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Working Group 4.1

PROPOSED MODIFICATIONS TO THE DRAFT CPM REPORT

AGENDA ITEM 1.6

1.6 to consider possible additional primary allocations:

1.6.1 to the fixed-satellite service (Earth-to-space and space-to-Earth) of 250 MHz in the range between 10 GHz and 17 GHz in Region 1;

(**WP 4A** / **WP 4C, WP 5A, WP 5B, WP 5C, WP 7B, WP 7C, WP 7D**, (WP 3M), (WP 6B))

1.6.2 to the fixed-satellite service (Earth-to-space) of 250 MHz in Region 2 and 300 MHz in Region 3 within the range 13-17 GHz;

(**WP 4A** / **WP 4C, WP 5A, WP 5B, WP 5C, WP 7B, WP 7C, WP 7D**, (WP 3M))

*and review the regulatory provisions on the current allocations to the fixed-satellite service within each range, taking into account the results of ITU-R studies, in accordance with Resolutions **151 (WRC-12)** and **152 (WRC-12)**, respectively;*

Resolution **151 (WRC-12)**: *Additional primary allocations to the fixed-satellite service in frequency bands between 10 and 17 GHz in Region 1*

Resolution **152 (WRC-12)**: *Additional primary allocations to the fixed-satellite service in the Earth-to-space direction in frequency bands between 13-17 GHz in Region 2 and Region 3*

4.1/1.6.1 Resolution 151 (WRC-12)

4.1/1.6.1/1 Executive summary

ITU-R has undertaken studies of possible bands for new primary allocations to the fixed-satellite service (FSS) in the Earth-to-space and space-to-Earth directions within the frequency range 10-17 GHz in ITU Region 1. Studies were performed in 11 different sub-bands from 10 to 17 GHz, and the analysis of the results of the studies and the methods to satisfy the agenda item can be found in section 4.1/1.6.1/4 and section 4.1/1.6.1/5, respectively. It should be noted that the studies performed and the methods considered only address geostationary (GSO) FSS.

4.1/1.6.1/2 Background

The existing unplanned FSS bands in the 10-15 GHz range are used extensively for a myriad of applications such as very small aperture terminal (VSAT) services, video distribution, broadband networks, internet services, satellite news gathering and backhaul links. Growth in demand for these applications has triggered a rapid rise in the demand for spectrum. Moreover, as satellite traffic is typically symmetrical in a large variety of applications, i.e. similar amounts of Earth-to-space (uplink) and space-to-Earth (downlink) traffic are transmitted.

WRC-12 adopted WRC-15 agenda item 1.6.1 to consider additional primary allocations to the FSS in the range 10-17 GHz in Region 1 (Earth-to-space and space-to-Earth) and a review of regulatory provisions for existing FSS allocations, taking into account ITU-R studies in accordance with Resolution **151 (WRC-12)**.

4.1/1.6.1/3 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

The main elements required for the decision under WRC-15 agenda item 1.6.1 are the established technical characteristics and operational parameters of GSO FSS systems (Earth-to-space and space-to-Earth) which could operate in the 10-17 GHz band, and also sharing studies of GSO FSS (Earth-to-space and space-to-Earth) with other radio services.

Relevant ITU-R documents:

The preliminary draft new (PDN) Report ITU-R S.[R1.FSS] and PDN Report ITU-R S.[FSS.DEPLOYMENT] and also the relevant ITU-R Recommendations and ITU-R Reports are indicated in the abovementioned PDN Reports which could be used in the studies performed in accordance with Resolution **151 (WRC-12)**.

4.1/1.6.1/3.1 Overview of current unplanned FSS allocations in Region 1

In Region 1, there are equal allocations between uplink and downlink spectrum, however there is a difference of 250 and 300 MHz of unplanned FSS spectrum when compared with Regions 2 and 3, respectively, as shown in Table 4.1/1.6.1/3-1.

TABLE 4.1/1.6.1/3-1

The current unplanned FSS bands in 10-15 GHz range in Region 1

Frequency bands (GHz)	Bandwidth (MHz)
Earth-to-space direction (uplink)	
13.75-14.5	750
Total spectrum in the uplink	**750**
space-to-Earth direction (downlink)	
10.95-11.2	250
11.45-11.7	250
12.5-12.75	250
Total spectrum in the downlink	**750**
Region 2 spectrum in the downlink	**1 000**
Region 3 spectrum in the downlink	**1 050**
Spectrum difference from other ITU Regions	**250/300**

4.1/1.6.1/3.2 Frequency bands examined

ITU-R has examined frequency bands in the 10-17 GHz range for their suitability in addressing the shortage in the uplink and downlink spectrum in Region 1 when compared with Region 2 and Region 3 FSS allocations.

Detailed study results on these bands are contained in PDN Report ITU-R S.[R1.FSS].

4.1/1.6.1/4 Analysis of the results of studies

Studies were performed in 11 different sub-bands from 10 to 17 GHz.

4.1/1.6.1/4.1 10.0-10.5 GHz band

Consideration is given to this band for possible primary allocations to FSS space-to-Earth operations. The band 10-10.45 GHz is allocated to the fixed service (FS) and mobile service (MS) on a primary basis in Region 1. The frequency band 10.45-10.5 GHz is also allocated to the FS and MS in some countries of Region 1 through RR No. **5.481**. The band 10-10.5 GHz is allocated to the radiolocation service (RLS) on a primary basis in Region 1.

4.1/1.6.1/4.1.1 FSS (space-to-Earth) sharing with the FS

The frequency band 10.0-10.5 GHz is used by digital wireless access systems of FS point-to-multipoint (PMP) links. Technical characteristics of digital PMP links of FS systems in the frequency band 10.0-10.68 GHz and the protection criteria are provided in Recommendation ITU-R F.758. The antenna patterns of the FS stations are described in Recommendations ITU-R F.1245 and ITU-R F.1336.

Statistical analysis showed a high probability of exceeding the permissible long-term aggregate interference level $I_{ag}/N = -10$ dB for terminal stations of PMP digital links of FS systems from the FSS (space-to-Earth) links with a spectral density e.i.r.p. equal to 40 dBW/MHz towards the horizon or with elevation angle lower than 5°. Thus, the achievement of compatibility of the proposed FSS (space-to-Earth) with FS terminal stations in the band 10.0-10.5 GHz is not feasible without use of additional mitigation techniques such as a power flux-density (pfd) mask like that developed to protect terrestrial stations in the band 10.7-11.7 GHz, i.e. RR Article **21** Table **21-4**.

For instance, when the e.i.r.p. spectral density of FSS space station is decreased by 6 dB (to 34 dBW/MHz, i.e. 2 dB lower than the RR Article **21** Table **21-4** value), the probability of exceeding the permissible long-term aggregate interference level of terminal stations of PMP FS links would be no more than about 1% (for FS station elevation angle no more than 5°).

Compatibility of the proposed FSS (space-to-Earth) with PMP links of FS systems in the frequency band 10.0-10.5 GHz is possible with the use of additional mitigation techniques like a pfd mask.

4.1/1.6.1/4.1.2 FSS (space-to-Earth) sharing with the MS

No ITU-R studies have been conducted to date.

4.1/1.6.1/4.1.3 FSS (space-to-Earth) sharing with the RLS

See section 4.1/1.6.1/4.2.3.

4.1/1.6.1/4.1.4 FSS (space-to-Earth) sharing with the radio astronomy service (RAS) operating in the adjacent frequency band

FSS emissions in the frequency band 10.0-10.5 GHz may cause interference to RAS receivers operating in the frequency band 10.6-10.68 GHz. The analysis of out-of-band (OOB) emissions in the RAS frequency band (10.6-10.68 GHz) from the main emissions of a single FSS space station

with maximum pfd level of −122 dB(W/(m^2 · MHz)) showed that to protect RAS stations (Continuum observations) for which Recommendation ITU-R RA.769 (see Table 1, Annex 1) specifies the allowed level of interference pfd of −180 dB(W/(m^2 · MHz)), the emissions from a FSS space station in the RAS frequency band should be suppressed by 58 dB. With the typical OOB emission of FSS space station in the adjacent band suppressed by 35 dB, to protect RAS stations (Continuum observations) OOB emissions from FSS space stations should be additionally suppressed by 23 dB.

It should be noted, however, that the sharing between the current FSS (space-to-Earth) in the band 10.7-10.95 GHz (RR Appendix **30B**) and RAS in the adjacent band 10.6-10.68 GHz is achieved without additional constraints* to OOB emissions from FSS space stations.

Note (*): See Annex 3 to RR Appendix **30B** – Under the assumed free space propagation conditions the pfd (space-to-Earth) created at any spot of the Earth surface offered by a new assignment or allocation should not exceed −114.0 dB(W/(m^2 · MHz)) in the frequency bands 10.70-10.95 GHz and 11.20-11.45 GHz.

This pfd value of FSS space stations is 8 dB higher than the maximum pfd level of the proposed FSS (space-to-Earth) of −122 dB(W/(m^2 · MHz)).

Therefore, if considering a minimum frequency separation of 100 MHz with a possible new FSS allocation in the band 10-10.5 GHz, no compatibility issue is expected with RAS.

4.1/1.6.1/4.1.5 Summary of studies for the band 10.0-10.5 GHz

With additional spectrum allocation to GSO FSS (space-to-Earth) on a primary basis in Region 1 in the frequency band 10.0-10.5 GHz, the compatibility of the proposed GSO FSS (space-to-Earth) with RLS and FS in the common frequency band will be difficult to achieve with respect to the required interference protection levels without the use of additional mitigation techniques.

4.1/1.6.1/4.2 10.5-10.6 GHz band

Consideration is given to this band for possible primary allocations to FSS space-to-Earth operations. The band 10.5-10.6 GHz is allocated to the FS and MS on a primary basis in Region 1. In the portion of the band 10.55-10.6 GHz, the aeronautical mobile service (AMS) is not permitted.

4.1/1.6.1/4.2.1 FSS (space-to-Earth) sharing with the FS

The frequency band 10.5-10.6 GHz is used by FS digital wireless systems PMP. The results of compatibility studies of FSS (space-to-Earth) links and FS links PMP in the frequency band 10.0-10.5 GHz (see section 4.1/1.6.1/4.1.1) are applicable to the frequency band 10.5-10.6 GHz.

Compatibility of the proposed FSS (space-to-Earth) with PMP links of FS systems in the frequency band 10.5-10.6 GHz would be difficult to achieve with respect to the required interference protection levels without the use of additional mitigation techniques. Compatibility could be reached by means of reduction of e.i.r.p. spectral density of FSS space station.

4.1/1.6.1/4.2.2 FSS (space-to-Earth) sharing with the MS

No ITU-R studies have been conducted to date.

4.1/1.6.1/4.2.3 FSS (space-to-Earth) sharing with the RLS

When implementing FSS (space-to-Earth) with a maximum pfd level at the RLS station of −122 dB(W/(m^2 · MHz)) (e.i.r.p spectral density of 40 dBW/MHz,) in the frequency band 10.5-10.6 GHz, the allowed pfd level of −146 dB(W/(m^2 · MHz)) specified by Recommendation ITU-R M.1796 to protect RLS stations will be exceeded by 24 dB.

A decrease of the maximum FSS (space-to-Earth) pfd level by 24 dB is required to respect the level of protection for RLS stations.

4.1/1.6.1/4.2.4 FSS (space-to-Earth) sharing with the RAS operating in the adjacent frequency band

The studies as contained in the section 4.1/1.6.1/4.1.4 concerning the sharing between FSS (space-to-Earth) in the band of 10.0-10.5 GHz and RAS are applicable to the 10.5-10.6 GHz band.

4.1/1.6.1/4.2.5 Summary of studies for the band 10.5-10.6 GHz

With additional spectrum allocation to GSO FSS (space-to-Earth) on a primary basis in Region 1 in the frequency band 10.5-10.6 GHz the compatibility of the proposed GSO FSS (space-to-Earth) with RLS and FS allocated in the shared frequency band and with RAS in adjacent frequency band 10.6-10.68 GHz will be difficult to achieve with respect to the required interference protection levels without the use of additional mitigation techniques.

4.1/1.6.1/4.3 10.6-10.68 GHz band

Consideration is given to this band for possible primary allocations to FSS (space-to-Earth) operations. In Region 1, the band 10.6-10.68 GHz is allocated to the Earth exploration-satellite service (EESS) (passive), FS, MS (except aeronautical mobile), RAS, and space research service (SRS) (passive) on a primary basis. RR Nos. **5.149**, **5.482** and **5.482A** apply.

4.1/1.6.1/4.3.1 FSS (Earth-to-space and space-to-Earth) sharing with the EESS (passive)

The compatibility analyses with the EESS (passive) are based on technical characteristics derived from Recommendation ITU-R RS.1861.

Compatibility analysis performed between the FSS (space-to-Earth) and EESS (passive) indicated that sharing between the two services in the 10.6-10.68 GHz band is not feasible.

In addition to this study dedicated to a possible FSS (space-to-Earth) allocation, an FSS (Earth-to-space) allocation will create harmful interference to the operation of EESS (passive) sensors within the 10.6-10.68 GHz band.

4.1/1.6.1/4.3.2 FSS (space-to-Earth) sharing with the FS

The frequency band 10.6-10.68 GHz is used by FS systems with restrictions according to RR No. **5.482**. Technical characteristics of digital PMP and point-to-point (PP) links of FS systems in the frequency band 10.6-10.68 GHz and the protection criteria are provided in Recommendation ITU-R F.758. The antenna patterns of the FS stations are described in Recommendations ITU-R F.1245 and ITU-R F.1336.

Statistical analysis showed a high probability of exceeding the permissible long-term aggregate interference level $I_{ag}/N = -10$ dB for stations of PP digital links of FS systems from the FSS (space-to-Earth) links. Thus, compatibility of the proposed FSS (space-to-Earth) with FS stations of PP links in the band 10.6-10.68 GHz is not achieved with respect to the interference protection level without the use of additional mitigation techniques.

For instance, when the e.i.r.p. spectral density of FSS space station is decreased by 6 dB (to 34 dBW/MHz), the probability of exceeding the permissible long-term aggregate interference level of FS stations of PP links would be no more than about 0.9% (for FS station elevation angle no more than 5°). With this restriction one may use FSS earth stations with antenna diameter of more than 1.2 m.

The results of compatibility studies of FSS (space-to-Earth) links and PMP links of FS in the band 10.0-10.5 GHz (see section 4.1/1.6.1/4.1.1) are applicable to the frequency band 10.6-10.68 GHz.

Without the use of additional mitigation techniques, compatibility of the proposed FSS (space-to-Earth) with PP links of FS systems in the frequency band 10.6-10.68 GHz is not achieved since the interference protection level would not be respected. Compatibility could be reached by means of reduction of e.i.r.p. spectral density of the FSS space station.

4.1/1.6.1/4.3.3 FSS (space-to-Earth) sharing with the MS

No ITU-R studies have been conducted to date.

4.1/1.6.1/4.3.4 FSS (space-to-Earth) sharing with the RAS

The frequency band 10.6-10.7 GHz is used by RAS stations for monitoring sources of continuous spectrum and VLBI observations. In accordance with Recommendation ITU-R RA.769 the threshold interference pfd level is −240 dB(W/(m^2 · Hz)) for continuum observations and −193 dB(W/(m^2 · Hz)) for VLBI observations.

The pfd limits for GSO FSS (space-to-Earth) in the frequency band 10.7-11.7 GHz are also given in RR Article **21** Table **21-4** at level –150/–140 dB(W/(m^2 · Hz)).

Summary: The proposed FSS (space-to-Earth) does not provide compatibility with RAS in the frequency band 10.6-10.68 GHz.

4.1/1.6.1/4.3.5 Summary of studies for the band 10.6-10.68 GHz

With additional allocation of spectrum to GSO FSS (space-to-Earth) on a primary basis in the band 10.6-10.68 GHz in Region 1, compatibility of the proposed GSO FSS (space-to-Earth) with passive services (EESS, SRS) and RAS, allocated in the shared frequency band, is not achieved as the interference protection level is not respected.

Compatibility of proposed FSS (space-to-Earth) and FS in the shared frequency band 10.6-10.68 GHz is not achieved without the use of additional mitigation techniques.

4.1/1.6.1/4.4 13.25-13.4 GHz band

Consideration is given to this band for possible primary allocations to FSS Earth-to-space and space-to-Earth operations. The band 13.25-13.4 GHz is allocated to the EESS (active), aeronautical radionavigation service (ARNS) and SRS (active) on a primary basis. RR Nos. **5.497**, **5.498A** and **5.499** apply.

4.1/1.6.1/4.4.1 FSS (Earth-to-space) sharing with the EESS (active)

With regard to sharing between EESS (active) and FSS (Earth-to-space), nine studies have been performed to date.

Three of the studies indicate that the EESS (active) protection criteria is always met for all kinds of sensors considered, assuming the current FSS frequency reuse factor (FRF) per satellite of 1.2. However, the FSS FRF per GSO location may be higher than 1.2. In addition, it is to be noted that EESS (active) altimeters and one type of precipitation radar have lower margins of compatibility from 3 to 6 dB below the protection criteria, than scatterometers, and that these studies have been performed on a worldwide basis without consideration of measurement area of interest.

Another study indicates that FSS (Earth-to-space) with EESS (active) are compatible subject to some FSS (Earth-to-space) parameters restriction, using the same hypothesis as previously stated. According to the results of these studies, compatibility is achieved for all transmission types of FSS

(Earth-to-space) earth stations with antenna diameters from 0.6m to 9 m with a maximum peak envelope power spectral density less than or equal to −50.8 dBW/Hz.

The last study provides a parametric analysis varying the FSS GSO FRF from 1.2 to 5. The parametric studies also examined varying the FSS deployment transmission types by percentage of transmissions. In addition, an assessment of the simplifying assumption of using a single continuously transmitting earth station in place of a TDMA network was done, showing that this simplifying assumption underestimates the amount of interference seen by the JASON-3 sensor by 3.4 dB considering a 100% VSAT TDMA deployment and a 0% wideband and PP deployment. Therefore, when considering a frequency reuse factor of 1.5, studies examining the random data availability criteria in Recommendation ITU-R RS. 1166-4 shows compatibilities between FSS (Earth-to-space) and EESS (active).

The results of dynamic analyses examining the compatibility between FSS (Earth-to-space) and EESS (active) in the 13.25-13.75 GHz band were based on a simplifying assumption for the representation of FSS TDMA networks and may underrepresent the interference that would be caused to EESS (active) sensors by FSS stations if an allocation to the FSS (Earth-to-space) is made in that band. The antenna size limitation and the regulatory obligation to coordinate each FSS earth station individually, should limit the total number of FSS earth stations that will be operated under TDMA technology.

Considering a linear extrapolation of the current trend, for the FRF implemented on new FSS satellites, it is expected to have an average FRF of 1.5 per satellite for the next 30 years. A FRF of 5 may be observed for high throughput satellite (HTS) at certain GSO orbital locations. When considering compatibility between EESS (active) and FSS (Earth-to-space), using the systematic data availability criteria of Recommendation ITU-R RS.1166-4, two of the studies show that, when examining specific measurement areas of interest (sea/land/wet areas) for EESS (active) altimetry, compatibility is not achieved. A single earth station uplink of median transmit power can corrupt the sensor measurements of a specific measurement area of interest. In one of the studies it was shown that the sharing criteria is not met for regions of the Earth extending from the equator to ±10 degrees latitude (VSAT) to ±45 degrees latitude (wideband). A specific mitigation technique to address sharing has not yet been identified. One study performed dynamic simulations of the FSS (Earth-to-space) with EESS active precipitation radar, and showed the protection criteria for Precipitation Measurement Radar 2 (PMR2) were not satisfied, exceeding the interference threshold by 10 dB.

4.1/1.6.1/4.4.2 FSS (space-to-Earth) sharing with the EESS (active)

The static analysis of interference from the FSS (space-to-Earth) space stations to EESS space stations active sensors is performed using two interference scenarios: Scenario 1 considers the variant of interference impact on the back lobes of the EESS space station antenna pattern, and Scenario 2 considers the option when the interfering signal is reflected from the earth surface and falls into the antenna main lobe of the EESS active sensor also known as backscatter.

The analysis showed the availability of positive margin for allowable interference protection criterion in both scenarios for all types of the considered EESS (active) sensors. The margin of protection criterion is from 16 to 21 dB (for Scenario 1) and 3 to 41 dB (for Scenario 2).

Dynamic analysis of interference from EESS (active) systems to receive FSS earth stations (E/Ss) with different antenna diameters (0.75-9 m) and different elevation angles located at different latitudes showed that the level of interference would exceed the FSS E/S protection criterion (I/N = 6% or –12.2 dB) during a very limited period of time (0.01% - 0.1%), which should not affect the quality of services provided.

Summary: Compatibility of proposed FSS (space-to-Earth) and considered EESS (active) sensors in the frequency band 13.25-13.4 GHz is possible should a pfd limit of −122 dB(W/(m^2 · MHz)) on the Earth surface from FSS space stations for all elevation angles not be exceeded.

Other studies for Global Precipitation Mission (GPM) DPR show that the interference threshold will not be exceeded taking into account the fact that the backscattering coefficient is usually less than 0 dB and that the reflected area is much smaller than for altimeters.

Considering that existing EESS (active) altimeter systems use 350 MHz bandwidth, and in future the EESS (active) is planning to use for altimeters the whole frequency band 13.25-13.75 GHz (500 MHz), it is necessary to consider the impact of aggregate interference simultaneously coming from all EESS (active) systems to FSS E/Ss.

ITU-R studies on these issues are ongoing.

4.1/1.6.1/4.4.3 FSS (space-to-Earth) sharing with the ARNS

The maximum allowable pfd to protect Doppler navigation systems (DNS) operating in the ARNS of −135.9 dB(W/(m^2 · MHz)) is 13.9 dB below the maximum pfd level of the proposed FSS (space-to-Earth) of −122 dB(W/(m^2 · MHz)).

The analysis of interference in the opposite direction, from emissions of DNS systems in ARNS to receive FSS E/S (with antenna size ranging 0.6 to 6.0 m) showed that in the considered interference scenarios the interference level significantly exceeds the allowable threshold (by 37.2-110.9 dB – to receive interference from radar side lobes and by 50.2-123.9 dB – to receive interference from radar main lobe).

Further studies should be performed to specify the probability and duration of interference impact from interference source in ARNS to the receive FSS E/S in the considered interference scenarios.

ARNS DNS systems operating in 13.25-13.4 GHz may cause out-of-band interference into the FSS (space-to-Earth and Earth-to-space) in the 13.4-13.75 GHz near the 13.4 GHz edge of the band.

4.1/1.6.1/4.4.4 FSS (Earth-to-space) sharing with the ARNS

Compatibility analysis between FSS (Earth-to-space) and ARNS (DNS systems installed in aircraft and helicopters, UAS) resulted in the allowable aggregate interference level being exceeded by up to 24.0 dB when considering interference from the side-lobes of FSS E/S into the side-lobes of ARNS DNS systems. When considering the main-lobe of single entry interference from the FSS E/S into the side-lobes of the ARNS DNS systems, the allowable interference level is exceeded by up to 53.7 dB.

ARNS DNS systems operating in 13.25-13.4 GHz may cause out-of-band interference into the FSS (space-to-Earth and Earth-to-space) in the 13.4-13.75 GHz near the 13.4 GHz edge of the band.

4.1/1.6.1/4.4.5 FSS (space-to-Earth and Earth-to-space) sharing with the SRS (active)

Since SRS (active) applications are active sensors used in the frequency band 13.25-13.4 GHz around other planets, no compatibility issue with the FSS proposed is expected.

4.1/1.6.1/4.4.6 FSS (space-to-Earth and Earth-to-space) sharing with the FS

No allocation to the FS exists in Region 1, thus no ITU-R studies are required.

4.1/1.6.1/4.4.7 Summary of studies for the band 13.25-13.4 GHz

Regarding an additional spectrum allocation for GSO FSS on a primary basis in Region 1 in the frequency band 13.25-13.4 GHz, compatibility between the FSS (space-to-Earth) and EESS (active)

in the frequency band 13.25-13.4 GHz may be possible after considering the simultaneous allowable level of aggregate interference caused from all EESS (active) systems to FSS E/S. FSS (space-to-Earth) operations would be compatible with EESS (active) systems. FSS (Earth-to-space) emissions will exceed the protection criteria for EESS (active) altimeter measurement areas of interest (inland lakes, rivers, reservoirs, coasts) as well as EESS (active) precipitation radars. No mitigation technique to address this incompatibility has yet been identified.

Given the features of the use of SRS (active) in the frequency band 13.25-13.4 GHz, problems of compatibility with the FSS (Earth-to-space and space-to-Earth) proposed is not expected.

Interference generated by FSS (space-to-Earth and Earth-to-space) proposed towards ARNS (DNS systems on board airplanes) in the common frequency band 13.25-13.4 GHz significantly exceeds the ARNS DNS protection criteria levels by very large margins, +14 dB by FSS (space-to-Earth) and +53.7 dB by FSS (Earth-to-space).

4.1/1.6.1/4.5 13.4-13.75 GHz band

Consideration is given to this band for possible primary allocations to FSS (Earth-to-space and space-to-Earth) operations. The band 13.4-13.75 GHz is allocated to the EESS (active), RLS and SRS (active) on a primary basis.

RR No. **5.501A** indicates that the use of the band 13.4-13.75 GHz by the SRS on a primary basis is limited to active spaceborne sensors. Other uses of the band by the SRS are on a secondary basis. RR Nos. **5.499**, **5.500**, **5.501** and **5.501B** apply.

4.1/1.6.1/4.5.1 FSS (Earth-to-space and space-to-Earth) sharing with the EESS

4.1/1.6.1/4.5.1.1 FSS (Earth-to-space) sharing with the EESS (active)

The description of use of EESS (active) in the frequency band 13.25-13.75 GHz and the feasibility of sharing with the proposed FSS (Earth-to-space) is shown in section 4.1/1.6.1/4.4.1.

4.1/1.6.1/4.5.1.2 FSS (space-to-Earth) sharing with the EESS (active)

See section 4.1/1.6.1/4.4.2.

4.1/1.6.1/4.5.2 FSS (Earth-to-space) sharing with the SRS

The SRS is currently allocated on a secondary basis in this band.

The frequency band 13.4-13.75 GHz is used by data relay satellite (DRS) systems operating in the SRS for return feeder links (downlinks) and for forward inter-orbit links (see Recommendations ITU-R SA.1018 and ITU-R SA.1019). Recommendation ITU-R SA.1414 describes characteristics of DRS systems operated by some administrations.

Two studies were performed between FSS (Earth-to-space) and SRS DRS system 1 in this band, using different FSS earth station deployment models, as well as other initial assumptions. The first study, which employed an apportioned protection criteria as indicated by the relevant ITU-R study group, concluded that sharing between FSS (Earth-to-space) and the return feeder links of SRS DRS systems was feasible, but that sharing between FSS (Earth-to-space) and DRS forward inter-orbit links was not, with all FSS earth stations located at the same latitude and considering parametrically a range of earth station antenna size (0.6 to 2.4 m) and maximum power spectral density (−42 to −60 dBW/Hz). The second study, which employed the aggregate interference criteria and used FSS earth station location according to deployment model in section 4 of the preliminary draft new (PDN) Report ITU-R S.[R1.FSS], reached the opposite result with respect to DRS forward inter-orbit links, concluding that sharing could be feasible subject to regulatory measures/technical limitations (minimum FSS earth station antenna diameter of 1.2 m, e.i.r.p. of

any emission limited between 68 dBW and 85 dBW for earth stations having an antenna diameter greater than or equal to 4.5 m). Currently the forward inter-orbit links are not operated under DRS system 1 in the band 13.4-13.75 GHz.

