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|  | | CPG15(15)084 Annex IV-11 |
| Norway, Bergen, 14th - 18th September 2015 | | |  |
|  | | |  |
| Date issued: | | 18th September 2015 | |
| Source: | | Minutes CPG15-8 | |

CEPT BRIEF ON AGENDA ITEM 1.10

1.10 to consider spectrum requirements and possible additional spectrum allocations for the mobile-satellite service in the Earth-to-space and space-to-Earth directions, including the satellite component for broadband applications, including International Mobile Telecommunications (IMT), within the frequency range from 22 GHz to 26 GHz, in accordance with Resolution 234 (WRC-12);

# ISSUE

“to complete, for WRC 15, sharing and compatibility studies towards additional allocations to the mobile-satellite service in the Earth-to-space and space-to-Earth directions, within portions of the bands between 22 GHz and 26 GHz, while ensuring protection of existing services within these bands as well as taking into account No. 5.340 and No. 5.149”.

# CEPT position

While CEPT notes the development in Ka band of satellite applications used in mobility, CEPT does not support MSS allocations under this Agenda Item because, among the bands considered by ITU-R within the frequency range 22 to 26 GHz, studies have shown incompatibly with some existing services in certain cases (e.g. in the frequency bands 22.65-22.95 GHz, 23.15-23.4 GHz, 25.25-25.5 GHz) while they have not been completed in other cases (e.g. in the frequency band 24.25-24.55 GHz).

# Background

The frequency range 22 to 26 GHz is allocated to a large number of radio services on primary and secondary basis with numerous major utilisations within CEPT, as given in ERC Report 25. Regarding the allocations to radio services on a primary basis the following services can be found in the Table of Allocations of Article 5 of the Radio Regulations as amended at WRC-15 (see Table 1):

Table 1: Primary allocations in the frequency range 22-26 GHz

|  |  |
| --- | --- |
| Frequency Band | Radio Service |
| 24-24.05 GHz | Amateur |
| 24-24.05 GHz | Amateur-Satellite |
| 22.21-22.5 GHz (passive), 23.6-24 GHz (passive), 25.5-27 GHz (s-E) | Earth Exploration-Satellite |
| 22-23.6 GHz, 24.25-25.25 GHz (Regions 1 and 3), 25.25-27 GHz | Fixed |
| 24.65-24.75 GHz (E-s) (Regions 1 and 3); 24.75-25.25 GHz (E-s) | Fixed-Satellite (Earth-to-space) |
| 22.55-23.55 GHz, 24.45-24.75 GHz, 25.5-27 GHz | Inter-Satellite |
| 22-23.6 GHz; 24.25-25.25 GHz (Region 3), 25.25‑27 GHz | Mobile |
| 22.21-22.5 GHz, 23.6-24 GHz | Radio Astronomy |
| 24.05 24.25 GHz | Radiolocation |
| 24.25-24.65 GHz (Regions 2 and 3) | Radionavigation |
| 24.65-24.75 (E-s) (Region 2) | Radiolocation-Satellite |
| 22.21-22.5 GHz (passive), 22.55-23.15 GHz (E-s), 23.6-24 GHz (passive), 25.5 -27 GHz (s-E) | Space Research |

For radio services on a secondary basis the Table of Allocations in Article 5 provides the following entries (see Table 2):

Table 2: Secondary allocations in the frequency range 22-26 GHz

|  |  |
| --- | --- |
| Frequency Band | Radio Service |
| 24.05-24.25 GHz | Amateur |
| 24.05-24.25 GHz (active) | Earth Exploration-Satellite |
| 25.25-27 GHz (E-s) | Standard Frequency and Time Signal-Satellite |

In addition, it is stated in the Radio Regulations that in making assignments to stations of other services to which the bands 22.01-22.21 GHz, 22.21-22.5 GHz, 22.81-22.86 GHz and 23.07-23.12 GHz are allocated, administrations are urged to take all practicable steps to protect the radio astronomy service from harmful interference. Emissions from space borne or airborne stations can be particularly serious sources of interference to the radio astronomy service (see provision 5.149).

