.

Note that the characteristics of a given telemetry system generally do not vary with frequency over the band 1 435 -1 525 MHz.

c) Common views with respect to sharing between MSS and AMT

In spite of the views reflected in a) and b) above, ITU-R has agreed that the use of the band 1 518-1 525 MHz by the MSS is feasible although the application of Recommendation ITU-R M.1459 pfd values would limit the MSS operation to 30% of the geostationary arc. However, this limitation in the GSO arc allows MSS to provide its services in Region 1 and 3 and sufficiently protect the AMT systems operating in Region 2 in conformance with Recommendation ITU-R M.1459.

Considering the recent information made available to ITU-R on the existing and future planned operations of AMT systems in the USA, a few specific AMT sites would require a pfd protection value of –155 dBW/m^2 per 4 kHz as a lower bound. This will allow MSS downlink operation from 45% of the GSO arc in spite of application of Recommendation ITU-R M.1459 pfd values to the geographic region where there are flight test ranges in continental United States.

The MSS downlink operation would be possible from any orbital location within the following ranges of the geostationary orbit:

– 7° E to 157° E and 112° W to 100° W (these values may be affected by satellite parameters such as orbital inclination).

2.8.1.2.2 Sharing with other mobile services

In the territory of Japan, the following pfd coordination threshold applies: –150 dB(W/m^2) in a 4 kHz bandwidth at all angles of arrival as specified in Appendix **5**. Recent ITU-R studies have recognized that this value continues to be applicable. MSS service could be provided outside the territory of Japan and a surrounding area while meeting this pfd value in Japan.

2.8.1.2.3 Sharing with the FS

Recommendations ITU-R M.1141 and M.1142 recommend the following pfd threshold values for non-GSO and GSO MSS systems to protect FS systems:

pfd per space station at angle of arrival δ (degrees) (dB(W/m^2) in a 1 MHz bandwidth)	–128 –128 + 0.5 (δ – 5) –118	for 0° ≤ δ < 5° for 5° ≤ δ < 25° for 25° ≤ δ ≤ 90°

These values are currently included in RR Appendix **5**. Both recommendations were approved in 1997. Studies conducted since 1997 have confirmed that these pfd values provide adequate protection to FS systems from GSO MSS space stations. These pfd values will allow co-coverage sharing with some MSS systems.

2.8.1.3 Methods to satisfy the agenda item and their advantages and disadvantages

2.8.1.3.1 Method A

Make a primary MSS (space-to-Earth) allocation in Regions 1 and 3 in the band 1 518-1 525 MHz. Protection of other services in the band would be ensured through the following provisions:

- pfd coordination thresholds consistent with Recommendation ITU-R M.1459 to protect AMT systems operating in the USA. These thresholds can be relaxed by the application of a number of mitigation techniques;
- a pfd level of –140 dB(W/m^2) in a 4 kHz bandwidth as a permissible level to protect AMT systems operating in the countries listed in No. **5.342**;
- pfd coordination thresholds given in Recommendations ITU-R M.1141 and M.1142, as already provided in Appendix **5**, to ensure protection of FS systems;
- a pfd coordination threshold of –150 dB(W/m^2) in a 4 kHz bandwidth, as already provided in Appendix **5**, to protect mobile services in Japan.

The existing MSS allocation in Region 2 in the range 1 492-1 518 MHz could be suppressed.

WRC-03 may consider the suppression or modification of Resolution **226 (WRC-2000)**.

Advantages:

- An additional global allocation would be available to the MSS.
- The need for additional MSS spectrum in the vicinity of the existing 1.5 GHz allocations, recognized in Resolution **226**, would be met.
- The new allocation would alleviate the MSS spectrum congestion.
- The new allocation is contiguous to the existing L-band MSS allocations, enabling speedy and less complex implementation of new networks using both the existing and the new allocation.
- The constraints on MSS required for protection of existing services would be acceptable, especially with the use of interference mitigation techniques.

- With the implementation of this method, all services operating in the band would be protected.
- The suppression of the Region 2 MSS allocation in the band 1 492-1 518 MHz would leave AMT systems unconstrained by MSS below 1 518 MHz.

Disadvantages:

- If the MSS were limited to the pfd limits in Recommendation ITU-R M.1459 without mitigation, then MSS systems would be constrained to a limited part of the geostationary orbit, in order to avoid causing harmful interference to AMT systems in the USA.
- There is no agreement on the use of the proposed mitigation techniques.
- Proposed mitigation techniques may not be practicable at some sites due to existing constraints and range safety concerns on AMT operations in the USA.

2.8.1.3.2 Method B

Make a primary MSS (space-to-Earth) allocation in Regions 1 and 3 in the band 1 518-1 525 MHz. Protection of other services in the band would be ensured through the following provisions:

- pfd limits consistent with Recommendation ITU-R M.1459 to protect AMT systems operating in continental United States west of 71° W. A pfd limit of −155 dB (W/m^2) in a 4 kHz bandwidth to protect AMT systems operating in Alaska, Hawaii and Puerto Rico;
- a pfd level of −140 $dB(W/m^2)$ in a 4 kHz bandwidth as a permissible level to protect AMT systems operating in the countries listed in No. **5.342**;
- pfd coordination thresholds given in Recommendations ITU-R M.1141 and M.1142, as already provided in Appendix **5**, to ensure protection of FS systems;
- a pfd coordination threshold of −150 $dB(W/m^2)$ in a 4 kHz bandwidth, as already provided in Appendix **5**, to protect mobile services in Japan.

The existing MSS allocation in Region 2 in the range 1 492-1 518 MHz could be suppressed.

WRC-03 may consider the suppression or modification of Resolution **226 (WRC-2000)**.

Advantages:

- An additional global allocation would be available to the MSS.
- The need for additional MSS spectrum in the vicinity of the existing 1.5 GHz allocations, recognized in Resolution **226**, would be met.
- The new allocation would reduce the MSS spectrum congestion.
- The new allocation is contiguous to the existing L-band MSS allocations, enabling speedy and less complex implementation of new networks using both the existing and the new allocation.
- The constraints on MSS required for protection of existing services would be acceptable.
- With the implementation of this method, all services operating in the band would be protected.
- The suppression of the Region 2 MSS allocation in the band 1 492-1 518 MHz would leave AMT systems unconstrained by MSS below 1 518 MHz.

Disadvantages:

- MSS systems would be constrained to 45% of the geostationary orbit, in order to avoid causing harmful interference to AMT systems in the USA. The usable orbital locations for MSS are defined within the GSO arc ranges (7 E to 157 E) and (112 W to 100 W).

2.8.1.3.3 Method C

No MSS allocation in Regions 1 and 3 in the 1 518-1 525 MHz band. It may be appropriate to suppress the MSS allocation in Region 2. WRC-03 may consider the suppression or modification of Resolution **226**.

Advantages:

- There would be no effect on existing services.
- AMT systems are not further constrained.
- AMT operators would not be required to change their operational practices.

Disadvantages:

- The need for additional MSS spectrum in the vicinity of the existing 1.5 GHz allocations, recognized in Resolution 226, would not be met.
- New allocations to the MSS would have to be found in other bands.
- If additional MSS allocations were made in non-contiguous bands, the implementation of new networks using both existing and new spectrum would be delayed and become more complex.

2.8.1.3.4 Method D

Make a primary MSS (space-to-Earth) allocation in Regions 1 and 3 in the band 1 520-1 525 MHz. This would align the MSS allocation across all three Regions in this band. Protection of other services in the band would be ensured through the same provisions suggested under Method A in § 2.8.1.3.1. As with Method A, the MSS allocation below 1 520 MHz in Region 2 could be suppressed.

WRC-03 may consider the suppression or modification of Resolution **226**.