Summary

Compatibility of the FSS uplinks with respect to SRS DRS return feeder links in the band 13.4-13.75 GHz is achievable by providing sufficient separation between FSS uplink earth stations and the DRS downlink earth stations. Necessary coordination distances could be defined by applying regulatory provisions for FSS uplinks (as for example application of RR No. **9.17A**).

Compatibility of the FSS uplinks with respect to the SRS DRS forward links in the band 13.4-13.75 GHz will not be ensured without adequate mitigation techniques which have not been identified. Mitigation techniques, such as hard limits for FSS earth station parameters, should be included into the RR.

The impact on SRS DRS system 2 forward links from FSS uplinks has not yet been studied. These studies are required to determine compatibility of the FSS uplinks with respect to the SRS DRS forward links in the band 13.4-13.75 GHz.

4.1/1.6.1/4.5.3 FSS (space-to-Earth) sharing with the SRS

The SRS is currently allocated on a secondary basis in this band.

Three studies were performed between FSS (space-to-Earth) and SRS DRS system 1 in this band and one study was performed between FSS (space-to-Earth) and SRS DRS system 2.

The results of the interference analysis, considering the same status for FSS and SRS allocations are summarized in Table 4.1/1.6.1/4-1 below.

TABLE 4.1/1.6.1/4-1

Summary of results of interference between SRS DRS systems and proposed FSS downlink allocation in the 13.4-13.75 GHz band

				Possible to establish compatibility between SRS and FSS for co-frequency operations?	
New allocation	**Frequency band (GHz)**	**Case**	**SRS (DRS) links**	**FSS interference into SRS**	**SRS interference into FSS**
FSS downlink (AI 1.6.1)	13.40-13.75	1	DRS return feeder link (downlink)	Yes*	Yes*
		2	DRS forward inter-orbit link	Yes**	Yes

* Coordination between SRS and FSS is feasible using measures like: satellite orbital separation, beam separation, E/S separation, etc.

** Compatibility between SRS and FSS is achievable using mitigation techniques which may include increasing minimum orbital separation and/or reducing e.i.r.p. of the FSS satellites.

Based on the summary table above and considering the assumptions used in the studies, the following can be observed for 13.4-13.75 GHz FSS downlinks:

– Case 1: The mutual interference between DRS downlinks and FSS downlinks would exceed the protection criterion, assuming the worst case condition. However, coordination measures like setting a minimum orbital separation between the GSO satellites, beam separation advantage for earth station locations and other measures

could considerably reduce the interference and achieve the protection criteria for SRS DRS systems.

– Case 2: The minimum orbital separation at the GSO between the SRS DRS space station and the nearest FSS space station could be not less than (3 / 21) degrees depending on the parameters of the SRS DRS and FSS systems (see Table 9-17 in PDN Report ITU-R S.[R1.FSS]). To ensure the required minimum orbital separation, frequency assignments of the GSO FSS networks in the 13.4-13.75 GHz band shall be subject to coordination with respect to DRS systems in the SRS (space-to-space).

Summary

Compatibility between SRS and FSS (space-to-Earth) is achievable in the 13.4-13.75 GHz band after applying regulatory provisions (as for example application of RR Nos. **9.7**, **9.21**) and technical measures like setting minimum orbital separation at the GSO between the SRS DRS space station and the nearest FSS space station and limiting maximum e.i.r.p. spectral density for FSS downlinks.

4.1/1.6.1/4.5.4 FSS (space-to-Earth) sharing with the RLS and radionavigation service (RNS)

RLS systems in the frequency band 13.4-13.75 GHz are the same as in 13.75-14 GHz; see Recommendation ITU-R M.1644. Compatibility conditions between FSS (space-to-Earth) and RLS, RNS stations are possible based on pfd limits applied to FSS space stations.

4.1/1.6.1/4.5.5 FSS (Earth-to-space) sharing with the RLS and RNS

RLS systems in the frequency band 13.4-13.75 GHz are the same as in the band 13.75-14 GHz; see Recommendation ITU-R M.1644. The frequency band 13.4-13.75 GHz is allocated to the RNS in six countries through RR No. **5.501**. In some of those countries, the RNS and the FSS can share the 13.4-13.75 GHz band under the same conditions as those stipulated in RR Nos. **5.502**, **9.17** and **9.18**. In addition, at least one administration operates an aeronautical precipitation radar under the RLS in this band.

Two studies with a static and dynamic analysis were performed using the HIWRAP aeronautical precipitation radar/scatterometer which operates under the RLS.

The study #1 results of the static analysis considered the FSS transmission type median, 1-sigma, and 2-sigma deviations. The results of the static analysis indicate that under all cases considered the interference from the FSS (Earth-to-space) will not exceed the RF front end saturation or maximum allowable sensor input power of the HIWRAP.

The study #1 results of the dynamic analysis for the HIWRAP aeronautical precipitation radar/scatterometer of the Gulf of Mexico were completed. Results indicate a maximum interference exceedance level of at least 26.4 dB for the −6 dB I/N criteria for radiolocation services operating over the Gulf of Mexico when considering FSS deployment FRF of 1.2. The results also indicate that for the analysis examining the operation of HIWRAP over the Gulf of Mexico that the −6 dB I/N criteria is exceeded 0.06% of the time for a FRF of 1.2.

The study #2 results of the dynamic analysis for an area of measurement of interest taken to be that of the Gulf of Mexico. This result of the parametric dynamic analysis shows that the Recommendation ITU-R M.1644 prescribed protection criteria of −6 dB I/N (equivalent to −130 dBW/100 MHz for HIWRAP) is exceeded 0.05% of the time considering a FRF of 1.5.

Following the revision of sharing conditions in the band 13.75-14 GHz under WRC-03 agenda item 1.24, some administrations might have migrated their radiolocation radar systems in the band 13.4-13.75 GHz, in order to limit interference from FSS earth stations. As the band 13.4-13.75 GHz

is used by the same radars as the band 13.75-14 GHz, at a minimum, the provisions existing in the band 13.75-14 GHz should also be applied in the band 13.4-13.75 GHz, and, in particular, the provisions of RR No. **5.502**.

4.1/1.6.1/4.5.6 FSS (space-to-Earth) sharing with the FS and MS

Compatibility conditions between FSS (space-to-Earth) and FS, MS stations are possible based on pfd limits applied to FSS space stations.

4.1/1.6.1/4.5.7 FSS (Earth-to-space) sharing with the FS and MS

Compatibility between FSS (Earth-to-space) and FS/MS stations in the frequency band 13.4-13.75 GHz is possible based on coordination measures and application of geographic separation using RR Appendix **7** methodology.

4.1/1.6.1/4.5.8 FSS (Earth-to-space and space-to-Earth) sharing with the standard frequency and time signal-satellite service (SFTSSS)

With regard to sharing between the SFTSSS (Earth-to-space) and FSS (Earth-to-space), 3 studies have been performed to date.

The first study, using an outdated deployment model, indicated that the protection criterion of −125 dBW/125 MHz was not exceeded, with a margin limited to 0.4 dB.

The second study, using the agreed upon deployment model based on the number of FSS transmissions, indicated an interference level of exceeding the protection criterion by 7.6 dB.

The third study, using the agreed upon deployment model based on the allocation of the overall FSS frequency resource amongst diverse earth stations, looked at differing FSS E/S bandwidths and FSS E/S power density values. The results indicated that a deployment of 60 cm FSS E/S with power density levels of −50 dBW/Hz and −42 dBW/Hz showed harmful interference. However, FSS E/S deployments of several bandwidths as well as FSS E/S deployments using 60 cm antenna size with power densities of −55 dBW/Hz did not exceed the interference criteria.

There is therefore uncertainty on the compatibility between the FSS (Earth-to-space) and the SFTSSS (Earth-to-space).

Another study indicated the interference level from FSS space stations to SFTSSS space station meets the permissible level without using mitigation techniques. The maximum separation distance for FSS E/S protection is 21 km without taking into account the propagation path terrain of interfering signal.

Based on the above, it can be concluded that FSS (space-to-Earth) and SFTSSS (Earth-to-space) are compatible.

4.1/1.6.1/4.5.9 Summary of studies for the band 13.4-13.75 GHz

Compatibility between FSS (space-to-Earth) and RLS, RNS, FS, MS stations are possible by applying appropriate pfd limits to FSS transmit space stations.

For summary of studies for FSS with respect to EESS (active) see section 4.1/1.6.1/4.4.7.

Compatibility between SRS and FSS (space-to-Earth) is achievable in the 13.4-13.75 GHz band after applying regulatory provisions (as for example application of RR Nos. **9.7**, **9.21**) and technical measures like setting minimum orbital separation at the GSO between the SRS DRS space station and the nearest FSS space station and limiting maximum e.i.r.p. spectral density for FSS downlinks.

Compatibility of the FSS (Earth-to-space) with respect to SRS DRS return feeder links in the band 13.4-13.75 GHz is achievable by providing sufficient separation between FSS uplink earth stations

and the DRS downlink earth stations. Necessary coordination distances could be defined by applying regulatory provisions for FSS uplinks (as for example application of RR No. **9.17A**).

Compatibility of the FSS (Earth-to-space) with respect to the SRS DRS forward links in the band 13.4-13.75 GHz will not be ensured without adequate mitigation techniques which have not been identified. Mitigation techniques, such as hard limits for FSS earth station parameters, should be included into the RR.

The impact on SRS DRS system 2 forward links from FSS (Earth-to-space) has not yet been studied. These studies are required to determine compatibility of the FSS (Earth-to-space) with respect to the SRS DRS forward links in the band 13.4-13.75 GHz.

There is some uncertainty about compatibility between the SFTSSS (Earth-to-space) and the FSS (Earth-to-space). However, no difficulty is expected with regard to FSS in the space-to-Earth direction. Further, to ensure compatibility with the FSS uplink allocation beginning at 13.75 GHz, the space-to-Earth allocation can be limited to 13.4-13.65 GHz whilst still achieving the objective of 250 MHz given in Resolution **151 (WRC-12)**.

Additional primary spectrum allocation to GSO FSS (Earth-to-space) in the frequency band 13.4-13.75 GHz in Region 1 could have significant impact on RLS systems without mitigation techniques, so the possibility of applying new FSS and minimum FSS E/S antenna diameter would be restricted by sharing conditions with RLS systems. For the HIWRAP operating in the RLS the protection criteria was exceeded by 26.4 dB for less than 0.06% of the time.

Therefore, to ensure protection from FSS (Earth-to-space) interference into RLS, at a minimum it is proposed to apply restrictions already existing for GSO FSS in the frequency band 13.75-14 GHz, including restrictions under RR No. **5.502**, that would avoid using in this band FSS E/S antenna with diameters less than 1.2 m and larger than 9 m. For FSS E/S antenna with diameters 4.5 m or more, e.i.r.p. of any emission shall comply with restrictions specified under RR No. **5.502**. For the HIWRAP system, further regulatory mechanisms may be needed to ensure that protection can be achieved in the above provisions.

4.1/1.6.1/4.6 14.5-14.8 GHz band

The band 14.5-14.8 GHz is allocated to the MS, FS and FSS (Earth-to-space) on a primary basis and to the SRS on a secondary basis. RR No. **5.510** indicates that the use of the band 14.5-14.8 GHz by the FSS (Earth-to-space) is limited to feeder links for the broadcasting-satellite service (BSS) and that this use is reserved for countries outside Europe.

Studies for sharing in this band included both (1) studies with other allocated services, and (2) studies within the FSS, taking into account Resolution **151 (WRC-12)**. Studies included consideration of utilizing existing allocations to the FSS through a review of regulatory provisions, except RR Nos. **5.502** and **5.503**.

4.1/1.6.1/4.6.1 FSS and BSS feeder link Plan/List, contained in RR Appendix 30A (AP 30A)

In the 14.5-14.8 GHz bands, appropriate measures need to be taken with regard to the AP **30A** Plan and List to ensure the integrity and full protection of the 14.5-14.8 GHz band, specifically taking into account:

a) the required coordination procedures between any new FSS utilization of the band and the existing AP **30A** networks and future evolution/modification of the Plan;

b) the need for transmitting earth stations in the AP **30A** Plan and List to be able to be located anywhere within their respective service areas;

c) the need to appropriately protect assignments in the AP **30A** Plan and List, as the case may be, from the aggregate effect of any new FSS utilization of the band so as the cumulative effect of the proposed FSS, if allocated, would not degrade the equivalent protection margin (EPM) below the level if such allocation was not made, i.e. maintaining the EPM degradation less than or equivalent to that emanated from BSS feeder links.

Appropriate regulatory procedures together with calculation methods need to be developed to implement any agreed criteria to protect assignments in the AP **30A** Plan and List. Subject to final procedure retained, modification to the Bureau software (for example, GIBC) could be required. In order to determine the appropriate criteria, interference simulation of the cumulative effect of the new FSS system is needed to demonstrate that protection of the AP **30A** Plan is ensured at levels equivalent to that of the EPM criteria in the RR and together with the EPM reference situation of the Plan and List assignments.

One of the difficulties of using the EPM approach to identify affected administrations is that, due to the structure of the MSPACE software and its implementation, assignments having very low EPM would not be identified as affected. This issue was brought to previous WRCs. No practical and implementable solution has yet been made available. This is the reason that there is a need to try to find criteria equivalent to EPM which could resolve the problem mentioned above as well as take into account the cumulative effect of potential FSS assignments to the assignments of the feeder link BSS Plan/List, if the band is allocated to FSS under WRC-15 agenda item 1.6.

The technical feasibility for FSS systems to operate in the band 14.5-14.8 GHz, whilst maintaining the protection of the AP **30A** planned assignments, has been assessed. The results of the studies show that coexistence between FSS systems subject to AP **30A** and other FSS systems is feasible under certain conditions, and compatibility between these systems could be provided through coordination process.

In order to ensure protection of the AP **30A** Plan and List assignments from new FSS (Earth-to-space) links, coordination triggers need to be defined. Three coordination triggers, pfd, $\Delta T/T$, and C/I have been examined in the studies.

Based on these studies, a pfd threshold is proposed to be used as a trigger for coordination for a new assignment in the FSS (Earth-to-space) allocation with respect to an assignment in the Regions 1 & 3 feeder link Plan and List.

Specifically, in one of the studies it has been proposed that the pfd produced by a new assignment in the FSS (Earth-to-space) allocation in the orbital position of any existing assignment in the Regions 1 and 3 AP **30A** Plan and List has to be lower than $-193.9 - GRx$ dB(W/(m^2 · Hz)), where GRx is the relative receive antenna gain of the space station in the Regions 1 and 3 feeder-link Plan or List at the location of the transmitting earth station in the fixed-satellite service not subject to Regions 1 and 3 feeder-link Plan or List. Therefore, if a new assignment in the FSS (Earth-to-space) produces a pfd higher than $-193.9 - GRx$ dB(W/(m^2 · Hz)) in the orbital position of an existing assignment in the Regions 1 and 3 AP **30A** Plan and List, coordination between them will be required.

To obtain this pfd coordination threshold, MSPACE simulations have been run to calculate the maximum pfd that a new assignment in the Region 1 and 3 AP **30A** Plan and List could produce at the orbital position of an existing AP **30A** Plan assignment and not "affect" it. An assignment is considered as not affected when the EPM of the existing AP **30A** assignment does not fall more than 0.45 dB below 0 dB, or, if already negative, more than 0.45 dB. Extrapolating, the pfd value obtained has been proposed as threshold for coordination for a new assignment in the FSS (Earth-to-space) allocation with respect to any existing AP **30A** assignment.

To evaluate the impact that new assignments in the FSS allocation transmitting below the proposed coordination threshold would have into the existing AP **30A** Plan and List assignments, C/I calculations were performed and C/I values higher than 36.5 dB were found in all cases. MSPACE simulations were also performed and showed that no assignments of the AP **30A** Plan and List would be affected according to MSPACE simulations.

In addition, another study used MSPACE to examine the cumulative effect of multiple new FSS assignments to AP **30A** Plan or List assignments. A pfd threshold mask was derived from the results of the study. This pfd mask limits the effect a new FSS assignment would have on the EPM of the existing AP **30A** assignment. This pfd mask criteria is to be applied for cases where the orbital separation is larger than 0° and smaller than 9°.

Another of the proposed methods is a ΔT/T threshold to be used to trigger coordination for a new assignment in the FSS (Earth-to-space) allocation with respect to an assignment in the Regions 1 and 3 AP **30A** Plan and List. Specifically, it has been proposed that new FSS (Earth-to-space) systems that cause the ΔT/T of an AP **30A** Plan or List assignment to exceed 6% will require coordination. The 6% ΔT/T is the threshold currently used to trigger coordination between GSO systems in RR Appendix **5** and for coordination between networks defined in Annexes 1 and 4 of AP **30A**.

ITU-R also carried out the C/I studies for Regions 1 and 3 feeder-link Plan assignments considering interference from new FSS assignments not subject to AP **30A**. Both single-entry and aggregate C/I were determined for co-channel operation in a single polarization. Interference into the upper and lower adjacent channels of the protected assignment were not considered. The results showed that the single-entry C/I of the protected plan assignment was at least 27 dB at 1.5 degrees while the aggregate C/I for satellites with 0.5/2 degree spacing within ±9 degrees of a Plan assignment approaches 27 dB.

Summary

Compatibility analyses have been performed in order to determine if assignments in or proposed modifications to the AP **30A** Plan/List in the 14.5-14.8 GHz band can be protected from FSS systems sharing the band. Both single-entry and aggregate analyses have been conducted. The studies also provided technical criteria to trigger coordination with the AP **30A** assignments to ensure the protection and integrity of the AP **30A** Plan and List. Three alternatives were considered (ΔT/T, C/I and pfd threshold) and the studies have shown that the alternatives provide protection to Plan assignments. Studies showed that a pfd threshold provides protection of the List assignments.

4.1/1.6.1/4.6.2 FSS (Earth-to-space) sharing with the FS

Two studies were performed using the methods contained in RR Appendix **7** and both indicated that the RR Appendix **7** provisions are adequate to determine the coordination distances between FSS (Earth-to-space) and the FS. This sharing situation is similar to current sharing between the FSS (Earth-to-space) feeder links for the broadcasting-satellite service (BSS) and the FS.

An estimation was carried out of the coordination area necessary to protect FS receive stations from interference from FSS (Earth-to-space) E/Ss on worst-case interference scenario on RR Appendix **7** methodology for 37 countries of Region 3 and one country of Region 1. A separation distance value of the maximum coordination distance identified by RR Appendix **7** achieves 100-140 km with elevation angle of FSS E/S 5° and maximum interference power spectrum density (PSD) from –42 to –50 dBW/Hz. It should be noted that the separation distance can be 100-237 km without careful siting of stations, off-axis antenna gains of both systems, shielding, and avoidance of overlapping channels. While the sharing between FSS E/S and FS is manageable, it is preferable to have a small number of FSS earth-stations operating in this frequency band.

Additionally, in order to address the case of multiple FSS earth stations potentially interfering with FS, masks of allowable overall aggregate PSD interference coming from FSS E/S (Earth-to-space) to FS stations with antennas having antenna pattern of Recommendation ITU-R F.699-7 and maximum gain value 15, 30 and 40 dBi were constructed. For such cases, RR Appendix **7** should be used to determine the coordination area, such that the maximum aggregate interference power density (dBW/MHz) from all FSS earth stations to a FS station is below all FS PSD protection masks.

Summary

Provision of compatibility conditions between FSS (Earth-to-space) and FS stations in frequency band 14.5-14.8 GHz is possible based on coordination measures and application of geographic separation using RR Appendix **7** methodology as already performed between the FSS (Earth-to-space) feeder links for the broadcasting-satellite service (BSS) and the FS in frequency band 14.5-14.8 GHz.

4.1/1.6.1/4.6.3 FSS (Earth-to-space) sharing with the MS/AMS

Aeronautical mobile data links and land mobile data links currently operate in the 14.5-14.8 GHz band under the MS allocation, the parent service to the Aeronautical Mobile Service (AMS) and land mobile service (LMS). Eight studies were performed and the results from all eight studies show that interference from the FSS (Earth-to-space) into the AMS aircraft station or AMS land station or LMS land station could exceed the protection criterion (i.e. I/N −6 dB for 100% of the time) depending on three main factors: the altitude of the AMS aircraft or MS land station, the distance between the AMS aircraft or LMS/AMS land station and the FSS earth station and the terrain scenario. The area around an AMS aircraft or LMS/AMS land station within which the protection criterion is exceeded is non-uniform. It is also noted that the AMS land stations can be fixed or transportable: in the latter case, they can be deployed in different positions, on a case-by-case basis, depending from the operational mission needs (e.g. need to guarantee adequate radio frequency coverage for the AMS data link during the whole mission). For transportable AMS land stations, the shape and orientation variation of the non-uniform area has to be taken into account after relocating the AMS land station itself.

All studies are considering at least a single FSS station interferer. Multiple interferers will lead to an aggregate effect that is likely to increase the harmful interference levels.

The probability to have multiple FSS stations in a limited area operating simultaneously in the same bandwidth as the AMS will be reduced with increased minimum antenna size.

With respect to the AMS, the following studies, currently contained in PDN Report ITU-R S.[R1.FSS] (for studies #1 to #4A) or in the input 142 and 153 to the CPM 15-2, were considered in the meeting and can be summarized as follows:

- Study #1 (static analysis) showed that VSAT FSS earth stations exceed the AMS aircraft station protection criterion at distances up to 575 km when the aircraft station operates at 19 km in altitude.
- Study #1A (static analysis) showed that the percentage of the total square area where the AMS aircraft station protection criteria is exceeded is 0.05% for a separation distance 550 km (which is 475 km² when the AMS land station sees the AMS aircraft with an elevation angle of 0.1°) and 5.57% for a separation distance of 200 km (which is 7 000 km² when the AMS land station sees the AMS aircraft with an elevation angle of 10°) when the aircraft station operates at 19 km in altitude.
- Study #2 (dynamic analysis) considered the hypothesis that a single VSAT transmitting 100% of the time over the whole frequency band represents the effect of several VSAT

transmitting at different times over particular channels and over different FSS GSO satellites. Under this hypothesis, the study showed that the probability of exceeding the protection criteria and causing harmful interference in the range 0 to 450 km occurring from a VSAT FSS earth station into an AMS aircraft station operating at 19 km and 2.4 km are 0.9% and 7.3% respectively.

– Study #3 (static analysis) showed that using characteristics from AP **30A** feeder links currently allocated in this band exceed the AMS aircraft station protection criteria at distances of 150 km and 400-500 km when the AMS aircraft station operates at 2.4 km and 19 km in altitude, respectively. These results are in good agreement with the results issued from Study #1.

– Study #4 (dynamic analysis) showed that FSS earth station antenna size is irrelevant to the occurrence of interference exceeding the I/N protection criterion of the AMS aircraft station. Under the methodology proposed in this study, the probability of exceeding the protection criterion of an AMS aircraft station operating at 19 km was approximately 4% when a separation distance of 250 km is considered between the AMS land station and FSS earth station.

– Study #4A (dynamic analysis) showed that the interference from the FSS earth station into the AMS aircraft station is dependent on (1) the distance between the FSS earth station and AMS land station and (2) the position of the AMS aircraft station where the likelihood of interference occurring from an FSS earth station into an AMS aircraft station operating at 19 km was 0% when a separation distance of 482 km is considered between the AMS land station and FSS earth station.

– Study #5 (dynamic analysis) showed that the probability that the interference from an FSS earth station exceeds the protection criterion of an AMS aircraft station operating at a distance from 0 km and 450 km is 9% for aircraft altitudes between 1 000 m and 20 000 m and between 25% to 32% for an AMS aircraft station operating between 0 km and 200 km. This analysis considers an airplane to airplane AMS radio link; therefore there is no influence of the AMS land station position.

– Study #6 (dynamic and operational analysis) considered the geographical area of interference induced by an FSS earth station over the AMS aircraft station at various aircraft altitudes. Also, typical aircraft speed for various aircraft classes (helicopters, RPAS) were introduced to evaluate the time needed for the aircraft itself to cross the FSS interference area and determine the time required to reach a non-interference position where AMS link can be re-established. Moreover, this study focused on AMS operational needs, introducing the typical aircraft speed during the mission and correlating the impacts of FSS interference to the consequent AMS service interruption duration (taking in account the need to recover the link outside the FSS interference area). Also, it showed that the presence of multiple FSS stations overlapping with the AMS bandwidth will extend the geographical areas in which AMS services will not be able to operate.

The following Table 4.1/1.6.1/4-2 summarizes Studies #1 through #6 :

TABLE 4.1/1.6.1/4-2

Assumptions						**Results**		**Assumptions for assessment of the probability of exceeding AMS aircraft protection criteria**		**Results**	
Study Number	**Study Type**	**FSS E/S antenna diameter, max gain**	**AMS maximum antenna gain (dBi)**	**FSS PSD (dBW/Hz)**	**Propaga-tion model(1)**	**Separation distance between FSS earth station and AMS victim aircraft station (km)**		**Distance between**		**Probability of exceeding AMS protection criterion**	
						Aircraft altitude 2 400 m	**Aircraft altitude 19 000 m**	**AMS land station and FSS earth station in km**	**AMS victim aircraft and FSS earth station in km**	**Aircraft altitude 2400 m**	**Aircraft altitude 19 000 m**
1	Static	1.2 m, 42.7 dBi	27 (AMS system 2)	−42, −50, −55, −59	Rec ITU-R P.528	152-184	470-575	N/A	N/A	N/A	N/A
1A	Dynamic	1.2 m, 42.7 dBi	27	-50	Free Space	See Table 4.1/1.6.1/4-3					
2	Dynamic	0.75 m, 39.3 dBi	N/A	−57	N/A	N/A	N/A	N/A	225 km – 615 km	7.3% (for 225 km)	0.9% (for 615 km)
3	Static	6 m, 57.4 dBi	24	−49.3, −57	Rec ITU-R P.528	150	500, 400	N/A	N/A	N/A	N/A
4	Dynamic	(1.2, 2.4, 6) m, (42.7, 49.4, 57.4) dBi	N/A	−50	Free space	N/A	N/A	20 - 250	N/A	0.9% (for 250 km) 93.6% (for 20 km)	3.7% (250 km)- 50% (for 20 km)
4A	Dynamic	(1.2, 2.4, 6) m, (42.7, 49.4, 57.4) dBi	N/A	−50	Free space	180	482	20-500	N/A	0% (for 500 km) 39% (for 20 km)	

Assumptions						Results		Assumptions for assessment of the probability of exceeding AMS aircraft protection criteria		Results	
Study Number	Study Type	FSS E/S antenna diameter, max gain	AMS maximum antenna gain (dBi)	FSS PSD (dBW/Hz)	Propaga-tion model(1)	Separation distance between FSS earth station and AMS victim aircraft station (km)		Distance between		Probability of exceeding AMS protection criterion	
						Aircraft altitude 2 400 m	Aircraft altitude 19 000 m	AMS land station and FSS earth station in km	AMS victim aircraft and FSS earth station in km	Aircraft altitude 2400 m	Aircraft altitude 19 000 m
5	Dynamic	2.4 m , 6 m, 49.4 dBi, 57.4 dBi	3 (AMS system 6)	−49	Rec ITU-R P.528	83 to 151(4)	87 to 451(4)	N/A(3)	83 to 450	5% (for 450 km) 100% (for 83 km)(2)	
6	Dynamic/ Operationa l	2.4 m , 6 m, 49.1 dBi, 57.1 dBi	3 (AMS system 6)	-50	Rec ITU-R P.528	See Table 4/1/1.6.1/4-4					

(1) In the calculations, when the propagation model defined by Recommendation ITU-R P.528 is used, the value of the basic transmission loss is the value not exceeded for 1% of the time

(2) When the FSS earth station and AMS aircraft station separation distance vary from 0 to 450 km and the AMS aircraft station altitude ranges from 1 and 20 km. There is no influence of the AMS land station position. The closer the AMS aircraft station from the FSS earth station, the higher the likelihood of harmful interference into the AMS aircraft station i.e. 100% for distances below 83 km distance.