In accordance with the NATO Joint civil/military Frequency Agreement 2014 as of 19.02.2015, the frequency band 24.05-24.25 GHz is used for radiolocation purposes and the frequency band 25.25-27.5 GHz is used for various applications of the fixed and mobile service, which serve communications in and between the nations.

Furthermore, within Europe the frequency range 21.65-26.65 GHz has been designated for short range radar (SRR) applications. The frequency range 21.65-24.25 GHz is available until 30 June 2013 while the frequency range 24.25-26.65 GHz is available until 01 January 2018. The latter date is extended by 4 years for automotive short range radars applications for which type-approval application has been submitted and has been granted before 01 January 2018. Furthermore, the frequency range 24.05-27 GHz has been designated for tank level probing radar applications. The operation of devices of the aforementioned radio applications is permitted through ECC- and EU-Decision. They operate on a non-interference, non-protected basis and must comply with general requirements given in those Decisions.

## Estimated future spectrum requirements in the frequency range 22 to 26 GHz

Resolution 234 (WRC-12) “Additional primary allocations to the mobile-satellite service within the bands from 22 GHz to 26 GHz”, in its considering part states that ITU-R has studied the spectrum requirements for the satellite component of International Mobile Telecommunications (IMT) for the period 2010-2020, and the results are contained in Report ITU-R M.2077. The results in Report ITU-R M.2077 indicate a shortfall of spectrum available for the satellite component of IMT in the Earth-to-space direction of between 19 MHz and 90 MHz by the year 2020. The results in Report ITU-R M.2077 indicate a shortfall of spectrum available for the satellite component of IMT in the space-to-Earth direction of between 144 MHz and 257 MHz by the year 2020. MSS systems which are not part of the satellite component of IMT may also require additional spectrum. However, Report ITU-R M.2077 does focus on the frequency range 1-6 GHz.

ITU-R has also studied the spectrum requirements for MSS broadband applications by the year 2020, and the results are contained in Report ITU-R M.2218. The results in Report ITU-R M.2218 indicate a shortfall of spectrum for MSS broadband applications of between 240 MHz and 335 MHz by the year 2020 in both the space-to-Earth and Earth-to-space directions. Resolution 234 (WRC‑12) in its recognizing part, also states “that no allocations were made for the mobile-satellite service in the range 4-16 GHz at WRC-12, and therefore the shortfall of spectrum for satellite IMT and broadband applications still needs to be addressed”.

ITU-R WP 4C develops Report ITU-R M.[MSS KA\_REQ] on traffic forecasts and estimated spectrum requirements for the future development of broadband applications of the mobile-satellite service in the frequency range 22-26 GHz. In the introductory part of this Working Document towards a preliminary Report it is stated the spectrum demand estimates in Report ITU-R M.2077 are inapplicable to the frequency range 22-26 GHz. Further, that the type of MSS user envisioned for the frequency range 22-26 GHz is completely different from the user that formed the basis of Report ITU-R M.2218. The spectrum demand estimates in Report ITU-R M.2218 are therefore also inapplicable to the frequency range 22-26 GHz. However, some administrations are of the view that the new preliminary draft Report is outside the scope of WRC-15 agenda item 1.10 as Resolution 234 (WRC-12) does not call to calculate spectrum requirements and that it is irrelevant to this resolution and agenda item. Further, they are of the believe that the spectrum requirements have been already identified by ITU-R as indicated in Resolution 234 (WRC-12). This Report has not seen much progress apart from some initial work in the study cycle 2012-2015.

CEPT is of the view that insufficient studies have been presented to ITU to quantify the amount of spectrum required for additional MSS allocations in the frequency range 22 to 26 GHz. Taking into account the studies carried out to date, the mobility-related markets meant to be served by proposed MSS systems operating in the frequency bands between 22-26 GHz can be better served by Ka-band FSS Earth Stations on Mobile Platforms. Consequently, changes to the Radio Regulations as envisioned for Agenda Item 9, Issue 2, are a more efficient and effective way of addressing the current demand for mobility-related applications aimed to be addressed under Agenda Item 1.10.