Advantages:

- An additional global allocation would be available to the MSS.
- The new allocation would partially alleviate the MSS spectrum congestion.
- The new allocation is contiguous to the existing L-band MSS allocations, enabling speedy and less complex implementation of new networks using both the existing and the new allocation.
- The constraints on MSS required for protection of existing services would be acceptable, especially with the use of interference mitigation techniques.
- With the implementation of this method, all services operating in the band would be protected.
- The performance of point-to-multipoint systems operating below 1 520 MHz would not be affected.
- The suppression of the Region 2 MSS allocation in the band 1 492-1 520 MHz would leave AMT systems unconstrained by MSS below 1 520 MHz.

Disadvantages:

- If the MSS were limited to the pfd limits in Recommendation ITU-R M.1459 without mitigation, then MSS systems would be constrained to a limited part of the geostationary orbit, in order to avoid causing harmful interference to AMT systems in the USA.
- There is no agreement on the use of the proposed mitigation techniques.
- The need for 2 × 7 MHz of additional MSS spectrum in the vicinity of the existing 1.5 GHz allocations, recognized in Resolution 226, would not be met.
- Proposed mitigation techniques may not be practicable at some sites due to existing constraints and range safety concerns on AMT operations in the USA.

2.8.1.3.5 Consideration of other bands

Current use of the band 1 492-1 517 MHz

The 1 492-1 517 MHz band is extensively used in some administrations by subscriber radio systems in the FS in a point-to-multipoint deployment mode. The subscriber radio systems provides basic communications directly to subscribers in rural and remote areas and is therefore constrained with respect to station siting and pointing. A central hub station serves several subscribers via either single hop or repeatered connections. System costs, particularly those associated with individual subscriber links, are a major consideration and must be kept to an absolute minimum.

Worst-case exposure studies by the ITU-R demonstrate that co-frequency, co-coverage operation between the GSO MSS (space-to-Earth) and the FS would not be possible.

Recent probabilistic interference studies by ITU-R have shown that point-to-point systems and subscriber radio system repeater stations would be adequately protected by the current RR Appendix **5** pfd trigger levels. However, subscriber radio systems (point-to-multipoint) hub and subscriber stations in the 1 492-1 517 MHz band will be subject to excessive interference from GSO MSS satellites if the present pfd trigger levels in Appendix **5** were applied.

One study employed the latest FS point-to-multipoint system parameters from the draft revision of Recommendation ITU-R F.758-2 and the most recent antenna patterns as modelled in Recommendation ITU-R F.1336-1, which addresses point-to-multipoint systems specifically. The study concluded that the Appendix **5** pfd trigger levels must be reduced by 7 dB in the band 1 492-1 517 MHz in order to protect 90% of subscriber stations of the point-to-multipoint systems considered to an I/N level of –6 dB. This is a relaxed criterion from the fixed service interference objective of I/N = –10 dB at all stations. No viable mitigation techniques have been identified to ease the required pfd reduction.

2.8.1.4 Regulatory and procedural considerations

If Method A is adopted, the following regulatory changes could be considered:

- Modify Article **5** appropriately to include a primary allocation for MSS (space-to-Earth) in the 1 518-1 525 MHz band in Regions 1 and 3.
- Retain the existing primary allocation for MSS (space-to-Earth) in the 1 518-1 525 MHz band in Region 2.
- Suppress the existing primary allocation for MSS (space-to-Earth) in the 1 492-1 518 MHz band in Region 2.
- Modify Appendix **5** to apply the pfd levels referred to under this method to protect AMT, mobile services in Japan, and the FS.

If Method B is adopted, similar regulatory changes as with Method A could be considered, except that in lieu of pfd coordination thresholds to protect AMT in Appendix **5**, pfd limits would be inserted in Article 21.

If Method C is adopted, there would be no allocation made to MSS in the band 1 518-1 525 MHz in Regions 1 and 3. The existing MSS allocation in the 1 492-1 525 MHz band in Region 2 may also be suppressed.

If Method D is adopted, similar regulatory changes as with Method A could be considered, but instead applicable to the band 1 520-1 525 MHz.

If Method B is adopted, the following change to Article 21 could be considered.

TABLE **21-4**

Frequency band	**Service***	**Limit in dB(W/m²) for angle of arrival (d) above the horizontal plane**			**Reference bandwidth**
		0°-5°	**5°-25°**	**25°-90°**	

Frequency band	**Service***					**Reference bandwidth**
1 518-1 525 MHz (Applicable to the territory of the United States in Region 2 between the longitudes 71° W and 125° W)	Mobile-satellite (space-to-Earth)	0° ≤ d ≤ 4°	4° < d ≤ 20°	20° < d ≤ 60°	60° < d ≤ 90°	4 kHz
		−181.0	−193.0 + 20 log d	−213.3 + 35.6 log(d)	−150.0	
1 518-1 525 MHz (Applicable to all other territory of the United States in Region 2)	Mobile-satellite (space-to-Earth)	0° ≤ d ≤ 43.4°	43.4° < d = 60°	60° < d ≤ 90°		4 kHz
		−155.0	−213.3 + 35.6 log d	−150.0		

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2.8.2 Resolution 227 (WRC-2000)

"Sharing studies for, and possible additional allocations to, the mobile-satellite service (Earth-to-space) in the 1-3 GHz range, including consideration of the band 1 683-1 690 MHz"

Resolution 227 invites ITU-R to assess, with the participation of WMO, the current and future spectrum requirements of the MetAids service in the band 1 683-1 690 MHz, taking into account improved characteristics, and the MetSat service in the band 1 683-1 690 MHz, taking into account future developments. Resolution 227 also resolves that in the event that studies of the specific frequency band 1 683-1 690 MHz lead to an unsatisfactory conclusion, to carry out studies in order to recommend alternative MSS (Earth-to-space) frequency bands in the 1-3 GHz range.

ITU-R has considered frequency sharing between MetAids and MSS (Earth-to-space) in the band 1 668.4-1 700 MHz. This had led to a proposed revision of Recommendation ITU-R SA.1264.

ITU-R has also considered frequency sharing between the MetSat (space-to-Earth) service and the MSS (Earth-to-space) in the band 1 670-1 710 MHz, including sharing with GVAR/S-VISSR MetSat earth stations which operate in the range 1 683-1 690 MHz. These studies have led to a proposed revision of Recommendation ITU-R SA.1158.

Studies submitted prior to WRC-2000 concluded that sharing between MetAids and MSS in the bands 1 675-1 683 MHz and between MetSat and MSS in the band 1 690-1 710 MHz is considered not feasible as reflected in Resolution **227**.

2.8.2.1 Band 1 683-1 690 MHz

The band 1 683-1 690 MHz is allocated on a primary basis to the MetAids, the MetSat (space-to-Earth), the fixed, and the mobile services in all three Regions and to the mobile-satellite service in Region 2.

2.8.2.1.1 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

ITU-R has conducted several studies regarding separation distances required between MSS and MetSat earth stations considering in particular GVAR/S-VISSR earth stations. The studies have been based on a range of MSS system characteristics and a range of different deployment scenarios of MetSat Main and GVAR/S-VISSR stations. An attempt was made to avoid best and worst-case assumptions by considering system and shielding assumptions ranging from favourable to unfavourable conditions. The studies revealed that shielding conditions had the most significant impact on the required separation distances. The following results were obtained for a range of MSS system parameters where the terms "favourable, typical and unfavourable" refer primarily to the MetSat deployment and shielding conditions. The lower separation distances are mainly due to favourable MSS parameters whereas the higher separation distances are obtained for unfavourable MSS parameters:

	MetSat main stations: favourable-unfav. MSS	GVAR/S-VISSR stations: favourable-unfav. MSS parameters
Favourable conditions:	< 20-35 km	20-100 km
Typical conditions:	< 20-45 km	35-300 km
Unfavourable conditions:	75-320 km	70-370 km

At this point in time, GVAR MetSat stations are mostly deployed in many Region 2 countries and S-VISSR MetSat stations are mostly deployed in many Region 3 countries. In Region 1 countries there are a few MetSat GVAR/S-VISSR stations. More than 15 MetSat Main stations are deployed throughout all three Regions. It is expected that the MetSat service will make more extensive use of this band in the future. However, there are also transportable GVAR/S-VISSR stations in Regions 2 and 3. Exclusion zones are required but cannot be practically established around transportable earth stations that may be periodically relocated.