(3) There is no influence of the AMS land station position due to the ubiquitous position of the aircraft.

(4) The distance range limits correspond to the worst and the best cases of interference (AMS aircraft in the FSS main beam or outside the FSS main beam).

The following Table 4.1/1.6.1/4-3 summarizes Study #1A:

TABLE 4.1/1.6.1/4-3

Study Type	FSS E/S antenna diameter, max gain	AMS maximum antenna gain (dBi)	AMS PSD (dBW/Hz)	Propagation model	FSS earth station – AMS land station distance (km)	Maximum elevation angle of AMS aircraft with I/N criteria exceeded	Percentage of total area[(1)] where I/N criteria is exceeded (%)	Area where I/N criteria is exceeded (km²)
Dynamic	1.2 m, 42.7 dBi	27 dBi (AMS system 2)	−50	Free space	550	0.1˚	0.05%	475
					500	0.5˚	0.15%	1 178
					450	1.0˚	0.45%	2 863
					400	1.5˚	1.10%	5 529
					300	3.0˚	2.31%	6 531
					200	10.0˚	5.57%	7 000

(1) Total area represents the area where the aircraft could be seen by the AMS ground station with a minimum elevation angle of 0°

The following Table 4.1/1.6.1/4-4 summarizes Study #6:

TABLE 4.1/1.6.1/4-4

Inland scenario FSS 2.4 m antenna		**FSS zone where the protection criteria is not met**				**AMS land station total tracking loss**
		Interference area		**Time to cross**		
Altitude km	**Aircraft Speed m/s**	**Length km**	**Width km**	**min s**	**max s**	
10	200	63	27	135	315	Yes
	150			180	420	Yes
6	100	52.3	24.7	247	523	Yes
3	50	34.1	19.7	394	682	Yes
	30			657	1136.7	Yes

Inland scenario FSS 6 m antenna		**FSS zone where the protection criteria is not met**				**AMS land station total tracking loss**
		Interference area		**Time to cross**		
Altitude km	**Aircraft Speed m/s**	**Length km**	**Width km**	**min s**	**max s**	
10	200	87	28	140	435	Yes
	150			187	580	Yes
6	100	72.1	27.2	272	721	Yes
3	50	67.2	28.4	568	1344	Yes
	30			947	2240	Yes

With respect to the LMS (see PDN Report S.[R1.FSS] section 10.2.4):

- Study #1 (static analysis) showed that VSAT FSS earth stations exceed the MS land mobile protection criterion at distances of 46 km when the MS land mobile station operates at 13 m above the terrain.
- Study #2 (dynamic analysis) showed that the percentage of interference occurring from a VSAT FSS earth station into an MS land mobile station operating 13 m above the terrain was 15%.
- Study #3 (dynamic analysis) showed that an aggregate analysis of FSS earth stations interfering into MS land mobile station operating at 13 m above the terrain exceeds the protection criteria by 0.3% of the time.

With respect to interference into FSS space stations at the GSO, since the main beams of AMS systems can point toward the GSO arc, FSS space stations may be subject to interference that exceeds the FSS protection criterion from AMS systems operating under the existing primary allocation in this band. Nevertheless, it is important to note that the time period, when the AMS aircraft/AMS base station's antenna beam is pointing towards the GSO, is very limited. Therefore, considering all possible configurations, study shows that the percentage of the potential interference impact from AMS into FSS GSO receiver is very limited, i.e. FSS availability greater than 99.96% considering a G/T of 7 dB/K.

Views on the Summary of the studies

View 1:

Except over Europe, this sharing situation is similar to current sharing between the FSS (Earth-to-space) feeder links for the broadcasting-satellite service (BSS) and the MS/AMS. For example, results obtained in all studies with AMS are similar to Study #3 which represents the current sharing situation with AP30A feeder-link.

Previous experience has demonstrated practical possibility of coexistence between FSS (E-s) and AMS). Therefore, provision of compatibility conditions between FSS (Earth-to-space) and MS/AMS stations in frequency band 14.5-14.8 GHz is possible based on coordination measures and application of geographic separation using RR Appendix **7** methodology.

It should be also noted that the permissible interference power used under Appendix **7** to determine the coordination distance for an FSS Earth station limited to feeder-link to BSS outside Europe in the band 14.5-14.8 GHz is equivalent to −98 dBW/MHz.

End of View 1

View 2:

It is essential to realize that although a coordination procedure is currently in place in Regions 2 and 3 for the coordination between FSS (Earth-to-space) feeder links and the MS/AMS, no FSS earth station is currently notified in this band and associated to an operational FSS space station in this band; in consequence, there is no evidence that the sharing situation is real and currently implemented. Moreover, in the case that non-notified FSS earth stations were in operation under this allocation, there is no evidence that they can effectively coexist with the AMS without imposing undue operational constraints to AMS systems.

It is also noted that the coordination procedure is impractical to implement given the ubiquitous nature of AMS network. Even in the case that a coordination procedure would be completed, it will impose large exclusion zones to the operation of AMS systems.

It shall be noted that the AMS land station can be fixed or transportable. Due to the ubiquitous nature of the AMS aircraft position, all the studies (statics and dynamics/operational), confirm that the protection of AMS systems can only be achieved when separation distances between the transmitting FSS earth station and the AMS aircraft station are in the range of 400-575 km for aircraft altitude of 19 km and in the range of 150-180 km for aircraft altitude of 2.4 km.

In addition, when considering aircraft to aircraft communications, there is a high probability of interference even for larger separation distances. Probabilities of interference reach 10% in case of AMS aircraft-FSS earth station separation distance in the range of 0 to 450 km and between 24% and 32% in case of AMS aircraft-FSS earth station separation distance in the range 0 to 200 km. The results for this scenario do not depend on the AMS land station position.

Moreover, it has been demonstrated by two studies that the implementation of one FSS earth station creates an exclusion zone of operation for the AMS aircraft of several hundred thousand square kilometres.

The results of studies confirm that the sharing between the proposed FSS and the incumbent AMS is not feasible.

End of View 2

4.1/1.6.1/4.6.4 FSS (Earth-to-space and space-to-Earth) sharing with the SRS

The SRS is currently allocated on a secondary basis in this band.

The frequency band 14.5-14.8 GHz is used by DRS systems operating in the SRS for forward feeder uplinks and for return inter-orbit links (see Recommendations ITU-R SA.1018 and ITU-R SA.1019). Recommendation ITU-R SA.1414 describes characteristics of DRS systems operated by some administrations.

The results of the interference analysis, considering the same status for FSS and SRS allocations, are summarized in Table 4.1/1.6.1/4-5.

TABLE 4.1/1.6.1/4-5

Summary of results of interference between SRS DRS systems and proposed FSS allocations in the 14.5-14.8 GHz band

				Possible to establish compatibility between SRS and FSS for co-frequency operations?	
New FSS allocation	**Frequency band (GHz)**	**Case**	**SRS (DRS) Links**	**FSS interference into SRS**	**SRS interference into FSS**
FSS uplink (AI 1.6)	14.5-14.8	1	DRS forward feeder link (uplink)[1]	Yes[3]	Yes[3]
		2	DRS return inter-orbit link[2]	N.A.[4]	N.A.[4]
FSS downlink (AI 1.6.1)		3	DRS forward feeder link (uplink)[1]	Yes[3]	Yes[3]
		4	DRS return inter-orbit link[2]	Yes[3]	Yes

[1] DRS Earth station to GSO DRS space station.

[2] NGSO DRS user space station to GSO DRS space station.

[3] Coordination between SRS and FSS is feasible using measures like: satellite orbital separation, beam separation, E/S separation, etc.

[4] This band is not currently used for DRS return inter-orbit links.

Based on the summary table above, the following can be observed for 14.5-14.8 GHz FSS uplinks and downlinks:

– Case 1: The mutual interference between DRS uplinks and FSS uplinks would exceed the protection criterion, assuming worst case conditions with the FSS earth station being collocated with the DRS uplink station. However, coordination measures like setting a minimum orbital separation between the GSO satellites, beam separation advantage for earth station locations and possibly other measures could considerably reduce the interference and will permit coexistence.

– Case 2: DRS return inter-orbit links would receive interference from FSS uplinks higher than the protection criterion under co-frequency situations using the assumptions of this study. However, as the current DRS return inter-orbit links are using the band above 14.8 GHz, sharing between SRS and FSS (Earth-to-space) in the band 14.5-14.8 GHz is feasible.

– Case 3: The mutual interference between DRS uplinks and FSS downlinks represents a reverse band scenario and mutual compatibility can be established by using coordination measures like minimum orbital separation and earth station contour distance, etc.

– Case 4: The mutual interference between DRS return inter-orbit links and FSS downlinks represents another reverse band scenario and mutual compatibility can be established by using coordination measures like minimum orbital separation, etc.

Thus, taking into account that currently SRS DRS return links are restricted to bands above 14.8 GHz it can be summarized that the compatibility between FSS links and SRS DRS links in the band 14.5-14.8 GHz is achievable with coordination measures, assuming that SRS and FSS allocations will have equal status.

DRS return inter-orbit links and FSS downlinks in the band 14.5-14.8 GHz demonstrate mutual compatibility using coordination measures like minimum orbital separation.

Summary

Assuming that the SRS DRS return inter-orbit links are restricted to the band above 14.8 GHz, it can be summarized that the compatibility between FSS (Earth-to-space and space-to-Earth) links and SRS in the band 14.5-14.8 GHz is achievable with coordination measures, considering the same status for SRS and FSS.

4.1/1.6.1/4.6.5 FSS (Earth-to-space) sharing with the RAS operating in adjacent band

The band 14.5-14.8 GHz is already allocated to FSS (Earth-to-space) limited to BSS feeder link and due to the frequency separation with the adjacent RAS band (i.e. minimum 550 MHz), no compatibility issues are expected with the RAS band 15.35-15.40 GHz. However, no study has been performed to date.

4.1/1.6.1/4.6.6 FSS (space-to-Earth) sharing with the MS/AMS

Static analysis of compatibility between FSS (space-to-Earth) and AMS/MS stations in different scenarios has shown interference levels exceeding the MS/AMS protection criteria in the worst case situation (i.e. MS/AMS transmit station located exactly in the line of sight of the GSO FSS and the MS/AMS receive station). Nevertheless, considering the nature of the MS/AMS transmit and receive stations, the time period when the MS/AMS receive station is in this situation may be limited. However there are no ITU-R studies for assessing the probability of this event.

One study demonstrated that FSS (space-to-Earth) operations, pfd levels of −128 dB(W/(m^2 · MHz)), –145 dB(W/(m^2 · MHz)), and –126 dB(W/(m^2 · MHz)), would be needed in order to protect AMS aircraft, AMS land station and MS system receivers considering the worst case situation (i.e. MS/AMS receive station located exactly in the line of sight of the GSO FSS and the MS/AMS transmit station), respectively when the elevation angle is equal to 5°. Considering the nature of the MS/AMS transmit and receive stations, the time period when the MS/AMS receive station is in this situation is supposed to be limited; however, the study did not assess the probability for the situation to occur.

With respect to AMS and MS interference into FSS earth stations, one study shows that the FSS protection criterion may be exceed at distances of up to 572 km and 46 km, respectively (not accounting for terrain obstructions).

4.1/1.6.1/4.6.7 FSS (space-to-Earth) sharing with the FS

4.1/1.6.1/4.6.7.1 Interference from FS to FSS (space-to-Earth)

See section 4.1/1.6.1/4.7.5.1.

Compatibility analysis results between FS and FSS (space-to-Earth) in the frequency band 14.8-15.35 GHz are applicable to the frequency band 14.5-14.8 GHz.

4.1/1.6.1/4.6.7.2 Interference from FSS (space-to-Earth) to FS

The development of pfd masks for allowable aggregate interference was considered in the frequency band 14.5-15.35 GHz from 120 GSO FSS space stations using the protection criteria for FS stations stated in Recommendation ITU-R F.758-5. Compatibility analysis with FSS (space-to-Earth) was carried out for FS stations with antenna elevation angle equal to 0°.

See section 4.1/1.6.1/4.7.5.2.

Compatibility analysis results between FSS (space-to-Earth) and FS in the frequency band 14.8-15.35 GHz are applicable to the frequency band 14.5-14.8 GHz.

4.1/1.6.1/4.6.8 Summary of studies for the band 14.5-14.8 GHz

Views on the summary of studies on FSS (Earth-to-space) with respect to AMS/MS can be found in Section 4.1/1.6.1/4.6.3.

Considering FSS (space-to-Earth), interference from AMS into FSS earth stations may exceed the protection criterion of the FSS earth station at distances of up to 572 km (not accounting for terrain obstruction).

To ensure the protection for the FSS (space-to-Earth)from LMS, a separation distance of up to 46 km (not accounting for terrain obstruction) may be required considering a required 100% probability of meeting the protection criterion.

To ensure protection for the AMS and MS from FSS (space-to-Earth), pfd levels of −128 dB(W/(m^2 · MHz)), −145 dB(W/(m^2 · MHz)), and −126 dB(W/(m^2 · MHz)), may be required in order to protect AMS aircraft, AMS land station and MS system receivers considering the worst case situation (i.e. MS/AMS receive station located exactly in the line of sight of the GSO FSS and the MS/AMS transmit station), respectively when the elevation angle is equal to 5°. Considering the nature of the MS/AMS transmit and receive stations, the time period when the MS/AMS receive station is in this situation may be limited; however, the probability to create harmful interference from FSS (space-to-Earth) to stations of MS/AMS was not assessed.

Provision of compatibility conditions between FSS (Earth-to-space) and FS stations in frequency band 14.5-14.8 GHz is possible based on coordination measures and application of geographic separation using RR Appendix **7** methodology as already performed between the FSS (Earth-to-space) feeder links for the broadcasting-satellite service (BSS) and the FS in frequency band 14.5-14.8 GHz.

Compatibility between FSS (space-to-Earth) and FS is achieved with appropriate FSS space station pfd limits.

With respect to the BSS feeder links under RR No. **5.510**, compatibility is possible with appropriate provisions and technical criteria for the new FSS assignments to ensure protection and integrity of AP **30A** Plan and List assignments.

Assuming that the SRS DRS return inter-orbit links are restricted to the band above 14.8 GHz, it can be summarized that the compatibility between FSS (Earth-to-space and space-to-Earth) links and SRS in the band 14.5-14.8 GHz is achievable with coordination measures, considering the same status for SRS and FSS.

4.1/1.6.1/4.7 14.8-15.35 GHz band

Consideration is given to this band for possible primary allocations to FSS Earth-to-space and space-to-Earth operations. The band 14.8-15.35 GHz is currently allocated to the FS and MS on a primary basis and to the SRS on a secondary basis.

4.1/1.6.1/4.7.1 FSS (Earth-to-space) sharing with the MS/AMS

See section 4.1/1.6.1/4.6.3 for sharing study results applicable to this frequency band.

4.1/1.6.1/4.7.2 FSS (Earth-to-space) sharing with the FS

The studies and conclusion on the possibility for compatibility between FSS (Earth-to-space) and FS stations based on coordination measures and separation protection distances as contained in section 4.1/1.6.1/4.6.2 dealing with the sharing between FSS (Earth-to-space) and FS in the frequency band 14.5-14.8 GHz are also applicable to the 14.8-15.35 GHz band.

4.1/1.6.1/4.7.3 FSS (space-to-Earth and Earth-to-space) sharing with the SRS

The SRS is currently allocated on a secondary basis in this band.

The frequency band 14.8-15.35 GHz is used by SRS DRS systems for forward feeder links (uplinks) and return inter-orbit links (see Recommendations ITU-R SA.1018 and ITU-R SA.1019). Recommendation ITU-R SA.1414 describes characteristics of DRS systems operated by some administrations.

The frequency band 14.8-15.35 GHz is also used by SRS systems for data transmit from spacecraft to earth stations. These missions are limited in number with an estimated three to five satellites per year worldwide, and will generally be either in a low-polar orbit or in an equatorial orbit with some at geostationary altitudes or in the highly elliptical Earth orbit (HEO) and others at the L1 or L2 libration points. The characteristics of the GSO, low-orbiting and highly elliptical-orbiting SRS satellites transmitting in the space-to-Earth direction are reflected in the Recommendation ITU-R SA.1626.

An analysis has been performed to assess the potential for interference between the near-Earth DRS missions and potential FSS systems in the 14.8-15.35 GHz band. Static analysis is used when analysing compatibility between FSS and SRS uplinks/downlinks and dynamic simulation is used when considering SRS inter-satellite links. Dynamic simulation is carried out assuming the FSS satellite beam gain of 20 dB and 30 dB and an uplink power spectral density ranging between −42 to −60 dBW/Hz at the input of a 60 cm to 2.8 m FSS earth station antenna and a downlink e.i.r.p. density of −20 dBW/Hz. Earth station sizes larger than 2.0 m would cause the same levels of interference because of the common off-axis pattern. One FSS earth station per FSS satellite is assumed to use the bandwidth used by SRS carriers. The FSS earth stations are assumed at different latitudes (0 deg, 30 deg and 60 deg) and GSO longitudes.

The results of the interference analysis, considering the same status for FSS and SRS allocations are summarized in Table 4.1/1.6.1/4-6.

TABLE 4.1/1.6.1/4-6

Summary of results of interference between SRS DRS systems and proposed FSS allocations in the 14.8-15.35 GHz band

				Possible to establish compatibility between SRS and FSS for co-frequency operations?	
New FSS allocation	**Frequency band (GHz)**	**Case**	**SRS (DRS) links**	**FSS interference into SRS**	**SRS interference into FSS**
FSS uplink (AI 1.6)	14.8-15.35	1	DRS forward feeder link (uplink)[1]	Yes[3]*	Yes[3]*
		2	DRS return inter-orbit link[2]	No	Yes
FSS downlink (AI 1.6.1)		3	DRS forward feeder link (uplink)[1]	Yes[3]*	Yes[3]*
		4	DRS return inter-orbit link[2]	Yes[3]*	Yes

[1] DRS Earth station to GSO DRS space station.

[2] NGSO DRS user space station to GSO DRS space station.

[3*] Coordination between SRS and FSS is feasible using measures like: satellite orbital separation, beam separation, E/S separation, etc.

Based on the summary table above, the following can be observed for 14.8-15.35 GHz FSS uplinks and downlinks:

– Case 1: The mutual interference between DRS uplinks and FSS uplinks would exceed the protection criteria, assuming worst case condition like the FSS uplink earth station being collocated with the DRS uplink station. However, coordination measures like setting a minimum orbital separation between the DRS satellites and a GSO FSS satellite, beam separation advantage for earth station locations and possibly other measures could considerably reduce the interference and will permit coexistence.

– Case 2: DRS return inter-orbit links would receive interference from FSS uplinks higher than the desired protection criterion under co-frequency situations using the assumptions of the study.

– Case 3: The mutual interference between DRS uplinks and FSS downlinks represents a reverse band scenario and mutual compatibility can be established by using coordination measures like minimum orbital separation and earth station contour distance, etc.

– Case 4: The mutual interference between DRS return links and FSS downlinks represents another reverse band scenario and mutual compatibility can be established by using coordination measures like minimum orbital separation, etc.

Summary

Compatibility between FSS (Earth-to-space and space-to-Earth) links and SRS (except return inter-orbit links) in the band 14.8-15.35 GHz is achievable with coordination measures, considering the same status for SRS and FSS.

Compatibility of the FSS uplinks with respect to the SRS DRS return inter-orbit links in the band 14.8-15.35 GHz will not be met without adequate mitigation techniques which have not been defined. Some mitigation techniques that could be studied include minimum orbital separation

between DRS and FSS satellites, limits on off-axis e.i.r.p density of associated FSS earth stations, etc.

Further compatibility studies between FSS (uplinks and downlinks) and SRS system downlinks are required.

4.1/1.6.1/4.7.4 FSS (space-to-Earth) sharing with the MS/AMS

The studies as contained in section 4.1/1.6.1/4.6.6 concerning the sharing between FSS (space-to-Earth) and AMS/MS in the band of 14.5-14.8 GHz are applicable to the 14.8-15.35 GHz band.

4.1/1.6.1/4.7.5 FSS (space-to-Earth) sharing with the FS

4.1/1.6.1/4.7.5.1 Interference from FS to FSS (space-to-Earth)

The technical characteristics of PP FS systems in frequency band 14.4-15.35 GHz are derived using Recommendation ITU-R F.758 and the antenna pattern for PP FS stations was assumed according to Recommendation ITU-R F.1245.

The antenna pattern of GSO FSS earth stations in the frequency band 14.8-15.35 GHz was assumed according to Recommendations ITU-R S.1855 (for FSS earth station antennas with 0.6 to 1.2 m diameter) and ITU-R S.580-6 (for FSS earth station antennas with 2.4 to 6.0 m diameter).

Compatibility analysis between GSO FSS (space-to-Earth) and FS in the frequency band 14.8-15.35 GHz has shown that required protection level of receive FSS E/S from FS stations emission is provided with a separation distance between FS station and receive FSS E/S from 130-197 km to 23.7 km depending of mutual orientation antennas axes of these stations.

The required separation distance for FSS E/S with elevation angles of 10 to 20 degrees and for opposite azimuth orientation of the antennas is reduced to 60-150 km.

For 53.8% of possible cases of mutual azimuth orientation of FS transmit station and FSS E/S antenna, the required separation distance will be minimum S_{min} = 23.7 km for any elevation angle of the FSS E/S and the FS station antenna.

These results were obtained with maximum level of e.i.r.p. spectral density from FS station (32.4 dBW/MHz, System 1) to receiving FSS E/S. Protection of receiving FSS E/S from other types of FS stations (Systems 2 and 3) is provided with smaller separation distances due to the interference level reduced by 0.8 to 4.4 dB.

Compatibility between FS stations and receive FSS E/S (space-to-Earth) in the frequency band 14.8-15.35 GHz with maximum level of e.i.r.p. interference spectral density from FS station 32.4 dBW/MHz is achieved at separation distances from 130-197 km to 23.7 km depending of mutual orientation of FS and FSS E/S station antennas pattern axes.

4.1/1.6.1/4.7.5.2 Interference from FSS (space-to-Earth) to FS

Statistical analysis of overall interference to FS PP stations in the frequency band 14.8-15.35 GHz from 120 GSO FSS space stations (e.i.r.p. spectral density 40 dBW/MHz) with orbital separation 3 degrees between neighbour GSO FSS space stations has shown that probability to exceed protection criteria (I_{ag}/N = -10 dB) of FS stations has values from 3.92% to 1.76% and from 1.4% to 0.018% for interference scenarios without offset and with offset of FS station antenna beam from pointing to the GSO correspondingly. These results are to be taken into account when defining allowable limits of FSS (space-to-Earth) pfd in the given frequency band.

4.1/1.6.1/4.7.6 Summary of studies for the band 14.8-15.35 GHz

Regarding the sharing of MS and AMS with FSS, see section 4.1/1.6.1/4.6.8.

Compatibility between FSS (Earth-to-space and space-to-Earth) links and SRS (except return inter-orbit links) in the band 14.8-15.35 GHz is achievable with coordination measures, considering the same status for SRS and FSS.

Compatibility of the FSS uplinks with respect to the SRS DRS return inter-orbit links in the band 14.8-15.35 GHz will not be met without adequate mitigation techniques which have not been defined. Some mitigation techniques that could be studied include minimum orbital separation between DRS and FSS satellites, limits on off-axis e.i.r.p density of associated FSS earth stations, etc.

Interference from FSS (Earth-to-space) into the FS may exceed the protection criteria at hundreds of km without careful siting of stations, off-axis antenna gains of both systems, shielding, and avoidance of overlapping channels. The coordination between FSS (Earth-to-space) and FS is manageable for a small number of FSS earth stations.

Compatibility between FSS (space-to-Earth) and FS is achieved with appropriate FSS space station pfd limits.

4.1/1.6.1/4.8 15.35-15.4 GHz band

The frequency band 15.35-15.4 GHz is allocated to the EESS (passive), RAS and SRS (passive). In a range of countries, the frequency band 15.35-15.4 GHz is also allocated to FS and MS on a secondary base by means of RR No. **5.511**. All emissions in the frequency band 15.35-15.4 GHz excluding those that are foreseen in RR No. **5.511**, are forbidden in accordance with RR No. **5.340**.

4.1/1.6.1/4.8.1 Summary of studies for the band 15.35-15.4 GHz

The frequency band 15.35-15.4 GHz was excluded from consideration of possibility to allocate additionally spectrum for GSO FSS in accordance with Resolution **151 (WRC-12)** in regard with the difficulty for compatibility between FSS (space-to-Earth and Earth-to-space) and passive services (EESS, SRS) and RAS, having allocations on a primary basis in this frequency band.

4.1/1.6.1/4.9 15.4-15.7 GHz band

Consideration is given to this band for possible primary allocations to FSS Earth-to-space and space-to-Earth operations. The band 15.4-15.43 is allocated to the RLS and ARNS on a primary basis. RR Nos. **5.511E**, **5.511F** and **5.511D** apply.

The band 15.43-15.63 is allocated to the FSS (Earth-to-space), RLS and ARNS on a primary basis. RR Nos. **5.511A**, **5.511E**, **5.511F**, and **5.511C** apply.

The band 15.63-15.7 GHz is allocated to the RLS and ARNS on a primary basis. RR Nos. **5.511E**, **5.511F** and **5.511D** apply.

The band 15.4-17.1 GHz is used by many different types of radars including land-based, transportable, shipboard and airborne platforms. Radiolocation functions performed in the band include airborne and surface search, surface surveillance, ground-mapping, terrain-following, maritime and target-identification. Radar operating frequencies can be assumed to be uniformly spread throughout each radar's tuning range. The major radiolocation radars operating or planned to operate in the band 15.7-16.6 GHz are primarily for detection of airborne objects and some are used for ground mapping. They are required to measure target altitude, range, bearing, and form terrain maps. Some of the airborne and ground targets are small and some are at ranges as great as 300 nautical miles (556 km), so these radiolocation radars must have great sensitivity and must provide a high degree of suppression to all forms of clutter return, including that from sea, land and precipitation. Some of the radars are used as the airport surveillance detection equipment (ASDE-3) to provide a tool to enhance the situational awareness of air traffic controllers in an effort to reduce

runway incursions and aircraft collisions. These radars provide non-cooperative aeronautical surveillance including detection and position information for all aircraft and vehicles on the airport movement area.

4.1/1.6.1/4.9.1 FSS sharing with the RLS

4.1/1.6.1/4.9.1.1 FSS (Earth-to-space) sharing with the RLS

With respect to a potential allocation to the FSS (Earth-to-space), two studies were performed to determine the distance from a radiolocation station within which the I/N interference protection criteria of –6 dB will be exceeded. One analysis shows that in order to protect radiolocation stations operating in the 15.4-17.3 GHz band, a separation distance of up to 420 km or more (not accounting for terrain obstruction) describes a non-uniform area around a radiolocation receiver where the protection criteria is exceeded. For fixed, ground-based radiolocations systems (as opposed to airborne radiolocations systems), the other analysis indicates that the required separation distances may be reduced down to ranges between 5 to 53 km if the FSS earth station PSDs are reduced to values range from –55 dBW/Hz to –60 dBW/Hz, and if there are horizon obstruction losses. The receiver in the radiolocation system can either be fixed or mobile. When the radiolocation station moves, so does the associated non-uniform area.

