CHAPTER 4

Fixed and fixed-satellite services and high altitude platform systems

(WRC-03 agenda items 1.13, 1.18, 1.25, 1.26, 1.32)

CONTENTS

4.1 Agenda item 1.13

"to consider regulatory provisions and possible identification of existing frequency allocations for services which may be used by high altitude platform stations, taking into account No. **S5.543A** and the results of the ITU-R studies conducted in accordance with Resolutions **122 (Rev.WRC-2000)** and **734 (WRC-2000)**"

4.1.1 Resolution 122 (Rev.WRC-2000)

"Use of the bands 47.2-47.5 GHz and 47.9-48.2 GHz by high altitude platform stations (HAPS) in the fixed service and by other services and the potential use of bands in the range 18-32 GHz by HAPS in the fixed service"

4.1.1.1 Summary of technical and operational studies

The ITU-R has conducted sharing and compatibility studies between systems using HAPS and the following systems/services:

a) fixed wireless access (FWA) systems in the FS in the 28 and 31 GHz bands;

b) GSO satellite systems in the FSS in the 28 GHz band;

c) the EESS (passive) in the 31 GHz band;

d) the radio astronomy service (RAS) in the 31 GHz band;

e) systems in the FS and FSS in the bands 47.2-47.5 GHz and 47.9-48.2 GHz.

Relevant Recommendations ITU-R: F.758, RA.769-1, SA.1029, S.1328-3, F.1336-1, S.1432, SF.1481-1, F.1570, SF. [HAPS-FSS METHOD] (Doc. 4-9/BL/7), F.[HAPS-MT] (Doc. 9/BL/40), F.[HAPS-FWA] (9/BL/42), F.[HAPS-RAS] (Doc. 9/BL/45), F.[9B/HAPS1] (Doc. 9/BL/41) and F.1569.

One administration has conducted studies that have not yet been submitted to ITU-R, of interference from some HAPS to FWA receivers and to FSS GSO receivers, from which it concludes that interference to the FS could be reduced by use of appropriate mitigation techniques, and that interference to the FSS could be controlled by keeping the pfd reaching the GSO are below a specific value. This administration plans on making these studies formally available in the appropriate ITU-R forum prior to WRC-03.

4.1.1.1.1 A reference model of a system using HAPS

The ITU-R has performed a basic technical examination of a proposed system using HAPS in the fixed service within the bands 27.5-28.35 GHz and 31.0-31.3 GHz, leading to Recommendation ITU-R F.1569, which establishes a reference model of a system using HAPS, including a set of performance and operational parameters. These parameters are for use in studies relating to sharing and compatibility issues in these specific bands.

The studies have also included an investigation and a feasibility study of interference mitigation measures that could be applicable for the system using HAPS in order to facilitate sharing and compatibility with other services contained in DNR ITU-R F.[HAPS-MT] (Doc. 9/BL/40). Results of the studies indicate that the mitigation schemes contained in the referenced DNR could contribute to viable solutions to interference situations.

4.1.1.1.2 Interference evaluation from FS systems using HAPS to other types of FS systems within the 27.5-28.35 GHz and 31.0-31.3 GHz bands

The ITU-R has developed interference evaluation methodologies for use between systems using HAPS in the FS and FWA systems in the FS in the bands 27.5-28.35 GHz and 31.0-31.3 GHz. Interference scenarios for two different types of FWA systems have been examined. These

scenarios may be applicable within an administration and between administrations. On the basis of assumed interference criteria, the results of these studies include the expected level of interference and the required separation distance to avoid harmful levels of interference and are given in DNR ITU-R F.[HAPS-FWA] (Doc. 9/BL/42).

The studies indicate that a separation distance of 500 km may be needed in the worst case. The studies indicate that frequency sharing may only be possible if appropriate interference mitigation techniques are applied.

Applicable Recommendation - ITU-R F.758.

4.1.1.1.3 Sharing between systems using HAPS and FSS/GSO systems within the 27.5-28.35 GHz band

The ITU-R has developed a methodology for interference evaluation from the downlink (HAPS-to-ground direction) of systems using HAPS to the uplink of the GSO satellite system in the FSS within the band 27.5-28.35 GHz. The preliminary results produced by the application of this methodology were derived using the most sensitive GSO/FSS parameters in the band 27.5-28.35 GHz obtained from link budgets listed in Recommendation ITU-R S.1328-3 which may not be typical of the most sensitive GSO systems deployed in the band. The study assumed interference from a single system using HAPS, consisting of 95 airships and three identical HAPS systems with adjacent service areas, spaced 10 degrees apart in longitude, each consisting of 95 airships.

The preliminary results suggest that the aggregate interference from a single system using HAPS to a GSO satellite would represent an I/N increase of at most 1.5% at the GSO satellite. The aggregate interference increase from three identical systems using HAPS into a GSO satellite would be at most 4%. Practical and operational considerations stemming from limited elevation angles and ATPC in the downlink from HAPS may lower these levels even further. Additional studies are required in order to take into account the impact of deployments over larger geographic areas, different latitudes and different satellite antenna beam sizes.

The applicable Recommendations are ITU-R S.1432 and DNR ITU-R SF.[HAPS-FSS METHOD] (Doc. 4-9/BL/7).

4.1.1.1.4 Compatibility between systems using HAPS and EESS (passive) around the 31 GHz band

Results of ITU-R studies indicate that systems using HAPS may be compatible with EESS (passive) sensor operations in the band 31.3-31.8 GHz if the unwanted emissions from a ground station of a system using HAPS meet the level of −106 dB(W/MHz) into an antenna for an uplink to a HAPS for clear sky conditions and −100 dB(W/MHz) under rainy conditions. In case of a phased array antenna, this level constitutes the total unwanted emission power feeding all elements of the antenna sub-system. These studies show that uplinks to HAPS would have to operate under severe restrictions in order not to cause harmful interference.

The applicable Recommendations are ITU-R SA.1029 and F.1570.

4.1.1.1.5 Compatibility between systems using HAPS and RAS around the 31 GHz band

Results of ITU-R studies indicate that systems using HAPS may be compatible with RAS in the band 31.3-31.8 GHz. The studies show that the level of unwanted emissions into the antenna for an uplink to a HAPS of −106 dB(W/MHz) for clear sky conditions and −100 dB(W/MHz) for rainy conditions would result in compatibility. Appropriate separation distance between the RAS antenna and the ground stations of a system using HAPS need also to be implemented.

Applicable Recommendations: ITU-R RA.769 and DNR ITU-R[HAPS-RAS] (Doc. 9/BL/45).

4.1.1.1.6 Sharing between systems using HAPS and other types of FS systems in the bands 47.2-47.5 GHz and 47.9-48.2 GHz

The ITU-R has studied sharing between systems using HAPS and other types of FS systems in the FS in the bands 47.2-47.5 GHz and 47.9-48.2 GHz leading to a DNR ITU-R F.[9B/HAPS1] (Doc. 9/BL/41).

4.1.1.1.7 Sharing between systems using HAPS in the FS and FSS GSO systems in the bands 47.2-47.5 GHz and 47.9-48.2 GHz

The ITU-R has studied sharing between systems using HAPS in the FS and satellite systems in the GSO in the FSS in the bands 47.2-47.5 and 47.9-48.2 GHz. The results of this work are contained in Recommendation ITU-R SF.1481-1.

4.1.1.2 Analysis of results of studies relating to the agenda item

4.1.1.2.1 Interference evaluation from FS systems using HAPS to other types of FS systems in the bands 27.5-28.35 GHz and 31.0-31.3 GHz

The possibility of frequency sharing between a system using HAPS and a point-to-multipoint (P-MP) FWA system, and between a system using HAPS and a point-to-point (P-P) FWA system has been studied. The system parameters of the system using HAPS used in the calculation are based on Recommendation ITU-R F.1569. The parameters of the FWA systems are taken from typical FWA systems in the frequency bands under consideration in combination with various antenna patterns, including those given in Recommendation ITU-R F.1336-1.

DNR ITU-R F.[HAPS-FWA] (Doc. 9/BL/42) was developed evaluating interference from systems using HAPS into other types of FS systems, and based on the assumptions of a value of I/N and of the required separation distance between a ground station of a system using HAPS and an FWA station.

The results of the evaluation are summarized as follows:

a) frequency sharing between the HAPS airship and the base station of a P-MP FWA system would be possible, if the parameters of the system using HAPS are appropriately chosen and the location of the HAPS airship is adequately coordinated;

b) frequency sharing between ground stations of systems using HAPS and FWA systems will only be possible if appropriate interference mitigation techniques are applied.

In this examination, some FWA parameters such as the transmitter output power are taken from operating systems and others are from the lists in Recommendation ITU-R F.758. It is noted that the separation distance varies largely, up to 500 km, depending on geographical relationships among the HAPS airships, their ground stations and the FWA stations.

4.1.1.2.2 Sharing between systems using HAPS and FSS GSO systems in the band 27.5-28.35 GHz

Preliminary sharing studies of interference into the FSS from HAPS indicate an I/N increase of 1.5% for a single system and 4% for multiple systems having adjacent service areas. Additional studies are required within the ITU-R to assess the impact of different types of HAPS deployments and of FSS configurations to assess the compatibility between the two systems.

4.1.1.2.3 Compatibility between systems using HAPS and EESS (passive) around 31 GHz

Studies have revealed that compatibility between uplinks to HAPS and passive sensor operations may be achieved if the uplinks to HAPS are operated under severe constraints. These include

filtering of unwanted emission side-lobe levels by around 90 dB, and in the inclusion of a guardband. Automatic transmit power control (ATPC) would have to be used to overcome high rain attenuation or increase system availability.

In addition, Recommendation ITU-R F.1570 was formulated to provide a methodology to evaluate the impact from uplinks to HAPS on the EESS (passive). The results of studies indicate that an unwanted emissions level of −100 dB(W/MHz) into an antenna for an uplink to a HAPS with a gain of 35 dBi will not create interference in excess of protection criteria for the passive sensors. It is noted that the required attenuation levels in excess of 90 dB are more than the unwanted emission levels currently under discussion in ITU-R, which are typically around 35 dB. The technical feasibility to achieve attenuation levels in excess of 90 dB in the band 31.3-31.8 GHz has been demonstrated by one administration by prototyping a transmitter module and making appropriate measurements. These show that the required unwanted emissions level of −106 dB(W/MHz) can be met in combination with some guardbands, typically around twice the width of the spectral main lobe. The required guardband may be smaller if the spectral main lobe is reduced. However, this guardband is also likely to increase if non-linear devices are used.

The studies also considered the impact of cumulative interference from several ground stations of systems using HAPS and concluded that the interference coming from four stations within one beam is dominant in the cumulative interference for the assumed configurations. Further study may be required regarding different system constellations as well as the aggregate interference of many systems using HAPS deployed in the territory of administrations listed in No. **5.543A** or possibly worldwide, if other administrations decide to be added to this footnote at a later stage.

The studies concluded that the specification of a single unwanted emission power density in No. **5.543A** constitutes the most suitable approach due to a minimum set of specifications, maximum flexibility for the design of a system using HAPS and full assurance of adequate protection of EESS (passive).

4.1.1.2.4 Compatibility between systems using HAPS and RAS around 31 GHz

Results of ITU-R studies provided in DNR ITU-R F.[HAPS-RAS] (Doc. 9/BL/45) have indicated that some systems using HAPS may be compatible with RAS in the band 31.3-31.8 GHz provided that:

a) appropriate interference mitigation techniques are utilized by systems using HAPS to achieve the requested level of unwanted emissions into the RAS band. The level of unwanted emission from a ground station of a system using HAPS into the 31.3-31.8 GHz band is a key parameter and −106 dB(W/MHz) for clear sky conditions and −100 dB(W/MHz) for rainy conditions are required for the compatibility;

b) the required guardband between the carrier frequency and the RAS band is implemented (40 MHz from the centre frequency of a 20 MHz bandwidth signal to the RAS band);

c) appropriate separation distances are implemented. The required separation distances depend on the minimum elevation angle of the RAS antennas and on the deployment of the ground stations of systems using HAPS.

The above evaluation of the separation distance was done assuming a minimum elevation angle of 5 degrees for the radio telescope antenna and a range of weather and propagation conditions.

4.1.1.2.5 Sharing between systems using HAPS and other types of FS systems in the bands 47.2-47.5 GHz and 47.9-48.2 GHz

The ITU-R has completed significant studies dealing with sharing between systems using HAPS and other types of FS systems in the bands 47.2-47.5 GHz and 47.9-48.2 GHz leading to DNR ITU-R F.[9B/HAPS1] (Doc. 9/BL/41).

4.1.1.2.6 Sharing between systems using HAPS in the FS and FSS GSO systems in the bands 47.2-47.5 GHz and 47.9-48.2 GHz

The ITU-R has studied sharing between systems using HAPS in the FS and satellite systems in the GSO in the FSS in the bands 47.2-47.5 and 47.9-48.2 GHz. The results of this work are contained in Recommendation ITU-R SF.1481-1, which notes that further studies could identify additional operational scenarios and mitigation techniques which could further facilitate frequency sharing.

4.1.1.2.7 Conclusion

4.1.1.2.7.1 Frequency bands 27.5-28.35 GHz and 31.0-31.3 GHz

With the exception of the FSS, the results of studies already completed indicate that the systems using HAPS could operate in the bands 27.5-28.35 GHz and 31.0-31.3 GHz without any unacceptable interference to other types of FS systems or other co-primary services (except FSS), through appropriate interference mitigation measures and taking into account the required geographical separation distance and frequency guardband. It is also confirmed that deployment of systems using HAPS in the band 31.0-31.3 GHz could operate without causing harmful interference to the passive services in the band 31.3-31.8 GHz, through appropriate interference mitigation measures.

With regard to the FSS, additional studies are required within the ITU-R to assess the impact of different types of HAPS deployments and of FSS configurations to assess the compatibility between the two systems.

4.1.1.2.7.2 Frequency bands 47.2-47.5 GHz and 47.9-48.2 GHz

Significant sharing studies in this band have been completed within ITU-R. No additional issues are considered necessary in sharing between systems using HAPS in the FS and other types of FS systems in the 48 GHz range at this time.

4.1.1.3 Methods to satisfy the agenda item

4.1.1.3.1 Frequency bands 27.5-28.35 GHz and 31.0-31.3 GHz

Identification of suitable FS bands for systems using HAPS should be in bands that are already allocated to the FS on a primary basis. The bands considered should be limited to the 27.5-28.35 GHz and 31.0-31.3 GHz bands identified in Resolution **122**.

A possible method would be the identification of bands for systems using HAPS by country footnote and limited to countries indicating a need for an additional 2 × 300 MHz identification of bands, because of difficulties with severe rain attenuation associated with the existing 2 × 300 MHz bands at 47 GHz identified for systems using HAPS.

Additionally the amount of spectrum identified for systems using HAPS in the referenced bands, 27.5-28.35 GHz and 31.0-31.3 GHz, should be consistent with the amount identified at 47 GHz (i.e. 2 × 300 MHz), unless a specific technical rationale for more spectrum is provided. Nevertheless, a different view, expressed by two administrations, states that, taken in its totality, Resolution **122** does not suggest that the spectrum bandwidth to be considered for systems using HAPS in the range 18-32 GHz should necessarily conform to the 2 × 300 MHz bands designated for

this application in the 47 GHz region of the spectrum and further, that the amount of downlink spectrum in the range 27.5-28.35 GHz as is suggested in *request* 3 of that Resolution is appropriate.

The sharing and compatibility issue of a system using HAPS in the fixed service in the range 18-32 GHz with other systems or other services is divided into three issues as follows:

Issue 1: Interference from a system using HAPS to other types of FS systems sharing the same frequency bands (See sections 4.1.1.1.2 and 4.1.1.2.1.)

Issue 2: Interference from a system using HAPS to satellite systems of the FSS operating in the GSO in the 27.5-28.35 GHz (See sections 4.1.1.1.3 and 4.1.1.2.2.)

Issue 3: Compatibility of a system using HAPS with the science services (passive) having a primary allocation in the band 31.3-31.8 GHz (See sections 4.1.1.1.4, 4.1.1.1.5, 4.1.1.2.3 and 4.1.1.2.4.)

These issues are independent and can be discussed individually. Methods to solve each issue are proposed as follows:

4.1.1.3.1.1 Methods for Issue 1 (Interference from systems using HAPS to other types of FS systems)

4.1.1.3.1.1.1 Method A

Modification to RR No. **5.537A** and **5.543A** so as to contain the appropriate interference methodology, if any, from a system using HAPS to other types of FS systems or other services.

Advantages:

Interference to victim systems or services is completely controlled.

Disadvantages:

- Various criteria for different services would be specified in footnotes of the RR and may make them very complex.
- To date, no criteria have been agreed.

4.1.1.3.1.1.2 Method B

No change to RR No. **5.537A** and **5.543A**.

Advantages:

Simplest approach forward.

Disadvantages:

Bilateral agreements by administrations will be required in those sharing situations where compatibility is needed.

4.1.1.3.1.2 Methods for Issue 2 (Interference from systems using HAPS to FSS/GSO)

The identification of bands for systems using HAPS should be done in such a way as not to impact the ability to operate existing and planned FSS systems.

Method

Defer a decision on the identification of bands.

As additional studies are required within the ITU-R to assess the impact of systems using HAPS on the FSS/GSO operating in the bands proposed for consideration by agenda item 1.13, WRC-03 should consider deferring a decision on this aspect of the matter until the next WRC. Under this

method, it is proposed that Resolution **122** should be revised accordingly or a new Resolution should be adopted and that an appropriate agenda item should be taken into consideration at a competent WRC.

Advantages:

More time is permitted to study and resolve one of the difficult sharing situations for use of HAPS in these bands.

Disadvantages:

Resolution **122 (Rev.WRC-2000)** is only partially satisfied.

4.1.1.3.1.3 Methods for Issue 3 (Protection of science services (passive))

4.1.1.3.1.3.1 Method A

Modification to No. **5.543A** so as to contain the operational restrictions for systems using HAPS through specification of an unwanted emission power level.

Advantages:

- Science services (passive) in the adjacent band are completely protected.
- Maximum flexibility for a system using HAPS design.

Disadvantage:

Some restrictions on implementation of systems using HAPS.

4.1.1.3.1.3.2 Method B

Modification to No. **5.543A** so as to incorporate the appropriate operational restrictions for systems using HAPS contained in ITU-R recommendations by reference.

Advantages:

Science services in the adjacent band are completely protected.

Disadvantages:

- Some restrictions on implementation of systems using HAPS.
- The set of recommendations for design of systems using HAPS is quite voluminous.
- Some guidelines in the recommendations may unduly constrain the design of systems using HAPS.

4.1.1.3.1.3.3 Method C

Maintenance of No. **5.543A** and extension of the present restriction for systems using HAPS to the conference following WRC-03.

Advantages:

Science services in the adjacent band are appropriately protected.

Disadvantages:

Resolution **122 (Rev.WRC-2000)** cannot be fulfilled.

4.1.1.3.2 Frequency bands 47.2 to 47.5 GHz and 47.9 to 48.2 GHz

Some administrations support the consideration of another method to satisfy this agenda item as described in section 4.1.1.3.3 below.

Method

All portions of Resolution **122** dealing with systems using HAPS in the frequency bands 47.2 to 47.5 GHz and 47.9 to 48.2 GHz can be suppressed. No. **5.552A** would need to be amended to remove the reference to Resolution **122** and to reference the appropriate sections of Article 9 of the Radio Regulations. Consequential changes may be required to Article 9 in order to correctly define the coordination required between the FSS and systems using HAPS.