ITU-R has also reviewed the studies regarding MetAids use of the band 1 683-1 690 MHz and concluded that the relatively few MetAids systems operated in the band 1 683-1 690 MHz can be concentrated in the range 1 675-1 683 MHz if sufficient time for transition is provided.

Relevant Recommendations ITU-R: SA.1264 and SA.1158.

2.8.2.1.2 Analysis of sharing studies

a) Sharing between MSS and MetAids

Sharing studies indicate that co-channel sharing between MetAids and MSS in the band 1 675-1 683 MHz is not feasible due to unacceptable levels of interference to both systems. Studies also indicate that time-sharing between MetAids and MSS is also not feasible due to the operational nature of both services. The band 1 683-1 690 MHz is also allocated to the MetSat service on a co-primary basis. Studies and operational experience have shown that co-frequency sharing between MetAids and MetSat downlinks is not feasible. Therefore, MetAids operations are mainly concentrated in the range 1 675-1 683 MHz in many parts of the world (Regions 2 and 3) to avoid interference to GVAR/S-VISSR (also see section b) below) MetSat downlinks. WMO has identified future requirements for narrow-band MetAids operations as 1 675-1 683 MHz. However some administrations continue to use wideband systems that should not exceed a requirement of 12 MHz, which is consistent with national spectrum availability in those countries. In reviewing the available study results, an MSS allocation in the band 1 683-1 690 MHz will most affect MetAids operations in ITU Region 1 in those locations where the limited number of MetSat stations does not prevent their use in 1 683-1 690 MHz.

b) Sharing between MSS and MetSat

Sharing the band 1 683-1 690 MHz would require the establishment of geographical separation between MSS earth stations and co-frequency MetSat stations. There are currently more than 15 main earth stations operated in all three Regions and more than 400 registered data user stations operated mostly in Regions 2 and 3, with some also in Region 1. The number of registered data user stations is increasing and the actual number of existing stations is expected to be in excess of 1 000. The studies concluded that, even though feasible in some areas of the world, implementation of sharing would be subject to such practical constraints and limitations for the MSS that it should not be considered suitable for providing MSS spectrum on a global basis.

Appendix **7** contains the methodology and parameters to determine the coordination area for mobile earth stations with respect to MetSat earth stations. The coordination area is the service area of the mobile earth stations extended by the coordination distance. For operation of MSS in the territory of one administration, it would be necessary to coordinate with MetSat stations operated by other administrations if the MetSat earth station is located within the coordination area of the MSS terminals. The available study results show that for the most favourable climatic zone, A2, the required coordination distances are often in excess of several hundred kilometres and would cause a coordination burden for the MSS noting the number of MetSat stations indicated above. The extent of the coordination burden would depend on the number and location of MetSat stations affected. The problem increases for coastal areas where coordination distances above 1 000 km could be required in a few cases. Coordination would also be required between MSS and MetSat earth stations within the territory of a given administration but would be a domestic rather than an international matter.

In addition to the coordination requirement, available studies have concluded that the actual required separation distances are typically 70-105 km, but can be up to 400 kilometres. This would in some cases cause large service areas not being available to the MSS; rendering typical features of this service such as global or regional coverage as well as unrestricted mobility, unavailable without the use of selectable frequency agility. Resolution **227** also recognizes that the use of the data user stations is on the increase and given the implications of No. **5.377**, this would mean an unpredictable risk for any MSS operator to lose service areas in addition to those unavailable today. As an additional system requirement, the MES locations would have to be determined with sufficient accuracy to comply with the required separation distances. However, there are current operational MSS systems that implement spot beam configurations (150-300 spot beams), frequency reuse and position determination capabilities. In combination with spectrum availability outside of the band 1 683-1 690 MHz, selectable frequency agility would increase the possibility of sharing this band between the MSS and MetSat.

In addition to in-band interference in the band 1 683-1 690 MHz, the problem of adjacent band interference to thousands of meteorological earth stations operating in the band 1 690-1 698 MHz requires either a guardband below 1 690 MHz or a limitation of out-of-band emissions. Studies have shown that the out-of-band emission limits contained in Recommendation ITU-R M.1480 (and proposed revisions to this Recommendation), if extended to MESs operating in 1 683-1 690 MHz, would be adequate to protect MetSat earth stations operating above 1 690 MHz. However, further study may be required.

Assuming the band 1 670-1 675 MHz would be allocated to the MSS, finding an additional 2 MHz of spectrum in the range 1 683-1 690 MHz would be difficult on a global basis. In the range 1 683-1 688 MHz, service areas in many countries, in particular Region 2, will be constrained by current and future GVAR operations and not available where transportable MetSat earth stations are deployed. In the range 1 688-1 690 MHz, in all Region 2 countries, GVARs do not operate and hence there are few constraints on sharing and sharing may be feasible depending on final conclusions regarding the necessity of guardbands. Around 1 687 MHz, up to 6 MHz are not available in major parts of Region 3 due to S-VISSR operations. In countries where few MetSat earth stations are deployed, it is likely to be possible to identify additional spectrum which could be used for the MSS with minor constraints. MSS systems would have to be sufficiently flexible to use frequencies available at each earth station location, taking into account future deployment of MetSat stations.

With regard to sharing between MSS space stations and MetSat space stations, ITU-R studies have shown that sharing between MetSat space stations and MSS space stations is feasible except for some very close GSO constellations.

2.8.2.2 Alternative frequency bands in response to Resolution 227

Due to the sharing difficulties between the MSS and MetSat service in the band 1 683-1 690 MHz in Regions 2 and 3, ITU-R studied the band 1 670-1 675 MHz as an alternative band for an MSS allocation. To meet the requirements of MSS (2 × 7 MHz) as identified within CPM-99 and Resolution 227 (WRC-2000), preliminary studies were undertaken regarding sharing in the band 1 668-1 670 MHz. The band 1 670-1 675 MHz is allocated to meteorological aids, fixed, meteorological-satellite (space-to-Earth) and mobile services on a primary basis. The mobile service is intended for aeronautical public correspondence (through No. **5.380**). The band 1 668.4-1 670 MHz is allocated to radio astronomy, meteorological aids, and the fixed and mobile services on a primary basis. The band 1 668-1 668.4 MHz is allocated to the radioastronomy and the space research service (passive) on a primary basis, and to the fixed and mobile services on a secondary basis. The adjacent band, 1 660-1 668 MHz has a primary allocation to the radio astronomy service.

2.8.2.2.1 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

Sharing between the relatively few MetSat main earth stations and MSS uplinks in the band 1 670-1 675 MHz is feasible provided the MSS protect the few MetSat main earth stations through the use of exclusion zones and position determination. Sharing between the MSS earth stations and the MetAids service is feasible if protection is provided to MetAids operations in those countries where there is a continuing requirement to use 1 670-1 675 MHz. However, sharing between MetAids and MSS space stations is not feasible if the MSS space station antenna coverage area and the area used by MetAids coincide. Providing protection to MetAids systems operating in the few countries requiring use of 1 670-1 675 MHz may limit MSS use within those countries and in neighbouring countries. The relevant ITU-R Recommendations are SA.1264 and SA.1158.

Studies into the effect of unwanted emissions from MESs into radio astronomy stations operating in the band 1 660-1 670 MHz have been conducted, taking into account Recommendation ITU-R M.1480 (and proposed revisions to this Recommendation), and Recommendation ITU-R RA.769. The studies estimated the separation distances required between MESs and radio astronomy stations.