In addition, since the main beams of such radiolocation systems can point toward the GSO, FSS space stations may be subject to unacceptable levels of interference over periods of time from radiolocation systems operating under the existing primary allocation in this band.

4.1/1.6.1/4.9.1.2 FSS (space-to-Earth) sharing with the RLS

With respect to a potential allocation to the FSS (space-to-Earth) in Region 1, the analysis shows that in order to protect FSS receiving earth stations in the 15.4-17 GHz band from radiolocation system transmissions, a separation distance of up to 435 km (not accounting for terrain obstruction) describes a non-uniform area around a FSS receiving earth station receiver where the protection criteria is exceeded.

In addition, since the main beams of such radiolocation systems, including those located in Region 2 or 3, may point at the GSO, radiolocation system receivers may be subject to unacceptable levels of interference over periods of time. This study determined that a pfd of -142 dB(W/(m^2 · MHz)), would protect radiolocation system receivers, which is more restrictive than the pfd limits applicable in nearby bands.

4.1/1.6.1/4.9.2 FSS (Earth-to-space) sharing with the ARNS

The band 15.4-15.7 GHz is allocated to ARNS on a primary basis and provision RR No. **4.10** (addressing safety-related services) applies. The characteristics of aeronautical radionavigation systems which operate in the band 15.4-15.7 GHz are contained in Recommendation ITU-R S.1340 as well as in Report ITU-R M.2170. One sharing study has been made between the FSS (Earth-to-space) and ARNS. This study shows that a separation distance of up to 486 km is required in order to protect aircraft landing system (ALS) receivers from transmitting FSS earth stations according to Recommendation ITU-R S.1340. It should be noted that according to this Recommendation, the minimum separation distance is equal to 472 km even in absence of FSS (Earth-to-space) emission. Such FSS (Earth-to-space) emission increases this distance by 13.7 km. Ground stations of ALS are often re-locatable and are used at unspecified points. ALS ground station transmitters can also cause interference to GSO space station receivers. The study between ALS transmitter and receiving GSO satellite shows that worst-case interference exceeds the permissible level by 42 dB above protection criteria considering the worst case situation (i.e. ALS transmitting station located exactly in the line of sight of the GSO FSS and the ALS receiving station and a satellite FSS G/T value of 17 dB).

However, taking into account the nominal 3 dB beamwidth of ALS antenna and the fact that ALS antenna scans horizontally and vertically through the required coverage volume, transmitting ALS station can cause interference to satellites at any time and also when ALS is not pointing to a satellite.

4.1/1.6.1/4.9.3 Summary of studies for the band 15.4-15.7 GHz

For additional spectrum allocation to GSO FSS (Earth-to-space and space-to-Earth) in the frequency band 15.4-15.7 GHz in Region 1, FSS (Earth-to-space and space-to-Earth) exceeds the protection criteria levels of systems having allocations in this band without adequate technical/regulatory mitigation measures.

Sharing studies between ARNS and FSS (space-to-Earth) have not been conducted to date.

The band 15.4-15.7 GHz is allocated to the ARNS on a primary basis and provision RR No. **4.10** (addressing safety-related services) applies. One study shows that separation distances up to 486 km is required to ensure protection between the FSS earth station (Earth-to-space) and ARNS receiver considering worst case situation (i.e. FSS earth station antenna pointing towards the ARNS receiver), according to Recommendation ITU-R S.1340 that was used in this study. Separation distances will be lower considering earth station configurations that reduce e.i.r.p towards ARNS receiver, e.g. additional antenna discrimination between FSS earth station antenna and ARNS receiving antenna. Furthermore, if receiving GSO satellite is not having sufficient – in the worst case when the ARNS antenna is pointing directly towards the GSO, up to 42 dB – antenna discrimination, receiving GSO satellite could be subject to interference from existing ARNS transmitters.

With respect to RLS airborne systems, one study shows that separation distances of 420 km (not accounting for terrain obstruction) would be needed to ensure protection between the FSS and RLS airborne systems operating in this band. Moreover, if FSS receiving space stations are not having sufficient antenna discrimination at low elevation angles, these may be subject to interference from existing RLS airborne systems in this band.

Another study shows that for fixed, ground-based RLS systems (as opposed to airborne RLS systems) the required separation distances may be reduced down to ranges between 5 to 53 km if the FSS earth station PSDs are reduced to values ranging from –55 dBW/Hz to –60 dBW/Hz, and if there are horizon obstruction losses. The receiver in the radiolocation system can either be fixed or mobile. With respect to RLS ground-based systems into FSS space station receiving antennas, one study shows that an antenna discrimination of up to 60 dB may be required.

Concerning FSS (space-to-Earth), pfd limits ranging from −98 dB(W/(m^2 · MHz)), to −142 dB(W/(m^2 · MHz)), depending on which radiolocation system to protect, would be required to protect existing RLS systems operating in this band.

4.1/1.6.1/4.10 15.7-16.6 GHz band

Consideration is given to this band for possible primary allocations to FSS Earth-to-space and space-to-Earth operations. The band 15.7-16.6 GHz is allocated to the RLS on a primary basis. The band 15.7-17.3 is also allocated to the FS and MS in certain countries via RR No. **5.512**. Additional information on the use of this band by the RLS is provided in section 4.1/1.6.1/4.9.

4.1/1.6.1/4.10.1 FSS sharing with the RLS

4.1/1.6.1/4.10.1.1 FSS (Earth-to-space) sharing with the RLS

The sharing study results in section 4.1/1.6.1/4.9.1.1 are also applicable to this frequency band.

In addition to the studies in section 4.1/1.6.1/4.9.1.1, another study was performed considering the compatibility between FSS (Earth-to-space) and radiolocation system-5 RLS ground systems in the 15.7-16.6 GHz band.

The results of this study showed the required coordination/separation areas (using Recommendation ITU-R P.452-14 with p = 0.01%) to protect the RLS system-5 stations from interference due to transmitting FSS earth stations at 26 locations in the United States.

Coordination areas up to 304 km are required to protect RLS system-5 from the emissions of transmitting FSS E/S in the 15.7-16.6 GHz frequency range. These results should be taken into account should a primary FSS allocation in the Earth-to-space direction be considered in this frequency band.

Since the main beams of such radiolocation systems can point toward the GSO arc, FSS receiving space stations may, under such worst case scenarios, be subject to harmful levels of interference for periods of time from radiolocation systems operating under the existing primary allocation in this band, unless sufficient antenna discrimination of 60 dB is achieved.

4.1/1.6.1/4.10.1.2 FSS (space-to-Earth) sharing with the RLS

See section 4.1/1.6.1/4.9.1.2 for sharing study results applicable to this frequency band.

4.1/1.6.1/4.10.2 Summary of studies for the band 15.7-16.6 GHz

With respect to RLS airborne systems, one study shows that separation distances of 420 km (not accounting for terrain obstruction) would be needed to ensure protection between the FSS and RLS airborne systems operating in this band. Moreover, if FSS receiving space stations are not having sufficient antenna discrimination at low elevation angles, these may be subject to interference from existing RLS airborne systems in this band.

Another study shows that for fixed, ground-based RLS systems (as opposed to airborne RLS systems) the required separation distances may be reduced down to ranges between 5 to 53 km if the FSS earth station PSDs are reduced to values ranging from –55 dBW/Hz to −60 dBW/Hz, and if there are horizon obstruction losses. The receiver in the radiolocation system can either be fixed or mobile. With respect to RLS ground-based systems into FSS space station receiving antennas, one study shows that an antenna discrimination of up to 60 dB may be required.

Concerning FSS (space-to-Earth), pfd limits ranging from −98 dB(W/(m^2 · MHz)), to −142 dB(W/(m^2 · MHz)), depending on which radiolocation system to protect, would be required to protect existing RLS systems operating in this band.

4.1/1.6.1/4.11 16.6-17 GHz band

Consideration is given to this band for possible primary allocations to FSS Earth-to-space and space-to-Earth operations. The band 15.7-16.6 GHz is allocated to the RLS on a primary basis. The band 15.7-17.3 is also allocated to the FS and MS in certain countries via RR No. **5.512**.

4.1/1.6.1/4.11.1 FSS sharing with the RLS

4.1/1.6.1/4.11.1.1 FSS (Earth-to-space) sharing with the RLS

See section 4.1/1.6.1/4.9.1.1 for sharing study results applicable to this frequency band.

4.1/1.6.1/4.11.1.2 FSS (space-to-Earth) sharing with the RLS

See section 4.1/1.6.1/4.9.1.1 for sharing study results applicable to this frequency band.

4.1/1.6.1/4.11.2 Summary of studies for the band 16.6-17 GHz

With respect to RLS airborne systems, separation distances of 420 km (not accounting for terrain obstruction) would be needed to ensure protection between the FSS and RLS airborne systems operating in this band. Moreover, if FSS receiving space station is not having sufficient antenna discrimination at low elevation angles, these stations may be subject to interference from existing RLS airborne systems in this band.

Coordination distances up to 304 km are required to protect RLS system-5 from the emissions of transmitting FSS E/S in the 15.7-16.6 GHz frequency range.

Since the main beams of such radiolocation systems can point toward the GSO arc, FSS receiving space stations may, under such worst case scenarios, be subject to harmful levels of interference for periods of time from radiolocation systems operating under the existing primary allocation in this band, unless sufficient antenna discrimination of 60 dB is achieved.

Another study shows that for fixed, ground-based RLS systems (as opposed to airborne RLS systems), including RLS system-5, the required separation distances may be reduced down to ranges between 5 to 53 km if the FSS earth station PSDs are reduced to values ranging from -55 dBW/Hz to –60 dBW/Hz, and if there are horizon obstruction losses. The receiver in the radiolocation system can either be fixed or mobile. With respect to RLS ground-based systems into FSS space station receiving antennas, one study shows that an antenna discrimination of up to 60 dB may be required.

Concerning FSS (space-to-Earth), pfd limits ranging from −98 dB(W/(m^2 · MHz)), to −142 dB(W/(m^2 · MHz)), depending on which radiolocation system to protect, would be required to protect existing RLS systems operating in this band.

4.1/1.6.1/5 Methods to satisfy this part of the agenda item

The methods to satisfy the agenda item are considered below for each of the examined frequency bands. Therefore, each method should address all the concerned existing allocations in each examined frequency band. Each of the following methods suggests regulatory amendments (or No change) that would provide only for the use by GSO satellite networks.

Methods for No change may be accompanied by reasons.

The table below assigns a method “letter prefix” to each of the sub-bands as split in section 4.1/1.6.1/4 (Analysis of the results of studies).

Sub-band frequency (GHz)	Assigned method "letter prefix"	
	Earth-to-space	Space-to-Earth
10.00-10.50	A	AA
10.50-10.60	B	BB
10.60-10.68	C	CC
13.25-13.40	D	DD
13.40-13.75	E	EE
14.50-14.80	F	FF
14.80-15.35	G	GG
15.35-15.40	H	HH
15.40-15.70	I	II
15.70-16.60	J	JJ
16.60-17.00	K	KK

4.1/1.6.1/5.1 AA: 10.00-10.50 GHz for FSS (space-to-Earth)

4.1/1.6.1/5.1.1 Method AA1: No change to RR Article 5

Advantages:

− No impact on the existing services.

Disadvantages:

− The demand for the FSS spectrum may not be met.

4.1/1.6.1/5.2 E: 13.4-13.75 GHz for FSS (Earth-to-space)

4.1/1.6.1/5.2.1 Method E1: No change to RR Article 5

Advantages:

− No impact on the existing services.

Disadvantages:

− The demand for the FSS spectrum may not be met.

4.1/1.6.1/5.2.2 Method E2: Make an allocation of 250 MHz to the FSS (Earth-to-space) in the band 13.4-13.75 GHz in Region 1

This method includes the following provisions:

− Modification of RR Article **5**.
  − Modification of RR No. **5.502** to only extend the frequency band to which it applies.
  − Footnote in RR Article **5** to restrict the PSD to -53.5 dB(W/Hz) computed from the peak envelope power and the occupied bandwidth.
  − Footnote in RR Article **5** to protect Earth exploration-satellite system from FSS (Earth-to-space).
  − An allocation for FSS (Earth-to-space) in Region 1 limited to geostationary satellite networks.

– Modify existing provisions to protect SRS (DRS) existing systems on a same status basis:
  – Modify existing provisions to protect SRS inter-orbit links by imposing hard limits on FSS (Earth-to-space) such as FSS earth station antenna size and/or maximum power spectral density; and

    Protect existing SRS (DRS) systems (SRS feeder downlinks) with regard to FSS, by modifying RR No. **5.501A** and apply RR No. **9.17A** for the coordination of FSS earth stations (Earth-to-space) with regard to SRS receiving earth stations, for the grandfathered systems.
– Modify Table 7b of RR Appendix **7** to extend the coordination trigger between FSS (Earth-to-space) with the RLS and RNS.

Views expressed in favour of this method

Views were expressed that this method will provide for an FSS (Earth-to-space) allocation in the band 13.45-13.75 GHz. This will permit the balancing of the current inter-regional imbalance in FSS spectrum for ITU Region 1 and satisfies Resolution **151 (WRC-12).**

Sharing studies performed in ITU-R and using appropriate assumptions for FSS earth station deployment model developed in ITU-R, demonstrate compatibility between the proposed FSS (Earth-to-space) allocation in this band including the necessary technical/regulatory measures, to protect the incumbent services. For example, it is proposed under such method to apply the same constraints as in the band 13.75-14.00 GHz (i.e. RR No. **5.502**) to protect systems operating in the 13.4-14.00 GHz in order to ensure the sharing with the RLS.

Considering the proposed FSS earth station antenna size limitation under this method and the current allocation of other services in this band, each new FSS earth station shall be coordinated individually. Therefore, this band will not be used for VSAT type deployment and the limited number of FSS earth stations will be deployed worldwide (few hundreds). Therefore, all simulations performed in ITU-R considering several tens of thousands FSS earth stations are unrealistic and the associated sharing results are not valid for use in evaluating the sharing feasibility.

Views expressed against this method

Views were expressed that an allocation to the FSS (Earth-to-space) in the band 13.4-13.75 GHz is not feasible for the following reasons:

- An FSS (Earth-to-space) allocation imposes undue constraints on existing incumbent services.
- EESS (active) altimeter measurements of inland and coastal water heights would experience unacceptable measurement degradation in certain regions of the Earth.
- Aeronautical precipitation radar operating under the radiolocation service in this band would experience unacceptable interference.
- DRS systems operating forward inter-orbit links in the SRS would receive interference exceeding the protection criteria.
- For DRS, elevation of the SRS (space-to-Earth and space-to-space) allocation to primary status with respect to the additional use of the FSS (Earth-to-space) only, is needed to facilitate coordination under RR Article **9** providing protection of SRS DRS feeder downlink. This method does not adequately reflect this status change in RR Article **5** in the Table of Frequency Allocations.

- For DRS, grandfathering provisions imposed on the SRS would constrain future development of the DRS systems.
- ARNS airborne Doppler navigation systems operating near 13.4 GHz would not be protected (up to 53.7 dB exceedance of the ARNS protection criteria) from FSS (Earth-to-space) systems operating near 13.4 GHz.
- The SFTSSS would receive severe interference up to I/N of 7 dB on board the space station receivers operating in the secondary allocation.

4.1/1.6.1/5.3 EE: 13.4-13.75 GHz for FSS (space-to-Earth)

4.1/1.6.1/5.3.1 Method EE1: No change to RR Article 5

Advantages:

– No impact on the existing services.

Disadvantages:

– The demand for the FSS spectrum may not be met.

4.1/1.6.1/5.3.2 Method EE2: Make an allocation of 250 MHz to the FSS (space-to-Earth) in the band 13.4-13.75 GHz

This method includes the following provisions:

– Modification of RR Article **5**.
  – Dividing the Table of Frequency Allocations into two sub-bands: 13.4-13.65 GHz and 13.65-13.75 GHz.
  – Making an allocation of 250 MHz for FSS (space-to-Earth) in the band 13.4-13.65 GHz in Region 1 limited to geostationary satellite networks.
  – Footnote in RR Article **5** to protect Earth exploration-satellite system from FSS (space-to-Earth).
  – Protect existing SRS (DRS) systems with regard to FSS, by modifying RR No. **5.501A** and adding a new footnote to apply RR No. **9.7** for the coordination of FSS with regard to SRS feeder downlink, and RR No. **9.21** for the coordination of FSS with regard to SRS forward inter-orbit links, for the grandfathered systems.
– Pfd limits in RR Article **21** (hard limits on FSS) to protect existing services in the band.

Advantages:

– Balances the current inter-regional imbalance in FSS spectrum for ITU Region 1 and satisfies Resolution **151 (WRC-12)**.
– The demand for the FSS (space-to-Earth) spectrum in Region 1 may be met by an allocation in this band.
– Results of studies indicate that FSS (space-to-Earth) operations are compatible with EESS (active) operations in this band.

Disadvantages:

– A minimum orbital separation between DRS satellites and the nearest FSS satellite, and other technical measures are required in order to meet the aggregate interference criteria (Io/No level = −10 dB in 0.1% of time).

– The FSS receiving earth station could receive harmful interference from existing systems.

4.1/1.6.1/5.4 F: 14.5-14.8 GHz for FSS (Earth-to-space)

The methods developed in this section are developed for an allocation on a global basis. However, depending on the decisions of the Conference regional differences could apply.

4.1/1.6.1/5.4.1 Method F1: No change to RR Article 5

Reasons for No change:

Each FSS earth station creates a volume where the AMS protection criterion is exceeded, as indicated in the studies. Such volume may extend to several hundreds of kilometres in latitude and longitude and preclude the AMS operations.

Advantages:

– No impact on the existing services.

Disadvantages:

– The demand for the FSS spectrum may not be met.

For information related to the views against this Method, see section 5.4.2.1.

For information related to the views in favour of this Method, see section 5.4.2.2.

4.1/1.6.1/5.4.2 Method F2: Modify the existing FSS allocation to support FSS uplinks that are not limited to BSS feeder links

This method includes the following provisions:

– Modify Article **5** to remove the limitation to BSS feeder links.

– Add consequential coordination provisions.

Consequential modifications to existing provisions are explained below:

With respect to coordination between FSS assignments (Earth-to-space) where both are not subject to AP **30A**:

– Modify Table 5-1 of RR Appendix **5** to include 14.5-14.8 GHz GSO/GSO coordination trigger under RR No. **9.7**.

With respect to coordination between FSS (Earth-to-space) assignments where one is subject to AP **30A** and the other one is not subject to AP **30A**:

Article revisions

Modification to Articles 4 and 7 of AP **30A** is required to define the procedure for coordination of unplanned FSS assignments vis-à-vis assignments in, or proposed modifications to, the AP **30A** Plan/List, in the band 14.5-14.8 GHz.

– Modify Article **7** of AP **30A** to define a mechanism for coordination between unplanned FSS assignments and assignments in, or proposed modifications to, the AP **30A** Plan/List in the band 14.5-14.8 GHz.

– Modify § 4.1.1 d) of Article **4** of AP **30A** to add requirements for coordination between FSS assignments in 14.5-14.8 GHz with the AP **30A** Plan or List.

– Develop a new provision in Article **7** of AP **30A** using existing or new mechanism for coordination between unplanned FSS assignments with assignments in the AP **30A** Plan or List or already submitted under Article **4**.

Annex revisions

Modification to Annexes 1 and 4 for the trigger for coordination of unplanned FSS assignments vis-à-vis assignments in, or proposed modifications to, the AP **30A** Plan/List, in the band 14.5-14.8 GHz.

Modify Section 6 of Annex 1 to AP **30A** to extend the existing coordination trigger for unplanned services and the Plan/List to coordinate the Regions 1 and 3 feeder-link Plan or List with FSS assignments in 14.5-14.8 GHz.

Option (A):

– Modify Section 2 of Annex 4 to AP **30A** to extend the existing ΔT/T trigger identifying the requirement to coordinate assignments in the unplanned FSS with assignments of, or proposed modifications to, the AP **30A** Plan/List, in the band 14.5-14.8 GHz.

Option (B):

– Add a new Section 3 to Annex 4 to AP **30A** to define a new trigger based on studies conducted under this agenda item identifying the requirement to coordinate assignments of the unplanned FSS with assignments in, or proposed modifications to, the AP **30A** Plan/List, in the band 14.5-14.8 GHz.

Option (C):

– Modify Section 4 of Annex 1 to AP **30A** to extend the existing calculation of the equivalent protection margin (EPM) to include the FSS (Earth-to-space) frequency assignments in the band 14.5-14.8 GHz not subject to AP **30A**, which had been considered by the Bureau as having been brought into use according to the provisions of RR No. **11.44B**.

– It was noted that option C proposes to address the cumulative interference of newly FSS allocated systems into the AP **30A** EPM reference situation. The current proposal needs to be further evaluated in order to assess all possible regulatory impacts.

In the final regulatory text, it will be necessary to select Option A or Option B and possibly in addition to select Option C.

With respect to the MS:

Option (A):

– Both FSS (limited to BSS feeder links) and MS are currently primary in the band 14.5-14.8 GHz. The current framework in the RR that is used for the coordination between the FSS and the MS under Appendix **7** would apply to the potential modified allocation.

Option (B):

– For coordination of FSS frequency assignments (not associated with AP **30A**) and MS frequency assignments, developing a new Resolution describing the procedures to coordinate fixed and known locations of FSS earth stations with MS stations is needed.

– For coordination of FSS frequency assignments subject to RR No. **5.510** and MS frequency assignments, the existing provisions of RR Article **9** and coordination methodologies of RR Appendix **7** continue to apply.

With respect to the SRS:

− The FSS is primary and the SRS is secondary in the band 14.5-14.8 GHz. Due to existing deployment of the DRS in the SRS, the SRS is treated on equal basis with FSS. The current framework in the RR supports the coordination between the FSS and the SRS by applying the procedures and criteria associated with RR No. **9.7** by upgrading the SRS (Earth-to-space) allocation to primary vis-à-vis the FSS (not including FSS providing feeder links to BSS (example AP **30A** assignments in Regions 1 and 3 and unplanned FSS in Region 2)).

4.1/1.6.1/5.4.2.1 Views expressed in favour of this method

Views were expressed in support of this method in the band 14.5-14.8 GHz as a way to increase the use of the orbit spectrum resource, in particular by removing current limitations on the use of an existing FSS allocation for supporting FSS uplinks that are not limited to BSS feeder links.

Except over Europe, this sharing situation is similar to current sharing between the FSS (Earth-to-space) feeder links for the broadcasting-satellite service (BSS) and the MS/AMS. For example, results obtained in all studies with AMS are similar to Study #3 which represents the current sharing situation with AP **30A** feeder-link.

Previous experience has demonstrated practical possibility of coexistence between FSS (E-s) and AMS). Therefore, provision of compatibility conditions between FSS (Earth-to-space) and MS/AMS stations in frequency band 14.5-14.8 GHz is possible based on coordination measures and application of geographic separation using RR Appendix **7** methodology.

It should be also noted that the permissible interference power used under Appendix **7** to determine the coordination distance for an FSS earth station limited to feeder-link to BSS outside Europe in the band 14.5-14.8 GHz is equivalent to −98 dBW/MHz.

This method contains appropriate measures which are needed to ensure the integrity and adequate protection of the AP **30A** Plan and List. Views were also expressed that the current provisions and procedures in the RR for coordination of the FSS (Earth-to-space) and other services were adequate and appropriate to coordinate this additional use of the FSS

Finally, views were stated that this method satisfied Resolution **151 (WRC-12)**. Additionally, other views also expressed the advantage that the 14.5-14.8 GHz band is contiguous to the current FSS allocation in the band 13.75-14.5 GHz band.

4.1/1.6.1/5.4.2.2 Views expressed against this method

- With respect to AMS/MS systems in the 14.5-14.8 GHz, all studies so far have demonstrated that separation distances of more than 500 km between the FSS ES and the AMS station are required to avoid the exceedance of the AMS protection criterion. No regulatory method has been proposed to ensure that the required separation distances between the FSS ES and the mobile AMS station are maintained.
- Coordination between FSS (Earth-to-space) and AMS under RR Article **9** was proposed but, given the large separation distances (greater than 500 km) between FSS ES and AMS station, this approach is not practical. Indeed, the coordination procedure will lead to an area around the FSS earth station in which no aircraft will be able to fly because both air-air and ground-air AMS communications will suffer from harmful interference. Furthermore, due to the ubiquitous nature of the AMS aircraft position, sharing between the FSS (Earth-to-space) and the AMS aircraft station will not be possible in practice.
- Increased complexity of regulatory examination of networks submitted under RR Articles **9** and **11**, or under AP **30A**, in the band 14.5-14.8 GHz.

- Places burden on administrations and AMS/MS operators to conduct operational and international bilateral/multilateral coordination with the FSS.
- Requires comprehensive sharing/coordinating mechanism between proposed FSS and existing authorized services.
- Places restrictions and/or constraints to the existing and future operations of the MS, FS and SRS.
- If the frequency band 14.5-14.8 GHz is allocated to FSS, the operation and development of the incumbent AMS/MS will be significantly constrained proportionally to the development of the proposed FSS service.
- An FSS earth station always creates an area where the AMS protection criteria is exceeded, as indicated in the reference studies. In many practical cases the geographical extension of such area (in latitude, longitude, and altitude) can be significant. Considering the typical aircraft speed during surveillance operations, when the AMS airborne station enters the FSS interference zone and the AMS link interruption occurs, the link loss period is long enough to determine a total loss of tracking by the AMS earth station. In such case, a complete link recovery procedure must be initiated, i.e. the aircraft must be redirected to a waypoint in a non-interfered area before the connection can be successfully resumed. In these conditions, a service interruption from several tens of seconds to several minutes can be predicted (depending on the speed and the trajectory of the aircraft). This is unacceptable for the operational requirements of the AMS service and would lead, *de facto*, to the need to exclude the interference area generated by the FSS earth station from the aircraft trajectory.
- For DRS, elevation of the SRS (Earth-to-space) allocation to primary status with respect to the additional use of the FSS (Earth-to-space) only, will facilitate coordination under RR Article **9** providing protection of SRS DRS feeder uplinks.

4.1/1.6.1/5.5 FF: 14.5-14.8 GHz for FSS (space-to-Earth)

4.1/1.6.1/5.5.1 Method FF1: No change to RR Article 5

Advantages:

− No impact on the existing services.

Disadvantages:

− The demand for the FSS spectrum may not be met.

4.1/1.6.1/5.5.2 Method FF2: New allocation to the FSS (space-to-Earth) in the band 14.5-14.8 GHz

This method includes the following provisions:

− modify RR Article **5** to allocate the frequency band to the GSO FSS (space-to-Earth). Insert footnote into RR Article **5** to limit use of the FSS allocation to the GSO systems.

− modify Table 8c in RR Appendix **7** to compute the coordination distance between receiving earth station in the FSS and transmitting stations in the FS and MS/AMS based on the allowable interference criterion I/N = 6%, see Recommendation ITU-R S.1432.