Advantages:

Permanently entrenches the coordination regime between the fixed service using HAPS and the FSS in the Radio Regulations.

Disadvantages:

There is a need to develop a coordination procedure between systems using HAPS operating in the FS and FSS systems.

4.1.1.3.3 Method for assessment of interference from systems using HAPS and FSS in the 48 GHz band

Compatibility between the systems using HAPS and the FSS service in the 48 GHz band could be achieved by further study as noted in Recommendation ITU-R SF.1481-1.

It is recognized that there may be better methods for coordination between systems using HAPS and FSS in the 48 GHz band and initiate further studies. Resolution **122 (Rev.WRC-2000)** should be amended and an appropriate agenda item should be taken into consideration at a competent WRC.

Advantages:

- Further studies may identify better methods and additional mitigation techniques.
- More compatible operational scenarios may be identified.

Disadvantages:

This method will prolong the inability of BR to process FSS notifications (except feeder links for BSS).

4.1.1.4 Regulatory and procedural consideration

4.1.1.4.1 Operation of systems using HAPS in the fixed service in the band 31.0-31.3 GHz

In the methods described in the above sections relating to the 31 GHz band, implementation of one or more methods would require modifications to certain provisions in Article **5**.

Regarding passive services including EESS and RAS, modification of No. **5.543A** may be considered as follows:

MOD

5.543A In Bhutan, Indonesia, Iran (Islamic Republic of), Japan, Maldives, Mongolia, Myanmar, Pakistan, the Dem. People's Rep. of Korea, Sri Lanka, Thailand and Viet Nam, the allocation to the fixed service in the band 31-31.3 GHz may also be used by systems using high altitude platform stations (HAPS) in the ground-to-HAPS direction. The use of the band 31-31.3 GHz by systems using HAPS shall not cause harmful interference to, nor claim protection from, other types of fixed-service systems or other co-primary services, taking into account No. **5.545**. ~~The use of~~Systems using HAPS in the band 31-31.3 GHz shall not cause harmful interference to the radio astronomy service having a primary allocation in the band 31.3-31.8 GHz, taking into account the protection criterion of –141 dB(W/(m^2•500 MHz)). In order to ensure the protection of satellite passive

services, the level of unwanted emissions from a ground station of a system using HAPS into the band 31.3-31.8 GHz shall be limited to –106 dB (W/MHz) under a clear-sky condition, and may be increased under rainy conditions in accordance with rain attenuation, provided that effective impact on the passive services is not in excess of –100 dB (W/MHz) ~~to the passive services having a primary allocation in the band 31.3-31.8 GHz, taking into account the interference criteria given in Recommendations ITU-R SA.1029 and ITU-R RA.769. The administrations of the countries listed above are urged to limit the deployment of HAPS in the band 31-31.3 GHz to the lower half of this band (31-31.15 GHz) until WRC-03~~.

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Furthermore, revision of Resolution **122 (Rev.WRC-2000)** may be considered to extend the time frame of the ITU-R study on the sharing issues (except compatibility studies with passive services) to the WRC-07.

The example revision of No. **5.543A** as shown here removes the limitation on the deployment of systems using HAPS to the 31.0-31.15 GHz part of the allocation to the fixed service at 31.0-31.3 GHz. Some administrations do not agree with the removal of limitation to the use of this band.

4.1.1.4.2 Operation of systems using HAPS in the fixed service in the band 47.2-47.5 GHz and 47.9-48.2 GHz

Two different views have emerged during the discussions on this topic:

Some administrations believe that the paragraph, *instructs the Director of the Radiocommunication Bureau* 2*,* of Resolution **122** should be suppressed. In this connection, these administrations are of the view that appropriate revisions to Article **9** of the Radio Regulations could be adopted which would permit coordination between systems using HAPS and the FSS in these bands. Administrations holding this view maintain that Recommendation ITU-R SF.1481-1 indicates that sufficient work has been accomplished under the auspices of Resolution **122** to permit the suppression of this "*instructs*". It is also the view of these administrations that any further required studies can be completed within the Study Group structure of the ITU-R.

Other administrations believe that, consistent with the requirements of certain parts of Recommendation ITU-R SF.1481-1, further sharing studies are required and that the provisions of Resolution **122** as they apply to this portion of the spectrum should be maintained, These administrations also recognized that ITU-R SF.1481-1 is based on the findings of already completed significant sharing studies, but they are concerned that these studies have not addressed all of the potential sharing problems that may arise in these bands. Regarding sharing between systems using HAPS and FSS systems in the 48 GHz range, the need for further studies noted above may be facilitated by amending Resolution **122 (Rev.WRC-2000)**. For example, the following modifications have been suggested:

- add a new "*considering n bis)*" that Recommendation ITU-R SF.1481-1 provides useful reference information in regard to sharing between systems using HAPS and GSO FSS but also notes that further study of operational scenarios and mitigation techniques is required, and such study would enable greater confidence in sharing the radio spectrum in the 47.2-47.5 GHz band and 47.9-48.2 GHz band, which have been designated for systems using HAPS;
- modify "*requests ITU-R* 2" to continue carry out studies on the appropriate technical sharing criteria for the situations referred to in *considering j* and *n bis*; and
- modify "*instructs the Director of the Radiocommunication Bureau* 2" that from 22 November 1997, and pending review of sharing studies in *considering j* and *n bis,* and

review of the notification process by WRC-07, the Bureau shall accept notices in the bands 47.1-47.5 GHz and 47.9-48.2 GHz only for HAPS in the FS and for feeder links for the BSS, shall continue to process notices for the FSS networks (except for feeder links for BSS) for which complete information for advance publication has been received prior to 27 October 1997, and shall inform notifying administrations accordingly.

4.1.2 Resolution 734 (WRC-2000)

"Feasibility of use by high altitude platform stations in the fixed and mobile services in the frequency bands above 3 GHz allocated exclusively for terrestrial radiocommunication"

4.1.2.1 Summary of technical and operational studies

ITU-R has examined the Table of Frequency Allocations as well as associated footnotes for bands allocated exclusively to terrestrial services in accordance with Resolution **734 (WRC-2000)**, which requests ITU-R to carry out studies for the possibility of identifying more spectrum for systems using HAPS. Table 4.1-1 shows the frequency bands, which fall under Resolution **734**.

There have been very few studies by administrations on sharing conditions and no studies on the amount of spectrum required for systems using HAPS in these bands. Without more detailed studies, it is not apparent, if any of the bands listed in Table 4.1-1 contain sufficient spectrum for operation of systems using HAPS. In addition, some of these bands are adjacent to passive service allocations and may require guardbands larger than the available spectrum.

TABLE 4.1-1

Frequency bands to be studied for possible use by systems using HAPS (RR Article 5)

Frequency band (GHz)	Bandwidth (MHz)	Table allocation		Footnote allocation (small letters: secondary)	Comments and remarks
		Primary	Secondary		
3.30-3.332	32	RLS (all)	AS (R2, R3) FS/MS (R2)	RNS (5.430, all), FS/MS (5.429, R1, R3)	(1), (2), (3)
3.339-3.40	61	RLS (all)	A (all) FS/MS (R2)	RNS (5.430, all), FS/MS (5.429, R1, R3)	(2), (3)
4.20-4.40	200	ARNS (all)		FS (5.439, R3)	(3), (4)
4.40-4.50	100	FS/MS (all)			(5)
5.47-5.65	180	MRNS (all)	RLS	MS (5.451, R1)	(6), (3), (7)
5.725-5.83	105	RLS (all) FS (R1)	AS (all)	FS/MS (5.453, 5.455, R2, R3)	(8), (3)
7.0725-7.145	70	FS/MS (all)			(9)-(13)
7.235-7.250	15	FS/MS (all)			(9)-(13)
7.85-7.90	50	FS/MS * (all)			(14), (15)
8.50-8.55	50	RLS (all)		FS/MS (5.468, all)	(2), (3)
8.65-8.75	100	RLS (all)		FS/MS (5.468, all)	(2), (3)
9.80-9.975	175	RLS (all)	FS (all)	RNS (5.430, all), FS (5.477, R1, R3)	(16), (17), (3)
10.025-10.45	425	RLS (all) FS/MS (R1, R3)	AS (all)	FS/MS (5.480, R2)	(17), (3)
10.50-10.55	50	RLS (R2, R3) FS/MS (all)	RLS (R1)		(18), (3)
10.55-10.60	50	FS/MS * (all)	RLS (all)		(19), (15)
15.7-16.6	900	RLS (all)		FS/MS (5.512, all)	(17), (3), (20)
17.10-17.20	100	RLS (all)		FS/MS (5.512, all)	(3)
* except aeronautical mobile R1-Region 1, R2-Region 2, R3-Region 3, all-Regions 1, 2 and 3					

Comments and remarks for Table 4.1-1

(1) The band 3.332-3.339 GHz is referred to in No. **5.149** with respect to radio astronomy and does not fit with the provisions in Resolution **734**.

(2) Extensively used in all Regions by radiolocation systems.

(3) Sharing with radio astronomy, radiolocation or radionavigation is expected to be very difficult.

(4) The frequency 4.202 GHz may be used by standard frequency and time signal-satellite service (No. **5.440**).

(5) Extensively used by fixed systems and by mobile systems in Region 2 (between 4.46 and 4.50 GHz).

(6) Extensively used in all Regions by maritime and meteorological radars.

(7) WRC-03 is expected to consider new allocations to the EESS and mobile service and upgrading the radiolocation allocation under agenda item 1.5. Further sharing is expected to be difficult.

(8) Extensively used by licence-exempt wireless access systems. In addition all services must accept harmful interference from ISM.

(9) The band 7.075-7.250 GHz is related to passive microwave sensor measurement stated in No. **5.458**.

(10) 7.10-7.155 and 7.19-7.235 GHz**: Space operation No. **5.459** (** the band outside the scope of Resolution **734**).

(11) 7.145-7.235 GHz**: Space research in all Regions No. **5.460**. (** the band outside the scope of Resolution **734**).

(12) Extensively used by point-to-point fixed systems in all regions, including critical telemetry and control for utilities.

(13) Sharing is expected to be very difficult.

(14) Meteorological satellite operating in the adjacent band 7.750-7.850 GHz will require further consideration.

(15) Compatibility with systems using HAPS is expected to be very difficult.

(16) Meteorological satellite service operating in the adjacent band 9.975-10.025 GHz may require consideration.

(17) Extensively used worldwide by radiolocation systems.

(18) Extensively used by radiolocation including licence-exempt applications.

(19) Radio astronomy, EESS (passive), space research (passive) operating in the adjacent band 10.6-10.68 GHz will require further consideration.

(20) This band is also used by radionavigation (i.e. airport surface detection equipment) in one administration.

4.1.2.2 Analysis of results of studies

Since a feasibility study on systems using HAPS in the frequency range 18-32 GHz is being conducted under Resolution **122 (Rev.WRC-2000)**, the studies relating to Resolution **734 (WRC-2000)** are focusing primarily on the range 3-18 GHz.

4.1.2.2.1 General consideration of the frequency range 3-18 GHz

The technical considerations are made for the following frequency ranges taking account of frequency dependent characteristics:

1) the 3 to 7 GHz frequency range;

2) the 7 to 18 GHz frequency range.

The 3-7 GHz frequency range is suitable for achieving a highly reliable service because of very low rainfall attenuation. Since a system would need no rain margin in the link budget, the availability of higher than 99.99% could be achieved without resorting to any special techniques. This range is also suitable for a ground station of a system using HAPS using an omnidirectional antenna because of the lower propagation loss. A typical application may be systems in the mobile service.

The 7-18 GHz frequency range is susceptible to rain attenuation in the higher part of the frequency range. The link availability could be 99.99% in the lower frequency bands below about 10 GHz and 99.95% in the higher frequency bands above about 10 GHz. The propagation loss also increases when the frequency becomes higher. It might be practical to use this frequency range for a fixed service or a nomadic type service using a terminal with a directive antenna.

However, at this time it has to be noted that no band has been allocated exclusively to the FS or MS in accordance with the RR Article **5** in the 10.6 to 18 GHz range, although there are footnote allocations in this frequency range under the scope of Resolution **734**. Table 4.1-2 summarizes the above considerations.

TABLE 4.1-2

Typical application of systems using HAPS above the 3 GHz band

Frequency range	3-7 GHz	7-18 GHz
Rain attenuation	Very small	Small-moderate
Typical link availability	99.99% or higher	99.95% or higher
Possible user terminal mobility	mobile/nomadic/fixed	Nomadic/fixed

4.1.2.2.2 Frequency sharing consideration with other services

The equation of geometrically visible distance given in Recommendation ITU-R F.1501 may not be applicable for a system using HAPS operating in the frequency bands considered in Resolution **734**. It is understood that a system using HAPS could operate locally in a limited area compared with the area generally covered by GSO FSS system.

To date, only one preliminary sharing study between a system using HAPS in the FS and a FWA system in the FS has been undertaken but not completed with respect to Resolution **734** in the range 3-18 GHz.

Nevertheless, it was assumed that for most of the bands in Table 4.1-1, the sharing or compatibility with existing services will be difficult.

Interference scenarios to be considered are as follows:

a) interference between HAPS airships and terrestrial stations in other terrestrial services;

b) interference between ground stations of systems using HAPS and terrestrial stations in other terrestrial services;

c) unwanted emissions from airships and ground stations of systems using HAPS into other services utilizing the adjacent bands;

d) the effects of unwanted emissions falling within adjacent or nearby passive service bands, e.g. 10.6-10.7 GHz.

A detailed methodology to evaluate the coordination distance and sharing criteria of systems using HAPS for 3-18 GHz needs further study.

4.1.2.3 Methods to satisfy the agenda item

Method 1

To continue studies in accordance with possible revision of Resolution 734 at WRC-03 from the technical and regulatory points of view on some or all the frequency bands listed in Table 4.1-1, in particular the services and technical requirements for sharing and compatibility issues which largely depend on the frequency bands of interest.

Advantages:

- There is the possibility to continue studies on the required amount of spectrum and sharing conditions.

Disadvantages:

- Sharing studies seem to be very complex and time consuming.

Method 2

Continue studies under normal activities of ITU-R; suppress Resolution 734.

Advantages:

- Could allow a decrease of the financial constraints on BR and administrations.

Disadvantages:

- No additional identification of frequencies under Resolution 734.

4.1.2.4 Regulatory and procedural consideration

If Method 1 is adopted for implementation of systems using HAPS in the fixed and mobile services in the bands above 3 GHz that are allocated exclusively by the Table of Frequency Allocations or by footnotes for terrestrial radiocommunication, various regulatory and technical studies are required under Resolution 734 which may be revised at WRC-03 to identify the frequency bands suitable for this application. It is necessary to take into account the co-located services sharing the same band as well as passive services in adjacent bands, and their operational requirements, which differ over the bands 3-18 GHz. All the studies carried out for systems using HAPS in the bands 47/48 GHz and 28/31 GHz are considered as useful references. Further studies are required in ITU-R in order to solve the sharing issue between the FS system using HAPS and other services, and to determine the feasibility of systems using HAPS in the mobile services in the range above 3 GHz.

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4.2 Agenda item 1.18

"to consider a primary allocation to the fixed service in the band 17.3-17.7 GHz for Region 1, taking into account the primary allocations to various services in all three Regions"

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

The 17.3-17.7 GHz band is allocated to the FSS (Earth-to-space) in all three Regions. The use of this allocation by GSO networks is limited to BSS feeder links and subject to the Plans in App. **30A**. In Region 2, the band 17.3-17.7 GHz is also allocated (from 1 April 2007) to BSS. There are therefore three sharing issues related to BSS to be considered possible, namely: interference

from an FS station into BSS feeder-link space station receivers, interference from BSS feeder-link earth stations into FS receive stations, as well as the potential impact on BSS in Region 2.

4.2.2 Analysis of the results of studies

4.2.2.1 Interference from an FS station into BSS feeder-link space station receivers

With regard to this scenario, the situation is the same as in the adjacent band (17.7-18.1 GHz). Protection of BSS feeder-link space station receivers could be ensured by the extension of the limits currently applicable in Article 21 in the 17.7-18.1 GHz band. In applying these limits sharing between FS stations and BSS space stations would not cause difficulties for BSS feeder-link space station receivers.

4.2.2.2 Interference from BSS feeder-link earth stations into FS receive stations

The addition of an FS allocation in Region 1 would result in possible interference from Regions 1, 2 and 3 BSS feeder-link earth stations into the FS receivers. Sharing between transmit FSS earth stations and FS receivers is normally handled through the coordination under RR No. 9.17, using specific earth stations.

However, with the App. **30A** Plan the locations of the feeder-link earth stations are not pre-determined; in general, such stations can be located anywhere within the feeder-link service area, which is often coincident with the service area of the associated BSS space station.

Although the size of the area around the BSS feeder-link earth station within which this earth station may cause harmful interference to FS receivers, may vary according to the shape of the terrain and the presence of obstacles, this size may be expected to range within about 20-100 kilometres. A separation distance would become even larger when BSS feeder-link earth stations adopt power control by 5 to 10 dB in order to overcome the rain attenuation.

In order to ensure protection of Appendix **30A** Plans, no protection can be given to future FS receivers from interference caused by BSS feeder links in conformity with the Plan. Such BSS Plan feeder links can be located and operated free of constraints anywhere within the service area of the associated BSS satellite.

If FS receivers have to be protected from future BSS feeder-link earth stations in Regions 1 and 3 List, as evolving, of App. **30A**, the deployment of future/additional BSS feeder-links would be significantly constrained.

4.2.2.3 Impact on the Region 2 BSS (space-to-Earth)

In Region 2, BSS networks are expected to be deployed once the allocation comes into effect. Sharing between FS applications under a new FS allocation in Region 1 and BSS in Region 2 is feasible.

4.2.3 Methods to satisfy the agenda item

Method

Recognizing the results of the ITU-R studies carried out, no new allocation should be made to the FS in Region 1 in the band 17.3-17.7 GHz. Furthermore, the review of the actual FS use and future plans currently makes the use and interest by FS within Region 1 in the 17.3-17.7 GHz band limited. Therefore a primary allocation to the FS is not required.

NOTE - A few administrations of Region 1 were of the view that a primary allocation for the fixed service in the band 17.3-17.7 GHz in Region 1 is required.

4.2.3 Methods to satisfy the agenda item

Method

Recognizing the limitations highlighted above, no new allocation should be made to the FS in Region 1 in the band 17.3-17.7 GHz. Furthermore, the review of the actual FS use and future plans currently makes the use and interest by FS within Region 1 in the 17.3-17.7 GHz band limited. Therefore a primary allocation to the FS is not required.

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4.3 Agenda item 1.25

"to consider, with a view to global harmonization to the greatest extent possible, having due regard to not constraining the development of other services, and in particular of the fixed service and the broadcasting-satellite service, regulatory provisions and possible identification of spectrum for high-density systems in the fixed-satellite service above 17.3 GHz, focusing particularly on frequency bands above 19.7 GHz"

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

A High Density application in the FSS (HD-FSS) is one which operates on a system in the FSS, deploying a large number of ubiquitous earth stations. Satellite systems can be of any orbital type, such as GSO or non-GSO, and using any of the available technologies.

High Density applications are generally characterized as follows:

- flexible, rapid and ubiquitous deployment of earth stations (terminals);
- high frequency reuse typically through the use of satellite spot beams;
- small terminal antenna size;
- cost optimized terminals.