Preliminary studies have been conducted with regard to sharing between the mobile-satellite service and the radio astronomy service in the band 1 668-1 670 MHz, taking into account Recommendations ITU-R M.1184, ITU-R RA.769 and ITU-R RA.1513. The studies estimated the separation distance required between MESs and radio astronomy stations. However, further study is required.

2.8.2.2.2 Analysis of sharing studies

a) Sharing between MSS and MetAids

Although co-channel sharing between MetAids and MSS is not feasible due to mutual interference, in most countries there is a low use or no use of the band 1 670-1 675 MHz for MetAids operations which allows for sharing based on geographical separation. Globally, the majority of MetAids operations are concentrated in the frequency range 1 675-1 683 MHz. A survey of band usage indicates that MetAids frequency requirements can be satisfied with the spectrum available above 1 675 MHz. Most of those countries using 1 670-1 675 MHz for MetAids operations can transfer operations to 1 675-1 683 MHz over a period. There are a few countries operating MetAids systems that will continue to require use of the band 1 670-1 675 MHz where sharing may not be feasible.

b) Sharing between MSS and MetSat

Sharing is feasible in the band 1 670-1 675 MHz if an appropriate separation distance is maintained at all times between the few MetSat main earth stations and mobile earth stations, as determined pursuant to coordination under No. **9.17A**. The mobile earth stations locations will have to be determined with sufficient accuracy to ensure the required separation distances are maintained. The use of mobile earth stations in this band would therefore be subject to the ability of MSS systems to respect these separation distances through location determination capabilities.

c) Sharing between MSS and MS

With regard to Aeronautical Public Correspondence, ITU-R studies indicated that no systems are currently implemented and no future plans exist for implementation of such systems in this band. The band was intended for use on the ground-to-air link. Based on the indications that this band will no longer be required for APC, MSS sharing with APC in this band does not present any difficulty. MSS sharing with other applications of the mobile service has not been studied in the band 1 670-1 675 MHz as system characteristics were not available.

d) Adjacent band compatibility and co-frequency sharing between MSS and RAS

The radio astronomy service is allocated on a primary basis in the band 1 660-1 670 MHz. Both continuum and spectral line observations are carried out in the band. Two spectral lines of the hydroxyl radical (OH) are observed in this band: their rest frequencies are 1 665.402 MHz and 1 667.359 MHz (see Recommendation ITU-R RA.314). The associated protection criteria are given in Recommendations ITU-R RA.769 and ITU-R RA.1513.

Studies have been conducted regarding unwanted and in-band emissions for mobile earth stations into radio astronomy receivers operating below 1 670 MHz.

d1) Mobile-satellite service mobile earth stations and radio astronomy service operating in adjacent bands

Taking the unwanted emission limits of Recommendation ITU-R M.1480 as a guide for the level of unwanted emissions for MESs operating above 1 670 MHz, separation distances in the range of about 20 to 58 km are required to meet the protection criteria of Recommendations ITU-R RA.769 and RA.1513. Hence, exclusion zones would be required with regard to radio astronomy stations operating in the band 1 660-1 670 MHz. In practice, these should be defined on a case-by-case basis, taking into account the appropriate characteristics of the radio astronomy station, the surrounding terrain and the characteristics of the MSS system operating in the band 1 670-1 675 MHz. MESs operating in the 1 670-1 675 MHz frequency range would have to be able to determine their location with sufficient accuracy to avoid operating in these zones in this frequency range. From these results it can be concluded that adjacent band operations are feasible.

d2) Mobile-satellite service mobile earth stations and radio astronomy service operating in the shared band 1 668-1 670 MHz

To ensure the protection of radio astronomy stations, it would be necessary to set up exclusion zones around each of them. MESs operating in the 1 668-1 670 MHz frequency range would have to be able to determine their location with sufficient accuracy to avoid operating in these zones in this frequency range.

Preliminary studies indicated that, taking the emission limits of Recommendation ITU-R M.1184 as a guide for the in-band emission levels of MESs operating in the band 1 668-1 670 MHz, separation distances of the order of 500 km are required to meet the protection criteria of Recommendations ITU-R RA.769 and ITU-R RA.1513. These results require further validation within ITU-R. Due to the small number of radio astronomy stations using this band all around the world, coordination is thus felt to be manageable in large parts of the world.

e) Sharing between mobile-satellite service and fixed service

No studies have been submitted during the current study cycle regarding sharing between MSS and FS in the band 1 670-1 675 MHz in response to Resolution 227. Some studies are available with regard to sharing between MSS and FS in the range 1-3 GHz leading to recommendations, including Recommendations ITU-R M.1141, M.1142, and M.1143.

f) Sharing between mobile-satellite service and space research (passive)

No studies have been conducted between the space research (passive) service and the mobile-satellite service in 1 668-1 668.4 MHz.

2.8.2.3 Methods to satisfy the agenda item and their advantages and disadvantages

2.8.2.3.1 Method A

A primary worldwide MSS (Earth-to-space) allocation would be created in the band 1 670-1 675 MHz, with the necessary protection of existing services in the band, and protection of the radio astronomy service in the band 1 660-1 670 MHz.

Since MSS operations may not be possible in countries that continue to use the band 1 670-1 675 MHz for MetAids operations, the Conference could consider curtailing the long-term use of the band for MetAids (Refer to section 2.8.2.2.2a)). As a consequence of making a worldwide MSS allocation at 1 670-1 675 MHz, the Conference may further consider aligning the Region 2 MSS allocation by suppressing the allocations in all or parts of the band 1 675-1 710 MHz taking into account in particular the conclusions of Recommendations ITU-R SA.1264 for the sub-band 1 675-1 683 MHz and SA.1158 for the sub-band 1 690-1 710 MHz. In addition, the status of the current mobile allocation will need consideration.

Advantages:

The MSS would be provided additional spectrum. Protection of the few MetSat main earth stations and radio astronomy stations in the adjacent band will place little constraint on the MSS. Subject to limited sharing constraints with MetSat, MetAids, fixed and mobile services, a global allocation would be available to the MSS (Earth-to-space).

Disadvantages:

This allocation would be limited to 5 MHz. MSS operations may not be possible in those countries that continue to use the band 1 670-1 675 MHz for MetAids operations (Refer to section 2.8.2.2.2a)).

2.8.2.3.2 Method B

In addition to the 5 MHz of spectrum identified in Method A, an additional allocation, with spectrum of about 2 MHz, could be created in other bands in the vicinity of the existing allocations around 1.6 GHz taking into consideration the conclusions of studies. Since an isolated allocation of 2 MHz would be less attractive for MSS, and sharing with MetAids above 1 675 MHz is not feasible, a possible allocation to MSS in the band 1 668-1 675 MHz could be considered with the necessary protection of existing services in the band and protection of RAS in the band 1 660-1 668 MHz.

Advantages:

The spectrum requirement of a total of 7 MHz would be met.

A contiguous MSS allocation of 7 MHz would be achieved.

Subject to the results of the sharing studies, existing services operating in the band 1 668-1 670 MHz would be protected.

Disadvantages:

The requirement to protect existing services may result in constraints to MSS.

2.8.2.3.3 Method C

A worldwide MSS allocation would be created in the band 1 683-1 690 MHz, taking into account that WRC-2000 confirmed the requirement for continued protection of MetSat and MetAids services under No. **5.377**.

As a consequence of making a worldwide MSS allocation at 1 683-1 690 MHz, the Conference may consider aligning the Region 2 MSS allocation by suppressing the allocations in parts of the band 1 675-1 710 MHz taking into account in particular the conclusions of Rec. ITU-R SA.1264 for the sub-band 1 675-1 683 MHz and ITU-R SA.1158 for the sub-band 1 690-1 710 MHz.