## General sharing considerations

For the protection of the incumbent services it is necessary to carry out sharing and compatibility studies with characteristics of potential MSS systems to facilitate the identification of frequency bands in the range 22‑26 GHz suitable for additional allocations for the MSS.

When identifying candidate bands for MSS up- and downlinks the following issues may need to be taken into consideration:

Within CEPT a number of ECC Decision, Recommendations and Reports have been developed to harmonise the use of a wide range of applications in the frequency range 22-26 GHz. Furthermore, for the Member States of the European Union a number of Commission Decisions and CEPT Reports have been developed. The relevant documents can be found in the section list of relevant documents.

### Sharing with the Amateur Service

Although only low activity in the amateur service in the frequency bands 24-24.05 GHz and 24.05-24.25 GHz could be observed, there are characteristics of amateur systems for Morse on-off keying in Table 1 and characteristics of amateur analogue voice systems in Table 3 of Recommendation ITU-R M.1732 available which can be used in sharing and compatibility studies. It should be noted that the latter frequency band is allocated to the amateur service on a secondary basis.

In Region 1, and globally for Earth-Moon-Earth communication, the frequency 24.0481 GHz is used as the narrow-band calling frequency. In the United States of America the frequency 24.1921 GHz is used as the narrow-band calling frequency.

No sharing/compatibility studies have been performed yet.

### Sharing with the Amateur-Satellite Service

The frequency band 24-24.05 GHz is allocated to the amateur-satellite service on a primary basis. No activity in this service could be observed in the frequency band 24-24.05 GHz. However, characteristics of amateur-satellite systems in the Earth-to-space direction for different modes of operation can be found in Tables 5 and 6 of Recommendation ITU-R M.1732 which can be used in sharing and compatibility studies. A satellite project is planned in this band in the near future.

No sharing/compatibility studies have been performed yet.

### Sharing with the Earth Exploration-Satellite Service

The frequency bands 22.21-22.5 GHz and 23.6-24 GHz are allocated to the earth-exploration service (EESS) (passive). In the latter frequency band all emissions are prohibited (see provision 5.340 of the Radio Regulations). Both frequency bands are allocated on a primary basis.

The frequency band 25.5-27 GHz is allocated to the EESS (space-to-Earth) and is used for data links for EESS payloads. Relevant sharing criteria for this service are given in Recommendation ITU-R SA.1027. Studies have been performed with SRS receiving Earth stations tracking non-GSO SRS satellites and are reported in section 3.2.12. These studies, using protection criteria given in Recommendation ITU-R SA.609 show no compatibility between MSS downlink and SRS. Since the sharing criteria in Recommendation ITU-R SA.1027 are globally more stringent than the protection criteria in Recommendation ITU-R SA.609, it is expected that similar conclusions would apply to the EESS (space to-Earth). With regard to MSS uplinks, it has been shown that separation distances larger than 330 km would be required for SRS. These distances would even be larger when considering EESS.

Furthermore, the frequency band 24.05-24.25 GHz is allocated to the earth-exploration service (active) on a secondary basis.

Regarding the EESS (passive), two studies were performed and included in the ITU-R Report on MSS sharing and compatibility studies. One study addressed the potential impact of unwanted emissions from MSS (s-E) in the frequency band 23.15-23.4 GHz on EESS in the frequency Band 23.6-24.0 GHz, while the other study addressed the potential impact of unwanted emissions from MSS (E-s) in the frequency band 24.25-24.45 GHz on EESS (passive) in the frequency band 23.6-24.0 GHz. However, due to incorrect assumptions with regard to the EESS measurement area, no conclusion was drawn regarding the compatibility of MSS (s-E) and the MSS (E-s) operating in 23.15-23.4 GHz and the 24.25-24.45 GHz, respectively, and EESS (passive) in 23.6-24 GHz. The Report further notes that these studies of the potential impact of MSS unwanted emissions on EESS (passive) were incorporated into the Report without the opportunity for the ITU-R EESS (passive) expert working party to review and comment on the contents or conclusions of this study prior to WRC 15.