As a consequence of these general characteristics, it may be a rather long process to coordinate HD-FSS earth stations on an individual site-by-site basis. Because the status of assignments to earth stations in respect of terrestrial stations or earth stations operating in the opposite direction of transmission is derived from the application of the relevant coordination procedure (No. **8.3**), the conclusion is that, under the current regulatory provisions, where coordination among earth stations and terrestrial stations is required (i.e. RR Appendix **5**, Table 5-1 is triggered):

- receiving FSS earth stations may not be ensured to be protected from harmful interference from terrestrial stations or earth stations operating in the opposite direction of transmission unless coordination, notification and recording are conducted for specific earth stations;
- transmitting FSS earth stations will have to take steps to eliminate harmful interference caused to existing and future terrestrial stations or earth stations operating in the opposite direction of transmission unless coordination, notification and recording are conducted for specific earth stations;
- FSS receive/transmit earth stations are not required to be coordinated if their coordination area does not cover in whole or in part the territory of another country.

Some regulatory means may be required to facilitate coordination of FSS earth stations in certain frequency bands identified for HD-FSS deployment to allow terminals to operate on a protected basis in these bands. The feasibility and impact on other services of such means are being studied. Some administrations require HD-FSS terminals to coordinate with the FS or to operate on a non-protected basis in some FSS bands.

It is noted that access to and from rural and urban areas is necessary for the HD-FSS to ensure its economic viability.

4.3.1.1 Bands allocated to FSS (Earth-to-space)

Technical studies in the band 27.5-29.5 GHz have been carried out within the ITU-R. These studies indicate the non-practicability of the co-frequency sharing between HD-FSS earth stations and terrestrial services in the same geographical area. They have shown that transmissions from FSS terminals can cause interference into FS receivers unless a minimum separation distance is maintained. No mitigation technique has been identified in the ITU-R to allow wide-scale deployment of HD-FSS terminals that will also ensure protection of receiving FS stations in the same geographical area.

4.3.1.2 Bands allocated to FSS (space-to-Earth)

Technical studies in the band 17.7-19.3 GHz have been carried out within the ITU-R. These studies show that HD-FSS terminals can receive interference from transmitting terrestrial stations which creates areas around each transmitter where operation of HD-FSS terminals may not be possible. The size of these areas depends on the characteristics of the HD-FSS and FS systems and can be reduced by the use of mitigation techniques.

Some administrations believe that these mitigation techniques (e.g. ATPC and larger antenna size for FS or adaptive coding and spread spectrum for FSS) can be implemented by both FS and FSS, improving co-frequency sharing between HD-FSS earth stations and terrestrial services in the same geographical area.

Other administrations believe that these mitigation techniques to be applied by FS (e.g. ATPC and larger antenna size) can reduce the interference areas, but there will always remain some area around each FS transmitter where deployment of FSS terminals will not be possible. These administrations believe that mitigation techniques proposed to be applied to the FSS, while theoretically feasible, are not practicable for HD-FSS systems.

As a result of the above, it is agreed that as the number of coordinated FSS receivers grows, there will be more constraints on the deployment of FS and similarly as the number of FS transmitters grows, more of the potential service area will be lost by the FSS.

Although the specific conditions under which HD-FSS terminals will be deployed in a given geographical area may depend on the FS deployment and the practicability and effectiveness of mitigation techniques, the identification of bands for HD-FSS may not be based solely on these specific sharing conditions.

4.3.1.3 Bands currently not allocated to FSS (space-to-Earth)

Some administrations support the identification of bands which would require new allocations to FSS (space-to-Earth) and are of the view that the identification of spectrum under agenda item 1.25 does not preclude the consideration of new FSS bands and the corresponding sharing studies.

Other administrations do not support the identification of any bands for HD-FSS that are not currently allocated to the FSS, in the indicated direction. These administrations are of the view that the allocation of a band requires analysis of sharing considerations with current services while the identification of a band is assumed to be the identification of specific bands from among the bands allocated to a service.

Three bands not allocated to FSS (space-to-Earth) have also been studied for possible allocation to this service and identification for HD-FSS applications. Of these, only the bands 17.3-17.7 GHz (in Regions 1 and 3) and (parts of) 47.2-50.2 GHz are still being considered, whereas the 21.4-22 GHz

band is no longer under consideration since the ITU-R has concluded that it is not feasible for that purpose.

4.3.1.3.1 Band 17.3-17.7 GHz (in Regions 1 and 3)

The 17.3-17.7 GHz band is allocated to the FSS (Earth-to-space) in all three Regions. The use of this allocation by GSO FSS networks is limited to BSS feeder links and the use of the band 17.3-18.1 GHz is subject to the Plans in Appendix **30A**. In Region 2, the band 17.3-17.7 GHz is also allocated (from 1 April 2007) to BSS. The use of the band 17.3-18.1 GHz by all of the above services is fully defined in No. **5.516**. The radiolocation service is allocated on a secondary basis in all three Regions. The band is also allocated to the fixed and mobile services on a secondary basis in the 31 countries in No. **5.514**.

There are therefore three sharing issues involving BSS or BSS feeder-link allocations as well as other sharing issues.

In relation to the possible addition of an FSS (space-to-Earth) allocation in the 17.3-17.7 GHz band, the ITU-R studies concluded the following:

Sharing between FSS transmit space stations and BSS feeder-link receive space stations would be feasible under the current provisions in the Radio Regulations applicable in the adjacent band (17.7-18.1 GHz), i.e. by extending to the band 17.3-17.7 GHz the application of Article **7** and Section 1 of Annex 4 to Appendix **30A** to protect assignments subject to Appendix **30A** Plans from GSO FSS and by extending the application of the current $epfd_{is}$ limits in Article **22** to protect Appendix **30A** Plans and the List from non-GSO FSS.

In order to ensure protection of Appendix **30A** Plans, no protection can be given to FSS receive earth stations from interference caused by assignments to BSS feeder-link earth stations previously included in the relevant Plan or in the List or for which the procedures of Article 4 of Appendix **30A** and No. **9.17A**, as appropriate, have been previously initiated. Such BSS Plan feeder links can be located anywhere within the service area of the associated BSS satellite. The procedures in Article 7 of Appendix **30A** ensure that BSS feeder-link earth stations in conformity with the Plan will be able to operate free of constraints anywhere in the service area. Feeder-link earth stations in the List will share on an equal basis with FSS receive earth stations by applying the procedure of No. **9.17A**, which involves only specific earth stations. Hence, FSS receive earth stations in the same band cannot be protected from interference that may be caused by existing or future BSS feeder-link earth stations in conformity with Appendix **30A** or the relevant BSS feeder-link Plan. However, the current procedure under No. **9.17A** also enables specific FSS receive earth stations to be protected from feeder-link earth stations in the Regions 1 and 3 List after successful application of this procedure, as currently possible in the band 17.7-18.1 GHz. Some administrations consider that this may constrain the development of future additional BSS feeder-link uses in the Regions 1 and 3 List. Other administrations consider that the potential constraint is very limited due to the possibility of applying No. **11.41** in case of disagreement from the administration of the receive FSS earth station.

Sharing between FSS (space-to-Earth) and BSS feeder links in the Regions 1 and 3 List would be feasible under the current provisions applicable in the adjacent band (17.7-18.1 GHz) since the FSS receive earth stations are specific.

Sharing between FSS (space-to-Earth) in Region 2 and BSS in Region 2 would lead to very serious constraints on the development of the BSS in that Region, hence the allocation to FSS (space-to-Earth) in Region 2 is not supported.

Sharing between FSS (space-to-Earth) in Regions 1 and 3 and BSS in Region 2, would be feasible under the current RR provisions, i.e. No. **9.7** for the coordination between GSO BSS and GSO FSS

networks, and No. **22.2** for the protection of GSO BSS networks against non-GSO FSS systems or for the protection of GSO FSS networks against non-GSO BSS networks.

Sharing between FSS (space-to-Earth) in Regions 1 and 3 and non-GSO FSS in Regions 1 and 3 would be feasible under the current RR provisions applicable to the adjacent band 17.7-18.1 GHz.

Sharing between FSS (space-to-Earth) in Regions 1 and 3 and radiolocation is feasible without imposing undue constraints on either services.

Some administrations believed that the sharing situation between small FSS receive terminals in Regions 1 and 3 and radiolocation in this band may be similar to the existing situation regarding sharing between BSS (space-to-Earth) and radiolocation in Region 2.

However, further studies to compare the characteristics and availability of BSS (space-to-Earth) in Region 2 with the FSS characteristics considered to date, would be required before any conclusion can be reached on the similarities.

Sharing between FSS (space-to-Earth) in Regions 1 and 3 and the FS in Region 1, as a result of a potentially new primary allocation under agenda item 1.18, could be treated under the current provisions of the Radio Regulations applicable to the adjacent band 17.7-19.7 GHz.

Some administrations consider that the allocation of the FSS on a primary basis in Regions 1 and 3 shall not claim protection from the fixed and mobile services of the countries mentioned in No. **5.514**.

Other administrations that support new FSS allocations under this agenda item, believe that FSS (space-to-Earth) allocations in the band 17.3-17.7 GHz would be feasible under the current RR provisions without unduly constraining the fixed and mobile services (secondary) of those countries in No. **5.514**.

It was also noted that some administrations propose to use the BSS feeder-link assignments in the frequency band 17.3-18.1 GHz for GSO FSS (Earth-to-space) and to clarify this by aligning No. **5.516** with No. **5.492**. It should be noted that no consideration on the impact on the radiolocation service has been studied.

If an allocation to the FSS (space-to-Earth) were to be made in the band 17.3-17.7 GHz in Regions 1 and 3, the extension to this band of the regulatory provisions currently applicable in the band 17.7-18.4 GHz, may provide a satisfactory regulatory framework for sharing between BSS feeder links, BSS and HD-FSS (space-to-Earth), in the band 17.3-17.7 GHz, as well as in the band 17.7-18.4 GHz.

As to the new regulatory provisions that may be adopted in conjunction with the identification of any part of the band 17.3-18.4 GHz for HD-FSS use, serious concern was expressed on the possibility of modifying the current provisions under No. **9.17A** or adopting new provisions in order to allow the coordination of typical FSS receive earth stations. If such a modification was not implemented with great care in order to ensure equitable access between the services, it could severely constrain the development of future BSS feeder-link uses in the 17.3-18.4 GHz band.

This issue is also discussed under Section 3.4 (agenda Item 1.30, typical earth stations).

Some administrations objected to the proposal for an allocation to FSS (space-to-Earth) in the band 17.3-17.7 GHz.

4.3.1.3.2 Band 47.2-50.2 GHz:

Such new allocation to the FSS (space-to-Earth) leads to the following sharing and compatibility scenarios:

- sharing between FSS (space-to-Earth) and FSS (Earth-to-space),

- sharing between FSS (space-to-Earth) and FS,
- compatibility between FSS (space-to-Earth) and EESS (passive) in the band 50.2-50.4 GHz,
- compatibility between FSS (space-to-Earth) and RAS in the band 48.94-49.04 GHz.

The current status of the studies and the results of some of them are given in § 4.3.2.3.

4.3.2 Analysis of the results of studies

4.3.2.1 Possible candidate uplink bands

Table 4.3-1 gives the analysis of the results of the studies (where applicable) carried out for each bands considered for identification for HD-FSS applications in the uplink direction, providing comments and conclusions.

TABLE 4.3-1

81-86 GHz	**Conclusion:** Seems not to be usable with current technology.
50.4-51.4 GHz	**Comments:** Part of this band might be intended for use in all three Regions by some administrations for FSS other than public communication systems (e.g. national defence systems). In one country in Region 3, there is deployment of RLAN in this band. **Conclusion:** This band is not proposed for "HD-FSS" identification.
47.2-50.2 GHz	**Comments:** There are filings for "HD-FSS" type systems. The sub-band 48.2-50.2 GHz represents 2 GHz of spectrum that might be considered for "HD-FSS" use since there would be no overlap with the HAPS designated spectrum. There is some intention to use this band for FS PP links. Some FS links are already deployed in Region 1. Sharing in the same geographical area between HD-FSS transmitting earth stations and FS is generally not practicable however studies may be required. Sharing in the same geographical area may not be feasible between HAPS (intended to be used in the 47.2-47.5 and 47.9-48.2 GHz sub-bands) in the fixed service and "HD-FSS". Some discussions took place at WRC-2000 and studies are ongoing, as detailed by Resolution 122 (WRC-2000). Taking into account the possible use of HAPS in some countries in the 47.2-47.5 and 47.9-48.2 GHz sub-bands, the possible identification of these sub-bands for "HD-FSS" is limited. The band 48.94-49.04 GHz is also allocated to the radio astronomy service on a primary basis.

47.2-50.2 GHz (continued)	For information, part of this band is under study for an FSS allocation in the downlink direction (see section 4.3.2.3). **Conclusions:** Some administrations consider that the band 48.2-50.2 GHz is suitable for "HD-FSS" identification on a global basis. Other administrations consider that the 47.2-50.2 GHz band is not suitable for HD-FSS identification on a global basis.
42.5-43.5 GHz	**Comments:** This band was identified for HDFS at WRC-2000, so some sharing difficulties can be anticipated with the HD-FSS. This band is also allocated to radio astronomy, which could impose constraints on "HD-FSS" and HDFS around the radio astronomy sites. Some HDFS applications are well under way in Region 1 for the 42.5-43.5 GHz band. **Conclusion:** This band is not proposed for "HD-FSS" identification.
30-31 GHz	**Comments:** In all three Regions, the use of this band is limited by some administrations for FSS other than public communication systems (e.g. national defence systems). **Conclusion:** This band is not proposed for "HD-FSS" identification.
29.5-30 GHz	**Comments:** No primary terrestrial allocations. "HD-FSS" systems are already in development in this band. **Conclusion:** This band is suitable for "HD-FSS" identification on a global basis.
29.1-29.5 GHz	**Comments:** In Region 1, some administrations will deploy "HD-FSS" applications in the band 29.4525-29.5 GHz. In Region 2 GSO "HD-FSS" programme under development in the band 29.25-29.5 GHz. Studies may be required on the assessment of the impact of "HD-FSS" sharing with feeder links to non-GSO MSS. In Region 1, some administrations have decided to allow dense deployment of FS applications in the range 29.1-29.4525 GHz and have already begun licensing. Studies conclude that sharing is generally not practicable between FS and "HD-FSS" in the same geographical area. **Conclusions:** Part of this band is suitable for "HD-FSS" identification on a global basis. Some administrations consider that the band 29.4525-29.5 GHz is suitable for "HD-FSS" identification on a global basis. Other administrations consider that the band 29.25-29.5 GHz is suitable for "HD-FSS" identification on a global basis.

28.6-29.1 GHz	**Comments:** This entire band is designated for "HD-FSS" in some administrations in all Regions while in other administrations only a part of this band has been so designated. Some administrations in all Regions have adopted regulatory provisions limiting use of terrestrial systems in this entire band in order to facilitate its use by "HD-FSS". Some "HD-FSS" systems are already in development in this band and there are other filings for "HD-FSS" type systems. In Region 1, some administrations are intending to deploy "HD-FSS" applications in the sub-band 28.6-28.8365 GHz. Some administrations in Region 1 are intending to allow dense deployment of FS applications in the sub-band 29.0605-29.1 GHz (and have begun licensing in this band), and, on a geographical basis, dense deployment of FS or "HD-FSS" in the sub-band 28.8365-29.0605 GHz. Studies conclude that sharing is generally not practicable between FS and "HD-FSS" in the same geographical area. It is noted that in the band 28.6-29.1 GHz, footnote **5.523A** applies, providing a different set of provisions to the non-GSO FSS utilizing this band to those provisions for non-GSO FSS utilizing bands outside 28.6-29.1 GHz. **Conclusions:** Some administrations are of the view that the band 28.6-29.1 GHz is suitable for "HD-FSS" identification on a global basis. Other administrations are of the view that only the sub-band 28.6-28.8365 GHz is suitable for "HD-FSS" identification on a global basis.
27.5-28.6 GHz	**Comments:** In Region 1, some administrations are intending to deploy "HD-FSS" applications in both sub-bands 27.5-27.8285 GHz and 28.4445-28.6 GHz. In Region 2, GSO "HD-FSS" program under development in the band 28.35-28.6 GHz There are some filings for "HD-FSS" type systems in part of this band. Some administrations in Region 1 are intending to allow dense deployment of FS applications in the sub-band 28.0525-28.4445 GHz (and have begun licensing in this band), and on a geographical basis, for dense deployment of FS applications or "HD-FSS" in the sub-band 27.8285-28.0525 GHz. There are sharing studies being conducted with respect to planned HAPS deployment by administrations listed in 5.537A (Resolution 122, WRC-2000) in the sub-band 27.5-28.35 GHz with respects to FS and FSS. Studies are required to conclude focusing on this sub-band as a matter of urgency by WRC-03. In Region 2, dense deployments of FS applications (LMCS/LMDS) are currently in use in the sub-band 27.5-28.35 GHz. **Conclusions:** Part of this band is suitable for "HD-FSS" identification on a global basis. Some administrations consider that the bands 27.5-27.8285 GHz and 28.4445-28.6 GHz are suitable for "HD-FSS" identification on a global basis. Other administrations consider that the band 28.35-28.6 GHz is suitable for "HD-FSS" identification in Region 2 or on a global basis.

27-27.5 GHz	**Comments:** The FSS allocation is only in Regions 2 and 3. This band is intended for use by some administrations in Region 1 and possibly all three Regions, for FS and MS other than public communication systems (e.g. national defence systems). In Region 2, dense deployments of FS applications (LMCS/LMDS) are currently in use. **Conclusion:** This band is not proposed for "HD-FSS" identification.
24.75-25.25 GHz	**Comments:** This band is allocated to FSS only in Regions 2 and 3, and its use for feeder links of the BSS has priority over other use of the FSS (Earth-to-space) as per No. **5.535**. This band is allocated to the radionavigation service on a primary basis until 2008 in one administration in Region 3. In Region 1, dense deployments of FS applications are currently in use. **Conclusion:** This band is not proposed for "HD-FSS" identification.
19.3-19.7 GHz	**Comments:** The use of the FSS in the band 19.3-19.6 GHz in the Earth-to-space direction is limited to non-GSO MSS feeder links. In Regions 1 and 3, there is a large number of FS links already in use in this band. **Conclusion:** This band is not proposed for "HD-FSS" identification.
18.1-18.4 GHz	**Comments:** The use of FSS in this band is limited to BSS feeder links. In Regions 1 and 3, there are a large number of FS links already in use in this band. **Conclusion:** This band is not proposed for "HD-FSS" identification.
17.3-17.8 GHz	**Comments:** The use of the FSS in this band is limited to feeder links for BSS in the case of GSO FSS networks according to AP30A. Other FSS uses of the band are defined in No. 5.516. In Region 2, the FSS use of the band is limited to GSO systems only. In Region 2, an allocation to BSS comes into effect on 1 April 2007 (RR 5.517). There is an agenda item (1.18) of WRC-03 to possibly introduce in Region 1 a primary FS allocation in the 17.3-17.7 GHz sub-band. In Region 1 (in the band 17.7-17.8 GHz in CEPT countries) and 3, there are a large number of FS links already in use in this band. **Conclusion:** This band is not proposed for "HD-FSS" identification.

4.3.2.2 Possible candidate downlink bands

Table 4.3-2 gives the analysis of the results of the studies (where applicable) carried out for each band considered for identification for HD-FSS applications in the downlink direction, providing comments and conclusions.