− insert the following regulatory provisions in order to coordinate and protect existing allocations to the FS, MS/AMS from GSO FSS (space-to-Earth) interferences:

– insert in Table **21-4** of RR Article **21** pfd limits (−132/−122) dB(W/(m^2 · MHz)) produced by GSO FSS satellites at the Earth's surface (free space) for corresponding angles of arrival, in order to protect receiving stations in terrestrial services (FS and MS/AMS).

– specify that the direction of maximum gain of FS receiving antennas in the frequency band 14.5-15.8 GHz in Region 1 should be separated from the geostationary-satellite orbit by at least 1.5°; appropriate modifications should be made to RR No. **21.2.1**.

– with respect to coordination in the FSS for opposite direction of transmission, RR No. **9.17A** will apply.

With respect to the compatibility between the FSS (space-to-Earth) and the SRS:

– to protect GSO SRS DRS space stations, the coordination procedure of RR No. **9.7** is required for newly filed GSO FSS networks. Relevant footnote should be added to RR Article **5**, as well as modification to RR Appendix **5**. Taking into account that coordination under RR Article **9** considers only those frequency assignments for which the frequency band is allocated on an equal basis, the relevant footnote should be added to RR Article **5**.

Advantages:

– Balances the current interregional imbalance in FSS spectrum for ITU Region 1 and satisfies Resolution **151 (WRC-12)**.

– The demand for the FSS (space-to-Earth) spectrum in Region 1 may be met by an allocation in this band.

Disadvantages:

– Requires regulatory provisions to coordinate and protect DRS systems operating within the existing SRS allocation. In particular, technical and regulatory constraints to facilitate sharing between FSS uplinks and DRS feeder uplinks must be defined as part of this method.

4.1/1.6.1/5.6 G: 14.8-15.35 GHz for FSS (Earth-to-space)

4.1/1.6.1/5.6.1 Method G1: No change to RR Article 5

Reasons for No change: See section 4.1/1.6.1/5.4.1

Advantages:

– No impact on the existing services.

Disadvantages:

– The demand for the FSS spectrum may not be met.

4.1/1.6.1/5.6.2 Method G2: Allocate the 14.8-15.1 GHz frequency band to the FSS (Earth-to-space)

This method includes the following provisions:

– Modify RR Article **5** to allocate the FSS (Earth-to-space) to this frequency band.

– Modify Table 7b of RR Appendix **7** to extend the coordination trigger between FSS (Earth-to-space) with the FS and MS.

– Regulatory provisions to coordinate and protect existing systems within SRS allocation need to be defined.

– An allocation for FSS (Earth-to-space) in Region 1 limited to geostationary satellite networks.

Views expressed in favour of this method

Views were expressed in support of this method in the band 14.8-15.1 GHz as a way to increase the use of the orbit spectrum resource. Views were also expressed that the current provisions and procedures in the RR for coordination of the FSS (Earth-to-space) and other services were adequate and appropriate to coordinate this additional use of the FSS. Finally, views were stated that this method satisfied Resolution **151 (WRC-12)**.

Views expressed against this method

- With respect to AMS/MS systems in the 14.8-15.1 GHz, all studies so far have demonstrated that separation distances of more than 500 km between the FSS ES and the AMS station are required to avoid the exceedance of the AMS protection criterion. No regulatory method has been proposed to ensure that the required separation distances between the FSS ES and the mobile AMS station are maintained.
- Coordination between FSS (Earth-to-space) and AMS under RR Article **9** was proposed but, given the large separation distances (greater than 500 km) between FSS ES and AMS station, this approach is not practical. Indeed, the coordination procedure will lead to an area around the FSS earth station in which no aircraft will be able to fly because both air-air and ground-air AMS communications will suffer from harmful interference. Furthermore, due to the ubiquitous nature of the AMS aircraft position, sharing between the FSS (Earth-to-space) and the AMS aircraft station will not be possible in practice.
- If the frequency band 14.8-15.1 GHz is allocated to FSS, the operation and development of the incumbent AMS/MS may be significantly constrained proportionally to the development of the proposed FSS service.
- SRS allocation upgrade to primary status with respect to the FSS (Earth-to-space) will be required together with the associated conditions to enable coordination under RR Article **9** which will provide protection of existing systems of SRS. This method does not adequately reflect this status change in RR Article **5** in the Table of Frequency Allocations.
- DRS systems operating return inter-orbit links in the SRS would receive harmful interference from FSS earth station resulting in the loss of valuable science data.
- Grandfathering provisions imposed on the SRS would constrain future development of the DRS systems.

4.1/1.6.1/5.7 GG: 14.8-15.35 GHz for FSS (space-to-Earth)

4.1/1.6.1/5.7.1 Method GG1: No change to RR Article 5

Advantages:

– No impact on the existing services.

Disadvantages:

– The demand for the FSS spectrum may not be met.

4.1/1.6.1/5.7.2 Method GG2: New allocation to the FSS (space-to-Earth) within the band 14.8-15.35 GHz

This method includes the following provisions:

– modify RR Article **5** to allocate the frequency band to the GSO FSS (space-to-Earth). Insert footnote into RR Article **5** to limit use of the FSS allocation to the GSO systems.

– modify Table 8c in RR Appendix **7** to compute the coordination distance between receiving earth station in the FSS and transmitting stations in the FS and MS/AMS based on the allowable interference criterion I/N = 6%, see Recommendation ITU-R S.1432.

– insert the following regulatory provisions in order to coordinate and protect existing allocations to the FS, MS/AMS from GSO FSS (space-to-Earth) interferences:

– insert in Table **21-4** of RR Article **21** pfd limits (−132/−122) dB(W/(m^2 · MHz)) produced by GSO FSS satellites at the Earth's surface (free space) for corresponding angles of arrival, in order to protect receiving stations in terrestrial services (FS and MS/AMS).

– specify that the direction of maximum gain of FS receiving antennas in the frequency band 14.8-15.1 GHz in Region 1 should be separated from the geostationary-satellite orbit by at least 1.5°; appropriate modifications should be made to RR No. **21.2.1**.

With respect to the compatibility between the FSS (space-to-Earth) and the SRS:

– to protect GSO SRS DRS space stations, the coordination procedure of RR No. **9.7** is required for newly filed GSO FSS networks. Relevant footnote should be added to RR Article **5**, as well as modification to RR Appendix **5**. Taking into account that coordination under RR Article **9** considers only those frequency assignments for which the frequency band is allocated on an equal basis, the relevant footnote should be added to RR Article **5**. Protection of existing NGSO SRS systems (space-to-Earth) would also require equal basis with newly filed GSO FSS networks, therefore relevant footnote should be added to RR Article **5**.

Advantages:

– Balances the current inter-regional imbalance in FSS spectrum for ITU Region 1 and satisfies Resolution **151 (WRC-12)**.

Disadvantages:

– The FSS receiving earth station could receive harmful interference from existing systems.

4.1/1.6.1/5.8 I: 15.4-15.7 GHz for FSS (Earth-to-space)

4.1/1.6.1/5.8.1 Method I1: No change to RR Article 5

Advantages:

– No impact on the existing services.

Disadvantages:

– The demand for the FSS spectrum may not be met.

4.1/1.6.1/5.9 II: 15.4-15.7 GHz for FSS (space-to-Earth)

4.1/1.6.1/5.9.1 Method II1: No change to RR Article 5

Advantages:

– No impact on the existing services.

Disadvantages:

– The demand for the FSS spectrum may not be met.

4.1/1.6.1/6 Regulatory and procedural considerations

The regulatory and procedural considerations to satisfy the agenda item are considered below for each of the proposed methods defined in section 4.1/1.6.1/5.

It should be noted that apart from the method described in section 4.1/1.6.1/6.1, all other proposed methods implicitly assume suppression (SUP) of Resolution **151 (WRC-12)**.

4.1/1.6.1/6.1 Methods AA1, E1, EE1, F1, FF1, G1, GG1, I1, II1: No change to RR Article 5

NOC

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations
(See No. **2.1**)

SUP

RESOLUTION 151 (WRC-12)

Additional primary allocations to the fixed-satellite service in frequency bands between 10 and 17 GHz in Region 1

4.1/1.6.1/6.2 AA: 10.00-10.50 GHz for FSS (space-to-Earth)

No additional method (besides Method AA1) is proposed.

4.1/1.6.1/6.3 E: 13.4-13.75 GHz for FSS (Earth-to-space)

4.1/1.6.1/6.3.1 Method E2

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations
(See No. **2.1**)

MOD

11.7-14 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
13.4-13.~~7~~5	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH MOD 5.501A Standard frequency and time signal-satellite (Earth-to-space) 5.499 5.500 5.501 5.501B	
13.54-13.75 EARTH EXPLORATION-SATELLITE (active) FIXED-SATELLITE (Earth-to-space) ADD 5.A161, ADD 5.A161*bis* ADD 5.L161 RADIOLOCATION SPACE RESEARCH MOD 5.501A Standard frequency and time signal-satellite (Earth-to-space) 5.499 5.500 5.501 5.501B MOD 5.502 ~~ADD 5.B161~~	**13.54-13.75** EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH MOD 5.501A Standard frequency and time signal-satellite (Earth-to-space) 5.499 5.500 5.501 5.501B	

ADD

5.A161 In the band 13.5-13.75 GHz in Region 1, the peak envelope power delivered to the antenna of stations of the fixed-satellite service (Earth-to-space) shall not exceed the spectral density of −53.5 dB(W/Hz) computed from the peak envelope power and the occupied bandwidth. (WRC-15)

ADD

5.A161*bis* The use of the band 13.5-13.75 GHz by the fixed-satellite service (Earth-to-space) is limited to geostationary-satellite systems.

ADD

5.L161 The use of the band 13.5-13.75 GHz by systems in the fixed-satellite service (Earth-to-space) in Region 1 shall not cause harmful interference to, nor claim protection from, nor constrain the use and development of EESS (active) systems, and No. **22.2** does not apply. (WRC-15)

MOD

5.502 In the band 13.5-13.75 GHz in Region 1 and in the band 13.75-14 GHz, an earth station of a geostationary fixed-satellite service network shall have a minimum antenna diameter of 1.2 m. ~~and~~ In the band 13.75-14 GHz, an earth station of a non-geostationary fixed-satellite service system shall have a minimum antenna diameter of 4.5 m. In addition, the e.i.r.p., averaged over one second, radiated by a station in the radiolocation or radionavigation services shall not exceed 59 dBW for elevation angles above 2° and 65 dBW at lower angles. Before an administration brings into use an earth station in a geostationary-satellite network in the fixed-satellite service in this band with an antenna diameter smaller than 4.5 m, it shall ensure that the power flux-density produced by this earth station does not exceed:

– –115 dB(W/(m^2 · 10 MHz)) for more than 1% of the time produced at 36 m above sea level at the low water mark, as officially recognized by the coastal State;

– –115 dB(W/(m^2 · 10 MHz)) for more than 1% of the time produced 3 m above ground at the border of the territory of an administration deploying or planning to deploy land mobile radars in this band, unless prior agreement has been obtained.

For earth stations within the fixed-satellite service having an antenna diameter greater than or equal to 4.5 m, the e.i.r.p. of any emission should be at least 68 dBW and should not exceed 85 dBW. (WRC-03)

MOD

5.501A The allocation of the band 13.4-13.75 GHz to the space research service on a primary basis is limited to active spaceborne sensors, as well as satellite systems, operating in the space research service (space-to-Earth, space-to-space) to relay data from space stations in the geostationary-satellite orbit to associated earth stations and space stations in the non-geostationary-satellite orbit, for which information for advance publication has been received by the Bureau prior to 27 November 2015. Other uses of the band by the space research service are on a secondary basis. (WRC-~~97~~15)

APPENDIX 7 (REV.WRC-12)

Methods for the determination of the coordination area around an earth station in frequency bands between 100 MHz and 105 GHz

ANNEX 7

System parameters and predetermined coordination distances for determination of the coordination area around an earth station

MOD

TABLE 7B (REV.WRC-~~12~~15)

Parameters required for the determination of coordination distance for a transmitting earth station

Transmitting space radiocommunication service designation		**Fixed-satellite, mobile-satellite**	**Aero-nautical mobile-satellite (R) service**	**Aero-nautical mobile-satellite (R) service**	**Fixed-satellite**	**Fixed-satellite**	**Fixed-satellite**	**Fixed-satellite**		**Space operation, space research**		**Fixed-satellite, mobile-satellite, meteorological-satellite**		**Fixed-satellite**		**Fixed-satellite**		**Fixed-satellite** [3]	**Fixed-satellite**	**Fixed-satellite** [3]
Frequency bands (GHz)		2.655-2.690	5.030-5.091	5.030-5.091	5.091-5.150	5.091-5.150	5.725-5.850	5.725-7.075		7.100-7.235 [5]		7.900-8.400		10.7-11.7		12.5-14.8		13.~~7~~5-14.3	15.43-15.65	17.7-18.4	19.3-19.7
Receiving terrestrial service designations		Fixed, mobile	Aeronautical radio-navigation	Aeronautical mobile (R)	Aeronautical radio-navigation	Aeronautical mobile (R)	Radiolocation	Fixed, mobile		Fixed, mobile		Fixed, mobile		Fixed, mobile		Fixed, mobile		Radiolocation radionavigation (land only)	Aeronautical radionavigation	Fixed, mobile	Fixed, mobile
Method to be used		§ 2.1	§ 2.1, § 2.2	§ 2.1, § 2.2			§ 2.1	§ 2.1		§ 2.1, § 2.2		§ 2.1		§ 2.1		§ 2.1, § 2.2		§ 2.1		§ 2.1, § 2.2	§ 2.2
Modulation at terrestrial station [1]		A						A	N	A	N	A	N	A	N	A	N	–		N	N
Terrestrial station interference parameters and criteria	p_0 (%)	0.01						0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.01		0.005	0.005
	n	2						2	2	2	2	2	2	2	2	2	2	1		2	2
	p (%)	0.005						0.005	0.0025	0.005	0.0025	0.005	0.0025	0.005	0.0025	0.005	0.0025	0.01		0.0025	0.0025
	N_L (dB)	0						0	0	0	0	0	0	0	0	0	0	0		0	0
	M_S (dB)	26 [2]						33	37	33	37	33	37	33	40	33	40	1		25	25
	W (dB)	0						0	0	0	0	0	0	0	0	0	0	0		0	0
Terrestrial station parameters	G_x (dBi) [4]	49 [2]	6	10	6	6		46	46	46	46	46	46	50	50	52	52	36		48	48
	T_e (K)	500 [2]						750	750	750	750	750	750	1 500	1 100	1 500	1 100	2 636		1 100	1 100
Reference bandwidth	B (Hz)	4×10^3	150×10^3	37.5×10^3	150×10^3	10^6		4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	10^7		10^6	10^6
Permissible interference power	$P_T(p)$ (dBW) in B	−140	−160	−157	−160	−143		−131	−103	−131	−103	−131	−103	−128	−98	−128	−98	−131		−113	−113

4.1/1.6.1/6.4 EE: 13.4-13.75 GHz for FSS (space-to-Earth)

4.1/1.6.1/6.4.1 Method EE2

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations
(See No. **2.1**)

MOD

11.7-14 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
13.4-13.~~75~~65 EARTH EXPLORATION-SATELLITE (active) FIXED-SATELLITE (space-to-Earth) ADD 5.C161 ADD 5.X161, ADD 5.C161*bis* RADIOLOCATION SPACE RESEARCH ~~MOD 5.501A~~ ADD 5.L161 Standard frequency and time signal-satellite (Earth-to-space) 5.499 5.500 5.501 5.501B	**13.4-13.~~75~~65** EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH ADD 5.L161~~5.501A~~ Standard frequency and time signal-satellite (Earth-to-space) 5.499 5.500 5.501 5.501B	
13.~~4~~65-13.75	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH MOD 5.501A Standard frequency and time signal-satellite (Earth-to-space) 5.499 5.500 5.501 5.501B	

Reasons: To allocate the band 13.4-13.6~~7~~5 GHz to the FSS (space-to-Earth) in Region 1.

ADD

5.C161 The use of the band 13.4-13.65 GHz by the fixed-satellite service (space-to-Earth) is limited to geostationary-satellite systems and is subject to agreement obtained under No. **9.21** with respect to satellite systems, operating in the space research service (space-to-space) to relay data from space stations in the geostationary satellite orbit to associated space stations in the non-geostationary satellite orbit, for which information for advance publication has been received by the Bureau prior to 27 November 2015. (WRC-15)

Reasons: To limit use of the new FSS allocation (space-to-Earth) in Region 1 to GSO FSS, and to specify the terms and conditions for sharing between newly filed GSO FSS networks and SRS systems already notified to the Bureau, operating on space-to-space link to relay data from GSO space station to non-GSO user space station. There is understanding, that coordination of newly filed GSO FSS networks and already notified to the Bureau SRS (space-to-Earth) systems is subject to RR No. **9.7**.

ADD

5.L161 The allocation of the band 13.4-13.65 GHz to the space research service on a primary basis is limited to active spaceborne sensors, as well as satellite systems, operating in the space research service (space-to-Earth and space-to-space) to relay data from space stations in the geostationary-satellite orbit to associated earth stations and space stations in the non-geostationary-satellite orbit, for which information for advance publication has been received by the Bureau prior to 27 November 2015. Satellite systems in the space research service (space-to-Earth and space-to-space) shall not cause harmful interference to nor claim protection from stations in the fixed, mobile, radiolocation and Earth exploration-satellite (active) services. Other uses of the band by the space research service are on a secondary basis. (WRC-15)

Reasons: Since only the frequency assignments having allocation of the considered frequency band on an equal basis are taken into account in the coordination under RR Article **9** it is proposed to modify footnote No. **5.501A** and to add a new footnote under which the status of the ITU BR notified frequency assignments of DRS in SRS (s-E and s-s) will be increased up to the primary with regard to FSS. With respect to FSS stations in Region 1 in any case it is required to seek the agreement of other administrations (under RR No. **9.21**) operating DRS in SRS (space-to-space) in Region 1, with NGSO user which can be potentially located over the territories of Regions 2 and 3. The direction of the DRS SRS links (space-to-Earth and space-to-space) is defined by the relevant Recommendations therefore it is not specified in RR Article **5** footnotes.

ADD

5.X161 Administrations shall not preclude the deployment and operation of transmitting earth stations in the standard frequency and time signal-satellite (Earth-to-space) allocated on a secondary basis in the band 13.4-13.65 GHz, due to the primary allocation to FSS (space-to-Earth).

Reasons: To ensure the deployment of transmitting Earth stations for the European ACES system in the band 13.4-13.75 GHz operating under the standard frequency and time signal-satellite.

ADD

5.C161*bis* In the band 13.4-13.65 GHz, geostationary-satellite networks in the fixed-satellite service (space-to-Earth) shall not claim protection from space stations in the Earth exploration-satellite service (active) operating in accordance with these Regulations. No. **5.43A** and No. **22.2** do not apply. (WRC-15)

MOD

5.501A The allocation of the band 13.654-13.75 GHz to the space research service on a primary basis is limited to active spaceborne sensors. Other uses of the band by the space research service are on a secondary basis. (WRC-97-15)

Reasons: To ensure operation of notified to the Bureau SRS systems on space-to-Earth and space-to-space links on an equal basis with newly filed stations in the fixed-satellite service (space-to-Earth).

ARTICLE 21

Terrestrial and space services sharing frequency bands above 1 GHz

Section I − Choice of sites and frequencies

MOD

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[1] **21.2.1** For their own protection receiving stations in the fixed or mobile service operating in bands shared with space radiocommunication services (space-to-Earth) should also avoid directing their antennas towards the geostationary-satellite orbit if their sensitivity is sufficiently high that interference from space station transmissions may be significant. In particular, in the bands 13.4-13.675 GHz and 21.4-22 GHz, it is recommended to maintain a minimum separation angle of 1.5° with respect to the direction of the geostationary-satellite orbit. (WRC-125)

Section V − Limits of power flux-density from space stations

MOD

TABLE **21-4** (*continued*) (Rev.WRC-1215)

Frequency band	Service*	Limit in dB(W/m^2) for angles of arrival (δ) above the horizontal plane					Reference bandwidth
		0°-5°	5°-25°		25°-90°		
12.2-12.75 GHz[7] (Region 3) 12.5-12.75 GHz[7] (Region 1 countries listed in Nos. **5.494** and **5.496**)	Fixed-satellite (space-to-Earth) (geostationary-satellite orbit)	−148	−148 + 0.5(δ − 5)		−138		4 kHz
13.4-13.765 GHz (Region 1)	Fixed-satellite (space-to-Earth) (geostationary-satellite orbit)	**0°-0.6°**	**0.6°-1.25°**	**1.25°-21.25°**	**21.25°-70°**	**70°-90°**	1 MHz
		−137.5	−136.5	−130.5	−127.5	−122	

Reasons: To insert pfd limits for GSO FSS (space-to-Earth) into RR Article **21** in order to protect allocations to terrestrial services (FS, MS) and RLS.

APPENDIX 5 (Rev.WRC-12)

Identification of administrations with which coordination is to be effected or agreement sought under the provisions of Article 9

MOD

TABLE 5-1 (Rev.WRC-~~12~~15)

Technical conditions for coordination
(see Article **9**)

Reference of Article 9	Case	Frequency bands (and Region) of the service for which coordination is sought	Threshold/condition	Calculation method	Remarks
No. **9.7** GSO/GSO	A station in a satellite network using the geostationary-satellite orbit (GSO), in any space radiocommunication service, in a frequency band and in a Region where this service is not subject to a Plan, in respect of any other satellite network using that orbit, in any space radiocommunication service in a frequency band and in a Region where this service is not subject to a Plan, with the exception of the coordination between earth stations operating in the opposite direction of transmission	1) 3 400-4 200 MHz 5 725-5 850 MHz (Region 1) and 5 850-6 725 MHz 7 025-7 075 MHz	i) Bandwidth overlap, and ii) any network in the fixed-satellite service (FSS) and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8° of the nominal orbital position of a proposed network in the FSS		With respect to the space services listed in the threshold/condition column in the bands in 1), 2), 2*bis*), 3), 4), 5), 6), 7) and 8), an administration may request, pursuant to No. **9.41**, to be included in requests for coordination, indicating the networks for which the value of $\Delta T/T$ calculated by the method in § 2.2.1.2 and 3.2 of Appendix **8** exceeds 6%. When the Bureau, on request by an affected administration, studies this information pursuant to No. **9.42**, the calculation method given in § 2.2.1.2 and 3.2 of Appendix **8** shall be used
		2) 10.95-11.2 GHz 11.45-11.7 GHz 11.7-12.2 GHz (Region 2) 12.2-12.5 GHz (Region 3) 12.5-12.75 GHz (Regions 1 and 3) 12.7-12.75 GHz (Region 2)and 13.75-14.5 GHz	i) Bandwidth overlap, and ii) any network in the FSS or broadcasting-satellite service (BSS), not subject to a Plan, and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±7° of the nominal orbital position of a proposed network in the FSS or BSS, not subject to a Plan		
		2*bis*) 13.4-13.65 GHz (Region 1)	i) Bandwidth overlap, and ii~~i~~) any network in the space research service (SRS) or any network in the FSS and any associated space operation		

			functions (see No. **1.23**) with a space station within an orbital arc of ±7° of the nominal orbital position of a proposed network in the FSS		

Reasons: To specify the order and mechanism of coordination in accordance with provisions of RR No **9.7** between newly notifying networks of the FSS and SRS (space-to-Earth).

MOD

TABLE 5-1 (*end*) (Rev.WRC-12)

Reference of Article 9	**Case**	**Frequency bands (and Region) of the service for which coordination is sought**	**Threshold/condition**	**Calculation method**	**Remarks**
...					
No. **9.21** Terrestrial, GSO, non-GSO/ terrestrial, GSO, non-GSO	A station of a service for which the requirement to obtain the agreement of other administrations is included in a footnote to the Table of Frequency Allocations referring to No. 9.21	Band(s) indicated in the relevant footnote except 13.4-13.65 GHz in Region 1 13.4-13.65 GHz in Region 1	Incompatibility established by the use of Appendices 7, 8, technical Annexes of Appendices 30 or 30A, pfd values specified in some of the footnotes, other technical provisions of the Radio Regulations or ITU-R Recommendations, as appropriate Any network in the space research service (SRS) within an orbital arc of ±(24)° of the nominal orbital position of a proposed network in the FSS	Methods specified in, or adapted from, Appendices 7, 8, 30, 30A, other technical provisions of the Radio Regulations or ITU-R Recommendations	

Reasons: To define the procedure for coordination under the provisions of RR No. **9.21** between the newly notified FSS networks and SRS networks.

APPENDIX 7 (REV.WRC-15~~12~~)

Methods for the determination of the coordination area around an earth station in frequency bands between 100 MHz and 105 GHz

ANNEX 7

System parameters and predetermined coordination distances for determination of the coordination area around an earth station

MOD

TABLE 8C (REV.WRC-~~12~~15)

Parameters required for the determination of coordination distance for a receiving earth station

Receiving space radiocommunication service designation			**Fixed-satellite**		**Fixed-satellite, radio-determination satellite**	**Fixed-satellite**		**Fixed-satellite**		**Meteoro-logical-satellite [7, 8]**	**Meteoro-logical-satellite [9]**	**Earth exploration-satellite [7]**	**Earth exploration-satellite [9]**	**Space research [10]**		**Fixed-satellite**		**Broadcasting-satellite**		**Fixed-satellite [9]**	**Broad-casting-satellite**	**Fixed-satellite [7]**
														Deep space								
Frequency bands (GHz)			4.500-4.800		5.150-5.216	6.700-7.075		7.250-7.750		7.450-7.550	7.750-7.900	8.025-8.400	8.025-8.400	8.400-8.450	8.450-8.500	10.7-12.75 13.4-13. ~~76~~5[7]		12.5-12.75 [12]		15.4-15.7	17.7-17.8	17.7-18.8 19.3-19.7
Transmitting terrestrial service designations			Fixed, mobile		Aeronautical radionavigation	Fixed, mobile		Fixed, mobile		Fixed, mobile	Fixed, mobile	Fixed, mobile	Fixed, mobile	Fixed, mobile		Fixed, mobile		Fixed, mobile		Aeronau-tical radio-navigation	Fixed	Fixed, mobile
Method to be used			§ 2.1		§ 2.1	§ 2.2		§ 2.1		§ 2.1, § 2.2	§ 2.2	§ 2.1	§ 2.2	§ 2.2		§ 2.1, § 2.2		§ 1.4.5			§ 1.4.5	§ 2.1
Modulation at earth station [1]			A	N		N	A	N	N	N	N	N	N	N		A	N	A	N	–		N
Earth station interference parameters and criteria	p_0 (%)		0.03	0.005		0.005	0.03	0.005	0.002	0.001	0.083	0.011	0.001	0.1	0.03	0.003	0.03	0.003	0.003		0.003
	n		3	3		3	3	3	2	2	2	2	1	2	2	2	1	1	2		2
	p (%)		0.01	0.0017		0.0017	0.01	0.0017	0.001	0.0005	0.0415	0.0055	0.001	0.05	0.015	0.0015	0.03	0.003	0.0015		0.0015
	N_L (dB)		1	1		1	1	1	–	–	1	0	0	0	1	1	1	1	1		1
	M_S (dB)		7	2		2	7	2	–	–	2	4.7	0.5	1	7	4	7	4	4		6
	W (dB)		4	0		0	4	0	–	–	0	0	0	0	4	0	4	0	0		0
Terrestrial station parameters	E (dBW) in B [2]	A	92 [3]	92 [3]		55	55	55	55	55	55	55	25 [5]	25 [5]	40	40	55	55			35
		N	42 [4]	42 [4]		42	42	42	42	42	42	42	−18	−18	43	43	42	42		40	40
	P_t (dBW) in B	A	40 [3]	40 [3]		13	13	13	13	13	13	13	−17 [5]	−17 [5]	−5	−5	10	10			−10
		N	0	0		0	0	0	0	0	0	0	−60	−60	−2	−2	−3	−3		−7	−5
	G_X (dBi)		52 [3, 4]	52 [3, 4]		42	42	42	42	42	42	42	42	42	45	45	45	45		47	45
Reference band-width [6]	B (Hz)		10^6	10^6		10^6	10^6	10^6	10^7	10^7	10^6	10^6	1	1	10^6	10^6	27×10^6	27×10^6			10^6
Permissible interference power	$P_r(p)$ (dBW) in B					−151.2			−125	−125	−154 [11]	−142	−220	−216			−131	−131			

Reasons: To specify coordination distances for the FSS receiving earth station in order to protect it from interferences produced by terrestrial FS and MS stations, based on the allowable interference criterion I/N = 6%, see Recommendation ITU-R S.1432.