Advantages:

The MSS would be allocated additional spectrum.

Disadvantages:

In many countries, MSS operations would be restricted by the operation of a large and increasing number of MetSat earth stations including transportable stations. Protection of existing and future MetSat earth stations would result in a significant coordination burden. The required separation distances would make large areas not available for the MSS. Coordination with transportable

MetSat earth stations is not practicable. The constraint of No. **5.377** renders this band barely usable for MSS earth stations. Future deployment of MetSat earth stations would result in further reduction of MSS service areas. The whole 7 MHz MSS allocation would not be usable on a global basis.

2.8.2.3.4 Method D

This option is to make no additional allocations within the range 1 670-1 710 MHz to accommodate the MSS.

Advantages:

This option would ensure no impact to existing services.

Disadvantages:

The spectrum requirements for MSS would not be met in this frequency band.

2.8.2.4 Regulatory and procedural considerations

a) Regarding Method A, if a worldwide allocation is made in the band 1 670-1 675 MHz, stations in the MSS shall be subject to coordination. It would be necessary to require coordination under No. **9.11A** for MSS in this band. An example footnote could be: "**5.QQQ** The mobile-satellite service using the band 1 670-1 675 MHz shall be subject to coordination under No. **9.11A**."

Coordination between earth stations in bidirectionally allocated bands is currently provided through No. **9.17A**. However, this provision is limited to specific earth stations and may therefore require modification (or an alternative provision) to permit coordination of typical MESs, which may also be considered under agenda item 1.30.

One administration believes that provisions may be required to protect existing and planned MetAids stations.

To cover sharing with MetAids, the following footnote could be considered: "**5.UUU** In the band 1 670-1 675 MHz, administrations are encouraged to implement no new systems in the MetAids service and to take all practicable steps to migrate existing meteorological aids service operations from this band."

Moreover, in order to protect the radio astronomy service from unwanted emissions of MES operating in the 1 670-1 675 MHz band, it would be necessary to ensure that unwanted emission levels falling into the radio astronomy band 1 660-1 670 MHz are limited to the levels given in Recommendations ITU-R RA.769 and ITU-R RA.1513. An example of footnote could be: "**5.XXX** Mobile earth stations operating in the band 1 670-1 675 MHz shall not cause harmful interference to stations in the radio astronomy service operating in the band 1 660-1 670 MHz. The threshold levels of interference detrimental to the radio astronomy service are given in Recommendations ITU-R RA.769 and ITU-R RA.1513." It should be noted that this footnote could introduce constraints on the existing MESs from future RAS stations.

Some administrations consider that regulatory provisions will be required to ensure sharing with and protection of fixed and mobile services. Some administrations consider that application of Article **21** for sharing with MSS space stations should be considered.

b) Regarding Method B, the regulatory measures given under Method A apply, and with an additional allocation in the 1 668-1 670 MHz band, it would also be necessary to set up coordination under No. **9.11A** for MSS in this band. The example footnote given above for the protection of RAS could be extended to the 1 668-1 675 MHz band. Additional regulatory measures could be needed to ensure the protection of the space research (passive) service in the band 1 660.5-1 668.4 MHz.

As an alternative example footnote, and if it is considered necessary to ensure no constraints on new radio astronomy stations from MSS in the band 1 668-1 670 MHz only, the MSS could be placed on a secondary basis with respect to the radio astronomy service by adding the band 1 668-1 670 MHz to footnote **5.376A**.

c) Regarding Method C, if a worldwide MSS allocation is made in the band 1 683-1 690 MHz, protection of the incumbent MetSat and MetAids services could be ensured by the application of No. **5.377**, which would require revision to reflect the actual band limits of the MSS allocation, protection of MSS space stations which are deployed prior to new MetSat space stations at orbital locations different from ones already used, and other regulatory measures. In addition, a proper footnote could be required for which the following text could be considered:

"Mobile-satellite systems using the 1 683-1 690 MHz band shall not cause harmful interference to earth stations of the meteorological-satellite service and No. **5.43** shall not apply. To avoid causing harmful interference, mobile earth stations shall not operate, except on a non-interfering signalling channel, within the zones around the meteorological earth stations defined in the coordination process. The mobile-satellite system shall have position determination capabilities to ensure compliance with this provision."

Appropriate regulatory provisions may be required to ensure protection of MetSat user stations operating above 1 690 MHz from out-of-band emissions from MESs operating in the range 1 683-1 690 MHz.

d) Regarding all four methods WRC-03 may consider modification or suppression of Resolution **227**.

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2.9 Agenda item 1.33

"to review and revise technical, operational and regulatory provisions, including provisional limits in relation to the operation of high altitude platform stations within IMT-2000 in the bands referred to in No. **5.388A**, in response to Resolution **221 (WRC-2000)**"

2.9.1 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

Provisions for operation of HAPS were originally made at WRC-97, for HAPS providing FS operations in the 47.2-47.5 GHz and 47.9-48.2 GHz bands (No. **5.552A**). A definition of HAPS (No. **1.66A**) was also added to the RR. The use of HAPS as base stations within terrestrial IMT-2000 was approved at WRC-2000, resulting in provisions to facilitate this being added to the RR (No. **5.388A**). Resolution **221 (WRC-2000)** includes provisional co-channel and out-of-band pfd limits for HAPS operation, for the protection of other stations either sharing the same band or operating in adjacent bands.

Relevant Recommendations ITU-R: M.1456, and DNR M.[IMT-HAPSINT].

2.9.1.1 Protection of other IMT-2000 stations from co-channel interference from HAPS operating as an IMT-2000 base station

Based on updated information on typical noise figure of IMT-2000 mobile stations, the protection requirement of other IMT-2000 mobile stations operating co-frequency has been revised.

No interference to other IMT-2000 base stations can occur providing that HAPS operating as base stations have the same direction of transmission.

2.9.1.2 Review and, if necessary, revision of the provisional pfd thresholds

The –117 dB (W/(m^2 · MHz)) threshold is appropriate to protect other IMT-2000 mobile stations from co-channel interference.

2.9.1.3 Protection of non-IMT-2000 stations from co-channel interference from a HAPS downlink operating as an IMT-2000 base station

One study concluded that the present pfd thresholds exceed the interference allowance limits for pre-IMT-2000 PCS mobile-to-base link in a co-channel environment and proposes that the provisional co-channel pfd threshold in *resolves* 1.1 of Resolution 221 be revised. It is to be noted though that this is an issue concerning the protection from co-channel interference of certain stations in some neighbouring countries in Region 2. It is proposed that any proposed revisions related to this issue should be limited to this particular case and to the Region in question. Sharing studies have been carried out regarding the impact of the provisional pfd levels in *resolves* 1.1 of Resolution 221 on the operation of second generation PCS and on the operation of MMDS.

2.9.1.4 Protection of fixed stations from co-channel interference from HAPS operating as an IMT-2000 base station

With no studies to the contrary, the existing thresholds are deemed appropriate to protect the fixed service from co-channel interference.

2.9.1.5 Protection of fixed stations in adjacent bands from HAPS operating as an IMT-2000 base station

With no studies to the contrary, the existing thresholds are deemed appropriate to protect the fixed service from adjacent-channel interference.

2.9.2 Analysis of the results of studies

The study regarding sharing considerations between HAPS providing IMT-2000 and other non-IMT 2000 systems operating in the same bands or adjacent bands responds to the need to analyse and proposes changes to provisional pfd thresholds as specified in Resolution 221 to protect some stations operating in these bands in the fixed and mobile services.

This subject has been extensively studied for over five years and Recommendation ITU-R M.1456 was based on the results of such studies. Since the last Conference, one further study has been completed which suggests that, in certain countries in Region 2 for particular services, namely PCS and MMDS, the provisional pfd thresholds may not adequately meet system design allowances for interference for pre IMT-2000 PCS. The studies suggest that only for this particular system, the present value exceed the interference allowance limits for pre-IMT-2000 PCS mobile-to-base link in a co-channel environment and propose that the provisional co-channel pfd threshold in *resolves* 1 a) of Resolution 221 be revised.