TABLE 4.3-2

71-76 GHz	**Conclusion:** Seems not to be usable with current technology.
37.5-42.5 GHz	**Comments:** The bands 37-40 GHz and 40.5-43.5 GHz are already identified for HDFS (No. **5.547**), however, it is recognized that the band 39.5-42.0 GHz is targeted for the deployment of "HD-FSS" (No. **5.547** and Resolution 84). In Regions 1 and 3, there are a large number of FS links already in use in the sub-band 37.5-39.5 GHz. HDFS applications are well under way in some administrations for the 40.5-42.5 GHz band. Many administrations in Region 1 intend to deploy "HD-FSS" in the 39.5-40.5 GHz. In Region 2, there is deployment of HDFS links in the sub-band 38.6-40 GHz. In all Regions, the band 40.5-42-5 GHz is also allocated on a co-primary basis to the fixed, broadcasting-satellite and terrestrial broadcasting services. Any implementation of HD-FSS in this band could impose coordination constraints on BSS systems. **Conclusions:** Some administrations consider that the band 40-42 GHz is suitable for "HD-FSS" identification on a global basis. Other administrations consider that the band 39.5-40.5 GHz is suitable for "HD-FSS" identification on a global basis. Some administrations in Region 3 consider that the band 37.5–40.0 GHz is not suitable for HD-FSS allocation in this Region. At the minimum, the 40-40.5 GHz band is suitable for "HD-FSS" identification on a global basis.
20.2-21.2 GHz	**Comments:** In all three Regions, the use of this band is limited by some administrations for FSS other than public communication systems (e.g. national defence systems). **Conclusion:** This band is not proposed for "HD-FSS" identification.
19.7-20.2 GHz	**Comments:** Limited use of terrestrial services. Although not allocated on a regional basis to terrestrial services, footnote 5.524 identifies 44 administrations potentially having fixed and mobile service allocations. This footnote further states that these terrestrial uses shall not impose any limitation on the power flux-density of space stations in the fixed-satellite service, thereby not allowing terrestrial stations to claim protection from the MSS and FSS (see 5.43A). **Conclusion:** This band is suitable for "HD-FSS" identification on a global basis.

19.3-19.7 GHz	**Comments:** In addition to the reverse band allocation for the feeder link for the MSS in the E-S direction, the band 19.3-19.7 GHz in the S-E direction was also identified for use by MSS feeder links. This allocation was intended to provide a small number of gateway earth stations for the MSS systems. There are a large number of FS links already in use in this band in a number of countries in all Regions. The range 17.7-19.7 GHz is of vital importance to the FS telecommunication infrastructure, particularly in relation to the infrastructure of mobile networks, and to provide broadband service. This is due to the fact that this is the highest possible frequency band to be used to develop the FS infrastructure for mobile networks in geographic zones where the rain attenuation is high. The range 17.7-19.7 GHz is also of vital importance to the FSS in order to provide broadband service and to alleviate orbital congestion in the lower bands and because of severe rain attenuation in higher frequency bands. **Conclusion:** This band is not proposed for "HD-FSS" identification.
18.8-19.3 GHz	**Comments:** This entire band is designated for "HD-FSS" by some administrations in all Regions. Some "HD-FSS" systems are already in development in this band and there are other filings for "HD-FSS" type systems. Some administrations in all Regions have adopted regulatory provisions limiting use of terrestrial systems in this entire band in order to facilitate "HD-FSS". In some countries in Region 1, terminals in the "HD-FSS" applications will operate on a non-protected basis within their territory if they are not coordinated on a site-by-site basis. However, sharing with the FS is planned to be facilitated by the use of mitigation techniques. Some administrations are of the view that it is not appropriate to suggest the notion of "HD-FSS" operation without protection. There is a large number of FS links already in use in the band 18.8-19.3 GHz in a number of countries in all Regions. The range 17.7-19.7 GHz is of vital importance to the FS telecommunication infrastructure, particularly in relation to the infrastructure of mobile networks, and to provide broadband service. This is due to the fact that this is the highest possible frequency band to be used to develop the FS infrastructure for mobile networks in geographic zones where the rain attenuation is high. The range 17.7-19.7 GHz is also of vital importance to the FSS in order to provide broadband service and to alleviate orbital congestion in the lower bands and because of severe rain attenuation in higher frequency bands. It is noted that in the band 18.8-19.3 GHz, footnote **5.523A** applies, providing a different set of provisions to the non-GSO FSS utilizing this band to those provisions for non-GSO FSS utilizing bands outside 18.8-19.3 GHz. **Conclusions:** Some administrations consider that this band is suitable for "HD-FSS" identification on a global basis. Other administrations consider that this band is not suitable for "HD-FSS" identification on a global basis.

17.7-18.8 GHz	**Comments:** In some countries in Region 2, there are "HD-FSS" systems under development in the band 18.58-18.8 GHz. In some countries in Region 1, terminals in the "HD-FSS" applications will operate on a non-protected basis within their territory if they are not coordinated on a site-by-site basis. However, sharing with the FS is planned to be facilitated by the use of mitigation techniques. Some administrations were of the view that it is not appropriate to suggest the notion of "HD-FSS" operation without protection. There are a large number of FS links already in use in this band in some countries in all Regions. There are some filings for "HD-FSS" type systems. The range 17.7-19.7 GHz is of vital importance to the FS telecommunication infrastructure, particularly in relation to the infrastructure of mobile networks, and to provide broadband service. This is due to the fact that this is the highest possible frequency band to be used to develop the FS infrastructure for mobile networks in geographic zones where the rain attenuation is high. The range 17.7-19.7 GHz is also of vital importance to the FSS in order to provide broadband service and to alleviate orbital congestion in the lower bands and because of severe rain attenuation in higher frequency bands. In Regions 1 and 3, the band 17.7-18.1 GHz is a planned band for BSS feeder links (FSS allocation in Earth-to-space) (AP30A). The procedures in AP30A ensure that BSS feeder-link earth stations in conformity with the Plan will be able to operate free of constraints anywhere in their service area. Feeder-link earth stations in the List will share on an equal basis with FSS receive earth stations by applying the procedure of No. **9.17A**, which involves only specific earth stations. Some administrations consider that this may constrain the development of future additional BSS feeder-link uses in the Regions 1 and 3 List. Other administrations consider that the potential constraint is very limited due to the possibility of applying No. **11.41** in case of disagreement from the administration of the receive FSS earth station. In Region 2, the sub-band 17.7-17.8 GHz is a planned band for BSS feeder links (FSS allocation in Earth-to-space) (AP30A). Also as per No. **5.517**, an allocation to the BSS in the sub-band 17.3-17.8 GHz shall come into effect 1 April 2007. After this date, the FSS allocation becomes a secondary allocation thereby making it unsuitable for HD-FSS. Mitigation techniques should be studied to minimize the risk of interference from feeder links of earth stations of BSS and gateways (Earth-to-space) of non-GSO FSS in the bands where they can operate. It is moreover noted that 21.16.2 applies so as to protect the EESS (passive) and SRS (passive) in the 18.6-18.8 GHz band. **Conclusions:** Some administrations consider that the sub-band 18.58-18.8 GHz is suitable for "HD-FSS" identification in Region 2 or on a global basis. Other administrations consider that this band is not suitable for "HD-FSS" identification on a global basis.

4.3.2.3 Bands currently not allocated to FSS (space-to-Earth)

Table 4.3-3 gives the analysis of the results of the studies carried out for each bands considered for new allocation to FSS (space-to-Earth) including identification for HD-FSS applications, providing comments and conclusions.

TABLE 4.3-3

47.2-50.2 GHz	**Comments:** It is noted that many administrations plan to operate BSS feeder links and FSS uplinks (including HD-FSS uplinks) in this range. The feasibility of an FSS allocation (space-to-Earth) in this band is being studied by ITU-R. An allocation to the FSS (space-to-Earth), where feasible, would allow the identification of more downlink spectrum for HD-FSS applications than in the uplink. Results of studies carried out in ITU-R show that: • intra-system sharing in the opposite direction of transmission (i.e. using the same frequency band in both directions of transmission on the same satellite) is not a new issue for a new allocation. Passive intermodulation products have to be dealt with by administrations willing to use both the existing FSS (Earth-to-space) allocation and the possible new allocation to the FSS (space-to-Earth) on the same satellite payload; • sharing between transmitting FSS gateways and "HD-FSS" receiving terminals is feasible only if regulatory provisions are developed to indicate that there shall be no obligation on the FSS gateways to protect receiving "HD-FSS" terminals. This would constrain the deployment of the latter in a 4 to 10 km zone around the transmitting gateway stations (which are expected to be few in number) where "HD-FSS" receiving stations may suffer interference. The conclusions similarly apply for earth stations operating either with a GSO satellite or with non-GSO satellites; • sharing the same band between transmitting "HD-FSS" terminals and receiving "HD-FSS" terminals of the FSS (s-E) in the same geographical area would not be feasible The conclusion also applies for earth stations operating either with a GSO satellite or with non-GSO satellites; • sharing between two non-co-located GSO space stations operating in opposite direction of transmission in the same frequency band may be feasible. Initial studies have demonstrated that sharing under certain conditions would be feasible, however, further studies are necessary to bound the specific combinations of FSS parameters within which sharing is possible and outside of which there may be significant constraints. The current regulatory provisions (i.e. No. **9.7**) provide an appropriate regulatory framework to coordinate space stations if necessary; • further studies are required to cover the case of non-GSO space stations; • inter-service sharing between FS (excluding HAPS) and transmitting space stations in the FSS (space-to-Earth) can be ensured by appropriate pfd limits.

47.2-50.2 GHz (continued)	Based on studies, provided by one administration, the following maximum pfd levels in any 1 MHz band, -115 dB(W/m^2) for $\theta \leq 5°$ $-115 + 0.5\ (\theta - 5)$ dB(W/m^2) for $5° < \theta \leq 25°$ -105 dB(W/m^2) for $25° < \theta \leq 90°$ would ensure adequate protection of the fixed service. These studies will be further considered in ITU-R in order to confirm that these maximum pfd do not unduly constrain the FSS, and that HD-FSS systems which meet these limits are feasible. In addition, the question of the possibility of sharing with HAPS has been raised, and some further studies would be required. Moreover, further studies about the sharing between "HD-FSS" earth station receivers and FS stations would be required. • Compatibility between EESS and FSS (space-to Earth): Inter service compatibility studies between EESS (passive) in the band 50.2-50.4 GHz and FSS (space-to Earth) in the band 47.2-50.2 GHz have been initiated. However, some points still have to be addressed: • Inter-service compatibility studies between EESS (passive) in the band 50.2-50.4 GHz and FSS (space-to-Earth) in the band 47.2-50.2 GHz have been initiated. The case of interference coming into the main lobe of the EESS sensor after a scattering on the Earth's surface. ITU-R still needs to assess the scattering coefficient to be used in such a compatibility analysis. • The assumption in the study on the percentage of the power falling into the passive band was questioned. Other masks under consideration by ITU-R propose higher values. • There may be a need to consider the impact of FSS satellite operations under rainy conditions on the interference coming into EESS receiver.

47.2-50.2 GHz (continued)	• Compatibility between radio astronomy and FSS (space-to Earth): The band 48.94-49.04 GHz is also allocated to the radio astronomy service on a primary basis. Any deployment of "HD-FSS" systems should also ensure the protection of the radio astronomy sites in this band. The ITU-R has concluded that an FSS (space-to-Earth) allocation in the bands 47.5-47.9 GHz, 48.20-48.54 GHz and 49.44-50.2 GHz would be compatible with the RAS on the basis of the assumptions that the maximum satellite e.i.r.p. spectral density is –3 dBW/Hz and an appropriate out-of-band emission mask is used. **Conclusions:** Some administrations consider that the bands 47.5-47.9 GHz, 48.2-48.54 GHz and 49.44-50.2 GHz are suitable for an FSS (space-to-Earth) allocation and "HD-FSS" identification on a global basis. Other administrations consider that an FSS (space-to-Earth) allocation in these bands is not feasible because of technical constraints on the FSS in both directions of transmission and such an allocation would cause severe difficulties in the operation to EESS. Therefore these bands cannot be used to satisfy agenda item 1.25.
21.4-22.0 GHz	**Comments:** The 21.4-22.0 GHz band is currently allocated to BSS in Regions 1 and 3. This allocation is subject to future planning, in accordance with Resolution 507. Furthermore, Resolution 525 states that in Regions 1 and 3 the BSS is implemented after 1 April 2007 in order to protect the existing services and a future competent world radiocommunication conference will adopt definitive provisions. Therefore, a new FSS allocation would seriously limit the deployment of BSS networks including their future planning. **Conclusion:** This band is not proposed for "HD-FSS" identification.
17.3-17.7 GHz	**Comments:** This sub-band is part of a planned band for BSS feeder links (Earth-to-space) in all ITU Regions (APS30A) and is subject to No. **5.516**. In Region 2, as per 5.517, an allocation to the BSS in the band 17.3-17.7 GHz will come into effect 1 April 2007. There is an agenda item (1.18) of WRC-03 to possibly introduce a primary FS allocation in the 17.3-17.7 GHz sub-band. The band is also allocated in all ITU Regions to radiolocation on a secondary basis and also in the countries in No. **5.514** to the fixed and mobile services on a secondary basis. The ITU-R has undertaken a number of studies and the conclusions are documented in section 4.3.1.3.1 of the CPM text. **Conclusions:** This band is not suitable for an FSS (space-to-Earth) allocation in Region 2. Some administrations consider that this band is suitable for an FSS (space-to-Earth) allocation and "HD-FSS" identification in Regions 1 and 3. Other administrations consider that this band is not suitable for an FSS (space-to-Earth) allocation in Region 3.

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

The candidate uplink and downlink bands for HD-FSS must be determined whether they are appropriate for HD-FSS identification within the direction of the existing allocation. A few possible candidate downlink bands that are not currently allocated in this direction were proposed by some administrations for identification for HD-FSS and this would require a new allocation to the FSS (space-to-Earth).

If a candidate band in the indicated direction is deemed appropriate for HD-FSS identification, three methods are proposed to satisfy the agenda item:

4.3.3.1 Method A

Identification of frequency bands for high-density applications in the fixed-satellite service through a WRC Resolution.

Advantages:

- Identifies the frequency bands and provides necessary explanatory text.
- Could provide the date of implementation of the HD-FSS in the Resolution.

Disadvantage:

Does not clearly indicate HD-FSS global/regional frequency bands in the Table of Frequency Allocations of the Radio Regulations.

4.3.3.2 Method B

Identification of frequency bands for high-density applications in the fixed-satellite service through a footnote No. **5. HD-FSS** in Article **5** of the Radio Regulations.

Identification of bands for HD-FSS could be analogous to identification of bands for high-density applications in the fixed service (HDFS) in No. **5.547**.

Advantage:

Provides a reference in the Table of Frequency Allocations and indicates all HD-FSS global and regional frequency bands in one or several footnotes in Article 5 of the Radio Regulations.

Disadvantage:

This regulatory format for HD-FSS applications compared to other applications that are not referred to in a footnote in the RR could be misinterpreted as giving a different regulatory status to HD-FSS compared with other applications.

4.3.3.3 Method C

Identification of frequency bands for high-density applications in the FSS through a footnote (example given in Annex 4.3-1) in Article 5 of the Radio Regulations which also references a WRC-03 Resolution (example given in Annex 4.3-1) providing guidance on its implementation.

Identification of bands for HD-FSS could be analogous to identification of bands for high-density applications in the fixed service (HDFS) in No. **5.547**.

Advantages:

- Provides a reference in the Table of Frequency Allocations and indicates all HD-FSS global and regional frequency bands in one or several footnotes in Article **5** of the Radio Regulations.

- Provides further guidance on the footnote implementation and explanatory text through a WRC Resolution.
- Could provide the date of implementation of the HD-FSS through the WRC Resolution.

Disadvantages:

- This regulatory format for HD-FSS applications compared to other services that are not referred to in a footnote in the RR could be misinterpreted as giving a different regulatory status to HD-FSS compared with other applications, if not properly clarified in the Resolution.
- Risks of misinterpretation of guidance given in a resolution for matters to be decided by administrations, if not properly clarified in the resolution.

4.3.3.4 Other considerations

Irrespective of the method chosen by the Conference, a WRC Recommendation could also be adopted giving guidance to administrations desiring to enable HD-FSS systems.

4.3.4 Regulatory and procedural considerations

International coordination using RR should ensure interference free operation, however as a consequence of the general characteristics of HD-FSS mentioned in § 4.3.1, procedures for the coordination of the earth stations for HD-FSS applications may need further elaboration.

HD-FSS earth stations may be considered, from the point of view of applying the RR procedures, as typical earth stations and it is appropriate that discussions on the regulatory/procedural aspects of HD-FSS earth stations be based on the assumption that these earth stations may be characterized as typical.

The topic of coordination and notification of typical Earth stations was discussed under agenda item 1.30 (see section 3.4.3.3). The result of these discussions may be applicable to HD-FSS.

Identification of frequency bands for HD-FSS does not eliminate the need for satellite network coordination in accordance with the ITU Radio Regulations. It is important that such identification does not preclude the use of other types of FSS earth stations than those associated with systems characterized in § 4.3.1. Such identification should not result in any additional regulatory burden on the part of GSO and non-GSO FSS networks with respect to intra-service sharing.

ANNEX 4.3-1

ADD

5.[HD-FSS] The space-to-Earth fixed-satellite service bands AA-BB GHz, CC-DD GHz, … and EE-FF GHz and the Earth-to-space fixed-satellite service bands ZZ-YY GHz, XX-WW GHz, … and VV-UU GHz, are identified for use by high-density applications in the fixed-satellite service (HD-FSS). Implementation of HD-FSS should be in accordance with Resolution **[HD-FSS] (WRC-03)**. This identification does not preclude the use of these bands by other fixed-satellite service applications or by other services to which these bands are allocated and does not establish priority among users of the bands in the Radio Regulations. Administrations should take this into account when considering regulatory provisions in relation to these bands.

Some administrations are of the opinion that the above footnote should be aligned with the HDFS footnote **5.547**.