No further explicit sharing/compatibility studies with regard to the EESS, in particular EESS (passive), have been performed yet.

### Sharing with the Fixed Service

The frequency bands 22-23.6 GHz (23 GHz band) and 24.25-27 GHz (26 GHz band), with the exception of the band 24.25-25.25 GHz in Regions 2, are allocated to the fixed service on a primary basis. Within ITU‑R, a range of recommendations provide information on the characteristics and the protection criteria of the fixed service in the relevant frequency bands. Recommendation ITU-R F.758 contains the appropriate fixed service characteristics for sharing and compatibility studies between fixed service and other services. Recommendations ITU-R F.699, ITU-R F.1245, and ITU-R F.1336 provide fixed system antenna patterns to be used in relevant studies. Recommendations ITU-R F.637 and ITU-R F.748 provide the requisite channelling arrangements for fixed systems between 22-26 GHz.

ERC Technical Recommendation T/R 13-2 recommends a range of channel arrangements for the harmonised use frequencies by paired radio-relay systems with different carrier spacing in the frequency bands 22.0-22.6 GHz and 23.0-23.6 GHz, including those making use of frequencies in the centre-gap in the frequency bands 22.6-22.75 GHz and 22.84-23.0 GHz, as well as unpaired radio-relay systems in the frequency band 22.75-22.84 GHz.

In Europe, but also in a number of countries outside Europe, the frequency bands are extensively used by fixed links to provide the infrastructure requirements for existing 2G and 3G mobile networks and to develop broadband fixed wireless networks. It can be seen from ECC Report 173 that in the frequency bands 22-23.6 GHz and 24.5-26.5 GHz there are many thousands of operational FS links across CEPT. These FS links would limit or preclude operation of MSS earth stations across these bands.

ECC Report 173 indicates that the frequency band 24.25-24.5 GHz are insignificantly used by the fixed service, noting that “this band is poorly used (10 administrations gave an answer), less than 100 links, both for P-P and Base Stations, have been declared. Licensing regime appears link by link or block based, in relation to use (P-P or P-MP)”.

In the case of additional MSS allocations (space-to-Earth) in the frequency bands allocated to the fixed service, the results of a probabilistic analysis shows that hard pfd limit at the Earth’s surface would need to be applied to emissions from the space stations:

Table 3: Hard limits for the protection of the Fixed Service

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Frequency Band | Service | Limit in dB(W/m²) for angles of arrival(δ) above the horizontal plane | | | Reference bandwidth |
| 0° - 5 ° | 5° - 25° | 25° - 90° |
| Relevant band  (in the range 22-26 GHz, if allocated) | Mobile-satellite service  (space-to-Earth) | -125 | -125 + 0,5(δ - 5) | -115 | 1 MHz |

As for the frequency band 23.15-23.55 GHz, the current limits at the Earth surface are specified there for pfd of emissions from GSO space stations operating in the Inter-Satellite service. Those limits exceed the values shown in Table 3 by 10 dB. This suggests once again that the stations in the Fixed service would be reliably protected.

For an additional allocation to the MSS (Earth-to-space), a separation distance would be required between GSO MES and FS receiving station. In the case where an antenna of a transmitting MES and the antenna or a FS receiving station are pointing towards each other, and there are no any obstacles along the signal propagation path, the separation distances calculated in accordance with Recommendation ITU-R P.452 will reach several tens of km. In the case of AES, the required separation distance will be determined by the visibility limits between the aircraft and FS receiving station. Taking into account the large number of existing FS stations in some frequency bands, such separation distances could make operations of MES/AES impossible in the whole territory of a country in these bands.