4.1/1.6.1/6.5 F: 14.5-14.8 GHz for FSS (Earth-to-space)

4.1/1.6.1/6.5.1 Method F2

The regulatory and procedural considerations for this method may also be applied for section 4.1/1.6.2/6.3.1.

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations
(See No. **2.1**)

MOD

Note: It should be noted that the excerpt from the Table of Frequency Allocations below provides the proposed change for R1 as well as for R2 and R3 for ease of reference. If at the end different allocations would be made in different Regions, the Table should be updated accordingly.

14-15.4 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
...		
14.5-14.~~8~~75 FIXED FIXED-SATELLITE (Earth-to-space) MOD 5.510 ADD 5.D161 ADD 5.F161 ADD 5.Y161 MOBILE Space research ADD 5.E161		**14.5-14.8** FIXED FIXED-SATELLITE (Earth-to-space) MOD 5.510 ADD 5.D161 ADD 5.Y161 ADD 5.F161 ADD 5.Y161 MOBILE Space research ADD 5.E161
14.7~~5~~-14.8 FIXED FIXED-SATELLITE (Earth-to-space) MOD 5.510 MOBILE Space research ADD 5.E161		
...		

Note: ADD **5.F161** is one option (with respect to AMS). Therefore, the actual addition of this footnote to the above table depends on the option that will be implemented.

ADD

5.Y161 The use of the band 14.5-14.75 GHz in Regions 1 and 2 and 14.5-14.8 GHz in Region 3 by the fixed-satellite service (Earth-to-space) is limited to geostationary-satellite systems. (WRC-15)

MOD

5.510 The use of the band 14.5-14.8 GHz by the fixed-satellite service (Earth-to-space) ~~is limited to~~ for feeder links for the broadcasting-satellite service is subject to the provisions of Appendix **30A** for Regions 1 and 3~~. This use~~ and is ~~reserved~~ limited for countries outside Europe. (WRC-15)

ADD

5.D161 For the use of the band 14.5-14.75 GHz in Regions 1 and 2, and 14.5-14.8 GHz in Region 3 by the fixed-satellite service (Earth-to-space) not subject to No. **5.510**, the fixed-satellite service earth stations shall have a minimum antenna diameter of (between 2.4 and 6) metres in Region 1, [between 2.4 and 6] metres in Region 2, and [between 2.4 and 6] metres in Region 3.

ADD

5.E161 The band 14.5-14.8 GHz is also allocated to the space research service on a primary basis. However, such use is limited to satellite systems, operating in the space research service (Earth-to-space) to relay data to space stations in the geostationary-satellite orbit from associated earth stations, for which information for advance publication has been received by the Bureau prior to 27 November 2015. Stations in the space research service shall not cause harmful interference to nor claim protection from stations in the fixed, mobile services and stations in the fixed-satellite service limited to feeder links for the broadcasting satellite service operating under Appendix **30A** and feeder links for the broadcasting satellite service in Region 2. (WRC-15)

ADD

5.F161 In the band 14.5-14.8 GHz, the fixed-satellite service (Earth-to-space) not subject to No. **5.510** shall coordinate with the aeronautical mobile service in accordance with Resolution **[A161] (WRC-15)**.

Note: ADD 5.F161 is one option (with respect to AMS). Therefore, the actual addition of this footnote in the table of allocation depends on the option that will be implemented.

APPENDIX 5 (REV.WRC-12)

Identification of administrations with which coordination is to be effected or agreement sought under the provisions of Article 9

MOD

TABLE 5-1 (Rev.WRC-~~12~~15)

Technical conditions for coordination
(see Article **9**)

Reference of Article 9	Case	Frequency bands (and Region) of the service for which coordination is sought	Threshold/condition	Calculation method	Remarks
No. 9.7 GSO/GSO	A station in a satellite network using the geostationary-satellite orbit (GSO), in any space radiocommunication service, in a frequency band and in a Region where this service is not subject to a Plan, in respect of any other satellite network using that orbit, in any space radiocommunication service in a frequency band and in a Region where this service is not subject to a Plan, with the exception of the coordination between earth stations operating in the opposite direction of transmission	1) 3 400-4 200 MHz 5 725-5 850 MHz (Region 1) and 5 850-6 725 MHz 7 025-7 075 MHz	i) Bandwidth overlap, and ii) any network in the fixed-satellite service (FSS) and any associated space operation functions (see No. 1.23) with a space station within an orbital arc of ±8° of the nominal orbital position of a proposed network in the FSS		With respect to the space services listed in the threshold/condition column in the bands in 1), 2), 3), 4), 5), 6), 7) and 8), an administration may request, pursuant to No. 9.41, to be included in requests for coordination, indicating the networks for which the value of $\Delta T/T$ calculated by the method in § 2.2.1.2 and 3.2 of Appendix 8 exceeds 6%. When the Bureau, on request by an affected administration, studies this information pursuant to No. 9.42, the calculation method given in § 2.2.1.2 and 3.2 of Appendix 8 shall be used
		2) 10.95-11.2 GHz 11.45-11.7 GHz 11.7-12.2 GHz (Region 2) 12.2-12.5 GHz (Region 3) 12.5-12.75 GHz (Regions 1 and 3) 12.7-12.75 GHz (Region 2) and 13.75-14.5 GHz	i) Bandwidth overlap, and ii) any network in the FSS or broadcasting-satellite service (BSS), not subject to a Plan, and any associated space operation functions (see No. 1.23) with a space station within an orbital arc of ±7° of the nominal orbital position of a proposed network in the FSS or BSS, not subject to a Plan		
		3) 14.5-14.8 GHz	i) Bandwidth overlap, and		

			ii) any network in the space research service (SRS) or FSS not subject to a Plan and any associated space operation functions (see No. 1.23) with a space station within an orbital arc of ±7° of the nominal orbital position of a proposed network in the FSS not subject to a Plan		

APPENDIX 30A (REV.WRC-1512)*

Provisions and associated Plans and List[1] for feeder links for the broadcasting-satellite service (11.7-12.5 GHz in Region 1, 12.2-12.7 GHz in Region 2 and 11.7-12.2 GHz in Region 3) in the frequency bands 14.5-14.8 GHz[2] and 17.3-18.1 GHz in Regions 1 and 3, and 17.3-17.8 GHz in Region 2 (Rev. WRC-1503)

(See Articles **9** and **11**) (WRC-03)

ARTICLE 4 (Rev.WRC-03)

Procedures for modifications to the Region 2 feeder-link Plan or for additional uses in Regions 1 and 3

MOD

4.1 Provisions applicable to Regions 1 and 3

4.1.1 An administration proposing to include a new or modified assignment in the feeder-link List shall seek the agreement of those administrations whose services are considered to be affected, i.e. administrations[4, 5]:

a) of Regions 1 and 3 having a feeder-link frequency assignment in the fixed-satellite service (Earth-to-space) to a space station in the broadcasting-satellite service which is included in the Regions 1 and 3 feeder-link Plan with a necessary bandwidth, any portion of which falls within the necessary bandwidth of the proposed assignment; *or*

b) of Regions 1 and 3 having a feeder-link frequency assignment included in the feeder-link List or for which complete Appendix 4 information has been received by the

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* The expression "frequency assignment to a space station", wherever it appears in this Appendix, shall be understood to refer to a frequency assignment associated with a given orbital position. (WRC-03)

1 The Regions 1 and 3 feeder-link List of additional uses is annexed to the Master International Frequency Register (see Resolution **542** (WRC-2000)**). (WRC-03)

2 This use of the band 14.5-14.8 GHz is reserved for countries outside Europe.

** *Note by the Secretariat*: This Resolution was abrogated by WRC-03.

Note by the Secretariat: Reference to an Article with the number in roman is referring to an Article in this Appendix.

4 Agreement with administrations having a frequency assignment in the bands 14.5-14.8 GHz or 17.7-18.1 GHz to a terrestrial station, or having a frequency assignment in the band 17.7-18.1 GHz to an earth station in the fixed-satellite service (space-to-Earth), or having a frequency assignment in the band 17.3-17.8 GHz in the broadcasting-satellite service shall be sought under No. 9.17, No. 9.17A or No. 9.19, respectively.

5 Coordination under Nos. 9.17 or 9.17A is not required for an earth station of an administration on the territory of which this earth station is located and for which the procedures of former § 4.2.1.2 and 4.2.1.3 of Appendix 30A **(WRC-97)** have been successfully applied by that administration before 3 June 2000 in respect of terrestrial stations or earth stations operating in the opposite direction of transmission. (WRC-03)

Radiocommunication Bureau in accordance with the provisions of § 4.1.3, and any portion of which falls within the necessary bandwidth of the proposed assignment; *or*

c) of Region 2 having a feeder-link frequency assignment in the fixed-satellite service (Earth-to-space) to a space station in the broadcasting-satellite service which is in conformity with the Region 2 feeder-link Plan, or in respect of which proposed modifications to that Plan have already been received by the Bureau in accordance with the provisions of § 4.2.6 with a necessary bandwidth, any portion of which falls within the necessary bandwidth of the proposed assignment; *or*

d) having a feeder-link frequency assignment in the band 17.8-18.1 GHz in Region 2 in the fixed-satellite service (Earth-to-space) to a space station in the broadcasting-satellite service or a frequency assignment in the band 14.5-14.8 GHz in the fixed-satellite service (Earth-to-space) not subject to this Appendix which is recorded in the Master Register or which has been coordinated or is being coordinated under the provisions of No. **9.7**, or under § 7.1 of Article **7**, with a necessary bandwidth, any portion of which falls within the necessary bandwidth of the proposed. (Rev.WRC-~~03~~15)

MOD

ARTICLE 7 (Rev.WRC-~~12~~15)

Coordination, notification and recording in the Master International Frequency Register of frequency assignments to stations in the fixed-satellite service (space-to-Earth) in Region 1 in the band 17.3-18.1 GHz and in Regions 2 and 3 in the band 17.7-18.1 GHz, to stations in the fixed-satellite service (Earth-to-space) in Region 2 in the band 17.8-18.1 GHz, to stations in the fixed-satellite service (Earth-to-space) in all Regions in the band 14.5-14.8 GHz where those stations are not subject to the Regions 1 and 3 feeder-link Plan or List and to stations in the broadcasting-satellite service in Region 2 in the band 17.3-17.8 GHz when frequency assignments to feeder links for broadcasting-satellite stations in the 14.5-14.8 GHz, 17.3-18.1 GHz bands in Regions 1 and 3 or in the band 17.3-17.8 GHz in Region 2 are involved[28]

Section I – Coordination of transmitting space or earth stations in the fixed-satellite service or transmitting space stations in the broadcasting-satellite service with assignments to broadcasting-satellite service feeder links

7.1 The provisions of No. **9.7**[29] and the associated provisions under Articles **9** and **11** are applicable to transmitting space stations in the fixed-satellite service in Region 1 in the band 17.3-

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[28] These provisions do not replace the procedures prescribed in Articles **9** and **11** when stations other than those for feeder links in the broadcasting-satellite service subject to a Plan are involved. (WRC-03)

[29] The provisions of Resolution **33 (Rev.WRC-97)*** are applicable to space stations in the broadcasting-satellite service for which the advance publication information or the request for coordination has been received by the Bureau prior to 1 January 1999.

18.1 GHz, to transmitting space stations in the fixed-satellite service in Regions 2 and 3 in the band 17.7-18.1 GHz, to transmitting earth stations in the fixed-satellite service in Region 2 in the band 17.8-18.1 GHz, to transmitting earth stations in the fixed-satellite service in any region in the band 14.5-14.8 GHz where those stations are not subject to the Regions 1 and 3 feeder link Plan or List and to transmitting space stations in the broadcasting-satellite service in Region 2 in the band 17.3-17.8 GHz. (Rev.WRC-~~03~~15)

7.2 In applying the procedures referred to in § 7.1, the provisions of Appendix **5** are replaced by the following:

7.2.1 The frequency assignments to be taken into account are:

a) the assignments in conformity with the appropriate Regional feeder-link Plan in Appendix **30A**;

b) the assignments included in the Regions 1 and 3 feeder-link List;

c) the assignments for which the procedure of Article 4 has been initiated as from the date of receipt of the complete Appendix **4** information under § 4.1.3 or 4.2.6. (WRC-~~03~~15)

7.2.2 The criteria to be applied are those given in Annex 4.

7.2*bis* In applying the procedures referred to in § 7.1 for FSS frequency assignments in the band 14.5-14.8 GHz not subject to the Regions 1 and 3 feeder link Plan or List, the provision of No. **11.41** is replaced by the following provision. No. **11.41.2** continues to apply.

7.2*bis.1* If, after a notice is returned under No. **11.38**, should the notifying administration resubmit the notice and insist upon its reconsideration, and the assignment which was the basis of the unfavourable finding is ~~not~~neither an assignment in the Regions 1 and 3 Plan nor an assignment of definitive recording in the Regions 1 and 3 feeder-link List at the time when the notice is returned under No. **11.38**, the Bureau shall enter the assignment in the Master Register with an indication of those administrations whose assignments were the basis of the unfavourable finding (see also No. **11.42**).

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* *Note by the Secretariat*: This Resolution was revised by WRC-03.

Modifications to the Annexes

ANNEX 1

Limits for determining whether a service of an administration is considered to be affected by a proposed modification to the Region 2 feeder-link Plan or by a proposed new or modified assignment in the Regions 1 and 3 feeder-link List or when it is necessary under this Appendix to seek the agreement of any other administration (Rev.WRC-15~~03~~)

Start Option (C)

MOD

4 Limits to the interference into frequency assignments in conformity with the Regions 1 and 3 feeder-link Plan or with the Regions 1 and 3 feeder-link List or proposed new or modified assignments in the Regions 1 and 3 feeder-link List (Rev.WRC-~~03~~15)

Under assumed free-space propagation conditions, the power flux-density of a proposed new or modified assignment in the feeder-link List shall not exceed the value of −76 dB(W/(m^2 · 27 MHz)) at any point in the geostationary-satellite orbit, and the relative off-axis e.i.r.p. of the associated feeder-link antenna shall be in compliance with Fig. A (WRC-97 curves) of Annex 3. (WRC-03)

With respect to § 4.1.1 *a)* or *b)* of Article **4**, an administration in Region 1 or 3 is considered by the Bureau as being affected if the minimum orbital spacing between the wanted and interfering space stations, under worst-case station-keeping conditions, is less than 9°. (WRC-03)

However, an administration is not considered as being affected if, under assumed free-space propagation conditions, the effect of the proposed new or modified assignments in the feeder-link List is that the feeder-link equivalent protection margin[35] corresponding to a test point of its assignment in the feeder-link Plan or the feeder-link List or for which the procedure of Article 4 has been initiated, including the cumulative effect of any FSS frequency assignments not subject to this Appendix identified under § 4.1.1 *d)* in the band 14.5-14.8 GHz, which had been considered by the Bureau as having been brought into use under No. **11.44B**, and any previous modification to the feeder-link List or any previous agreement, does not fall more than 0.45 dB below 0 dB, or, if already negative, more than 0.45 dB below the value resulting from:

– the Regions 1 and 3 feeder-link Plan and List as established by WRC-2000; *or*

– a proposed new or modified assignment to the feeder-link List in accordance with this Appendix; *or*

– a new entry in the Regions 1 and 3 feeder-link List as a result of the successful application of Article 4 procedures. (WRC-03)

For a proposed new or modified assignment to the feeder-link List, in the interference analysis, for each test point, the antenna characteristics described in § 3.5 of Annex 3 shall apply. (WRC-03)

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[35] For the definition of the equivalent protection margin, see § 1.7 of Annex 3.

* *Note by the Secretariat*: This Resolution was revised by WRC-12.

End Option (C)

MOD

6 Limits applicable to protect a frequency assignment in the band 17.8-18.1 GHz (Region 2) to a receiving feeder-link space station in the fixed-satellite service (Earth-to-space) or a frequency assignment in the band 14.5-14.8 GHz (allny regions where the frequency assignment is not subject to the Regions 1 and 3 feeder-link Plan or List) to a receiving space station in the fixed-satellite service (Earth-to-space) (Rev.WRC-0315)

With respect to § 4.1.1 *d)* of Article 4, an administration is considered affected by a proposed new or modified assignment in the Regions 1 and 3 feeder-link List when the power flux-density arriving at the receiving space station of a broadcasting-satellite feeder-link in Region 2 or at the receiving space station of the fixed-satellite service uplinks not subject to the Regions 1 and 3 feeder-link Plan or Listthis Appendix, in allny regions of that administration would cause an increase in the noise temperature of the receiving feeder-link space station which exceeds the threshold value of $\Delta T/T$ corresponding to 6%, where $\Delta T/T$ is calculated in accordance with the method given in Appendix **8**, except that the maximum power densities per hertz averaged over the worst 1 MHz are replaced by power densities per hertz averaged over the necessary bandwidth of the feeder-linkuplink carriers. (Rev.WRC-0315)

ANNEX 4 (Rev.WRC-03)

Criteria for sharing between services

1 Threshold values for determining when coordination is required between, on one hand, transmitting space stations in the fixed-satellite service or the broadcasting-satellite service and, on the other hand, a receiving space station in the feeder-link Plan or List or a proposed new or modified receiving space station in the List, in the frequency bands 17.3-18.1 GHz (Regions 1 and 3) and in the feeder-link Plan or a proposed modification to the Plan in the frequency band 17.3-17.8 GHz (Region **2**) (WRC-03)

With respect to § 7.1, Article **7**, coordination of a transmitting space station in the fixed-satellite service or in the broadcasting-satellite service with a receiving space station in a broadcasting-satellite service feeder-link in the Regions 1 and 3 feeder-link Plan or List, or a proposed new or modified receiving space station in the List, or in the Region 2 feeder-link Plan or proposed modification to the Plan is required when the power flux-density arriving at the receiving space station of a broadcasting-satellite service feeder-link of another administration would cause an increase in the noise temperature of the feeder-link space station which exceeds a threshold value of $\Delta T_s / T_s$ corresponding to 6%. $\Delta T_s / T_s$ is calculated in accordance with Case II of the method given in Appendix **8**. (WRC-03)

Start Option (A)

MOD

2 Threshold values for determining when coordination is required between, on one hand, transmitting feeder-link earth stations in the fixed-satellite service in Region 2 in 17.8-18.1 GHz or transmitting earth stations in the fixed-satellite service in 14.5-14.8 GHz not subject to the Regions 1 and 3 feeder-link Plan or List and, on the other hand, a receiving space station in the Regions 1 and 3 feeder-link Plan or List or a proposed new or modified receiving space station in the List, in the frequency bands 14.5-14.8 GHz or 17.8-18.1 GHz (Rev.WRC-0315)

With respect to § 7.1, Article **7**, coordination of a transmitting ~~feeder-link~~ earth station in the fixed-satellite service with a receiving space station in a broadcasting-satellite feeder link in the Regions 1 and 3 feeder-link Plan or List, or a proposed new or modified receiving space station in the List, is required when the power flux density arriving at the receiving space station of a broadcasting-satellite service feeder link of another administration would cause an increase in the noise temperature of the feeder-link space station which exceeds a threshold value of $\Delta T/T$ corresponding to 6%, where $\Delta T/T$ is calculated in accordance with the method given in Appendix **8**, except that the maximum power densities per hertz averaged over the worst 1 MHz are replaced by power densities per hertz averaged over the necessary bandwidth of the ~~feeder-link~~uplink carriers. (Rev.WRC-~~03~~15)

End Option (A)

Start Option (B)

2 Threshold values for determining when coordination is required between transmitting feeder-link earth stations in the fixed-satellite service in Region 2 and a receiving space station in the Regions 1 and 3 feeder-link Plan or List or a proposed new or modified receiving space station in the List, in the frequency band 17.8-18.1 GHz (WRC-03)

With respect to § 7.1, Article **7**, coordination of a transmitting feeder-link earth station in the fixed-satellite service with a receiving space station in a broadcasting-satellite feeder link in the Regions 1 and 3 feeder-link Plan or List, or a proposed new or modified receiving space station in the List, is required when the power flux density arriving at the receiving space station of a broadcasting-satellite service feeder link of another administration would cause an increase in the noise temperature of the feeder-link space station which exceeds a threshold value of $\Delta T/T$ corresponding to 6%, where $\Delta T/T$ is calculated in accordance with the method given in Appendix **8**, except that the maximum power densities per hertz averaged over the worst 1 MHz are replaced by power densities per hertz averaged over the necessary bandwidth of the feeder-link carriers. (WRC-03)

ADD

3 Threshold values for determining when coordination is required between, transmitting earth stations in the fixed-satellite service in 14.5-14.8 GHz not subject to the Regions 1 and 3 feeder-link Plan or List and a receiving space station in the Regions 1 and 3 feeder-link Plan or List or a proposed new or modified receiving space station in the List, in the frequency band 14.5-14.8 GHz (WRC-15)

With respect to § 7.1, Article **7**, coordination of a transmitting earth station in the fixed-satellite service with a receiving space station in a broadcasting-satellite feeder link in the Regions 1 and 3 feeder-link Plan or List, or a proposed new or modified receiving space station in the List, is required when the power flux-density arriving at the receiving space station of a broadcasting-satellite service feeder link of another administration exceeds the value of −193.9 – GRx dB(W/(m^2 · Hz)) (WRC-15)

Where GRx is the relative receive antenna gain of the space station in the Regions 1 and 3 feeder-link Plan or List at the location of the transmitting earth station in the fixed-satellite service not subject to Regions 1 and 3 feeder-link Plan or List. (WRC-15)

End Option (B)

ADD

RESOLUTION [A161] (WRC-15)

Coordination between the fixed-satellite service* in the Earth-to-space direction and the mobile service in the frequency band 14.5-14.8 GHz

The World Radiocommunication Conference (Geneva, 2015),

considering

a) that the existing unplanned bands for the fixed-satellite service (FSS) in the 10-15 GHz range are extensively used for a large variety of applications, and these applications have triggered a rapid rise in the demand for this frequency range;

b) that prior to WRC-15, in ITU Region 3 the spectrum allocated to the unplanned FSS in the Earth-to-space and space-to-Earth directions in the 10-15 GHz band is 750 MHz and 1.05 GHz, respectively;

c) that prior to WRC-15, in ITU Region 2 the spectrum allocated to the unplanned FSS in the Earth-to-space and space-to-Earth directions in the 10-15 GHz band is 750 MHz and 1.0 GHz, respectively;

d) that the difference of capacity in *considering b)* and *c)* created a bandwidth limitation in the Earth-to-space direction and therefore restricted satellite operators from fully and effectively utilizing the limited frequency resource to cope with the increasing spectrum demand in *considering a)*;

e) that additional primary allocations to the unplanned FSS in the Earth-to-space direction that are contiguous (or near contiguous) to the existing allocations can best solve the spectrum insufficiency issue in *considering b)* and *c)* on a worldwide basis,

recognizing

a) that it is important to ensure that the FSS satellite networks in the band 14.5-14.8 GHz do not cause undue constraints to existing services;

b) that there are assignments in the 14.5-14.8 GHz band in the Regions 1 and 3 BSS feeder-link Plan, contained in Appendix **30A**, for 22 countries in Africa, Middle East and Asia-Pacific;

c) that new assignments could be added to the Appendix **30A** List of assignments for BSS feeder links Regions 1 and 3 following the successful application of Article 4 of Appendix **30A**;

d) that transmitting earth stations of these above-mentioned assignments in the Plans or Lists, as the case may be, could be located at any point within the service area of its associated satellite network,

further recognizing

that the fixed and mobile services are allocated on a primary basis in this frequency band,

resolves

TBD

instructs the Radiocommunication Bureau

TBD

ANNEX TO RESOLUTION [A161] (WRC-15)

TBD

4.1/1.6.1/6.6 FF: 14.5-14.8 GHz for FSS (space-to-Earth)

4.1/1.6.1/6.6.1 Method FF2

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations
(See No. **2.1**)

MOD

14-15.4 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
14.5-14.8	FIXED FIXED-SATELLITE (Earth-to-space) 5.510 FIXED-SATELLITE (space-to-Earth) ADD 5.G161 MOBILE Space research ADD 5.H161	

ADD

5.G161 The use of the band (14.5-14.8 GHz) by the fixed-satellite service (space-to-Earth) is limited to geostationary-satellite systems in Region 1. (WRC-15)

Note: There have been no proposals for specific band of 250 MHz within 14.5-14.8 GHz.

ADD

5.H161 The band 14.5-14.8 GHz is also allocated to the space research service on primary basis. However, such use is limited to satellite systems, operating in the space research service (Earth-to-space) to relay data to space stations in the geostationary-satellite orbit from associated earth stations, for which information for advance publication has been received by the Bureau prior to 27 November 2015. Stations in the space research service shall not cause harmful interference to nor claim protection from stations in the fixed and mobile services and stations in the fixed-satellite service limited to feeder links for the broadcasting-satellite service operating under Appendix **30A** and feeder links for the broadcasting satellite service in Region 2. (WRC-15)

Note: Similar provisions with respect to RR Article **21**, RR Appendix **5** and RR Appendix **7** as those in Method GG2 would apply.