EXAMPLE RESOLUTION [HD-FSS 4.3-1]

Guidelines for the implementation of high-density applications in the fixed-satellite service in frequency bands identified for HD-FSS

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that demand has been increasing steadily for global broadband communication services throughout the world, such as those provided by high-density applications in the fixed-satellite service (HD-FSS);

b) that HD-FSS systems are characterized by flexible, rapid and ubiquitous deployment of large numbers of cost-optimized earth stations employing small antennas and having common technical characteristics;

c) that HD-FSS is an advanced broadband communication application concept that will provide access to a wide range of broadband telecommunication applications supported by fixed telecommunication networks (including the Internet), and thus will complement other telecommunication systems;

d) that, as with other FSS systems, HD-FSS offers great potential to establish telecommunication infrastructure rapidly;

e) that HD-FSS applications can be provided by satellites of any orbital type, GSO or non-GSO;

f) that interference mitigation techniques have been and continue to be studied in the ITU-R to facilitate sharing between HD-FSS earth stations and terrestrial services;

g) that, to date, there is no agreement on the practicability of implementation of interference mitigation techniques for HD-FSS earth stations,

noting

a) that No. **5.[HD-FSS]** identifies bands for high-density applications in the fixed-satellite service (HD-FSS);

b) that in some of these bands, the FSS allocations are co-primary with fixed and mobile service allocations as well as other services;

c) that this identification does not preclude the use of these bands by other services or by other fixed-satellite service applications, and does not establish priority among users of the bands in the Radio Regulations;

d) that in the band 18.6-18.8 GHz, the FSS allocation is co-primary with the Earth exploration-satellite service (passive) with the restrictions of **5.522A** and **5.522B**;

e) that radio astronomy observations are carried out in the 48.94-49.04 GHz band, and that such observations require protection at notified radio astronomy stations;

f) that co-frequency sharing between transmitting HD-FSS earth stations and terrestrial services is very difficult in the same geographical area;

g) that co-frequency sharing between receiving HD-FSS earth stations and terrestrial stations in the same geographical area would require implementation of interference mitigation techniques (see considering *f)* and *g)*);

h) that a number of FSS systems with other types of earth stations and characteristics have already been brought into use or are planned to be brought into use in some of the frequency bands identified for HD-FSS in No. **5.[HD-FSS]**;

i) that HD-FSS stations in these bands are expected to be deployed in large numbers over urban, suburban and rural areas of large geographical extent,

recognizing

a) that in cases where FSS earth stations use bands that are shared on a co-primary basis with terrestrial services, the current (2001) Radio Regulations stipulate that earth stations of the FSS shall be individually notified to the Bureau when their coordination contours extend into the territory of another administration;

b) that as a consequence of their general characteristics, it is difficult and may be a rather long process to coordinate HD-FSS earth stations with fixed service stations on an individual site-by-site basis between administrations;

c) that to minimize the burden for administrations, procedures and provisions can be implemented by administrations for large numbers of HD-FSS earth stations associated with a given satellite system;

d) that harmonized worldwide bands for HD-FSS are desirable in order to achieve global access and the benefits of economies of scale,

recognizing further

a) that HD-FSS applications implemented on FSS networks and systems are subject to all provisions of the Radio Regulations applicable to the fixed-satellite service, such as coordination and notification pursuant to Articles **9** and **11**, including any ITU requirements to coordinate with terrestrial services across international borders, and the provisions of Articles **21** and **22**,

resolves

that administrations which implement HD-FSS:

1 consider making some or all of the frequency bands identified in No. **5.[HD-FSS]** available for HD-FSS applications;

2 in making frequency bands available under *resolves* 1, to take into account:

i) that HD-FSS deployment may be easier in bands that are not shared with terrestrial services;

ii) the impact that, in bands shared with terrestrial services, the further deployment of terrestrial stations or of HD-FSS earth stations would have on the existing and future development of HD-FSS or terrestrial services, respectively;

3 consider taking into account the relevant technical characteristics, as identified by ITU-R Recommendations (e.g., Recommendations ITU-R S.524-7 and S.1594;

4 take into account other existing and planned fixed-satellite service systems having different characteristics in frequency bands where HD-FSS is implemented in accordance with *resolves* 1 and the conditions specified in No. **5.[HD-FSS]**,

invites administrations

1 to give due consideration to the benefits of harmonized utilization of the spectrum for HD-FSS on a global basis, taking into account the use and planned use of these bands by all other services to which these bands are allocated, as well as other types of fixed-satellite service applications;

2 to consider implementing procedures and provisions that facilitate the deployment of HD-FSS systems within their territory in some or all of the bands identified in No. **5.[HD-FSS]**.

##########

4.4 Agenda item 1.26

"to consider the provisions under which earth stations located on board vessels could operate in fixed-satellite service networks, taking into account the ITU-R studies in response to Resolution **82 (WRC-2000)**"

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

Relevant ITU-R Recommendations: ITU-R SF.[ESV-A] (Doc. 4/95–9/154)[1], SF.1585, SF.[ESV-C] (Doc. 4/92–9/151)[1], SF.[ESV-FREQ] (Doc. 4/91–9/150)[1], S.1587.

These Recommendations contain information on the characteristics, frequency bands, guidance and example methods for use with ESVs operating at 4/6 GHz and 11/14 GHz to provide protection to the fixed service. It can be noted however that these Recommendations do not cover the case of other terrestrial services. In order to properly examine various aspects of ESV under agenda item 1.26, it is necessary to identify technical and operational characteristics of the ESV currently operating 4/6 GHz and 11/14 GHz frequency bands including proper reference and adequate information with respect to their associated space stations, including their class of station as well as their category of allocation.

Recommendation ITU-R SF.[ESV-A] recommends distances beyond which in motion ESVs are assumed not to cause unacceptable interference to the fixed service. For the band 5 925-6 425 MHz, the distance is 300 km and for the 14 GHz band, the distance is 125 km based, among others, on the assumption of a moving vessel (10 knots).

Recommendation ITU-R SF.1585 gives example on the development of the composite area within which the interference to the FS from ESVs needs to be evaluated and Recommendation ITU-R SF.[ESV-C] gives guidance for determination of the interference potential between ESVs and the FS when the ESV is operating close to shore. These two Recommendations may be used as guidance for those administrations, which wish to coordinate ESVs with fixed service stations.

Finally, draft new Recommendation ITU-R SF.[ESV-FREQ] considers use of frequencies by ESV transmitting in the 6 and 14 GHz bands and Recommendation ITU-R S.1587 provides technical characteristics of ESV for both the 6 and the 14 GHz band and ESV characteristics for use in sharing studies between the FS and FSS.

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[1] These ITU-R Recommendations were objected to by one Member State at the stage of adoption by ITU-R. Some other countries supported this objection.

4.4.2 Analysis of the results of studies

Since ESV shall not claim protection from terrestrial services (including the FS), the 4 GHz and 11 GHz bands, where the terrestrial systems have the potential to cause interference to ESVs, were not considered.

In addition, it was also acknowledged that if the ESV was intended to be operated only at specified fixed points the current regulations for specific FSS earth stations apply and thus there is no need for new regulatory procedures.

Studies carried out in the ITU-R indicate that in-motion ESVs may successfully operate in both the 4/6 GHz and the 11/14 GHz FSS allocations without causing unacceptable interference to the fixed service as well as other satellite services provided that necessary constraints be imposed on ESV operations.

In this regard, a distance beyond which unacceptable interference will not occur to fixed service stations has been determined to be 300 km at 6 GHz and 125 km at 14 GHz and certain technical limitations have been identified for operation of the ESVs.

Some administrations were of the view that it is necessary to complete studies to ensure protection of all terrestrial services in the 6 and 14 GHz bands before any use of these bands by ESVs. The minimum distances referred to in Resolution [ESV 4.4-1] and Resolution [ESV 4.4-2] beyond which an ESV will not have the potential to cause unacceptable interference to other services assume certain technical characteristics of ESVs. These distances will be affected if the assumptions used are changed.

Some administrations were of the view that there is a need to specify tracking control of the ESVs.

Regarding the protection of the fixed service, these limitations, required to ensure that the minimum distances remain valid for all ESVs, are:

In the 5 925-6 425 MHz

Maximum occupied bandwidth per vessel: 2.4 MHz

Maximum ESV e.i.r.p. spectral density toward the horizon: 17 dB(W/MHz)

In the 14-14.5 GHz

Maximum occupied bandwidth per vessel: 2.4 MHz

Maximum ESV e.i.r.p. spectral density toward the horizon: 12.5 dB(W/MHz)

In addition, a limit regarding the minimum antenna size is required in order to limit the number of vessels that would be able to implement an ESV. This limit also needs to be included in the RR.

Since a maximum ESV e.i.r.p. spectral density toward the horizon is proposed (consistently with the parameters used in the studies), several administrations were of the view that a reduction of the minimum antenna size will not necessarily lead to a significant increase in the number of vessels. Those administrations hence agreed that a minimum antenna size is required but that a certain level of flexibility on the antenna size in both bands would still ensure the same level of protection to the FS.

ITU-R Recommendations have been developed providing guidance and example on how to avoid unacceptable interference to fixed stations when ESV intend to operate within the distance.

In addition to the above limitations and in order to ensure the protection of the FSS networks, ESVs would also have to comply with the off-axis e.i.r.p. limits given in Recommendation ITU-R S.524. These limits should be met under normal operating conditions of ESVs. Some administrations sought clarification of the term "normal operation condition".

Some administrations were of the view that this limit could be included in the annexes of, for example, Resolutions [ESV 4.4-1] and [ESV 4.4-2], or in Article 21 or in a footnote in Article 5. For the 14-14.5 GHz band, the values are taken from Recommendation ITU-R S.728 as opposed to those in Recommendation ITU-R S.524. Further consideration of values for the band 14.0-14.5 GHz may be needed.

Finally, ITU-R also considered the possible use of ESVs in the FSS band 6 425-6 725 MHz (Earth-to-space). ITU-R was not able to conduct the relevant sharing studies with all systems using this band according to the current Radio Regulations and, noting that footnote No **5.458** states that passive microwave sensor measurements are carried out over the oceans in this band, and, prior to the completion of the studies, concluded that the 6 425-6 725 MHz band should not be recommended for ESV operations.

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

For the 4 and 11 GHz downlink bands, it was agreed that ESV shall not claim protection from other services, according to the RR provisions.

In order to ensure the protection of the terrestrial services in the 5 925-6 425 MHz and 14-14.5 GHz bands from unacceptable interference, it is necessary to impose technical and operational limitations on the operation of ESV and corresponding regulatory provisions in an adequate Resolution intending to replace Resolution **82**, and to be incorporated by reference in the corresponding provisions in Article **5**.

This would include the minimum distance within which ESVs could not operate without prior agreement of the concerned administration, along with other appropriate constraints as specified in section 4.4.2.

With respect to the protection of the FSS, the ESVs should comply with the technical and operational characteristics studied by ITU-R (see section 4.4.2) and also proposed to be incorporated in the Resolution. This will ensure the protection and future development of FSS networks.

Some administrations proposed an example of such a Resolution as given in Annex 4.4-2; some administrations proposed another example of such a Resolution as given in Annex 4.4-3.

Some administrations were of the view that a) in point 3 of attachment 1 of example Resolutions (Annex 4.4-2) the expression of "terrestrial services" should be replaced by "other services", that b) the expression of "coastline" be replaced by "reference point" to be decided by the concerned administrations (point 3 of Attachment 1 of example Resolutions (Annex 4.4-2)) and that c) any cost incurred by the operation of ESVs inside the minimum distance shall be borne by the ESV operator. These administrations also do not agree with any modification to any parameters in the example Resolutions.

Some administrations express their concerns and objections with regards to the application of Resolution 82 and the example Resolutions as per the following:

- The operations of mobile earth stations using an FSS band.
- The use of the uplink band 14-14.5 is not to be considered by WRC-03 (see Resolution 82, *resolves* 2).
- The antenna diameters in the example Resolution ESV 4.4-1 (Annex 4.4-2).
- The use of a reference point that shall be determined by the concerned administration.
- Any cost which may arise from the request to operate an ESV inside the minimum distance shall be borne by the ESV operators.

Some administrations were of the view that the technical limitations prescribed in Annex 2/Attachment 2 of both example Resolutions as given in Annexes 4.4-2 and 4.4-3 should not apply to MMSS in accordance with the current RR.

Some administrations were of the view that there is a need for ESV antenna tracking control and off axis e.i.r.p. limits. Therefore, those administrations are of the view that tracking control of the ESV antenna shall be such that the off axis e.i.r.p. shall not exceed Recommendation ITU-R S.524 tightened by 3 dB for the 6 GHz band and Recommendation ITU-R S.728 relaxed by 3 dB for the 14 GHz, and between the topocentric angle at the ESV between the nominal location of the space station associated with the ESV and any orbital locations within 3 degree of the GSO arc.

Some administrations were of the view that the antenna diameter in the example Resolution ESV 4.4-1 (Annex 4.4-2) shall be 2.4 m for the 6 GHz band and 1.2 m for the 14 GHz band as considered in the determination of the minimum distance. Those administrations are also of the view that tracking accuracy should be included in the list of parameters irrespective of the antenna diameter.

The methods for satisfying this agenda item elaborate on the regulatory provisions under which such limitations and operational constraints could be enforced.

In particular, it considers the status of the allocation as well as the means upon which to impose technical constraints on the operation of ESV.

Depending on the outcome of WRC-03, some regulatory means may be necessary to permit the continued operation of MMSS earth stations in the 14 GHz band on a secondary basis that do not meet the proposed limits and currently using transponders of the FSS on a primary basis.

4.4.3.1 Method A

ESV possible operations under the existing FSS allocations

In this case, a footnote (see Annex 4.4-1) pointing to an adequate Resolution is attached to the existing FSS allocations in the 5 925-6 425 MHz and 14-14.5 GHz bands.

Advantages:

- No need for additional allocation.
- Permits the operation of ESVs while ensuring adequate protection to the fixed service.
- Clarifies the regulatory procedures to be used for ESVs.
- Possible use of the coordination agreements obtained for the FSS networks under which the ESV will operate with other FSS networks on a primary basis under Article 9.

Disadvantages:

- Imply changes to the Radio Regulations in order to allow the use of maritime mobile satellite earth stations under a fixed-satellite service allocation.
- Difference between ESV use under the footnote and other stations operating under the existing MMSS secondary allocation in the 14 GHz band.

Other considerations:

- May need a definition of ESV and its consequential implication.

4.4.3.2 Method B

ESV possible operations under a secondary MMSS allocation.

In this case, a footnote (see Annex 4.4-1) pointing to an adequate Resolution is attached to the existing 14-14.5 GHz or possible new 5 925-6 425 MHz secondary MMSS allocations. Another possibility could be to add a new section in Art. 51 (Maritime mobile services) (see Annex 4.4-1).

Advantages:

- Permits the operation of ESVs while ensuring adequate protection to the fixed service.
- Clarifies the regulatory procedures to be used for ESVs.
- No additional allocation required in the 14-14.5 GHz.
- Consistent with the mobile nature of the ESV.
- All mobile satellite use in the 14-14.5 GHz band operating under a secondary allocation.

Disadvantages:

- May not allow the protection of the MMSS space stations from FSS networks.
- Inconsistent with the technical and operational characteristics of mobile maritime terminals currently in use in the 14-14.5 GHz band.
- New allocation required in the 5 925-6 425 GHz.
- May constrain the coordination process for secondary networks providing ESV operation with respect to primary FSS networks.

Other considerations:

- Even though the primary FSS service has no obligation to respond to a coordination request, it leaves open the possibility of coordinating the space networks associated with ESV under No. **9.7**, but only if agreed by the primary service.
- May need a definition of ESV and corresponding space station and their consequential implications.
- The FS protection criteria used in the sharing studies were based on allowance for interference as if the services were co-primary service.

4.4.3.3 Method C

Suppression of Resolution 82 (WRC-2000).

Advantages:

- No additional impact on the existing systems other than those which could eventually exist when ESV functions under No. 4.4. of the RR.
- Less burden put on administrations due to the fact that they will receive fewer requests to operate ESVs.

Disadvantages:

- Provides no regulatory framework for administrations to reach an agreement on how ESV stations could operate near the coast, while ensuring no harmful interference to terrestrial services.
- Potential of interference to the existing services when ESVs operate under No. 4.4 of the RR.
- No advantage taken from ITU-R studies, agenda item is not satisfied.

4.4.4 Regulatory and procedural considerations

Should WRC-03 allow such use, the RR should be modified in such a way to assure protection of other services, including FS, and make the provisions as easy as possible for concerned administrations to implement.

Administrations considering that the request for prior agreement by an ESV operator for the operation of an ESV within the minimum distance would impose a heavy burden on the administrations, or prior agreements could not be concluded within certain time constraints, or where there is not a particular national usage of the considered band by the fixed service, could add their names in a suitable footnote, which would allow the administrations to permit ESVs to operate within a particular corresponding portion of that FSS frequency band without the need of the prior agreement. As a result no prior agreement may be required when ESVs operate within the minimum distance. On the other hand this could restrict the choice for the ESV operator within the FSS frequency band.

Some administrations were of the view that:

- there is a need to define/characterize the earth station on board a vessel (ESV) and its relation with the corresponding space station (in particular with regard to the class of station and the category of service) and to clarify services under which the ESV could operate (MMSS or FSS).

  Defining ESV is a good concept and may ease the path to a solution that is coherent in regulatory terms. Problems exist, however, regarding:

  a) clarification that the equipment is distinct from a ship earth station (as defined by Nos. 1.68 and 1.78) and does not form part of the mandatory equipment associated with the GMDSS; and

  b) associating an earth station that operates in a mobile environment with the fixed-satellite service in a manner consistent with the Radio Regulations.

  Depending on the class of station and category of service under which the ESV will operate, relevant regulatory procedures including the corresponding coordination and notification to be applied must be specified.

  Under Method B, this could be addressed by following the existing regulatory procedure.

  In order to use an ESV on a secondary basis a request for coordination of the ESV network is to be submitted to BR. 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 ESV 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. These actions could therefore be done within the existing procedures of the Radio Regulations.

  The application of operational procedures described in Resolution [ESV 4.4-1] and Resolution [ESV 4.4-2] for operation inside the minimum distance could incur costs on the part of involved administrations. Any such cost should be borne by the ESV operators.

  The reference point from which the minimum distance is referred to is determined by the concerned administration.

- The proposed distances 300 km at 6 GHz and 125 km at 14 GHz are not adequate due to their geographical area composition. Therefore, these administrations believe it is necessary to include a footnote in Article 5 of the Radio Regulations that would require the cessation of the operation of ESVs in particular geographic areas. Other administrations believe that

such a footnote goes beyond the norms of the RR and would be inconsistent with the UNCLOS[2] and customary international law.

- Under Method A, protection of FSS satellites adjacent to those providing service to ESVs could be provided through an appropriate regulatory provision (for example through a footnote to Article 5) that would specify the off-axis emission limits as given in Recommendations ITU-R S.524 (6 GHz) and S.728 (14 GHz).
- Consistent with UNCLOS[2], 1982, the point to measure distances identified in Annex 4.4.2 [ESV 4.4-1] and Annex 4.4-3 Example Resolution [ESV 4.4-2] is the normal baseline, normally the low water mark line, from which the territorial sea is measured.

ANNEX 4.4-1

With regard to the means upon which limitations and operational constraints could be enforced the following considerations can be noted:

1 Footnote pointing for a Resolution

Advantage:

Straightforward from Article 5.

Disadvantage:

None.

1.1 If this footnote was to be attached to the existing FSS allocation (under Method A in section 4.4.3.1) the following examples could be considered:

5.ESV-FSS1: The operation of earth stations on board vessels shall be in accordance with Resolution [ESV 4.4-1] (Annex 4.4-2).

5.ESV-FSS2: Administrations operating earth stations on board vessels in the bands 5 925-6 425 MHz and 14-14.5 GHz shall take all practicable steps to comply with Resolution [ESV 4.4-2] (Annex 4.4-3). Such use shall not cause harmful interference to, claim protection from, or otherwise impose constraints on the operation or development of other radio services operating in the band 5 925-6 425 MHz.

5.ESV-FSS3: In the bands [X,Y] MHz, earth stations in the fixed satellite service may be operated on board vessels. Such use shall be in accordance with Resolution [ESV 4.4-1] (Annex 4.4-2).

1.2 If this footnote was to be attached to the existing or new MMSS allocation (under Method B in section 4.4.3.2), the following examples could be considered:

5.ESV-MMSS1: Transmit earth stations in the maritime mobile-satellite service in this band shall operate in accordance with the provision of Resolution [ESV 4.4-1] (Annex 4.4-2).

5.ESV-MMSS2: The operation of earth stations in the maritime mobile-satellite service in this band is subject to the provisions of Resolution [ESV 4.4-2] (Annex 4.4-3).

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[2] United Nations Convention on the Law of the Sea, 1982.