Another study has shown that a limited relaxation (by 4.5dB) of the pfd threshold could be afforded for the specific case of the protection of other IMT-2000 mobile stations from HAPS base stations. The protection of other IMT-2000 base stations from HAPS base stations can be ensured through appropriate provisions requesting HAPS operating as an IMT-2000 base station to transmit in the frequency bands 2110-2170 in Regions 1 and 3 and 2110-2160 in Region 2. Since an IMT-2000 mobile station has the same characteristics (as defined in Recommendation ITU-R M.1457) whether it is communicating with a HAPS base station or with another IMT-2000 base station, no specific study regarding mobile stations communicating with a HAPS is needed.

2.9.3 Methods to satisfy the agenda item and their advantages and disadvantages

In order to adequately protect MMDS in some neighbouring countries in Region 2 in the band 2 150-2 160 MHz from co-channel interference, a HAPS operating as a base station to provide IMT-2000 shall not exceed the following co-channel pfd at the Earth's surface outside an administration's borders unless agreed otherwise by the administration of the affected neighbouring country:

– −127 dB(W/(m^2 · MHz)) for angles of arrival (θ) less than 7° above the horizontal plane;

– -127+ 0.666 (θ – 7) dB(W/(m^2·MHz)) for angles of arrival between 7° and 22° above the horizontal plane; and

– -117 dB(W/(m^2 · MHz)) for angles of arrival between 22° and 90° above the horizontal plane.

It is to be noted that the above is an issue concerning the protection from co-channel interference of certain stations in some neighbouring countries in Region 2 only.

Although Resolution **221 (WRC-2000)** was inviting ITU-R to study regulatory provisions to allow co-ordination, ITU-R has concluded that seeking agreement from a neighbouring country does not require the development of a specific procedure. However, clarification of Resolution 221(WRC-2000) is needed to specify the method for the Bureau to check the conformity. Some administrations also noted that an ITU-R Recommendation providing technical guidance should be developed to facilitate consideration with neighbouring administrations. Some administrations consider that there is a need to have regulatory procedures for coordination and registration of HAPS.

2.9.4 Regulatory and procedural considerations

In order to enable the Bureau to check the conformity with pfd limits defined in Resolution 221, several provisions are needed:

- Modification of Article 11 to have an explicit obligation of notification of HAPS stations.
- Insertion in Appendix 4 of a new characteristic applying to HAPS operating in accordance with No. 5.388A on the compliance with the limits of Resolution 221.

Some administrations consider that further technical studies should be conducted in ITU-R under the revised version of Resolution 221. Some administrations consider that there is a need to have regulatory procedeces in Articles **9** and **11** for coordinating HAPS with affected administrations prior to notification of HAPS.

Example of draft modifications to Resolution 221 (WRC-2000)

Use of high altitude platform stations as IMT-2000 base stations ~~providing IMT-2000~~ in the bands 1885-1 980 MHz, 2010-2025 MHz and 2 110-2170 MHz in Regions 1 and 3 and 1885-1 980 MHz and 2 110-2160 MHz in Region 2

The World Radiocommunication Conference ~~(Istanbul, 2000),~~(Geneva, 2003),

considering

a) that the bands 1 885-2 025 MHz and 2 110-2 200 MHz are identified in No. **5.388** as intended for use on a worldwide basis for ~~International Mobile Telecommunications-2000 (IMT-2000),~~IMT-2000, including the bands 1 980-2 010 MHz and 2 170-2 200 MHz for both the terrestrial and the satellite component of IMT-2000;

b) that a high altitude platform station (HAPS) is defined in No. **1.66A** as "a station located on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth";

c) that HAPS may offer a new means of providing IMT-2000 services with minimal network infrastructure as they are capable of providing service to a large footprint together with a dense coverage;

d) that the use of HAPS as base stations within the terrestrial component of IMT-2000 is optional for administrations, and that such use should not have any priority over other terrestrial IMT-2000 use;

e) that in accordance with No. **5.388** and Resolution **212 (Rev.WRC-97)**, administrations may use the bands identified for IMT-2000, including the bands referred to in this Resolution, for stations of other primary services to which they are allocated;

f) that these bands are allocated to the fixed and mobile services on a co-primary basis;

~~*g)* that ITU-R has studied sharing and coordination between HAPS and other stations within IMT-2000, has considered compatibility of HAPS within IMT-2000 with some services having allocations in the adjacent bands, and has established Recommendation ITU-R M.1456;~~

~~*h)* that ITU-R did not address sharing and coordination between HAPS and some existing systems, particularly PCS (personal communications service), MMDS (multichannel multipoint distribution system) and systems in the fixed service, which are currently operating in some countries in the bands 1885-2025 MHz and 2110-2200 MHz;~~

~~*i)*~~*g)* that, in accordance with No. **5.388A**, HAPS may be used as base stations within the terrestrial component of IMT-2000 in the bands 1 885-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz in Regions 1 and 3 and 1 885-1 980 MHz and 2 110-2 160 MHz in Region 2; the use by IMT-2000 applications using HAPS as base stations does not preclude the use of these bands by any station in the services to which they are allocated and does not establish priority in the Radio Regulations~~,~~;

~~*recognizing*~~

~~that the values in *resolves* 1 may not be appropriate for the protection of some stations operating in these bands in the fixed and mobile services,~~

h) that ITU-R has studied sharing between HAPS and other stations within IMT-2000, has considered compatibility of HAPS within IMT-2000 with some services having allocations in the adjacent bands, and has established Recommendation ITU-R M.1456;

that radio interfaces of IMT-2000 HAPS are compliant with Recommendation ITU-R M.1457;

j) that ITU-R has addressed sharing between systems using HAPS and some existing systems, particularly PCS (personal communications system), MMDS (multichannel multipoint distribution system) and systems in the fixed service, which are currently operating in some countries in the bands 1 885-2 025 MHz and 2 110-2 200 MHz;

k) that HAPS stations are intended to transmit in the band 2 110-2 170 MHz in Regions 1 and 3 and in the band 2 110-2 160 MHz in Region 2,

resolves

1 that:

1.1 for the purpose of protecting~~certain~~ IMT-2000 mobile stations ~~operating~~~~within IMT-2000~~ in neighbouring countries from co-channel interference, a HAPS operating as an IMT-2000 base station ~~to provide IMT-2000~~ shall not exceed a ~~provisional~~ co-channel power-flux density (pfd) of

~~–121.5 dB(W/(m² · MHz))~~ –117 dB (W/(m^2 · MHz)) at the Earth's surface outside a~~n~~ country's ~~administration's~~ borders unless ~~agreed otherwise by the administration of the affected neighbouring country;~~explicit agreement of the affected administration is provided at the time of the notification ~~o~~of the HAPS station:

~~1.2 a HAPS operating as a base station to provide IMT-2000, in order to protect fixed stations from interference, shall not exceed the following provisional values of out-of-band~~ pfd ~~at the Earth's surface in the bands 2 025-2 110 MHz:~~

1.2 a HAPS operating as an IMT-2000 base station shall not transmit outside the frequency bands 2110-2170 MH~~h~~z in Regions 1 and 3 and 2110-2160 MHz in Region 2.