4.1/1.6.1/6.7 G: 14.8-15.1 GHz for FSS (Earth-to-space)

4.1/1.6.1/6.7.1 Method G2

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations
(See No. **2.1**)

MOD

14-15.4 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
14.5-14.8	FIXED FIXED-SATELLITE (Earth-to-space) 5.510 MOBILE Space research	
14.8-15.~~30~~5 FIXED-SATELLITE (Earth-to-space) ADD 5.I161*bis* FIXED MOBILE Space research 5.339 ADD 5.I161	**14.8-15.~~30~~5** FIXED MOBILE Space research 5.339 ADD 5.I161	
1~~4.85~~.05-15.35	FIXED MOBILE Space research 5.339	

ADD

5.I161 The band 14.8-15.05 GHz is also allocated to the space research service on a primary basis. However, such use is limited to geostationary-satellite systems, operating in the space research service (Earth-to-space and space-to-space) to relay data to space stations in the geostationary-satellite orbit from associated earth stations and space stations in the non-geostationary-satellite orbit, as well as non-geostationary-satellite systems, operating in the space research service (space-to-Earth), for which information for advance publication has been received by the Bureau prior to 27 November 2015. Stations in the space research service shall not cause harmful interference to nor claim protection from stations in the fixed and mobile services. (WRC-15)

ADD

5.I161*bis* The use of the band 14.8-15.05 GHz by the fixed-satellite service (Earth-to-space) is limited to geostationary-satellite systems which shall not claim protection from non-geostationary-satellite systems in the space research service (space-to-Earth), for which information for advance publication has been received by the Bureau prior to 27 November 2015. No. **5.43A** and No. **22.2** do not apply. (WRC-15)

APPENDIX 5 (REV.WRC-12)

Identification of administrations with which coordination is to be effected or agreement sought under the provisions of Article 9

MOD

TABLE 5-1 (Rev.WRC-~~12~~15)

Technical conditions for coordination
(see Article **9**)

Reference of Article 9	Case	Frequency bands (and Region) of the service for which coordination is sought	Threshold/condition	Calculation method	Remarks
No. **9.7** GSO/GSO	A station in a satellite network using the geostationary-satellite orbit (GSO), in any space radiocommunication service, in a frequency band and in a Region where this service is not subject to a Plan, in respect of any other satellite network using that orbit, in any space radiocommunication service in a frequency band and in a Region where this service is not subject to a Plan, with the exception of the coordination between earth stations operating in the opposite direction of transmission	1) 3 400-4 200 MHz 5 725-5 850 MHz (Region 1) and 5 850-6 725 MHz 7 025-7 075 MHz	i) Bandwidth overlap, and ii) any network in the fixed-satellite service (FSS) and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8° of the nominal orbital position of a proposed network in the FSS		With respect to the space services listed in the threshold/condition column in the bands in 1), 2), 3), 4), 5), 6), 7) and 8), an administration may request, pursuant to No. **9.41**, to be included in requests for coordination, indicating the networks for which the value of $\Delta T/T$ calculated by the method in § 2.2.1.2 and 3.2 of Appendix **8** exceeds 6%. When the Bureau, on request by an affected administration, studies this information pursuant to No. **9.42**, the calculation method given in § 2.2.1.2 and 3.2 of Appendix **8** shall be used
		2) 10.95-11.2 GHz 11.45-11.7 GHz 11.7-12.2 GHz (Region 2) 12.2-12.5 GHz (Region 3) 12.5-12.75 GHz (Regions 1 and 3) 12.7-12.75 GHz (Region 2) and 13.75-14.~~-~~5 GHz	i) Bandwidth overlap, and ii) any network in the FSS or broadcasting-satellite service (BSS), not subject to a Plan, and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±7° of the nominal orbital position of a proposed network in the FSS or BSS, not subject to a Plan		
		3) 14.8-15.05 GHz	i) Bandwidth overlap, and ii) any network in the space research service (SRS) or FSS and any associated		

			space operation functions (see No. 1.23) with a space station within an orbital arc of ±7° of the nominal orbital position of a proposed network in the FSS		

APPENDIX 7 (REV.WRC-12)

Methods for the determination of the coordination area around an earth station in frequency bands between 100 MHz and 105 GHz

ANNEX 7

System parameters and predetermined coordination distances for determination of the coordination area around an earth station

MOD

TABLE 7B (Rev.WRC-~~12~~15)

Parameters required for the determination of coordination distance for a transmitting earth station

Transmitting space radiocommunication service designation		**Fixed-satellite, mobile-satellite**	**Aero-nautical mobile-satellite (R) service**	**Aero-nautical mobile-satellite (R) service**	**Fixed-satellite**	**Fixed-satellite**	**Fixed-satellite**	**Fixed-satellite**		**Space operation, space research**		**Fixed-satellite, mobile-satellite, meteorological-satellite**		**Fixed-satellite**		**Fixed-satellite**		**Fixed-satellite** [3]	**Fixed-satellite**	**Fixed-satellite** [3]
Frequency bands (GHz)		2.655-2.690	5.030-5.091	5.030-5.091	5.091-5.150	5.091-5.150	5.725-5.850	5.725-7.075		7.100-7.235 [5]		7.900-8.400		10.7-11.7		12.5-15.05~~4.8~~		13.75-14.3	15.43-15.65	17.7-18.4	19.3-19.7
Receiving terrestrial service designations		Fixed, mobile	Aeronautical radio-navigation	Aeronautical mobile (R)	Aeronautical radio-navigation	Aeronautical mobile (R)	Radiolocation	Fixed, mobile		Fixed, mobile		Fixed, mobile		Fixed, mobile		Fixed, mobile		Radiolocation radionavigation (land only)	Aeronautical radionavigation	Fixed, mobile	Fixed, mobile
Method to be used		§ 2.1	§ 2.1, § 2.2	§ 2.1, § 2.2			§ 2.1	§ 2.1		§ 2.1, § 2.2		§ 2.1		§ 2.1		§ 2.1, § 2.2		§ 2.1		§ 2.1, § 2.2	§ 2.2
Modulation at terrestrial station [1]		A						A	N	A	N	A	N	A	N	A	N	–		N	N
Terrestrial station interference parameters and criteria	p_0 (%)	0.01						0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.01		0.005	0.005
	n	2						2	2	2	2	2	2	2	2	2	2	1		2	2
	p (%)	0.005						0.005	0.0025	0.005	0.0025	0.005	0.0025	0.005	0.0025	0.005	0.0025	0.01		0.0025	0.0025
	N_L (dB)	0						0	0	0	0	0	0	0	0	0	0	0		0	0
	M_S (dB)	26 [2]						33	37	33	37	33	37	33	40	33	40	1		25	25
	W (dB)	0						0	0	0	0	0	0	0	0	0	0	0		0	0
Terrestrial station parameters	G_x (dBi) [4]	49 [2]	6	10	6	6		46	46	46	46	46	46	50	50	52	52	36		48	48
	T_e (K)	500 [2]						750	750	750	750	750	750	1 500	1 100	1 500	1 100	2 636		1 100	1 100
Reference bandwidth	B (Hz)	4×10^3	150×10^3	37.5×10^3	150×10^3	10^6		4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	10^7		10^6	10^6
Permissible interference power	$P_r(p)$ (dBW) in B	−140	−160	−157	−160	−143		−131	−103	−131	−103	−131	−103	−128	−98	−128	−98	−131		−113	−113

4.1/1.6.1/6.8 GG: 14.8-15.1 GHz for FSS (space-to-Earth)

4.1/1.6.1/6.8.1 Method GG2

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations
(See No. **2.1**)

MOD

14-15.4 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
14.8-~~15.35~~14.85 FIXED MOBILE Space research ~~5.339~~	**14.8-15.35** FIXED MOBILE Space research ADD 5.K161	
14.85-15.1~~35~~ FIXED FIXED-SATELLITE (space-to-Earth) ADD 5.J161, ADD 5.K161*bis* MOBILE Space research ADD 5.K161 ~~5.339~~		
~~14.8~~15.1-15.35 FIXED MOBILE Space research 5.339	5.339	

Reasons: To allocate the band 14.85-15.1 GHz to the FSS (space-to-Earth) in Region 1.

ADD

5.J161 The use of the band 14.85-15.1 GHz by the fixed-satellite service (space-to-Earth) is limited to geostationary-satellite systems subject to the application of No. 9.7 provisions for coordination with satellite systems, operating in the space research service (Earth-to-space and space-to-space) to relay data to space stations in the geostationary-satellite orbit from associated earth stations and space stations in the non-geostationary-satellite orbit, for which information for advance publication has been received by the Bureau prior to 27 November 2015 . (WRC-15)

Reasons: To limit use of the new FSS allocation (space-to-Earth) in Region 1 to GSO FSS, and to specify the terms and conditions for sharing between newly filed GSO FSS networks and SRS systems already notified to the Bureau, operating on Earth-to-space and space-to-space links to relay data from non-GSO user space station to GSO space station. There is understanding, that

coordination of newly filed GSO FSS networks and already notified to the Bureau SRS systems is subject to RR No. **9.7**.

ADD

5.K161 The band 14.85-15.1 GHz is also allocated to the space research service on a primary basis. However, such use is limited to geostationary-satellite systems, operating in the space research service (Earth-to-space and space-to-space) to relay data to space stations in the geostationary-satellite orbit from associated earth stations and space stations in the non-geostationary-satellite orbit, as well as non-geostationary-satellite systems, operating in the space research service (space-to-Earth), for which information for advance publication has been received by the Bureau prior to 27 November 2015. Stations in the space research service shall not cause harmful interference to nor claim protection from stations in the fixed and mobile services (WRC-15)

ADD

5.K161*bis* In the band 14.85-15.1 GHz geostationary satellite systems in the fixed-satellite service (space-to-Earth) shall not claim protection from non-geostationary satellite systems in the space research service (space-to-Earth) for which information for advance publication has been received by the Bureau prior to 27 November 2015. Nos. **5.43A** and **22.2** do not apply in this case. (WRC-15)

Reasons: To ensure operation of SRS systems notified to Bureau on an equal basis with newly filed stations in the fixed-satellite service (space-to-Earth).

ARTICLE 21

Terrestrial and space services sharing frequency bands above 1 GHz

Section I – Choice of sites and frequencies

MOD

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[1] **21.2.1** For their own protection receiving stations in the fixed or mobile service operating in bands shared with space radiocommunication services (space-to-Earth) should also avoid directing their antennas towards the geostationary-satellite orbit if their sensitivity is sufficiently high that interference from space station transmissions may be significant. In particular, in the bands 14.85-15.1 GHz and 21.4-22 GHz, it is recommended to maintain a minimum separation angle of 1.5° with respect to the direction of the geostationary-satellite orbit. (WRC-~~12~~15)

Reasons: To protect receiving stations in terrestrial services (FS, MS) from GSO FSS (space-to-Earth) interferences.

Section V − Limits of power flux-density from space stations

MOD

TABLE **21-4** (*continued*) (Rev.WRC-~~12~~15)

Frequency band	Service*	Limit in dB(W/m^2) for angles of arrival (δ) above the horizontal plane			Reference bandwidth
		0°-5°	**5°-25°**	**25°-90°**	
12.2-12.75 GHz [7] (Region 3) 12.5-12.75 GHz [7] (Region 1 countries listed in Nos. **5.494** and **5.496**)	Fixed-satellite (space-to-Earth) (geostationary-satellite orbit)	−148	−148 + 0.5(δ − 5)	−138	4 kHz
14.85-15.1 GHz (Region 1)	Fixed-satellite (space-to-Earth) (geostationary-satellite orbit)	−132	−132 + 0.5(δ − 5)	−122	1 MHz

Reasons: To insert pfd limits for GSO FSS (space-to-Earth) into RR Article **21** in order to protect allocations to terrestrial services (FS, MS).

APPENDIX 5 (REV.WRC-15)

Identification of administrations with which coordination is to be effected or agreement sought under the provisions of Article 9

MOD

TABLE 5-1 (Rev.WRC-~~12~~15)

Technical conditions for coordination
(see Article **9)**

Reference of Article 9	**Case**	**Frequency bands (and Region) of the service for which coordination is sought**	**Threshold/condition**	**Calculation method**	**Remarks**
No. **9.7** GSO/GSO	A station in a satellite network using the geostationary-satellite orbit (GSO), in any space radiocommunication service, in a frequency band and in a Region where this service is not subject to a Plan, in respect of any other satellite network using that orbit, in any space radiocommunication service in a frequency band and in a Region where this service is not subject to a Plan, with the exception of the coordination between earth stations operating in the opposite direction of transmission	1) 3 400-4 200 MHz 5 725-5 850 MHz (Region 1) and 5 850-6 725 MHz 7 025-7 075 MHz 2) 10.95-11.2 GHz 11.45-11.7 GHz 11.7-12.2 GHz (Region 2) 12.2-12.5 GHz (Region 3) 12.5-12.75 GHz (Regions 1 and 3) 12.7-12.75 GHz (Region 2) and 13.75-14.5 GHz 2*bis*) 14.85-15.1 GHz (Region 1)	i) Bandwidth overlap, and ii) any network in the fixed-satellite service (FSS) and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8° of the nominal orbital position of a proposed network in the FSS i) Bandwidth overlap, and ii) any network in the FSS or broadcasting-satellite service (BSS), not subject to a Plan, and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±7° of the nominal orbital position of a proposed network in the FSS or BSS, not subject to a Plan i) Bandwidth overlap, and ii) any network in the space research service (SRS) or any network in the FSS and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±7° of the nominal orbital position of a proposed network in the FSS		With respect to the space services listed in the threshold/condition column in the bands in 1), 2), 3), 4), 5), 6), 7) and 8), an administration may request, pursuant to No. **9.41**, to be included in requests for coordination, indicating the networks for which the value of $\Delta T/T$ calculated by the method in § 2.2.1.2 and 3.2 of Appendix **8** exceeds 6%. When the Bureau, on request by an affected administration, studies this information pursuant to No. **9.42**, the calculation method given in § 2.2.1.2 and 3.2 of Appendix **8** shall be used

Reasons: To specify the order and mechanism of coordination in accordance with provisions of RR No **9.7** between newly notified networks of the FSS and SRS networks.

APPENDIX 7 (REV.WRC-12)

Methods for the determination of the coordination area around an earth station in frequency bands between 100 MHz and 105 GHz

ANNEX 7

System parameters and predetermined coordination distances for determination of the coordination area around an earth station

MOD

TABLE 8C (Rev.WRC-~~12~~15)

Parameters required for the determination of coordination distance for a receiving earth station

Receiving space radiocommunication service designation			**Fixed-satellite**		**Fixed-satellite, radio-determination satellite**	**Fixed-satellite**		**Fixed-satellite**		**Meteoro-logical-satellite [7, 8]**	**Meteoro-logical-satellite [9]**	**Earth exploration-satellite [7]**	**Earth exploration-satellite [9]**	**Space research [10]**		**Fixed-satellite**		**Broadcasting-satellite**		**Fixed-satellite [9]**	**Broad-casting-satellite**	**Fixed-satellite [7]**
														Deep space								
Frequency bands (GHz)			4.500-4.800		5.150-5.216	6.700-7.075		7.250-7.750		7.450-7.550	7.750-7.900	8.025-8.400	8.025-8.400	8.400-8.450	8.450-8.500	10.7-12.75		12.5-12.75 [12]		15.4-15.7	17.7-17.8	14. 85-15.1 [7] 17.7-18.8 19.3-19.7
Transmitting terrestrial service designations			Fixed, mobile		Aeronautical radionavigation	Fixed, mobile		Fixed, mobile		Fixed, mobile	Fixed, mobile	Fixed, mobile	Fixed, mobile	Fixed, mobile		Fixed, mobile		Fixed, mobile		Aeronau-tical radio-navigation	Fixed	Fixed, mobile
Method to be used			§ 2.1		§ 2.1	§ 2.2		§ 2.1		§ 2.1, § 2.2	§ 2.2	§ 2.1	§ 2.2	§ 2.2		§ 2.1, § 2.2		§ 1.4.5			§ 1.4.5	§ 2.1
Modulation at earth station [1]			A	N		N	A	N		N	N	N	N	N	N	A	N	A	N	–		N
Earth station interference parameters and criteria	p_0 (%)		0.03	0.005		0.005	0.03	0.005		0.002	0.001	0.083	0.011	0.001	0.1	0.03	0.003	0.03	0.003	0.003		0.003
	n		3	3		3	3	3		2	2	2	2	1	2	2	2	1	1	2		2
	p (%)		0.01	0.0017		0.0017	0.01	0.0017		0.001	0.0005	0.0415	0.0055	0.001	0.05	0.015	0.0015	0.03	0.003	0.0015		0.0015
	N_L (dB)		1	1		1	1	1		–	–	1	0	0	0	1	1	1	1	1		1
	M_S (dB)		7	2		2	7	2		–	–	2	4.7	0.5	1	7	4	7	4	4		6
	W (dB)		4	0		0	4	0		–	–	0	0	0	0	4	0	4	0	0		0
Terrestrial station parameters	E (dBW) in B [2]	A	92 [3]	92 [3]		55	55	55		55	55	55	55	25 [5]	25 [5]	40	40	55	55			35
		N	42 [4]	42 [4]		42	42	42		42	42	42	42	−18	−18	43	43	42	42		40	40
	P_t (dBW) in B	A	40 [3]	40 [3]		13	13	13		13	13	13	13	−17 [5]	−17 [5]	−5	−5	10	10			−10
		N	0	0		0	0	0		0	0	0	0	−60	−60	−2	−2	−3	−3		−7	−5
	G_X (dBi)		52 [3, 4]	52 [3, 4]		42	42	42		42	42	42	42	42	42	45	45	45	45		47	45
Reference band-width [6]	B (Hz)		10^6	10^6		10^6	10^6	10^6		10^7	10^7	10^6	10^6	1	1	10^6	10^6	27×10^6	27×10^6			10^6
Permissible interference power	$P_r(p)$ (dBW) in B					−151.2				−125	−125	−154 [11]	−142	−220	−216			−131	−131			

Reasons: To specify coordination distances for the FSS receiving earth station in order to protect it from interferences produced by terrestrial FS and MS stations, based on the allowable interference criterion I/N = 6%, see Recommendation ITU-R S.1432.

MOD

TABLE 9b

Parameters required for the determination of coordination distance for a transmitting earth station in bands shared bidirectionally with receiving earth stations

Space service designation in which the transmitting earth station operates		**Fixed-satellite**			**Fixed-satellite**			**Space research**	**Fixed-satellite [3]**	**Fixed-satellite**	**Fixed-satellite**	**Fixed-satellite[3]**	**Fixed-satellite[3]**	**Earth exploration-satellite, space research**	
Frequency bands (GHz)		10.7-11.7			12.5-12.75			14.85-15.1	15.43-15.65	17.3-17.8	17.7-18.4	19.3-19.6	19.3-19.6	40.0-40.5	
Space service designation in which the *receiving* earth station operates		Fixed-satellite			Fixed-satellite			Fixed -satellite	Fixed-satellite[3]	Broadcasting-satellite	Fixed-satellite, meteorological-satellite	Fixed-satellite[3]	Fixed-satellite[4]	Fixed-satellite, mobile-satellite	
Orbit[7]		GSO		Non-GSO	GSO		Non-GSO	GSO	Non-GSO		GSO	Non-GSO	GSO	GSO	Non-GSO
Modulation at *receiving* earth station[1]		A	N	N	A	N		N			N	N			
Receiving earth station interference parameters and criteria	p_0 (%)	0.03	0.003		0.03	0.003		0.003	0.003		0.003	0.01	0.003	0.003	
	n	2	2		2	2		2	2		2	1	2	2	
	p (%)	0.015	0.0015		0.015	0.0015		0.0015	0.0015		0.0015	0.01	0.0015	0.0015	
	N_L (dB)	1	1		1	1		1	1		1	0	1	1	
	M_S (dB)	7	4		7	4		6	4		6	5	6	6	
	W (dB)	4	0		4	0		0	0		0	0	0	0	
Receiving earth station parameters	G_m (dBi) [2]			51.9			31.2	37.6	48.4		58.6	53.2	49.5	50.8	54.4
	G_r [5]	9	9	10	9	9	11[11]	9	10		9	10	10	9	7[12]
	ε_{min} [6]	5°	5°	6°	5°	5°	10°	5°	5°		5°	5°	10°	10°	10°
	T_e (K)[8]	150	150		150	150		150	150		300	300	300	300	
Reference bandwidth	B (Hz)	10^6	10^6		10^6	10^6		10^6	2×10^6		10^6	10^6			
Permissible interference power	$P_r(p)$ (dBW) in B	−144	−144	−144	−144	−141	−144	−144	−141		−138	−141			

Reasons: To define coordination distances between transmitting SRS E/S and receiving FSS E/S in the frequency band 14.85-15.1 GHz.

4.1/1.6.2 Resolution 152 (WRC-12)

4.1/1.6.2/1 Executive summary

ITU-R has undertaken studies of possible bands for new primary allocations to the FSS in the Earth-to-space direction within the frequency range 13-17 GHz in ITU Regions 2 and 3. Studies were performed in 8 different sub-bands from 13 to 17 GHz, and the analysis of the results of the studies and the methods to satisfy the agenda item can be found in section 4.1/1.6.2/4 and section 4.1/1.6.2/5 respectively. It should be noted that the studies performed and the methods considered only address GSO FSS.

It should be noted that for the frequency bands under consideration for the FSS in the Earth-to-space direction, the studies performed, the conclusions reached and methodologies developed are the same as those under WRC-15 agenda item 1.6.1. Therefore, the sections below, where relevant will provide a cross-reference to the sections in § 4.1/1.6.1 of this document, and point out the differences, if any.

4.1/1.6.2/2 Background

The existing unplanned FSS bands in the 10-15 GHz range are used extensively for a myriad of applications such as VSAT services, video distribution, broadband networks, internet services, satellite news gathering, and backhaul links. Growth in demand for these applications has triggered a rapid rise in the demand for spectrum. Moreover, satellite traffic is typically symmetrical in a large variety of applications, i.e. similar amounts of Earth-to-space (uplink) and space-to-Earth (downlink) traffic are transmitted. However, in ITU Regions 2 and 3, there are asymmetrical Earth-to-space and space-to-Earth FSS allocations that are used for these services. Studies sought to address this imbalance so that the limited spectrum resources could be used in the most efficient and economical manner.

WRC-12 adopted WRC-15 agenda item 1.6.2 to consider additional primary allocations to the FSS in the range 13-17 GHz and review regulatory provisions for existing FSS allocations, taking into account ITU-R studies in accordance with Resolution **152 (WRC-12)**.

4.1/1.6.2/3 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

The main elements required for the decision under WRC-15 agenda item 1.6.2 are the established technical characteristics and operational parameters of GSO FSS systems (Earth-to-space) which could operate in the 13-17 GHz band, and also sharing studies of GSO FSS (Earth-to-space) with other radio services.

Relevant ITU-R documents:

The PDN Report ITU-R S.[R2R3.FSS] and PDN Report ITU-R S.[FSS.DEPLOYMENT] and also the relevant ITU-R Recommendations and ITU-R Reports are indicated in the abovementioned PDN Reports which were used in the studies performed in accordance with Resolution **152 (WRC-12)**.

4.1/1.6.2/3.1 Overview of current unplanned FSS allocations in Regions 2 and 3

In Table 4.1/1.6.2/3-1 below, the unplanned FSS allocations in Region 2 are shown where there is a difference of 200 MHz when comparing the amounts of spectrum allocated to the uplink and downlink operations.

TABLE 4.1/1.6.2/3-1

The current unplanned FSS bands in the 10-15 GHz range in Region 2

Frequency bands (GHz)	Bandwidth (MHz)
Earth-to-space direction (uplink)	
12.7-12.75	50
13.75-14.5	750
Total spectrum in the uplink	**800**
space-to-Earth direction (downlink)	
10.95-11.2	250
11.45-11.7	250
11.7-12.2	500
Total spectrum in the downlink	**1 000**
Uplink and downlink spectrum difference	**200**

In Table 4.1/1.6.2/3-2 below, the unplanned FSS allocations in Region 3 are shown where there is a difference of 300 MHz when comparing the amounts of spectrum allocated to the uplink and downlink operations.

TABLE 4.1/1.6.2/3-2

The current unplanned FSS bands in the 10-15 GHz range in Region 3

Frequency bands (GHz)	Bandwidth (MHz)
Earth-to-space direction (uplink)	
13.75-14.5	750
Total spectrum in the uplink	**750**
space-to-Earth direction (downlink)	
10.95-11.2	250
11.45-11.7	250
12.2-12.75	550
Total spectrum in the downlink	**1 050**
Uplink and downlink spectrum difference	**300**

4.1/1.6.2/3.2 Frequency bands examined

ITU-R has examined frequency bands in the 13-17 GHz range for their suitability in addressing the shortage in the uplink spectrum in Region 2 and Region 3.

Detailed study results on these bands are contained in PDN Report ITU-R S.[R2R3.FSS].

4.1/1.6.2/4 Analysis of the results of studies

Studies were performed in 8 different sub-bands from 13 to 17 GHz.

4.1/1.6.2/4.1 13.25-13.4 GHz band

Consideration is given to this band for possible primary allocations to FSS Earth-to-space operations. The band 13.25-13.4 GHz is allocated to the EESS (active), ARNS and SRS (active) on a primary basis. According to RR No. **5.499** in some countries of Region 3 the band 13.25-13.75 GHz is also allocated to the FS on a primary basis.

4.1/1.6.2/4.1.1 FSS (Earth-to-space) sharing with the EESS

The analysis and results are the same as given in section 4.1/1.6.1/4.4.1.

4.1/1.6.2/4.1.2 FSS (Earth-to-space) sharing with the ARNS

The analysis and results are the same as given in section 4.1/1.6.1/4.4.4.

4.1/1.6.2/4.1.3 FSS (Earth-to-space) sharing with the SRS (active)

Since SRS (active) applications are active sensors used in the frequency band 13.25-13.4 GHz around other planets, no compatibility issue with the proposed FSS is expected.

4.1/1.6.2/4.1.4 FSS (Earth-to-space) sharing with the FS

According to RR No. **5.499** in some countries of Region 3 the band 13.25-13.75 GHz is also allocated to the FS on a primary basis.

4.1/1.6.2/4.1.5 Summary of studies for the band 13.25-13.40 GHz

The summary of studies is the same as given in section 4.1/1.6.1/4.4.7, but only with respect to parts of the summary that deal with FSS (Earth-to-space).

4.1/1.6.2/4.2 13.4-13.75 GHz band

Consideration is given to this band for possible primary allocations to FSS (Earth-to-space) operations. The band 13.4-13.75 GHz is allocated to the EESS (active), RLS and SRS (active) on a primary basis.

RR No. **5.501A** indicates that the use of the band 13.4-13.75 GHz by the SRS on a primary basis is limited to active spaceborne sensors. Other uses of the band by the SRS are on a secondary basis. RR Nos. **5.499**, **5.500**, **5.501** and **5.501B** apply.

4.1/1.6.2/4.2.1 FSS (Earth-to-space) sharing with the EESS

See section 4.1/1.6.1/4.4.1 for sharing study results applicable to this frequency band.

4.1/1.6.2/4.2.2 FSS (Earth-to-Space) sharing with the SRS

The analysis and results are the same as given in section 4.1/1.6.1/4.5.2.

4.1/1.6.2/4.2.3 FSS (Earth-to-Space) sharing with the RLS and RNS

The analysis and results are the same as given in section 4.1/1.6.1/4.5.5.

4.1/1.6.2/4.2.4 Summary of studies for the band 13.4-13.75 GHz

The summary of studies is the same as given in section 4.1/1.6.1/4.5.9, but only with respect to parts of the summary that deal with FSS (Earth-to-space).

4.1/1.6.2/4.3 14.5-14.8 GHz band

The band 14.5-14.8 GHz is currently allocated to the MS, FS and FSS (Earth-to-space) on a primary basis and the SRS on a secondary basis. RR No. **5.510** indicates that the use of the band 14.5-14.8 GHz by the FSS (Earth-to-space) is limited to feeder links for the BSS. This use is reserved for countries outside Europe.

Studies for sharing in this band included both (1) studies with other allocated services, and (2) studies within the FSS service, taking into account Resolution **152 (WRC-12)**. Studies included consideration of utilizing existing allocations to the FSS through a review of regulatory provisions, except RR Nos. **5.502** and **5.503**.

Consideration is given to this band for possible primary allocations to FSS Earth-to-space operations.

4.1/1.6.2/4.3.1 FSS (Earth-to-space) and BSS feeder links

The analysis and results are the same as given in section 4.1/1.6.1/4.6.1.

4.1/1.6.2/4.3.2 FSS (Earth-to-space) sharing with the MS/AMS

The analysis and results are the same as given in section 4.1/1.6.1/4.6.3.

4.1/1.6.2/4.3.3 FSS (Earth-to-space) sharing with the FS

The analysis and results are the same as given in section 4.1/1.6.1/4.6.2.