5.ESV-MMSS3: Ship earth stations in the maritime mobile-satellite service in this band shall operate in accordance with the provision of Resolution [ESV 4.4-1] (Annex 4.4-2).

Different text may also be considered with regards to the 6 and 14 GHz bands.

2 Article 51 (limited to Method B)

Advantages:

- Do not need any footnote in Article 5 provided that the MMSS status is retained.
- Provide a global regulatory solution within Volume 1 of the RR.
- All provisions related to maritime services would be in a single article.

Disadvantage:

None.

ANNEX 4.4-2

EXAMPLE RESOLUTION [ESV 4.4-1]

Provisions relating to earth stations located on board vessels which operate in fixed-satellite service networks in the uplink bands 5 925-6 425 MHz and 14-14.5 GHz

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that there is a demand for global wideband satellite communication services on vessels;

b) that the technology exists that enables earth stations on board vessels (ESVs) to use fixed-satellite service (FSS) networks operating in the uplink bands 5 925-6 425 MHz and 14-14.5 GHz;

c) that ESVs have the potential to cause unacceptable interference to other services in the bands 5 925-6 425 MHz and 14-14.5 GHz;

d) that with respect to the bands considered in this Resolution global coverage is only available in the band 5 925-6 425 MHz and that only a limited number of geostationary FSS systems can provide such global coverage;

e) that without special regulatory provisions ESVs could place a heavy coordination burden on some administrations, especially those in developing countries;

f) that in order to ensure the protection and future growth of other services, ESVs shall operate with requisite technical and operational constraints;

g) that, based on agreed technical assumptions, minimum distances from the coast have been calculated, within ITU-R studies, beyond which an ESV will not have the potential to cause unacceptable interference to other services in the bands 5 925-6 425 MHz and 14-14.5 GHz,

noting

that the regulatory procedures of Article 9 apply for ESVs operating at specified fixed points,

resolves

that ESVs transmitting in the 5 925-6 425 MHz and 14-14.5 GHz bands shall operate under the regulatory and operational provisions contained in Annex 1 and the technical constraints in Annex 2 of this Resolution,

encourages concerned administrations

to cooperate with administrations which license ESVs while seeking agreement under these provisions,

instructs the Secretary-General

to bring this Resolution to the attention of Secretary-General of the International Maritime Organisation (IMO).

ANNEX 1 TO EXAMPLE RESOLUTION [ESV 4.4-1]

Regulatory and operational provisions for ESV transmitting in the 5 925-6 425 MHz and 14-14.5 GHz bands

1 The administration that issues the licence for the use of ESVs in these bands (licensing administration) shall ensure that such stations follow the provisions of this attachment and thus do not present any potential to cause unacceptable interference to the services of other concerned administrations.

2 ESVs service providers shall comply with the technical limitations listed in Annex 2 and, when operating within the minimum distances as identified in item 4 below, with the additional limitations agreed by the licensing and other concerned administrations.

3 In the associated downlink bands, 3 400-4 200 MHz and 10.7-12.75 GHz, ESVs in motion shall not claim protection from transmissions of terrestrial services operating in accordance with the Radio Regulations.

4 The minimum distance from the coast beyond which ESVs can operate without the prior agreement of any administration is 300 km in the 5 925-6 425 MHz band and 125 km in the 14-14.5 GHz band. Any transmissions from ESVs within the minimum distances shall be with the prior agreement of the concerned administration(s).

5 The potentially concerned administrations referred to in the previous item 5 are those where fixed or mobile services are allocated in the Table of Frequency Allocations of the Radio Regulations:

Frequency bands	Potentially concerned Administrations
5 925-6 425 MHz	All three Regions
14-14.25 GHz	Countries listed in No. **5.505**
14.25-14.3 GHz	Countries listed in Nos. **5.505**, **5.508** and **5.509**
14.3-14.4 GHz	Regions 1 and 3
14.4-14.5 GHz	All three Regions

6 Administrations, in applying the minimum distance referred to in item 4 above, are encouraged to exclude those parts of their territory, such as remote small islands, where terrestrial services in the bands 5 925-6 425 MHz and 14-14.5 GHz are neither operating nor planned.

7 The ESV system shall include means of identification and mechanisms to terminate transmissions, on a mandatory basis, whenever the station operates outside its authorized geographic (see item 4 above) or operational limits.

8 Termination of transmissions as referred to in item 7 above shall be implemented in such a way that the corresponding mechanisms can not be by-passed on board the vessel, except under the provisions of No **4.9**;

9 ESVs shall be equipped so as to enable the licensing administration under the provisions of Article **18** to verify earth station performance and to terminate ESV transmissions immediately upon request by an administration whose services may be affected.

10 When ESVs operating beyond the territorial waters but within the minimum distance (as referred to in item 4 above) fail to comply with the terms required by the concerned administration pursuant to items 2 and 4, then that administration may:

– request the ESV to comply with such terms or cease operation immediately; or

– request the licensing administration to require such compliance or immediate cessation of the operation.

ANNEX 2 TO EXAMPLE RESOLUTION [ESV 4.4-1]

Technical limitations applicable to ESVs transmitting in the bands 5 925-6 425 MHz and 14-14.5 GHz

	5 925-6 425 MHz	**14-14.5 GHz**
Minimum diameter of ESV antenna*	1.2 m	0.6 m
Maximum occupied bandwidth per vessel	2.4 MHz	2.4 MHz
Tracking accuracy of ESV antenna	± 0.2° peak	± 0.2° peak
Maximum ESV e.i.r.p. spectral density toward the horizon	17 dB(W/MHz)	12.5 dB(W/MHz)
* The aim of this minimum antenna size is to limit the number of vessels that would be able to implement such antenna.		

ANNEX 4.4-3

EXAMPLE RESOLUTION [ESV 4.4-2]

Provisions relating to earth stations located on board vessels operating with fixed-satellite service networks in the bands 5 925-6 425 MHz and 14.0-14.5 GHz

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that there is a demand for global wideband satellite communication services on vessels;

b) that ESVs are currently operating through fixed-satellite service networks in the bands 3 700-4 200 MHz, 5 925-6 425 MHz, 10.7-12.75 GHz and 14.0-14.5 GHz;

c) that ESVs have the potential to cause unacceptable interference to other services in the 5 925-6 425 MHz and 14.0-14.5 GHz (Earth-to-space) bands;

d) that ESVs operating in these bands require considerably less than the full bandwidth in the FSS allocation and only a portion of the visible geostationary arc;

e) that the number of vessels equipped with ESVs may be such that the procedures could place a heavy coordination burden on some administrations, especially those in developing countries;

f) that in order to ensure the protection and future growth of other services, ESVs should operate with requisite technical and operational constraints;

g) that a minimum distance has been identified beyond which an ESV will not have the potential to cause unacceptable interference to other services in the bands 5 925-6 425 MHz and 14-14.5 GHz,

noting

a) that ESVs may be assigned frequencies to operate in FSS networks in the bands 3 700-4 200 MHz, 5 925-6 425 MHz, 10.7-12.75 GHz and 14.0-14.5 GHz pursuant to No. **4.4** of the Radio Regulations and shall not claim protection from, nor cause harmful interference to other services having allocations in these bands;

b) that existing regulatory procedures provide for ESVs operating at specified fixed points,

recognizing

that the references to the distances in *resolves* 2 is solely for the purpose of facilitating avoidance of radio interference and does not confer any territorial rights on administrations,

resolves

1 that any transmissions from ESVs, except those operating pursuant to No. **4.4** of the Radio Regulations, within the distances identified in *resolves* 2 of this Resolution be based upon the prior agreement of the concerned administrations;

2 that the minimum distances from the normal baseline ("low water mark" as defined by the United Nations Convention on the Law of the Sea, 1982 (UNCLOS, 1982)), beyond which these stations are assumed not to have the potential to cause unacceptable interference to stations of other services of any administration and beyond which no agreement is necessary are 300 km for the 5 925-6 425 MHz band and 125 km for the 14.0-14.5 GHz band;

3 that operation of ESVs follow the procedures in Attachment 1 and the technical constraints in Attachment 2,

encourages concerned administrations

to cooperate with administrations that license ESVs and seek agreement under the provisions of Annex 1,

encourages ESV licensing administrations

to consider registering their ESV frequency assignments in the Master International Frequency Register, for information purposes only,

instructs the Secretary-General

to bring this Resolution to the attention of the Secretary-General of the International Maritime Organization.

ATTACHMENT 1 TO EXAMPLE RESOLUTION [ESV 4.4-2]

Operational procedures for ESV use

A Initiation of contact

When ships equipped with ESVs intend to operate in the band 5 925-6 425 MHz within 300 kilometres and in the band 14-14.5 GHz within 125 km of the normal baseline ("low water mark" as defined by UNCLOS, 1982) of other administrations having terrestrial stations operating in the same band as the ESV, the ESV licensing administration should contact, in advance of ESV operations within those distances, the concerned administration(s) to obtain agreements that will establish the technical basis for avoiding unacceptable interference to the terrestrial facilities of the concerned administration or administrations.

B Recommended actions of licensing administrations, ESV operators, and concerned administrations

Each administration having terrestrial stations in these bands should have a point of contact for the ESV licensing administration or the ESV operator to initiate discussions.

Licensing administration or the ESV operator should provide the following information:

1) The technical and operational parameters, including the range of its frequency operation.

2) The proposed dates and ports to be visited and the routes of the ship(s) equipped with ESVs to reach those ports within the minimum distance from the normal baseline ("low water mark" as defined by UNCLOS, 1982) of the concerned administration.

Concerned administrations that have terrestrial stations that could be affected by ESV operations should do the following when contacted by the ESV licensing administration or the ESV operator:

1) Determine if they have terrestrial stations in the same frequency band as the ESV.

2) Identify frequencies for ESV use that would avoid the potential for interference.

C ESV operating agreements

A concerned administration is encouraged to enter into an agreement with the ESV licensing administration that describes the conditions for operation of the ESV when operating near the coast or in ports of the concerned administration. These agreements should be concluded prior to the operation of the ESV stations near the coast or in the ports of the concerned administration. The agreement should consider using the 5 925-6 425 MHz band outside certain limits and not using this band inside certain limits in countries that have fixed service stations in the same band and should include the possibility of switching to the 14.0-14.5 GHz band if there are no terrestrial services in the band. The operating agreement may be revised at any time at the discretion of the concerned administration, particularly whenever new terrestrial facilities are authorized that could potentially receive unacceptable interference.

D Frequency use arrangements

National practices, as well as Recommendations and guidelines of the ITU-R (such as ITU-R SF.[ESV-A] (Doc. 4/85-9/108), [ESV-FREQ] (Doc. 4/91-9/150), [ESV-C] (Doc. 4/92-9/151), and S.1587), may be used in reaching bilateral or multilateral frequency usage arrangements. Typical characteristics for ESV operations are contained in Attachment 2.

E Protection from transmissions of other services

ESVs are not protected from the transmissions of other services operating in the 4 GHz and 11/12 GHz bands.

F ESV point of contact

Each ESV operator should provide a point of contact to the administration with which agreements have been reached for the purpose of reporting unacceptable interference caused by the ESV.

G Avoidance of unacceptable interference

The ESV licensing administration shall ensure that such stations do not cause unacceptable interference to the services of other concerned administrations. In the event that unacceptable interference occurs, the ESV operator must eliminate the source of any interference from its station immediately upon being advised of such interference. Additionally, the ESV operator must immediately terminate transmissions at the request of either the concerned administration or the ESV licensing administration if either administration determines that the ESV is causing unacceptable interference or is otherwise not being operated in compliance with the operating agreement.

Additionally, ESV stations should have the following operational capabilities:

1) The ESV system should include a means of identification and location, and automatic mechanisms to terminate transmissions whenever the station operates outside its authorized geographic (see *resolves* 2) or operational limits.

2) The ESV system should be equipped so as to enable the ESV licensing administration under the provisions of Article 18 to verify earth station performance and to terminate ESV transmissions immediately upon request by a concerned administration whose services may be affected.

ATTACHMENT 2 TO EXAMPLE RESOLUTION [ESV 4.4-2]

This attachment contains typical characteristics of ESV operations on board ships in both the 5 925-6 425 MHz and 14.0-14.5 GHz band.

	5 925-6 425 MHz	**14.0-14.5 GHz**
Minimum diameter of ESV antenna:	2.4 m	1.2 m
Maximum necessary bandwidth per vessel:	24 MHz	24 MHz
Maximum ESV transmitter power spectral density at the input to the antenna:	17 dB(W/MHz)	12.5 dB(W/MHz)

##########

4.5 Agenda item 1.32

"to consider technical and regulatory provisions concerning the band 37.5-43.5 GHz, in accordance with Resolutions **128 (Rev.WRC-2000)** and **84 (WRC-2000)**"

4.5.1 Resolution 128 (Rev.WRC-2000)

"Protection of the radio astronomy service in the 42.5-43.5 GHz band"

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

Relevant Recommendations ITU-R: RA.769, RA.1513, S.1542, S.1557, S.1586(Doc. 4/BL/30), SM.[BbB], DNR SF.1573 (Doc. 4-9/BL/3), SF.1484 (Doc. 4-9/BL/5) and DNR RA[PATTERN NGSO].

The provisional pfd levels given in No. **5.551G** are based on the radio astronomy protection criteria given in Recommendation ITU-R RA.769. This Recommendation, however, does not define explicitly the percentage of time for which this level applies in case of non-GSO systems. Recommendation ITU-R RA.1513 specifies that, over the sky, the percentage of data loss caused by any system should be lower than 2%. The provisional power flux-density (pfd) levels given in No. **5.551G** needed to be reviewed by using a methodology, which is appropriate to conduct studies between non-GSO systems and radio astronomy sites. ITU-R has developed such a methodology based on the equivalent power flux-density (epfd) concept to assess the unwanted emission levels from non-GSO systems at radio astronomy sites (see Recommendation ITU-R S.1586).

The 41.5-42.5 GHz band is allocated to the BSS and the FSS on a primary basis. Based on ITU filings, more than 250 GSO and non-GSO, FSS and BSS networks and systems plan to use this

band. The adjacent band, 42.5-43.5 GHz, is allocated to the RAS on a primary basis. Very long baseline interferometry (VLBI) and single dish telescope (SDT) observations are conducted in the 42.5-43.5 GHz band. As of this date, at 42.5-43.5 GHz, there are approximately 40 single-dish telescopes worldwide.

Typical downlink system characteristics of FSS and BSS networks that are planned for operation in the 37.5-42.5 GHz band are shown in Table 4.5.2-2 in § 4.5.2.1.3.1 below.

Some FSS and BSS systems that plan to operate in the 40 GHz band intend to provide broadband service with high-link availability. It should be noted that the propagation impairments in the 40 GHz band are severe in bad weather. In order to achieve their desired link availability and high data rates, most FSS and BSS systems propose to operate with high-gain satellite antennas. The 3 dB beamwidths of the 40 GHz transmit and the receive antennas are in a range from 0.3° to 0.65° for GSO satellites (as compared with a 3 dB beamwidth range of 4° to 8º for satellites operating in the 4/6 GHz and 11/14 GHz bands) and in a range of 0.6º to 1.8º for non-GSO satellites. Also, due to satellite weight and power constraints, the area covered by the beams active at any instant in all proposed FSS systems that plan to operate in these bands will be very small, typically representing less than 5% of the satellite field of view.

Some FSS and BSS systems, in this frequency range, operate at the power flux-density limits in Table **21-4** for only a small percentage of time, typically to overcome fading conditions. Therefore, for those systems using fade compensation techniques, in normal operation in the band 42.0 to 42.5 GHz, the power flux-density levels of the FSS and BSS systems will be at clear-sky levels (i.e. at a level of –117 dB(W/(m^2 · MHz)), which is 12 dB lower than the Table **21-4** limits) for all but very short periods of time during fading conditions. Hence, the level of unwanted emissions from these networks in the 42 GHz range is assessed based on clear-sky values.

It should be noted that, to protect co-frequency fixed service systems (see § 4.5.2), RR Article **21**, provides provisional pfd limit for both FSS and BSS (GSO and non-GSO) systems in the band 40.5-42.5 GHz as –105 dB(W/(m^2 · MHz)) at elevation angles between 25° and 90°. This limit has been reflected in Recommendations ITU-R SF.1573 and SF.1484.

The 42.5-43.5 GHz band is allocated to the RAS on a primary basis. Based on Recommendation ITU-R RA.769-1, the detrimental interference criteria of RAS stations operating in this band are as follows:

Single Dish Telescope (SDT): The threshold level of detrimental interference to RAS spectral line observations is –153 dB(W/(m^2 · 500 kHz)). The interference threshold of RAS continuum observations is –137 dB(W/(m^2 · GHz)).

Very Long Baseline Interferometry (VLBI): The detrimental interference threshold for VLBI RAS stations operating in the 42.5-43.5 GHz band is –116 dB(W/(m^2 · 500 kHz)).

It should be noted that the current protection criteria given in No. **5.551G** do not take into account the reference bandwidth and the type of observations being conducted at the radio astronomy station. The revised criteria above would therefore improve on the provisions of No. **5.551G**.

Using the relevant characteristics and criteria, studies were performed on the impact of FSS and BSS unwanted emissions on RAS observations in the 42.5-43.5 GHz band. The studies led to the review of the provisional pfd limit of No. **5.551G** as requested by Resolution **128 (Rev.WRC-2000)**.

4.5.1.2 Analysis of the results of studies

Two cases were considered depending on the type of FSS/BSS systems, which may cause interference to the RAS (noting that in this band the characteristics of BSS and FSS systems will be essentially the same):

1) *For GSO satellite systems:*

- The assessment of pfd levels produced by GSO satellite networks presents no difficulty.
- The RAS protection criteria, in the band 42.5-43.5 GHz, taking into account the type of observation conducted at the radio astronomy station are based on the pfd values given in Recommendation ITU-R RA.769. Results of studies indicate that the unwanted emission levels of the GSO FSS and BSS systems operating in the 42.0-42.5 GHz band meet the detrimental interference threshold for VLBI RAS stations operating in the 42.5-43.5 GHz band.

2) *For non-GSO satellite systems:*

- The definition of specific protection criteria for the radio astronomy service with regard to non-GSO constellations has been made through revision of Recommendations ITU-R RA.769 and RA.1513. This allows epfd criteria to be derived from Recommendation ITU-R RA.769 using a 93 dBi reference antenna gain. The epfd criteria are 93 dB below the pfd, using the detrimental interference thresholds given in Recommendation ITU-R RA.769 (depending on the type of observation conducted at the considered radio astronomy station).
- The epfd level resulting from unwanted emissions of a non-GSO system at a radio astronomy station is calculated assuming a 93 dBi reference antenna gain and using the reference antenna pattern and the methodology given in Recommendation ITU-R S.1586.
- Results of studies indicate that the unwanted emission levels of the non-GSO FSS and BSS systems operating in the 41.5-42.5 GHz band meet the detrimental interference threshold for VLBI RAS stations operating in the 42.5-43.5 GHz band.

The detrimental interference thresholds for a single dish telescope, for continuum observations and for spectral line observations, may not be met by unwanted emissions from a GSO FSS or BSS satellite in the 42.0-42.5 GHz band or by unwanted emissions from a non-GSO FSS or BSS system in the 41.5-42.5 GHz band. Because there are relatively few RAS sites operating with single dish telescopes in the 42.5-43.5 GHz band, it may be feasible to employ interference mitigation techniques, such as operational constraints, geographical isolation, time sharing, better RAS antenna roll-off, etc., in order to reduce the potential for detrimental interference to the RAS receiver sites operating in this band. It may also be productive to conduct analyses using the operational parameters of the FSS systems and the operational RAS receiver in question.