The existing provisions of RR can be applied to provide protection for the existing FS stations which are used for data transmission between base stations in the existing 2G and 3G mobile networks from the emissions created by transmitting MSS earth stations. In particular No.9.17 of Appendix 7 can be applied for determination of the coordination distances.

As mentioned above, the frequency band 24.25-24.5 GHz is not heavily used by the Fixed service stations therefore provisions in Article 9 and Appendix 7 may be applied to this frequency band when it is used in Earth-to-space direction.

One study on the sharing between earth stations on vessels of potential new MSS systems and the fixed service in the frequency range 22-26 GHz concludes that a separation distance of 70 km between the fixed service station and the earth station on board a vessel is required to protect the fixed service. However, this study addressing sharing between the MSS and the fixed service was incorporated into the MSS sharing and compatibility report without the opportunity for Working Party 5C to review and comment on the contents or conclusions of this study prior to WRC 15.

Studies up to date do not address AES operations. In addition, no studies have been performed with regard to interference from FS systems into potential MES.

### Sharing with the Fixed-Satellite Service

The frequency bands 24.65-24.75 GHz in Regions 1 and 3 and 24.75-25.25 GHz in all Regions are allocated to the fixed-satellite service (Earth-to-space) on a primary basis for feeder links in the broadcasting-satellite service (BSS). They are commonly used to provide feeder links for the BSS networks in all Regions and for some multimedia systems in Region 2. Feeder links for BSS are characterized by a relatively small number of large earth stations in known locations. Earth station antennas in the frequency band 24.65-25.25 GHz in Region 1 and earth stations in the frequency band 24.65-24.75 GHz in Region 3 are limited to a minimum diameter of 4.5 m.

The following recommendations and reports are applicable to the FSS in these bands:

* Recommendation ITU-R S.465 – Reference radiation pattern of earth station antennas in the fixed satellite service for use in coordination and interference assessment in the frequency range 2 to 31 GHz.
* Recommendation ITU-R S.1323 – Maximum permissible levels of interference in a satellite network (GSO/FSS; non-GSO/FSS; non-GSO/MSS feeder links) in the fixed satellite service caused by other co-directional FSS networks below 30 GHz.
* Recommendation ITU-R S.1432 – Apportionment of the allowable error performance degradations to fixed-satellite service (FSS) hypothetical reference digital paths arising from time invariant interference for systems operating below 30 GHz.
* Recommendation ITU-R S.1716 – Performance and availability objectives for fixed satellite service telemetry, tracking, and command systems.
* Report ITU-R BO.2071 – BSS system parameters between 17.3 GHz and 42.5 GHz and associated feeder links.

No sharing/compatibility studies have been performed yet.

### Sharing with the Inter-Satellite Service

The frequency bands 22.55-23.55, 24.45-24.75 and 25.25-27.0 GHz are allocated to the inter-satellite service (ISS) on a primary basis.

The bands 22.55-23.15 and 23.15-23.55 GHz are used for transmissions from data relay satellites in geostationary satellite orbits to user spacecraft in non-geostationary satellite orbits performing space research, Earth exploration-satellite service applications, and between satellites in the HIBLEO-2 non-GSO MSS constellation. The inter-satellite service allocation in the band 25.25-26 GHz is limited to the space research and Earth exploration-satellite service applications by No. 5.536 and is used for transmissions from user spacecraft in non-geostationary satellite orbit to data relays in geostationary satellite orbits.

Altogether, six sharing scenarios were considered with the following results:

* for the band 22.55-23.15 GHz

The operation of MSS will create a potential for harmful interference to ISS links supporting the SRS and EESS applications. To protect ISS links from MSS downlinks orbital separations of at least 2 degrees would be needed between GSO data relay satellite orbital position and the nearest MSS satellite depending on the required MSS link availability. To protect ISS links from MSS uplinks specific MSS orbital locations would be precluded for each DRS orbital location.

* for the band 23.15-23.55 GHz

The analysis for the HIBLEO-2 ISS links in the frequency band 23.15-23.55 GHz shows the potential for very large I/N values to occur during co-frequency interference events in which an HIBLEO-2 satellite is within the main beam of the GSO MSS user terminal transmission.