4.1/1.6.2/4.3.4 FSS (Earth-to-space) sharing with the SRS

The analysis and results are the same as given in section 4.1/1.6.1/4.6.4.

4.1/1.6.2/4.3.5 Summary of studies for the band 14.5-14.8 GHz

The summary of studies is the same as given in section 4.1/1.6.1/4.6.8, but only with respect to parts of the summary that deal with FSS (Earth-to-space).

4.1/1.6.2/4.4 14.8-15.35 GHz band

Consideration is given to this band for possible primary allocations to FSS Earth-to-space operations. The band 14.8-15.35 GHz is currently allocated to the FS and MS on a primary basis and the SRS on a secondary basis.

4.1/1.6.2/4.4.1 FSS (Earth-to-space) sharing with the SRS

The analysis and results are the same as given in section 4.1/1.6.1/4.7.3.

4.1/1.6.2/4.4.2 FSS (Earth-to-space) sharing with the MS/AMS

The analysis and results are the same as given in section 4.1/1.6.1/4.6.3.

4.1/1.6.2/4.4.3 FSS (Earth-to-space) sharing with the FS

The analysis and results are the same as given in section 4.1/1.6.2/4.7.2.

4.1/1.6.2/4.4.4 Summary of studies for the band 14.8-15.35 GHz

The summary of studies is the same as given in section 4.1/1.6.1/4.7.6, but only with respect to parts of the summary that deal with FSS (Earth-to-space).

4.1/1.6.2/4.5 15.35-15.4 GHz band

The analysis and results are the same as given in section 4.1/1.6.1/4.8.

The frequency band 15.35-15.4 GHz was excluded from consideration of possibility to allocate additionally spectrum for GSO FSS in accordance with Resolution **152 (WRC-12)** in regard with the difficulty for compatibility between FSS (Earth-to-space) and passive services (EESS, SRS) and RAS, having allocations on a primary basis in this frequency band.

4.1/1.6.2/4.6 15.4-15.7 GHz band

Consideration is given to this band for possible primary allocations to FSS Earth-to-space operations. The band 15.4-15.43 is allocated to the RLS and ARNS on a primary basis. RR Nos. **5.511E**, **5.511F** and **5.511D** apply.

The band 15.43-15.63 is allocated to the FSS (Earth-to-space), RLS and ARNS on a primary basis. RR Nos. **5.511A**, **5.511E**, **5.511F**, and **5.511C** apply.

The band 15.63-15.7 GHz is allocated to the RLS and ARNS on a primary basis. RR Nos. **5.511E**, **5.511F** and **5.511D** apply.

The band 15.4-17.1 GHz is used by many different types of radars including land-based, transportable, shipboard and airborne platforms. Radiolocation functions performed in the band include airborne and surface search, surface surveillance, ground-mapping, terrain-following, maritime and target-identification. Radar operating frequencies can be assumed to be uniformly spread throughout each radar's tuning range. The major radiolocation radars operating or planned to operate in the band 15.7-16.6 GHz are primarily for detection of airborne objects and some are used for ground mapping. They are required to measure target altitude, range, bearing, and form terrain maps. Some of the airborne and ground targets are small and some are at ranges as great as 300 nautical miles (556 km), so these radiolocation radars must have great sensitivity and must provide a high degree of suppression to all forms of clutter return, including that from sea, land and precipitation. Some of the radars are used as the airport surveillance detection equipment (ASDE-3) to provide a tool to enhance the situational awareness of air traffic controllers in an effort to reduce runway incursions and aircraft collisions. These radars provide non-cooperative aeronautical surveillance including detection and position information for all aircraft and vehicles on the airport movement area.

Recommendation ITU-R M.1730-1 provides the characteristics of and protection criteria for the radiolocation service in the frequency band 15.4-17.3 GHz. This Recommendation recommends that the *I*/*N of* −6 dB should be used as the required protection level for the portions of the 15.4-17.3 GHz band where there is a radiolocation allocation and that this represents the net protection level if multiple interferers are present.

4.1/1.6.2/4.6.1 FSS (Earth-to-space) sharing with the RLS

The analysis and results are the same as given in section 4.1/1.6.1/4.9.1.1.

4.1/1.6.2/4.6.2 FSS (Earth-to-space) sharing with the ARNS

The analysis and results are the same as given in section 4.1/1.6.1/4.9.2.

4.1/1.6.2/4.6.3 Summary of studies for the band 15.4-15.7 GHz

The summary of studies is the same as given in section 4.1/1.6.1/4.9.3, but only with respect to parts of the summary that deal with FSS (Earth-to-space).

4.1/1.6.2/4.7 15.7-16.6 GHz band

Consideration is given to this band for possible primary allocations to FSS Earth-to-space operations. The band 15.7-16.6 GHz is allocated to the RLS on a primary basis. The band 15.7-17.3 is also allocated to the FS and MS in certain countries via RR No. **5.512**. Additional information on the use of this band by the RLS is provided in section 4.1/1.6.2/4.6.

4.1/1.6.2/4.7.1 FSS (Earth-to-space) sharing with the RLS

The analysis and results are the same as given in section 4.1/1.6.1/4.10.1.1.

4.1/1.6.2/4.7.2 Summary of studies for the band 15.7-16.6 GHz

The summary of studies is the same as given in section 4.1/1.6.1/4.10.2, but only with respect to parts of the summary that deal with FSS (Earth-to-space).

4.1/1.6.2/4.8 16.6-17 GHz band

Consideration is given to this band for possible primary allocations to FSS Earth-to-space operations. The band 15.7-16.6 GHz is allocated to the RLS on a primary basis. The band 15.7-17.3 is also allocated to the FS and MS in certain countries via RR No. **5.512**. Additional information on the use of this band by the RLS is provided in section 4.1/1.6.2/4.6.

4.1/1.6.2/4.8.1 FSS (Earth-to-space) sharing with the RLS

The analysis and results are the same as given in section 4.1/1.6.1/4.9.1.1.

4.1/1.6.2/4.8.2 Summary of studies for the band 16.6-17 GHz

The summary of studies is the same as given in section 4.1/1.6.1/4.11.2, but only with respect to parts of the summary that deal with FSS (Earth-to-space).

4.1/1.6.2/5 Method(s) to satisfy this part of the agenda item

The methods to satisfy the agenda item are considered below for each of the examined frequency bands. Therefore, each method should address all the concerned existing allocations in each examined frequency band. Each of the following methods suggest regulatory amendments (or no change) that would provide only for the use by GSO satellite networks.

The table below assign a method "letters" to each of the sub-bands as split in section 4.1/1.6.2/4 (Analysis of the results of studies). To avoid confusion between WRC-15 agenda items 1.6.1 and 1.6.2, the same "letters" are used for the same sub-band.

Sub-band frequency (GHz)	Assigned method "letters"
13.25-13.40	D
13.40-13.75	E
14.50-14.80	F
14.80-15.35	G
15.35-15.40	H
15.40-15.70	I
15.70-16.60	J
16.60-17.00	K

4.1/1.6.2/5.1 D: 13.25-13.4 GHz for FSS (Earth-to-space)

4.1/1.6.2/5.1.1 Method D1: No change to RR Article 5

Advantages:

– No impact on the existing services.

Disadvantages:

– The imbalance of spectrum between Earth-to-space and space-to-Earth FSS allocations would not be resolved.

4.1/1.6.2/5.2 E: 13.4-13.75 GHz for FSS (Earth-to-space)

4.1/1.6.2/5.2.1 Method E1: No change to RR Article 5

The description of this method is the same as in section 4.1/1.6.1/5.2.1.

4.1/1.6.2/5.2.2 Method E2: Make an allocation of 250 MHz in the 13.4-13.75 GHz band to the FSS (Earth-to-space) in Regions 2 and 3

The description of this method is the same as in section 4.1/1.6.1/5.2.2, except for the fact that an allocation for the FSS (Earth-to-space) of 250 MHz in Region 2 and 300 MHz in Region 3 is concerned.

4.1/1.6.2/5.3 F: 14.5-14.8 GHz for FSS (Earth-to-space)

4.1/1.6.2/5.3.1 Method F1: No change to RR Article 5

The description of this method is the same as in section 4.1/1.6.1/5.4.1.

4.1/1.6.2/5.3.2 Method F2: Modify the existing FSS allocation to support FSS uplinks that are not limited to BSS feeder links

The description of this method is the same as in section 4.1/1.6.1/5.4.2, except for the fact that an allocation for the FSS (Earth-to-space) of 250 MHz in Region 2 and 300 MHz in Region 3 is concerned.

4.1/1.6.2/5.4 G: 14.8-15.35 GHz for FSS (Earth-to-space)

4.1/1.6.2/5.4.1 Method G1: No change to RR Article 5

The description of this method is the same as in section 4.1/1.6.1/5.6.1.

4.1/1.6.2/5.4.2 Method G2: Allocate the 14.8-15.1 GHz frequency band to the FSS (Earth-to-space)

The description of this method is the same as in section 4.1/1.6.1/5.6.2, except for the fact that an allocation for the FSS (Earth-to-space) of 250 MHz in Region 2 and 300 MHz in Region 3 is concerned.

4.1/1.6.2/5.5 H: 15.35-15.4 GHz for FSS (Earth-to-space)

4.1/1.6.2/5.5.1 Method H1: No change to RR Article 5

Under this Method, there would be no additional allocations to the FSS in the Earth-to-space direction within the frequency range 15.35-15.4 GHz in Regions 2 and 3 and therefore no change to RR Article **5**.

Advantages:

– There would be no impact on existing services.

Disadvantages:

– The imbalance of spectrum between Earth-to-space and space-to-Earth FSS allocations would not be resolved.

4.1/1.6.2/5.6 I: 15.4-15.7 GHz for FSS (Earth-to-space)

4.1/1.6.2/5.6.1 Method I1: No change to RR Article 5

The description of this method is the same as in section 4.1/1.6.1/5.8.1.

4.1/1.6.2/5.7 J: 15.7-16.6 GHz for FSS (Earth-to-space)

4.1/1.6.2/5.7.1 Method J1: No change to RR Article 5

Under this Method, there would be no additional allocations to the FSS in the Earth-to-space direction within the frequency range 15.7-16.6 GHz in Regions 2 and 3 and therefore no change to RR Article **5**.

Advantages:

– There would be no impact on existing services.

Disadvantages:

– The imbalance of spectrum between Earth-to-space and space-to-Earth FSS allocations would not be resolved.

4.1/1.6.2/5.8 K: 16.6-17 GHz for FSS (Earth-to-space)

4.1/1.6.2/5.8.1 Method K1: No change to RR Article 5

Under this Method, there would be no additional allocations to the FSS in the Earth-to-space direction within the frequency range 16.6-17 GHz in Regions 2 and 3 and therefore no change to RR Article **5**.

Advantages:

– There would be no impact on existing services.

Disadvantages:

– The imbalance of spectrum between Earth-to-space and space-to-Earth FSS allocations would not be resolved.

4.1/1.6.2/6 Regulatory and procedural considerations

The regulatory and procedural considerations to satisfy the agenda item are considered below for each of the proposed methods defined in section 4.1/1.6.2/5.

It should be noted that apart from the method described in section 4.1/1.6.2/6.1, all other proposed methods implicitly assume suppression (SUP) of Resolution **152 (WRC-12)**.

4.1/1.6.2/6.1 Methods D1, E1, F1, G1, H1, I1, J1 and K1: No change to RR Article 5

NOC

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations
(See No. **2.1)**

SUP

RESOLUTION 152 (WRC-12)

Additional primary allocations to the fixed-satellite service in the Earth-to-space direction in frequency bands between 13-17 GHz in Region 2 and Region 3

4.1/1.6.2/6.2 E: 13.4-13.75 GHz for FSS (Earth-to-space)

4.1/1.6.2/6.2.1 Method E2

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations
(See No. **2.1**)

MOD

11.7-14 GHz

<table>
<tr><th colspan="3">Allocation to services</th></tr>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td colspan="3">13.4-13.745
EARTH EXPLORATION-SATELLITE (active)
RADIOLOCATION
SPACE RESEARCH MOD 5.501A
Standard frequency and time signal-satellite (Earth-to-space)
5.499 5.500 5.501 5.501B</td></tr>
<tr><td colspan="2">13.45-13.75
EARTH EXPLORATION-SATELLITE (active)
RADIOLOCATION
SPACE RESEARCH MOD 5.501A
Standard frequency and time signal-satellite (Earth-to-space)
5.499 5.500 5.501 5.501B</td><td>13.45-13.75
EARTH EXPLORATION-FIXED-SATELLITE (Earth-to-space) ADD 5.A162 ADD 5.162bis ADD 5.D162
RADIOLOCATION
SPACE RESEARCH MOD 5.501A
Standard frequency and time signal-satellite (Earth-to-space)
5.499 5.500 5.501 5.501B</td></tr>
<tr><td>13.54-13.75
EARTH EXPLORATION-SATELLITE (active)
RADIOLOCATION
SPACE RESEARCH MOD 5.501A
Standard frequency and time signal-satellite (Earth-to-space)
5.499 5.500 5.501 5.501B</td><td colspan="2">13.54-13.75
EARTH EXPLORATION-SATELLITE (active)
FIXED-SATELLITE (Earth-to-space) ADD 5.A162 ADD 5.A162bis ADD 5.D162
RADIOLOCATION
SPACE RESEARCH MOD 5.501A
Standard frequency and time signal-satellite (Earth-to-space)
5.499 5.500 5.501 5.501B
MOD 5.502 ~~ADD 5.B162~~</td></tr>
</table>

ADD

5.A162 In the band 13.45-13.75 GHz in Region 3 and in the band 13.5-13.75 GHz in Region 2, the peak envelope power delivered to the antenna of stations of the fixed-satellite service (Earth-to-space) shall not exceed the spectral density of −53.5 dB(W/Hz) computed from the peak envelope power and the occupied bandwidth. (WRC-15)

ADD

5.A162*bis* The use of the band 13.5-13.75 GHz in Region 2 and 13.45-13.75 GHz in Region 3 by the fixed-satellite service (Earth-to-space) is limited to geostationary-satellite systems.

ADD

5.D162 The use of the band 13.5-13.75 GHz in Region 2, the band 13.45-13.75 in Region 3 by systems in the fixed-satellite service (Earth-to-space) shall not cause harmful interference to, nor claim protection from, nor constrain the use and development of EESS (active) systems, and No. **22.2** does not apply. (WRC-15)

MOD

5.502 In the band 13.45-13.75 GHz in Region 3, in the band 13.5-13.75 GHz in Region 2 and in the band 13.75-14 GHz, an earth station of a geostationary fixed-satellite service network shall have a minimum antenna diameter of 1.2 m. In the band 13.75-14 GHz, ~~and~~ an earth station of a non-geostationary fixed-satellite service system shall have a minimum antenna diameter of 4.5 m. In addition, the e.i.r.p., averaged over one second, radiated by a station in the radiolocation or radionavigation services shall not exceed 59 dBW for elevation angles above 2° and 65 dBW at lower angles. Before an administration brings into use an earth station in a geostationary-satellite network in the fixed-satellite service in this band with an antenna diameter smaller than 4.5 m, it shall ensure that the power flux-density produced by this earth station does not exceed:

– −115 dB(W/(m^2 · 10 MHz)) for more than 1% of the time produced at 36 m above sea level at the low water mark, as officially recognized by the coastal State;

– −115 dB(W/(m^2 · 10 MHz)) for more than 1% of the time produced 3 m above ground at the border of the territory of an administration deploying or planning to deploy land mobile radars in this band, unless prior agreement has been obtained.

For earth stations within the fixed-satellite service having an antenna diameter greater than or equal to 4.5 m, the e.i.r.p. of any emission should be at least 68 dBW and should not exceed 85 dBW. (WRC-~~03~~15)

MOD

5.501A The allocation of the band 13.4-13.75 GHz to the space research service on a primary basis is limited to active spaceborne sensors, as well as satellite systems, operating in the space research service (space-to-Earth, space-to-space) to relay data from space stations in the geostationary-satellite orbit to associated earth stations and space stations in the non-geostationary-satellite orbit, for which information for advance publication has been received by the Bureau prior to 27 November 2015. Other uses of the band by the space research service are on a secondary basis. (WRC-~~97~~15)

APPENDIX 7 (REV.WRC-12)

Methods for the determination of the coordination area around an earth station in frequency bands between 100 MHz and 105 GHz

ANNEX 7

System parameters and predetermined coordination distances for determination of the coordination area around an earth station

MOD

TABLE 7B (REV.WRC-~~12~~15)

Parameters required for the determination of coordination distance for a transmitting earth station

Transmitting space radiocommunication service designation		**Fixed-satellite, mobile-satellite**	**Aero-nautical mobile-satellite (R) service**	**Aero-nautical mobile-satellite (R) service**	**Fixed-satellite**	**Fixed-satellite**	**Fixed-satellite**	**Fixed-satellite**		**Space operation, space research**		**Fixed-satellite, mobile-satellite, meteorological-satellite**		**Fixed-satellite**		**Fixed-satellite**		**Fixed-satellite** [3]	**Fixed-satellite**	**Fixed-satellite** [3]
Frequency bands (GHz)		2.655-2.690	5.030-5.091	5.030-5.091	5.091-5.150	5.091-5.150	5.725-5.850	5.725-7.075		7.100-7.235 [5]		7.900-8.400		10.7-11.7		12.5-14.8		13.~~7~~4-14.3	15.43-15.65	17.7-18.4	19.3-19.7
Receiving terrestrial service designations		Fixed, mobile	Aeronautical radio-navigation	Aeronautical mobile (R)	Aeronautical radio-navigation	Aeronautical mobile (R)	Radiolocation	Fixed, mobile		Fixed, mobile		Fixed, mobile		Fixed, mobile		Fixed, mobile		Radiolocation radionavigation (land only)	Aeronautical radionavigation	Fixed, mobile	Fixed, mobile
Method to be used		§ 2.1	§ 2.1, § 2.2	§ 2.1, § 2.2			§ 2.1	§ 2.1		§ 2.1, § 2.2		§ 2.1		§ 2.1		§ 2.1, § 2.2		§ 2.1		§ 2.1, § 2.2	§ 2.2
Modulation at terrestrial station [1]		A						A	N	A	N	A	N	A	N	A	N	–		N	N
Terrestrial station interference parameters and criteria	p_0 (%)	0.01						0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.01		0.005	0.005
	n	2						2	2	2	2	2	2	2	2	2	2	1		2	2
	p (%)	0.005						0.005	0.0025	0.005	0.0025	0.005	0.0025	0.005	0.0025	0.005	0.0025	0.01		0.0025	0.0025
	N_L (dB)	0						0	0	0	0	0	0	0	0	0	0	0		0	0
	M_S (dB)	26 [2]						33	37	33	37	33	37	33	40	33	40	1		25	25
	W (dB)	0						0	0	0	0	0	0	0	0	0	0	0		0	0
Terrestrial station parameters	G_x (dBi) [4]	49 [2]	6	10	6	6		46	46	46	46	46	46	50	50	52	52	36		48	48
	T_e (K)	500 [2]						750	750	750	750	750	750	1 500	1 100	1 500	1 100	2 636		1 100	1 100
Reference bandwidth	B (Hz)	4×10^3	150×10^3	37.5×10^3	150×10^3	10^6		4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	10^7		10^6	10^6
Permissible interference power	$P_r(p)$ (dBW) in B	−140	−160	−157	−160	−143		−131	−103	−131	−103	−131	−103	−128	−98	−128	−98	−131		−113	−113

4.1/1.6.2/6.3 F: 14.5-14.8 GHz for FSS (Earth-to-space)

4.1/1.6.2/6.3.1 Method F2

See section 4.1/1.6.1/6.5.1 for the regulatory and procedural considerations for this method.

4.1/1.6.2/6.4 G: 14.8-15.35 GHz for FSS (Earth-to-space)

4.1/1.6.2/6.4.1 Method G2

ARTICLE 5

Frequency allocations

Section IV – Table of Frequency Allocations
(See No. **2.1**)

MOD

14-15.4 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
14.5-14.8	FIXED FIXED-SATELLITE (Earth-to-space) 5.510 MOBILE Space research	
14.8-15.~~30~~5 FIXED MOBILE Space research 5.339 ADD 5.C162	**14.8-15.~~30~~5** FIXED FIXED-SATELLITE (Earth-to-space) ADD 5.C162*bis* MOBILE Space research 5.339 ADD 5.C162	
14.~~8~~5.05-15.~~35~~1 FIXED MOBILE Space research 5.339 ADD 5.C162		**14.~~8~~5.05-15.~~35~~1** FIXED FIXED-SATELLITE (Earth-to-space) ADD 5.C162*bis* MOBILE Space research 5.339 ADD 5.C162
14.~~8~~5.1-15.35	FIXED MOBILE Space research 5.339	

ADD

5.C162 The band 14.8-15.1 GHz is also allocated to the space research service on a primary basis. However, such use is limited to geostationary-satellite systems, operating in the space research service (Earth-to-space and space-to-space) to relay data to space stations in the geostationary-satellite orbit from associated earth stations and space stations in the non-geostationary-satellite orbit, as well as non-geostationary-satellite systems, operating in the space research service (space-to-Earth), for which information for advance publication has been received by the Bureau prior to 27 November 2015. Stations in the space research service shall not cause harmful interference to nor claim protection from stations in the fixed and mobile services. (WRC-15)

ADD

5.C162*bis* The use of the band 14.8-15.05 GHz in Region 2 and 14.8-15.1 GHz in Region 3 by the fixed-satellite service (Earth-to-space) is limited to geostationary-satellite systems, which shall not claim protection from non-geostationary-satellite systems in the space research service (space-to-Earth), for which information for advance publication has been received by the Bureau prior to 27 November 2015. No. **5.43A** and No. **22.2** do not apply. (WRC-15)

APPENDIX 5 (REV.WRC-12)

Identification of administrations with which coordination is to be effected or agreement sought under the provisions of Article 9

MOD

TABLE 5-1 (Rev.WRC-~~12~~15)

Technical conditions for coordination
(see Article **9**)

Reference of Article 9	Case	Frequency bands (and Region) of the service for which coordination is sought	Threshold/condition	Calculation method	Remarks
No. **9.7** GSO/GSO	A station in a satellite network using the geostationary-satellite orbit (GSO), in any space radiocommunication service, in a frequency band and in a Region where this service is not subject to a Plan, in respect of any other satellite network using that orbit, in any space radiocommunication service in a frequency band and in a Region where this service is not subject to a Plan, with the exception of the coordination between earth stations operating in the opposite direction of transmission	1) 3 400-4 200 MHz 5 725-5 850 MHz (Region 1) and 5 850-6 725 MHz 7 025-7 075 MHz	i) Bandwidth overlap, and ii) any network in the fixed-satellite service (FSS) and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±8° of the nominal orbital position of a proposed network in the FSS		With respect to the space services listed in the threshold/condition column in the bands in 1), 2), 3), 4), 5), 6), 7) and 8), an administration may request, pursuant to No. **9.41**, to be included in requests for coordination, indicating the networks for which the value of $\Delta T/T$ calculated by the method in § 2.2.1.2 and 3.2 of Appendix **8** exceeds 6%. When the Bureau, on request by an affected administration, studies this information pursuant to No. **9.42**, the calculation method given in § 2.2.1.2 and 3.2 of Appendix **8** shall be used
		2) 10.95-11.2 GHz 11.45-11.7 GHz 11.7-12.2 GHz (Region 2) 12.2-12.5 GHz (Region 3) 12.5-12.75 GHz (Regions 1 and 3) 12.7-12.75 GHz (Region 2) and 13.75-14.~~-~~5 GHz	i) Bandwidth overlap, and ii) any network in the FSS or broadcasting-satellite service (BSS), not subject to a Plan, and any associated space operation functions (see No. **1.23**) with a space station within an orbital arc of ±7° of the nominal orbital position of a proposed network in the FSS or BSS, not subject to a Plan		
		3) 14.8-15.1 GHz	i) Bandwidth overlap, and ii) any network in the space research service (SRS) or FSS and any associated		

			space operation functions (see No. **1.23**) with a space station within an orbital arc of ±7° of the nominal orbital position of a proposed network in the FSS		

APPENDIX 7 (REV.WRC-12)

Methods for the determination of the coordination area around an earth station in frequency bands between 100 MHz and 105 GHz

ANNEX 7

System parameters and predetermined coordination distances for determination of the coordination area around an earth station

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TABLE 7B (REV.WRC-~~12~~15)

Parameters required for the determination of coordination distance for a transmitting earth station

Transmitting space radiocommunication service designation		**Fixed-satellite, mobile-satellite**	**Aero-nautical mobile-satellite (R) service**	**Aero-nautical mobile-satellite (R) service**	**Fixed-satellite**	**Fixed-satellite**	**Fixed-satellite**	**Fixed-satellite**		**Space operation, space research**		**Fixed-satellite, mobile-satellite, meteorological-satellite**		**Fixed-satellite**		**Fixed-satellite**		**Fixed-satellite** [3]	**Fixed-satellite**	**Fixed-satellite** [3]
Frequency bands (GHz)		2.655-2.690	5.030-5.091	5.030-5.091	5.091-5.150	5.091-5.150	5.725-5.850	5.725-7.075		7.100-7.235 [5]		7.900-8.400		10.7-11.7		12.5-1~~2~~5.1~~4~~.~~8~~		13.75-14.3	15.43-15.65	17.7-18.4	19.3-19.7
Receiving terrestrial service designations		Fixed, mobile	Aeronautical radio-navigation	Aeronautical mobile (R)	Aeronautical radio-navigation	Aeronautical mobile (R)	Radiolocation	Fixed, mobile		Fixed, mobile		Fixed, mobile		Fixed, mobile		Fixed, mobile		Radiolocation radionavigation (land only)	Aeronautical radionavigation	Fixed, mobile	Fixed, mobile
Method to be used		§ 2.1	§ 2.1, § 2.2	§ 2.1, § 2.2			§ 2.1	§ 2.1		§ 2.1, § 2.2		§ 2.1		§ 2.1		§ 2.1, § 2.2		§ 2.1		§ 2.1, § 2.2	§ 2.2
Modulation at terrestrial station [1]		A						A	N	A	N	A	N	A	N	A	N	–		N	N
Terrestrial station interference parameters and criteria	p_0 (%)	0.01						0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.01		0.005	0.005
	n	2						2	2	2	2	2	2	2	2	2	2	1		2	2
	p (%)	0.005						0.005	0.0025	0.005	0.0025	0.005	0.0025	0.005	0.0025	0.005	0.0025	0.01		0.0025	0.0025
	N_L (dB)	0						0	0	0	0	0	0	0	0	0	0	0		0	0
	M_S (dB)	26 [2]						33	37	33	37	33	37	33	40	33	40	1		25	25
	W (dB)	0						0	0	0	0	0	0	0	0	0	0	0		0	0
Terrestrial station parameters	G_x (dBi) [4]	49 [2]	6	10	6	6		46	46	46	46	46	46	50	50	52	52	36		48	48
	T_e (K)	500 [2]						750	750	750	750	750	750	1 500	1 100	1 500	1 100	2 636		1 100	1 100
Reference bandwidth	B (Hz)	4×10^3	150×10^3	37.5×10^3	150×10^3	10^6		4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	4×10^3	10^6	10^7		10^6	10^6
Permissible interference power	$P_r(p)$ (dBW) in B	−140	−160	−157	−160	−143		−131	−103	−131	−103	−131	−103	−128	−98	−128	−98	−131		−113	−113