1.3 In Region 2, for the purpose of protecting MMDS stations in some neighbouring countries in the band 2 150-2 160 MHz from co-channel interference, a HAPS operating as an IMT-2000 base station shall not exceed the following co-channel power-flux density (pfd) at the Earth's surface outside a~~n~~ country's ~~administration's~~ borders unless explicit agreement of the affected administration is provided at the time of the notification of the HAPS station:

– ~~–165 dB(W/(m² · MHz))~~ –127 dB(W/(m^2 · MHz)) for angles of arrival (θ) less than ~~5°~~7° above the horizontal plane;

– –127 + 0.666 (θ – 7) dB(W/(m^2 · MHz)) for angles of arrival between 7° and 22° above the horizontal plane; and

– –117 dB(W/(m^2 · MHz)) for angles of arrival between 22° and 90° above the horizontal plane;

~~– –165 + 1.75 (θ – 5) dB(W/(m² · MHz)) for angles of arrival between 5° and 25° above the horizontal plane; and~~

~~– –130 dB(W/(m² · MHz)) for angles of arrival between 25° and 90° above the horizontal plane;~~

1.4 a HAPS operating as a IMT-2000 base station, in order to protect fixed stations from interference, shall not exceed the following limits of out-of-band power-flux density (pfd) at the Earth's surface in the bands 2 025-2 110 MHz:

– –165 dB(W/(m^2 · MHz)) for angles of arrival (θ) less than 5° above the horizontal plane;

– –165 + 1.75 (θ– 5) dB(W/(m^2 · MHz)) for angles of arrival between 5° and 25° above the horizontal plane; and

– –130 dB(W/(m^2 · MHz)) for angles of arrival between 25° and 90° above the horizontal plane;

~~2 that, as of the end of WRC-03, such a HAPS shall operate only in accordance with such limits as are confirmed or, if appropriate, revised by WRC-03, irrespective of its date of bringing into use;~~

2 that all the limits in this resolution shall apply to all HAPS stations operating in accordance with No. 5.388A as of 1 January 2002;

3 that administrations wishing to implement HAPS within a terrestrial IMT-2000 system shall comply with the following:

3.1 for the purpose of protecting ~~certain~~ IMT-2000 stations operating ~~within IMT-2000~~ in neighbouring countries from co-channel interference, ~~administrations using~~ a HAPS operating as a base station~~s~~ within IMT-2000 shall use antennas that comply with the following antenna pattern:

$$G(\psi) = G_m - 3(\psi/\psi_b)^2 \quad \text{dBi} \quad \text{for} \quad 0° \leq \psi \leq \psi_1$$

$$G(\psi) = G_m + L_N \quad \text{dBi} \quad \text{for} \quad \psi_1 < \psi \leq \psi_2$$

$$G(\psi) = X - 60 \log(\psi) \quad \text{dBi} \quad \text{for} \quad \psi_2 < \psi \leq \psi_3$$

$$G(\psi) = L_F \quad \text{dBi} \quad \text{for} \quad \psi_3 < \psi \leq 90°$$

where:

$G(\psi)$: gain at the angle ψ from the main beam direction (dBi)

G_m : maximum gain in the main lobe (dBi)

ψ_b : one-half of the 3 dB beamwidth in the plane considered (3 dB below G_m) (degrees)

L_N : near side-lobe level in dB relative to the peak gain required by the system design, and has a maximum value of –25 dB

L_F : far side-lobe level, G_m – 73 dBi

$$\psi_1 = \psi_b \sqrt{-L_N/3} \quad \text{degrees}$$

$$\psi_2 = 3.745\,\psi_b \quad \text{degrees}$$

$$X = G_m + L_N + 60 \log(\psi_2) \quad \text{dBi}$$

$$\psi_3 = 10^{(X - L_F)/60} \quad \text{degrees}$$

The 3 dB beamwidth ($2\psi_b$) is again estimated by:

$$(\psi_b)^2 = 7\,442/(10^{0.1 G_m}) \quad \text{degrees}^2$$

where G_m is the peak aperture gain (dBi);

3.2 for the purpose of protecting mobile earth stations within the satellite component of IMT-2000 from interference, a HAPS operating as an IMT-2000 base station ~~to provide IMT-2000~~, shall not exceed an out-of-band pfd of –165 dB(W/(m^2 · 4 kHz)) at the Earth's surface in the bands 2 160-2 200 MHz in Region 2 and 2 170-2 200 MHz in Regions 1 and 3;

~~4 that administrations wishing to implement HAPS within a terrestrial IMT-2000 system shall, prior to their bringing into use, take into account in their bilateral coordination with affected neighbouring administrations the operation and growth of existing and planned systems in the fixed and mobile services having allocations on a primary basis;~~

~~5 that, for the purpose of protecting fixed service stations operating in neighbouring countries from co-channel interference, administrations wishing to implement HAPS within a terrestrial IMT-2000 system shall, pending the review by WRC-03 of the studies mentioned below, take full account of the relevant ITU-R Recommendations relating to protection values for fixed stations (see Recommendation ITU-R F.758),~~.

invites ITU-R

~~1 to complete, as a matter of urgency, additional regulatory, operational and technical studies on sharing criteria for HAPS with other systems in the bands 1 885-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz in Regions 1 and 3 and 1 885-1 980 MHz and 2 110-2 160 MHz in Region 2, and in adjacent bands, so as to allow revision of the values in *resolves* 1;~~

~~2 to develop appropriate regulatory and technical provisions to allow the coordination mentioned in *resolves* 4;~~

~~3 to report on the results of these studies in time for consideration by WRC-03.~~

to develop an ITU-R Recommendation providing technical guidance to facilitate consideration with neighbouring administrations.

instructs the Bureau

to review the findings made under No. **11.31** with respect to the conformity of HAPS stations operating in accordance with No. **5.388A**, and notified to the Bureau after 1 January 2002.

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2.10 Agenda item 1.38

"to consider provision of up to 6 MHz of frequency spectrum to the Earth exploration-satellite service (active) in the frequency band 420-470 MHz, in accordance with Resolution **727 (Rev.WRC-2000)**"

2.10.1 Summary of technical and operational studies

Relevant Recommendations ITU-R SA.577, SA.1166, SA.1260, M.1462, M.1174, F.758, M.1042, F.1108 and ITU-D 13[1].

2.10.2 Analysis of the results of studies

Recommendation ITU-R SA.577 establishes requirements for the operation of spaceborne synthetic aperture radars (SAR) at a frequency near 400 MHz to measure soil moisture, tropical biomass, Antarctic ice thickness and for documentation of geological history and climate change. SARs at these frequencies can provide data that are unattainable by any other means.

Active spaceborne sensors can be used to enable the monitoring of forests. The need for assessment and systematic observations of forest cover and the extent and rate of forest degradation in tropical and temperate regions was strongly expressed in Agenda 21 of the United Nations Conference on Economic Development (UNCED) in 1992. Studies have confirmed that 6 MHz of spectrum is still required to satisfy mission objectives.

2.10.2.1 Sharing with the amateur and amateur-satellite services

In the band 430-440 MHz, amateur services have allocations on a co-primary basis in Region 1 and on a secondary basis in Regions 2 and 3 (except in countries listed in No. **5.278**, where it is primary). Further, in accordance with No. **5.282** the amateur-satellite service may operate in part of this band (435-438 MHz) subject to not causing harmful interference to other services operating in accordance with the Radio Regulations.

Administrations may wish to consider the important role that the amateur services play in the provision of disaster communications, especially in developing countries. This role is recognized by Resolution **644 (WRC-97)**, Recommendations ITU-R M.1042, ITU-D 13 and elsewhere. Amateur radiotelephone repeaters in the band 430-440 MHz are used for disaster communications. Amateur radio operators are active in all parts of the world, even Antarctica.

There would likely be periods where SAR transmissions would have some impact on reception by amateur services. However, SARs and the amateur services can coexist as long as the technical and operational constraints given in DRR ITU-R SA.1260 are met by the EESS (active).

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[1] Recommendation ITU-D 13 "Effective utilization of the amateur services in disaster mitigation and relief operations".