4.5.1.2.1 Use of mitigation techniques by FSS and BSS systems

Mitigation techniques that may be implemented in order to protect stations in the radio astronomy service operating in the band 42.5-43.5 GHz are described in DNR ITU-R SM.[BbB]. Other potential mitigation methods are mentioned in Recommendation ITU-R SM.1542, Annex 2.

A combination of mitigation techniques could provide workable solution to all parties.

a) Geographical isolation

Geographic isolation consists of the separation between the SDT and the location of the peak gain of space station transmit antennas. This can be accomplished in one of two ways: deterministic or statistical avoidance. In the first case, the operator intentionally avoids the SDTs when designing the space station antenna pattern. The deterministic method may be feasible if the number of SDTs operating in the band is kept very small. A different approach would be to use a statistical method,

which would allow for a small percentage of the Earth's surface to exceed the SDT detrimental interference threshold. The small percentage would allow for the operation of spot beams while making it unlikely that an SDT would receive power above the detrimental interference threshold. This method may not protect all existing single dish radiotelescopes.

If geographical isolation is used as an interference mitigation technique, studies indicate that the required separation distance between the centre beam of GSO satellite and the RAS receiver site operating with a single dish telescope is a few hundred kilometres, depending on the type of RAS observations and the satellite beam size. The calculated distances were based on the GSO clear sky power flux-density levels.

One study found that the single dish, continuum detrimental interference threshold level could be met on large portions of the surface of the Earth. Given that space stations operating in the band will make use of narrow beams to focus power on very limited geographical areas, it is highly unlikely that these small high power areas, which are typically concentrated in populated areas, will coincide with the location of a radio telescope operating in single dish mode.

b) Filtering

If carriers are at the maximum in-band pfd allowed by Article **21**, meeting detrimental interference threshold levels of a single dish telescope in the 42.5-43.5 GHz band at the FSS/BSS antenna boresight requires about 45 dB of filter rejection at the 42.5 GHz band edge and about 40 dB of filter rejection at the 42.7 GHz (spectral line) and 43.0 GHz RAS centre frequency. Based on current technology, it is difficult to design and implement such filter. Even if the technology were available, the insertion loss of this filter would be in a range of from 3 to 4 dB, and that does not include the additional degradation due to in-band phase distortion.

In the 41.5-42.0 GHz band, in order to meet the interference threshold of a single dish telescope in the 42.5-43.5 GHz band, 40 to 45 dB filter rejection is required depending on the type of observation. The study shows that, in order to meet the RAS interference threshold levels, a 7-pole filter would be needed. The transmit filter insertion loss would be 2.0 dB, which corresponds to a 37% degradation in system capacity. In addition, because most proposed non-GSO FSS systems in this band plan to use phased array transmit antennas in order to optimize the system capacity, each transmit power amplifier must support the entire band, 41.5-42.5 GHz. In order to meet the RAS interference threshold levels, an 11-pole filter would be needed and the filter insertion loss would be increased. Since the satellite field-of-view of an non-GSO satellite is very wide, typically in a range from 25 degrees to 110 degrees depending on the satellite altitude, and the satellite 3-dB beamwidth of non-GSO FSS satellites operating in this band is less than 1 degree, it will require from 1 000 to 2 000 elements in order to implement the phased array antenna. Because the output of each transmit element needs a transmit filter, the additional weight added to the payload due to transmit filters along will have severe and perhaps prohibitive consequential cost and performance penalties.

c) Guard band

A guard band between the FSS/BSS and the RAS would be a possible mitigation method. However, this would result in a loss of capacity on the service or services into which the guard band is placed.

d) Frequency isolation

The operators and users of FSS and BSS space stations employing the 42 GHz band could adopt one or more of the following techniques to mitigate space-to-Earth interference in the band 42.5-43.5 GHz:

- use the transponder adjacent to the 42.5 GHz band edge (edge transponder) only in single-carrier mode;

- avoid using the edge transponder for carriers having near-maximum spectral density;
- if the edge transponder must be employed for a mixture of carrier types, place the nearest carrier to the band edge, which should be the lowest density carrier, as close to 42.5 GHz as possible, locate other low-density carriers near to it, and locate the carriers with the highest spectral densities the furthest away from 42.5 GHz.

4.5.1.2.2 Use of mitigation techniques by radio astronomy stations

Mitigation techniques that may be implemented in order to protect stations in the radio astronomy service operating in the band 42.5-43.5 GHz are described in DNR ITU-R SM.[BbB]. Other potential mitigation methods are mentioned in Recommendation ITU-R SM.1542, Annex 3.

Other methods to be assessed include:

- Reduction of side-lobe levels.
- Taking actual RAS operating parameters into consideration.
- A guard band between the FSS/BSS and the RAS. However, there is limited scope for taking a guard band within the radio astronomy band, without losing the capability to observe one or more of the spectral lines.

The use of such techniques in addition to mitigation techniques applied by the FSS or BSS would assist in providing adequate protection to RAS operating.

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

4.5.1.3.1 Method A

For 42-42.5 GHz band GSO networks and 41.5-42.5 GHz band non-GSO systems, protect single-dish radio telescope sites on an individual, bilateral basis; modify levels in No. 5.551G to be interference thresholds.

Under this method, No. **5.551G** would be modified to adopt the single dish, continuum threshold of –137 dB(W/(m^2 · GHz)) and –153 dB(W/m^2 · 500 kHz) as a threshold for bilateral arrangements at single-dish radio telescope sites. A Resolution, which would not require the involvement of the Bureau, would provide operational rules for bilateral sharing arrangements with affected single-dish radio telescope sites where the levels in No. **5.551G** are exceeded for more than 2% of the time.

Advantages:

- Limits the number of RAS sites that would have to be subject to bilateral discussions, and raises the prospect that SDT (single-dish radio telescope) sites could be accommodated on a site-by-site basis.
- Provides a basis for protection of 42.5-43.5 GHz band SDTs.
- Tailors the need for protection to sites where SDTs operate, and does not unduly constrain satellite operations in areas where SDTs do not operate.

Disadvantage:

Bilateral discussions would increase the administrative burden on the radio astronomy service and satellite services.

An example of how No. **5.551G** could be modified to implement this method is included in Annex 4.5.1-1.

4.5.1.3.2 Method B

For 42-42.5 GHz band, GSO systems apply the single dish interference criteria to all but a small percentage of the Earth's surface that is statistical in nature.

The single dish, continuum limit of –137 dB(W/(m^2 · GHz)) and –153 dB(W/(m^2 · 500 kHz)) for GSO would apply to 98% of the surface of the Earth.

Advantage:

Would limit emissions to most areas of world; including SDT sites that would not be within service areas of satellites.

Disadvantages:

- Existing SDTs may not be protected if they are not located within the 98% of the surface of the Earth where the SDT limit is met.
- No one knows where the 2% of unprotected Earth surface falls, creating uncertainty for RAS access to the 42.5-43.5 GHz band. Building new radio telescopes may be difficult.
- May constrain satellite operations in areas where SDTs do not operate.
- As the number of satellites grows, the area of the Earth available for RAS will be reduced.
- This method does not address the case of non-GSO systems.

4.5.1.3.3 Method C

Adopt permanent unwanted emission limits on GSO and non-GSO networks and systems only in the band 42-42.5 GHz; SUP Resolution 128.

Under this option, Resolution **128** would be suppressed. No. **5.551G** would be modified to apply to the non-GSO in the band 42.0-42.5 GHz (as well as to GSO, as it currently does). The levels derived from the protection criteria in Recommendation ITU-R RA.769 would apply at radio telescopes notified prior to the submission of advance publication information by the subject satellite network or system.

Advantages:

- Allows FSS and BSS to move forward with some regulatory certainty.
- Protects the RAS to the levels of the criteria in Recommendation ITU-R RA.769 from FSS and BSS transmissions in the 42.0-42.5 GHz band.
- Tailors the need for protection to sites where SDTs operate, and does not unduly constrain satellite operations in areas where SDTs do not operate.
- Allows conclusion of the Resolution 128 portion of agenda item 1.32 at WRC-03.
- Allows a relaxation for the FSS and BSS from the levels in the current version of No. **5.551G**.

Disadvantages:

- Does not mandate that RAS will be protected from non-GSO transmissions in the 41.5-42 GHz band, if limits are not included for non-GSO systems in 41.5-42 GHz.
- Imposes some constraints on FSS and BSS systems and networks in the 42-42.5 GHz band.

See Annex 4.5.1-1 for examples of how No. **5.551G** could be modified to implement this Method.

4.5.1.3.4 Method D

Adopt permanent unwanted emission limits on GSO networks in the band 42.0-42.5 GHz and on non-GSO systems in the band 41.5-42.5 GHz; review Resolution 128, as appropriate.

The levels derived from the protection criteria in Recommendation ITU-R RA.769 would apply at radio telescopes notified prior to the submission of advance publication information by the subject satellite network or system.

Advantages:

- Allows FSS and BSS to move forward with some regulatory certainty.
- Protects the RAS to the levels of the criteria in Recommendation ITU-R RA.769 from FSS and BSS transmissions in the 41.5-42.5 GHz band for non-GSO and in the band 42.0-42.5 GHz for GSO.
- Tailors the need for protection to sites where radio telescopes operate, and does not unduly constrain satellite operations in areas where radio telescopes do not operate.
- Allows a relaxation for the FSS and BSS from the levels in the current version of No. **5.551G**.

Disadvantages:

- Could constrain the deployment plans of administrations that contemplate using the band 41.5-42.0 GHz for ubiquitous deployment of non-GSO BSS and high-density non-GSO FSS earth terminals.
- Imposes some constraints on GSO operations at 42-42.5 GHz and non-GSO operations at 41.5-42.5 GHz.

See Annex 4.5.1-1 for an example footnote to implement this Method.

4.5.1.4 Regulatory and procedural considerations

Given the large number of demands currently placed on the Radiocommunication Bureau, along with the difficulty of gathering and analysing unwanted emission data from space station, it was concluded by ITU-R that BR could not be reasonably expected to make a finding in regard to the unwanted emission level of a space station. WRC-03, in developing regulations regarding Resolution **128** should consider explicitly limiting the involvement of BR. With regard to Methods C and D, and consistently with the current situation concerning No. **5.551G**, a modification to Appendix 4 may be required to include the compliance with the limits as a declaration by the relevant administrations (see Annex 4.5.1-1).

There will be a need to add fields to the radio astronomy station registration forms in Appendix 4, to denote a Single dish (S) or a VLBI (V) radio telescope, and the minimum operating elevation angle of the radio telescope. There may be a need for measures to ensure that the registration requirement is implemented in a practicable manner, and is not misapplied or used to protect sites where observations are not being made on an ongoing basis.

ANNEX 4.5.1-1

1 The following is an example of how No. **5.551G** could be modified to implement Method A from § 4.5.1.3.1 above:

MOD

5.551G ~~In~~The interference threshold in terms of ~~order to protect the radio astronomy service in the band 42.5-43.5 GHz,~~ the aggregate power flux-density ~~in the 42.5-43.5 GHz band~~ produced by all the space stations in any non-geostationary-satellite system in the fixed-satellite service (space-to-Earth) or in the broadcasting-satellite service (space-to-Earth) system operating in the 41.5-42.5 GHz band shall ~~not exceed –167 dB(W/m²) in any 1 MHz band~~be –137 dB(W/(m^2 · GHz)) for continuum observations in the 42.5-43.5 GHz band, and –153 dB (W/(m^2 · 500 kHz)) for spectral line observations in the 42.5*-43.5 GHz band, at the site of a radio astronomy station that is registered as a single-dish telescope in the 42.5-43.5 GHz band~~for more that 2% of the time~~. The interference threshold in terms of the power flux-density ~~in the band 42.5-43.5 GHz~~ produced by any geostationary station in the fixed-satellite service (space-to-Earth) or in the broadcasting-satellite service (space-to-Earth) operating in the band 42-42.5 GHz shall ~~not exceed –167 dB(W/m²) in any 1 MHz band at the site of a radio astronomy station. These limits are provisional and will be reviewed in accordance with Resolution **128 (Rev.WRC-2000)**. (WRC-2000)~~be –137 dB(W/(m^2 · GHz)) for continuum observations in the band 42.5-43.5 GHz, and –153 dB (W/(m^2 · 500 kHz)) for spectral line observations in the 42.5*-43.5 GHz band, at the site of a radio astronomy station that is registered as a single-dish telescope in the 42.5-43.5 GHz band. If the above thresholds are exceeded for more than 2%** of the time, bilateral arrangements between affected administrations would be required. The provisions of Resolution **[XXX]** (WRC-03) shall apply.

*****

This method may also be based on the epfd concept (see example in No. 2 b) below).

* Some administrations are still considering the lowest frequency in the 42.5-43.5 GHz range at which the spectral line protection level should begin and believe that it is premature for CPM to recommend a value at this time.

** Some administrations were of the view that the 2% time criterion does not apply to GSO networks according to Recommendations ITU-R RA.769 and RA.1513.

2 The following is an example of how No. **5.551G** could be modified to implement Method C from § 4.5.1.3.3 above:

a) Modify No **5.551G** as follows:

MOD

5.551G In order to protect the radio astronomy service in the band 42.5-43.5 GHz, the aggregate power flux-density ~~in the 42.5-43.5 GHz band~~ produced by all the space stations in any non-geostationary-satellite system in the fixed-satellite service (space-to-Earth) or in the broadcasting-satellite service (space-to-Earth) system operating in the ~~41.5~~42-42.5 GHz band shall not exceed~~ –167 dB(W/m²) in any 1 MHz band~~, for more than 2% of the time, –137 dB(W/(m^2 · GHz)) for continuum observations in the band 42.5-43.5 GHz, and –153 dB(W/(m^2 · 500 kHz)) for spectral line observations in the 42.5*-43.5 GHz band, at the site of a radio astronomy station ~~for more that 2% of the time~~registered as a single dish telescope, and shall not exceed, for more than 2% of the time, –116 dB (W/(m^2 · 500 kHz)) at the site of a radio astronomy station where VLBI observations are being conducted. The power flux-density ~~in the~~

~~band 42.5-43.5 GHz~~ produced by any geostationary station in the fixed-satellite service (space-to-Earth) or in the broadcasting-satellite service (space-to-Earth) operating in the band 42-42.5 GHz shall not exceed, for more than 2%** of the time, ~~–167~~–137 dB(W(m^2 · GHz)) for continuum observations in the band 42.5-43.5 GHz, and –153 dB(W/(m^2 · 500 kHz) for spectral line observations in the 42.5*-43.5 GHz band, at the site of a radio astronomy station registered as a single dish telescope, and shall not exceed, for more than 2%** of the time, –116 dB(W/(m^2 · 500 kHz)) at the site of a radio astronomy station where VLBI observations are being conducted. ~~in any 1 MHz band at the site of a radio astronomy station. These limits are provisional and will be reviewed in accordance with Resolution **128 (Rev.WRC-2000)**. (WRC-2000)~~ These values shall apply at any radio astronomy station that has been notified to ITU either before [end of WRC-03] or before the date of receipt of the advance publication information (API) of the space station to which the limits are to apply. For other radio astronomy stations, notified after these dates, agreement may be sought with administrations authorizing the space stations.

*****

This method may also be based on the epfd concept (see example in No. 2 b) below).

* Some administrations are still considering the lowest frequency in the 42.5-43.5 GHz range at which the spectral line protection level should begin and that it is premature for CPM to recommend a value at this time.

** Some administrations were of the view that the 2% time criterion does not apply to GSO networks in accordance with Recommendations ITU-R RA.769 and RA.1513.

b) Replace No. **5.551G** with two new footnotes as follows:

SUP

5.551G

ADD

5.551GX The equivalent power flux-density produced by all the space stations in any non-geostationary-satellite system in the fixed-satellite service (space-to-Earth) or in the broadcasting-satellite service (space-to-Earth) system operating in the 42-42.5 GHz band, shall not exceed at the radio astronomy station (depending on the type of observations conducted), for more than 2% of the time:

- –230 dB(W/m^2) in 1 GHz (for single dish continuum observations) in the band 42.5-43.5 GHz;
- –246 dB(W/m^2) in any 500 kHz (for single dish spectral-line observations) in the band 42.5*-43.5 GHz; or
- –209 dB(W/m^2) in any 500 kHz (for VLBI observations) in the band 42.5-43.5 GHz.

These epfd shall be evaluated using the antenna pattern given in Annex 2 to Recommendation ITU-R S.1586 and a maximum RAS antenna gain of 93 dBi and shall apply for elevation angles higher than the minimum operating angle θmin of the radio telescope (for which a default value of 5° should be adopted in the absence of notified information).

These values shall apply at any radio astronomy station that has been notified to ITU either before [end of WRC-03] or before the date of receipt of the advance publication information (API) of the space station to which the limits are to apply. Other radio astronomy stations, notified after these dates, may seek an agreement with administrations authorizing the space stations.

ADD

5.551GY The power flux-density produced by any geostationary space station in the fixed-satellite service (space-to-Earth) or in the broadcasting-satellite service (space-to-Earth) operating in the band 42-42.5 GHz** shall not exceed at a radio astronomy station (depending on the type of observations conducted):

- –137 dB(W/m^2) in 1 GHz (for single dish continuum observations) in the band 42.5-43.5 GHz;
- –153 dB(W/m^2) in any 500 kHz (for single dish spectral-line observations) in the band 42.5*-43.5 GHz; or
- –116 dB(W/m^2) in any 500 kHz (for VLBI observations) in the band 42.5-43.5 GHz.

These values shall apply at any radio astronomy station that has been notified to ITU either before [end of WRC-03] or before the date of receipt of the advance publication information (API) of the space station to which the limits are to apply. Other radio astronomy stations, notified after these dates, may seek an agreement with administrations authorizing the space stations.

*****

* Some administrations are still considering the lowest frequency in the 42.5-43.5 GHz range at which the spectral line protection level should begin and that it is premature for CPM to recommend a value at this time.

** Some administrations were of the view that the 2% of time criterion could also be applicable to the GSO networks

3 The example footnotes as present in 2b) above apply to Method D so long as the band for the non-GSO is made to apply from 41.5 to 42.5 GHz instead of the bandwidth as stated above.

4 The following is an example of how Appendix 4 could be modified associated with example 2b of Method C and Method D:

A.17 Compliance with equivalent power flux-density limits

…

b) For non-geostationary-satellite systems operating in the fixed-satellite service and broadcasting-satellite service in the band 42-42.5 GHz[1] the calculated equivalent power flux-density produced at the site of a radio astronomy station in the band 42.5-43.5 GHz, as defined in No. **5.551GX**.

….

A.18 Compliance with power flux-density limits

For geostationary satellites operating in the fixed-satellite service and broadcasting-satellite service in the band 42-42.5 GHz the calculated power flux-density produced at the site of a radio astronomy station in the band 42.5-43.5 GHz, as defined in No. **5.551GY**.

#########

[1] When A.17 pertains to the example for Method D, it will include the non-GSO band from 41.5 to 42.5 GHz.

4.5.2 Resolution 84 (WRC-2000)

"Power flux-density limits in the bands 37.5-42.5 GHz for the fixed-satellite service, broadcasting-satellite service and mobile-satellite service"

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

Relevant Recommendations ITU-R : P.530, F.1108, F.1245, F.1336, SF.1395, SF.1484, F.1498, F.[Doc. 9/BL/39], S.1557, SF.1572, SF.1573.