2.10.2.2 Sharing with radiolocation service

Airborne, shipborne, and land-based radars operate in the frequency band 420-450 MHz. Studies prior to WRC-97 concentrated on the very large aperture antenna radar systems used for space object tracking in the band 420-450 MHz. Studies since WRC-97 have included consideration of the compatibility of spaceborne SARs with the other types of radars operating in the band 420-450 MHz.

The ITU-R has determined that there is a potential for unacceptable interference from spaceborne SARs to a limited number (around ten worldwide) of land-based space object tracking radars operating in the frequency band 420-450 MHz if a SAR is within line-of-sight of the land-based radars. It has been determined that the degree of compatibility is highly dependent upon the characteristics (and associated mission) of the spaceborne SARs, and that a spaceborne SAR intended for certain missions can be designed such that the compatibility situation is considerably improved. Field testing may be required on a case-by-case-basis to confirm compatibility with specific systems.

The ITU-R has concluded that, taking into account the SAR processing gain, the interference to SARs caused by airborne, shipborne, and land-based radars is acceptable.

Operation by geographical separation (that is, spaceborne SAR operation beyond line-of-sight to the land-based radars) has been studied. Observation of significant portions of the land mass in the northern hemisphere will be denied to the spaceborne sensors under such a restriction. However, it does appear that if the SARs are limited to operations beyond line-of-sight of land-based radars an appreciable portion of the tropical forests or Antarctic ice sheets can still be observed, which are primary missions for active sensors at these frequencies.

Studies of the compatibility of spaceborne SARs with airborne and shipborne radars have produced results that are quite similar to those for the land-based radars: a potential for significant interference (i.e. with regard to the likelihood and duration of interference events) exists for some of the SARs studied, but that the potential is highly dependent upon the characteristics of the SARs (orbits, transmitter power, antenna side-lobe characteristics). SAR design and operation in compliance with DRR ITU-R SA.1260 would greatly improve compatibility.

The band 420-460 MHz is also allocated on a secondary basis to the aeronautical radionavigation service limited to the use of radio altimeters in countries listed in No. **5.271**. While there may be close similarities between airborne radars in the radiolocation service and radio altimeters operating in the aeronautical radionavigation service, the ITU-R could not determine the potential impact from EESS (active) sensors on these aeronautical radionavigation systems due to the lack of technical information on these radio altimeters.

In addition to the radars that operate in the 420-450 MHz band as addressed in the preceding paragraphs, a radar is located in Arecibo, Puerto Rico (United States) that is used for important atmospheric research programmes. It is an upward looking radar and there is a potential for interference from and to a spaceborne SAR. There will be a need to coordinate operations of the spaceborne SAR and the Arecibo radar. Such coordination is feasible since schedules for operation of the radar are known several weeks in advance, as are the times that the SAR will be visible and its planned operations.

Wind profiler radars operate in the radiolocation service in the range 440-450 MHz unless compatibility cannot be achieved with existing services, in which case the bands 420-435 MHz and 438-440 MHz could be considered for use by wind profiler radars in accordance with Resolution **217 (WRC-97)**. Operation in separate frequency bands may be necessary for spaceborne SARs and wind profiler radars in order to preclude interference to the SARs.

2.10.2.3 Sharing with fixed and mobile services

The frequency ranges 410-430 MHz and 440-470 MHz are allocated to the fixed and mobile services on a primary basis in all three Regions. The frequency range 430-440 MHz is allocated to the fixed service in over 40 countries on a primary basis.

DNR ITU-R F.[Doc. 9/47] gives channel arrangements for digital radio systems operating in the frequency range 406.1-450 MHz. General guidance on the performance characteristics of FS systems in the band 420-470 MHz are available in DRR ITU-R F.758.

The FS protection criteria to be applied is a fractional degradation of performance (FDP) of 10% (which is equivalent to I/N = –10 dB in case of permanent interference) from a primary service, and 1% FDP (equivalent to I/N = –20 dB in case of permanent interference) from a secondary service. Pfd derived from this criterion should not be exceeded. DRR ITU-R F.758 provides the receiver thermal noise as –143 dBW in 3.5 MHz IF bandwidth.

A design of some low power, low-side lobe, spaceborne SARs has been considered that may produce power flux-densities at the surface of the Earth lower than the levels imposed in frequency bands near 400 MHz allocated to the fixed and mobile services in order to protect fixed and mobile operations.

In the range 450-470 MHz, interference to land mobile receivers used for special applications is unacceptable if any interruption occurs, even for a brief period of time, as the interference could impact protection of life and property. It is essential that the pfd of any interference to the land mobile service from EESS be less than the level specified in Table 1 of the annex to DRR ITU-R SA.1260.

The maritime mobile service may use some frequencies within the band 457-467 MHz for on-board communications stations (No. **5.287**). Receiver characteristics are similar to those of land mobile equipment listed in Recommendation ITU-R M.1174-1.

2.10.2.4 Sharing with space operation service (range safety command receivers)

Range safety command receivers are used to send arm, destruct, and safe commands to an airborne missile or drone, as well as to launch vehicles. Terrestrial missile and drone operations are accomplished at all flight altitudes (from just above ground level up to maximum flight altitudes). Commands to space launch vehicles may need to be sent from nearly ground level (just after lift-off) up or approaching early parking orbit altitudes of 100 km or so (e.g. to send a final "safe" command).

Studies conducted within the ITU-R have demonstrated the potential for interference from spaceborne SARs operating in the EESS into launch vehicle range safety command receivers. Considering the safety implications of interference into range safety command receivers from SARs operating in the EESS, co-frequency sharing is not feasible during a launch window. Such receivers operate in the band 449.75-450.25 MHz (No. **5.286**), as well as at frequencies in the ranges 420-430 MHz and 440-450 MHz with a 600 kHz bandwidth in the United States, and, in the band 433.75-434.25 MHz in India on a primary basis and certain countries in Region 2 on a secondary basis (No. **5.281**). Compatibility could be achieved by frequency avoidance or other interference avoidance measures.

2.10.3 Methods to satisfy the agenda item and their advantages and disadvantages

2.10.3.1 Method A

Allocation to EESS (active) with operational and technical regulatory constraints.

Two options can be considered for Method A. One indicates an exact band inside the range 420-470 MHz, the other does not indicate an exact band but leaves to WRC-03 the identification of the band.

2.10.3.1.1 Method A1

Allocate the band 432-438 MHz to EESS (active), based on the technical and operational constraints contained in DRR ITU-R SA.1260.

Advantage:

This would allow observation of significant tropical biomass or thickness of the Antarctic ice sheet and could avoid unacceptable interference to radiolocation, fixed, and mobile services.

Disadvantage:

The amateur services may suffer some interference in some areas, although within the limits established in relevant ITU-R Recommendations.

2.10.3.1.2 Method A2

Allocate 6 MHz to EESS (active) within the range 420-470 MHz, based on the technical and operational constraints contained in DRR ITU-R SA.1260.

Advantage:

This would allow observation of significant tropical biomass or thickness of the Antarctic ice sheet.

Disadvantage:

Depending on the exact band selected, some other radio services may suffer unacceptable interference.

2.10.3.2 Method B

Make no allocation to EESS (active) in the range 420-470 MHz.

Advantage:

No impact on existing services.

Disadvantage:

Without an allocation to EESS (active) in the 420-470 MHz range, important measurements needed for the systematic observation of forest cover, Antarctic ice thickness and desert moisture would not be possible using active spaceborne sensors.

2.10.4 Regulatory and procedural considerations

If an allocation to the Earth exploration-satellite (active) service is made in the 420-470 MHz frequency range, regulatory provisions based on DRR ITU-R SA.1260 will be needed to ensure protection of existing allocated services.

The following example footnote associated to the allocation in Article 5 could be considered:

5.XXX *The use of the band 4XX – 4YY MHz by the Earth exploration-satellite (active) service sensors shall be in accordance with Draft revision Recommendation ITU-R SA.1260 (Doc. 7/69).*