4.5.2.1.1 Characteristics of the FS systems in the 37.5-42.5 GHz bands

The following FS parameters and deployment characteristics, considered to be representative of FS broadband wireless access (BWA) applications were used in the sharing studies:

- receiver antenna gain: up to 44 dBi (16 dBi for P-MP hub stations);
- feeder losses: 0 dB;
- receiver noise figure: 4 dB;
- noise increase due to intra service interference: 1 dB;
- elevation angle: 0 to 60° (0° for P-MP hub stations) (see Recommendation ITU-R F.1498);
- linear polarization.

These parameters are assumed to be sufficient to allow the calculation of interference into an FS system from an FSS satellite(s) applying an I/N methodology. The actual impact of any given level of interference depends on the availability objective and the fade margin of the FS system.

Whereas statistical deployment information is available for the 37-40 GHz band (see Recommendation ITU-R F.1498), corresponding information for the 40.5-42.5 GHz is not available at this time. In particular, Recommendation ITU-R F.1498 provides deployment characteristics of existing BWA networks in the 37.5-40 GHz band and states that links in these networks are beginning to carry higher loads of traffic (up to 155 Mbit/s and higher).

On this basis, it has also to be noted that BWA could be characterized with high levels of availability (99.999%) and short hop lengths, since deployment statistics indicate that 50% of BWA links present link distances lower than 0.75 km. Rain margins for such level of availability are given in Table 4.5.2-1.

Finally, it has been confirmed that arc avoidance is not applicable to FS on a regulatory basis, in particular for P-MP systems. However, it has been considered as a possible mitigation technique, which may be used, to avoid satellite interference, especially for short FS links, and should therefore be taken into account when assessing the impact of GSO satellites on particular FS links.

In addition, the following ITU-R Recommendations have to be taken into account:

- FS antenna pattern: F.1336 (for hub stations) and
  F.1245 (including polarization losses as described in NOTE 7)
- Gaseous attenuation: SF.1395

These characteristics have been considered for both conventional and broadband wireless access using both point-to-point (P-P) or point-to-multipoint (P-MP) systems, and are generally agreed to be the most sensitive. With regard to P-MP systems, these parameters are representative of terminal stations (TS); P-MP HUB stations have not been considered due to the low antenna gain and elevation angles expected for this kind of station. Other FS systems and links with less sensitive characteristics are also deployed or planned for deployment in this frequency range.

TABLE 4.5.2-1

Rain fade margins for 99.999% availability

Link Distance (km)	Fade Margin at 39.3 GHz, H-Pol (dB)					Fade Margin at 39.3 GHz, V-Pol (dB)				
	Rain Rate (mm/hr) (Zone)					Rain Rate (mm/hr) (Zone)				
	12 (B)	22 (E)	42 (K)	63 (M)	95 (N)	12 (B)	22 (E)	42 (K)	63 (M)	95* (N)
0.1	0.8	1.3	2.5	3.6	5.2	0.6	1.1	2.1	3	3.0
0.3	2.2	4	7.3	10.6	15.4	1.9	3.4	6.2	9	8.8
0.5	3.7	6.5	12	17.4	25.1	3.2	5.6	10.2	14.7	14.3
0.7	5.2	9.1	16.6	24	34.3	4.5	7.8	14.2	20.3	19.6
0.9	6.6	11.6	21	30.4	43.2	5.7	10.0	18.0	25.8	24.7
1.1	8	14.1	25.5	36.7	51.7	6.9	12.1	21.8	31	29.5
1.3	9.4	16.5	29.9	42.8	59.8	8.1	14.2	25.5	36.2	34.1
1.5	10.8	18.9	34.1	48.7	67.6	9.3	16.2	29.1	41.3	38.6
* NOTE – Fade margins for the case of 95 mm/hr rain rate for vertical polarization were calculated under the assumption that the latitude is less than 30 degrees (which impacts the calculation in accordance with Recommendation ITU-R P.530).										

Finally, it was acknowledged that not all the FS links with high elevation angles will be designed with the maximum 44 dBi antenna gain associated with the lowest fade margin, and that FS links with such specific parameter combinations (high elevation angles, low fade margin, high antenna gain and worst-case azimuth) should not be considered as to be typical. In some applications, high elevation angle FS links may have extra fade margins due to their location close to their hub station and due to the particular method used to design the cells.

4.5.2.1.2 Fixed service protection criteria in the 37.5-42.5 GHz bands

The FS protection criteria in the 37.5-40 and 40.5-42.5 GHz bands are given as follows in DNR ITU-R F.[Doc.9/BL/39] concerning time varying interference with regard to the non-GSO case:

- for the long term, the interference-to-noise ratio (I/N) at the input of the FS receiver should not exceed −10 dB for more than 20% of the time;
- for the short term, the interference-to-noise ratio (I/N) at the input of the FS receiver should not exceed +10 dB for more than 0.013% of the time, for systems designed in compliance with ITU-T Recommendation G.828, and 0.05% of the time for other systems;
- for the short term, for some links in certain BWA applications, the interference-to-noise ratio (I/N) at the input of the FS receiver should not exceed +5 dB for more than 0.013% of the time, for systems designed in compliance with ITU-T Recommendation G.828 and 0.05% of the time for other systems.

For the GSO case, the ITU-R studies pertaining to the definition of the protection criteria with regard to aggregate interference were not completed, but it was agreed that the interference-to-noise ratio (I/N) at the input of the FS receiver should not exceed −10 dB, except within a range of separation from the azimuth where the FS antenna main beam intersects with the GSO arc and for which positive I/N were agreed to apply. The range of azimuth and the maximum allowable I/N still need to be finalized, but the completion of these studies is not expected to modify in any way the conclusions concerning the pfd limits.

It has to be noted that these criteria were established to protect sensitive FS links.

4.5.2.1.3 Characteristics of satellite systems in the 37.5-42.5 GHz bands

4.5.2.1.3.1 Characteristics of FSS systems

The operational requirements and characteristics of FSS systems in the 38 and 40 GHz bands are given in Recommendation ITU-R S.1552. Table 4.5.2-2 summarizes the typical system parameters for FSS systems that have been considered in frequency sharing studies between FSS and FS systems operating in the 37.5-42.5 GHz band:

TABLE 4.5.2-2

Parameters	GSO FSS	Non-GSO FSS (MEO)
Satellite antenna beam size	0.3° to 0.65°	0.6° to 1.8° depending on the satellite altitude
Typical spacecraft DC power	10 kW to 15 kW	3 kW to 5 kW
Typical satellite transmit RF power into the antenna	2.5 kW to 3.5 kW	700 W to 1.1 kW
Number of beams[3)]	30 to 60 beams	10 to 20 beams
Bandwidth (per satellite)	Up to 2.0 GHz including HD-FSS and gateway/hub	Up to 2.0 GHz including HD-FSS and gateway/hub
Frequency reuse scheme	4 or 7 times (most systems use 4 times frequency reuse scheme)	4 or 7 times (most systems use 4 times frequency reuse scheme)
Link availability • Gateway/hub • HD-FSS (VSAT)	 • 99.9 to 99.95% • 99.5% to 99.7%	 • 99.9 to 99.95% • 99.5% to 99.7%
Payload	Transparent transponder or Processing payload	Transparent transponder or Processing payload
Minimum operation elevation angle	> 15°	> 20°
Modulation	QPSK/8PSK/16 QAM	QPSK/8PSK/16 QAM
BER	1E-8 to 1E-10	1E-8 to 1E-10
Coding	Concatenated code	Concatenated code
C/N threshold[1)]	7 dB to 10 dB depending on modulation and coding	7 dB to 10 dB depending on modulation and coding
Interference degradation[2)]	2 dB to 4 dB	2 dB to 4 dB
System margin	1 dB to 3 dB	1 dB to 3 dB
Earth terminal antenna size • Gateway/hub • HD-FSS (VSAT)	 • 1.8 m to 2.7 m • 0.3 m to 0.9 m	 • 1.5 m to 2.7 m • 0.3 to 0.9 m

Earth terminal system noise temperature	300 K to 500 K (user) 400 K to 800 K (gateway)	300 K to 500 K (user) 400 K to 800 K (gateway)
[1] Required downlink C/N may be 3 dB higher depending on whether the payload functions as transparent transponder or processing payload. [2] Degradation due to intra system and inter system interference. [3] FSS systems use single circular polarization.		

Finally, based on the elements provided in this DNR ITU-R S.[Doc. 4/40], the levels of performance consistent with FSS operations in the 38 and 40 GHz bands in most locations will not be possible if the pfd levels are more restrictive than those from the current RR No. **21-4** limits.

4.5.2.1.3.2 Characteristics of BSS and MSS systems

Technical characteristics of BSS and MSS satellites in the 40 GHz range are understood to be sufficiently similar to those of FSS satellites as to permit the analyses and pfd results applicable to FSS/FS sharing to apply as well to the BSS and MSS sharing cases.

4.5.2.1.4 Methodologies used to assess the adequacy of the limits to protect the fixed service in the 37.5-42.5 GHz bands

Several analyses using the "pfd mask simulation method" have been made to assess the adequacy of the pfd limits for the protection of the FS in the 37.5-42.5 GHz bands. In this method, the statistics of the aggregate power levels received at an FS station are calculated by applying the pfd limits from RR Table **21-4** to each visible satellite of a non-GSO constellation or a fully populated GSO arc (for example, satellites evenly spaced every 2° or 4°). Annex 1 of Rec. ITU-R F.1108 provides guidance on the calculation of visibility statistics of space stations operating in circular non-GSO orbits as seen by a terrestrial station.

For the case of non-GSO systems, this methodology assumes the FS receiver antenna is pointing in the direction of the worst-case azimuth for the non-GSO constellation under consideration, since in that pointing direction, the long-term and short-term power levels generated by the non-GSO constellation into the FS receivers are at their maximum.

For the case of GSO satellites, the methodology takes into account all azimuths with regard to the FS receiver, and allows for the calculation of interference to an FS receiver antenna at any elevation angle that is pointing directly through the GSO arc or offset from it. In the calculation, all GSO satellites in view of the FS receiver were considered in deriving the received level of interference. Studies have also shown that the peak interference level at the FS receivers is produced from just one or two GSO satellites, which occurs over only limited combinations of azimuth and elevation.

The "pfd mask simulation method" analysis allows for the computation of interference for both GSO and non-GSO cases to a percentage of FS links and thus can be used to determine the extent to which the protection level is exceeded. In the calculation, all GSO satellites in view of the FS receiver were considered in deriving the received level of interference (GSO: 2 to 4 degree spacing; non-GSO: all proposed non-GSO FSS systems) and that all satellites operate at the maximum pfd levels in clear sky conditions. These are conservative assumptions. If the computation method were to take into account the coverage capability, the power limitations of each satellite, and frequency reuse self-interference constraints on an FSS system, these factors would combine to result in lower-than-predicted levels of interference to FS receivers.

Therefore, applications of the "pfd mask simulation method" during this study cycle have been based on the assumption that pfd limits derived using this method should be set at a level which, according to this method, would show some tolerable percentage of FS links to be potentially interfered with.

In addition to the above method, and in order to make a more detailed analysis of the cases for which the "pfd mask I/N methodology" presents a high level of interference, two different methodologies have been applied to calculate the FSS interference to FS receive terminals using different sets of assumptions.

The first alternative methodology takes into account some fundamental operational constraints on, and the characteristics of, satellites in the 37.5-42.5 GHz bands, such as antenna patterns, spacecraft power limitations, and minimum operational elevation angles. Using these constraints and characteristics according to § 4.5.2.1.3.1 above together with the current pfd masks in Table **21-4**, this methodology permits a probabilistic assessment to be made of the likelihood that any given point on the Earth will be within the coverage area of a satellite beam radiating a specified level of pfd. Using this method, it is possible to estimate the occurrence of "worst-case" combinations of azimuth and elevation angle as a percentage of total FS deployment, and then possibly further reduce this number by the probability that any given FS receiver will receive the maximum pfd from a satellite in view.

In addition, another methodology, described in Recommendation ITU-R SF.1572, takes into account FS network modelling on a statistical basis in order to simulate the effect of satellite downlink transmissions on an FS network's availability.

4.5.2.2 Analysis of the results of studies

4.5.2.2.1 Assessment of the pfd limits to protect the fixed service in the 37.5-42.5 GHz bands

Studies have been performed within ITU-R to assess the effect on the fixed service in the 37.5-42.5 GHz band from the non-GSO and GSO FSS pfd limits included in Table **21-4**. For non-GSO FSS satellites, the results of these studies are contained in Recommendation ITU-R F.1484, which recommends that the current pfd levels in Table **21-4** of Article **21** are sufficient to protect the fixed service. For the GSO FSS case, the results of these studies are contained in Recommendation ITU-R SF.1573. ITU-R has agreed that the current pfd levels in Table **21-4** of Article **21** provide a sufficient level of protection to the fixed service.

With regard to GSO satellites, it was acknowledged that in some particular cases, FS receivers that would present very specific parameter combinations (high elevation angles, short hop length, low fade margin, maximum antenna gain) and that would point directly through the GSO arc without being able to implement "arc avoidance" mitigation technique could experience degradation.

However, it was agreed that these cases would only occur in situations where the FS deployment is within the satellite service area and can be solved by each affected administration (see Recommendation ITU-R SF.1573).

In particular, ITU-R noted the position of some administrations that, to protect certain sensitive BWA FS links in the 37.5-40 GHz band, it would be necessary for a GSO FSS satellite providing service on their territory to reduce the pfd levels that are produced during clear-sky operation by 12 dB from the respective levels in Table **21-4** of Article **21**. ITU-R also acknowledged that these pfds may constrain the FSS to the use of only large coordinated earth stations in this band. Nevertheless, for both GSO and non-GSO FSS satellites, the conclusions support maintaining the pfd values in Table **21-4** of Article **21**.

Furthermore, it has to be noted that DNR ITU-R F.[Doc.9/BL/39] states that the application of the FS interference criteria in this Recommendation is not intended to lead to a revisitation of the conclusions on pfd levels required to protect the FS in the band 37.5-42.5 GHz that are stated in Recommendation ITU-R SF.1484-1. The same understanding is true for the FS interference criteria now under development within the ITU-R with respect to GSO satellites in the 37.5-40 GHz and 40.5-42.5 GHz bands.

4.5.2.2.2 Criteria and techniques for addressing interference from transmitters of the FS into earth station receivers in high-density applications in the bands 39.5-40 GHz and 40.5-42.5 GHz and intended for operation in the same geographic area

Many administrations intend to use parts of the band 39.5-42 GHz for high-density applications in the FSS. These administrations intend to use other portions of the 37.5-42.5 GHz band for low-density, individually coordinated gateway/hub applications. To date, the ITU-R has not completed its studies requested in *invites* 6 of Resolution **84 (WRC-2000)** on the appropriate criteria and techniques for addressing interference from transmitters of the fixed service into earth station receivers in high-density applications in the bands 39.5-40 GHz and 40.5-42.5 GHz and intended for operation in the same geographic area. ITU-R is continuing studies on these matters.

4.5.2.2.3 Percentage of time clear sky pfd levels may be exceeded by FSS satellites to overcome fading while protecting FS receivers

ITU-R noted the position of some administrations that, to protect certain sensitive BWA FS links in the 37.5-40 GHz band, it would be necessary for GSO FSS satellite beams providing service on their territory to reduce the pfd levels that are produced during clear-sky operation by 12 dB from the respective levels in Table **21-4** of Article **21**. ITU-R has heavily studied this issue, however the results are so far inconclusive with respect to the percentage of time to which this 12 dB relates. It was agreed that ITU should continue to work in this area in order to provide guidance to administrations on this topic.

4.5.2.3 Methods to satisfy the agenda item

Method

No change to the current pfd limits in Article **21,** suppression of Resolution **84 (WRC-2000)** and development of a new Resolution based on *invites* 6 of Resolution **84 (WRC-2000).**

4.5.2.3.1 Pfd limits for FSS, BSS, and MSS within the 37.5-42.5 GHz range

The ITU-R has studied the applicability of the current Article **21** pfd limits in the 37.5-40 GHz and 40.5-42 GHz bands that apply to non-GSO FSS and GSO FSS satellites, in the 40.5-42.5 GHz band that apply to BSS satellites, and in the 39.5-40.5 GHz band that apply to MSS satellites, and confirms the suitability of these limits for the Radio Regulations. As a consequence of this, and as explained in § 4.5.2.4, Resolution **84 (WRC-2000)** can be suppressed.

In the case of non-GSO FSS this confirmation was affirmed through Recommendation ITU-R SF.1484, and in the case of GSO FSS through Recommendation ITU-R SF.1573. This solution provides regulatory and operational certainty for both FSS and FS operators to deploy their desired systems in the bands 37.5-40.0 GHz and 40.5-42.5 GHz, and also provides a framework for use of the spectrum by both services (FS and FSS) without undue constraints on either service. This solution also retains the flexibility for administrations to adopt, on a national or regional basis, a requirement for the pfd levels produced on their territory during clear-sky operations to be reduced in order to provide the desired protection of the FS.

4.5.2.3.2 Interference from FS transmitters to FSS earth station receivers in high density applications

Because studies pursuant to *invites* 6 of Resolution **84 (WRC-2000)** are not yet complete (see § 4.5.2.1.4), but are part of the overall arrangement between the FSS and the FS in the 37.5-42.5 GHz band, ITU-R should continue the studies called for in *invites* 6 of Resolution **84**, with a view to identifying appropriate criteria and techniques for addressing interference from transmitters of the fixed service into earth station receivers in high-density applications in the bands 39.5-42 GHz and intended for operation in the same geographic area. The 40-40.5 GHz band would be included, given the presence of the FS allocation.

4.5.2.4 Regulatory and procedural considerations

The regulatory and procedural considerations associated with the method described in § 4.5.2.3.1 involve making no change to the pfd values for the FSS in Table 21-4 of Article **21**. It is proposed, however, to suppress Nos. **21.16.11**, **21.16.12**, and **21.16.13,** which are notes to the Table.

In addition, it would be necessary to suppress Resolution **84**. With respect to the issue raised in section 4.5.2.3.2, it is necessary to retain, in a new Resolution, the call for studies now contained in *invites* 6 of Resolution **84**. There is also a relationship between this subject and WRC-03 agenda item 1.25 (see section 4.3).

Additionally, to address the concern and requirements of some administrations concerning the protection of more sensitive fixed BWA links from FSS emissions, footnote 5.551AA to the Table of Frequency Allocations in the bands from 37.5-40 GHz and 40.5-42.5 GHz should be modified to read:

MOD

5.551AA ~~In the bands 37.5-40 GHz and 42-42.5 GHz, non-geostationary-satellite systems in the fixed-satellite service should employ power control or other methods of downlink fade compensation of the order of 10 dB, such that the satellite transmissions are at power levels required to meet the desired link performance while reducing the level of interference to the fixed service. The use of downlink fade compensation methods are under study by the ITU-R (see Resolution **84 (WRC-2000)**).~~ ~~(WRC-2000)~~While addressing the sharing conditions with the fixed service in the bands 37.5-40 GHz and 40.5-42.5 GHz, the power flux-density at the Earth's surface from any FSS satellite should be at the level(s) required to meet the FSS link availability and performance objectives of the subject applications. In any case, the levels shall not exceed the applicable power flux-density limits in Table **21-4**.

ADD

5.551AAA The power flux-density from any FSS satellite should be at the level required to meet the designed FSS link availability and performance objectives, recognizing the sharing conditions with the fixed service.

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As a consequence of this additional footnote, No. **5.551AA** can be suppressed.

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