The operation of the MSS will create a potential for harmful interference to ISS links supporting the SRS and EESS applications. To protect ISS links from MSS downlinks orbital separations of at least 2 degrees would be needed to provide for the required MSS link availability of 99% between a GSO data relay satellite orbital position and the nearest MSS satellites. To protect ISS links from MSS uplinks specific MSS orbital locations would be precluded for each DRS orbital location.

It is being suggested that the protection of stations in the inter-satellite service connected to GSO networks is ensured by application of the current provisions of Article 9 (in particular No. 9.7) and also by meeting the e.i.r.p. limits defined for the protection of NGSO to NGSO ISS links. However, the maximum MSS satellite e.i.r.p. density level in the proposed mask would result in the need for very large orbital separations to ensure protection of data relay satellites (DRS) GSO-NGSO, making coordination under No. 9.7 impractical and potentially precluding future DRS satellite deployments. In addition, on the basis of the current rules of procedure, No. 9.7 coordination does not address protection of ISS NGSO receivers operating in the direction from GSO to NGSO from MSS GSO satellite emissions in the 23.15-23.55 GHz band since inter-satellite links between GSO data relay satellites and the NSGO DRS user satellites are not subject to coordination under Section II of Article 9.

Further, currently provisions of Article 9 do not provide coordination procedures covering geostationary satellites with non-GSO to non-GSO inter-satellite service links. However, to provide compatibility of the MSS in the frequency band 23.15-23.55 GHz with the receiving station of ISS in the direction NGSO to NGSO there e.i.r.p. limits shall be met.

Table 4: MSS EIRP limiting mask to meet I/N = -10 dB criterion in 0.1% of the time

|  |  |
| --- | --- |
| Off-nadir angle | Max MSS satellite EIRP |
| 0° ≤ϕ≤ 8.7° | 46.5 dB(W/MHz) |
| 8.7° <ϕ< 9,25° | 46.5+62log(9.7-ϕ) dB(W/MHz) |
| ϕ≥ 9,25° (up to 90°) | 25 dB(W/MHz) |

* for the band 25.25-25.5 GHz

In order to protect ISS links supporting the SRS and EESS applications, a minimum orbital separation of +/-7 degrees is required between each of 32 GEO data relay orbital locations and any MSS satellite, resulting in only 97 degrees of available orbital arc.

It is suggested that the protection of stations in the inter-satellite service may be ensured by application of the current provisions of RR Article 9 (in particular No. 9.7). (Note: +/- 7 degrees of orbital arc separation is needed around each of the 32 DRS satellite locations). ). However, on the basis of the current rules of procedure, RR No. 9.7 coordination does not address protection of DRS GSO receivers operating in the direction from NGSO to GSO from MSS earth station emissions in the 25.25-25.5 GHz band since inter-satellite links between GSO data relay satellites and the NSGO DRS user satellites are not subject to coordination under Section II of Article 9.Interference into MSS earth station receivers in 23.15-23.4 GHz and MSS satellite receivers in 25.25-25.5 from all incumbent services has not been studied. Therefore, it is unclear whether the MSS will be able to use the new allocation without suffering harmful interference from current and future incumbent service operations. In particular, RR No. 9.7 coordination does not address protection of MSS GSO satellite receivers in the 25.25-25.5 GHz band from ISS NGSO transmitters operating in the direction NGSO-GSO.

### Sharing with the Mobile Service

The frequency ranges 22-23.6 GHz and 25.25-27 GHz are allocated to the mobile service on a primary basis in Regions 1 to 3, while the frequency range 24.25-25.25 GHz is allocated to the mobile service on a primary basis in Region 3 only. For the protection of the mobile service the following ITU-R Recommendations and Reports are applicable:

* Recommendation ITU-R F.758 “System parameters and considerations in the development of criteria for sharing or compatibility between digital fixed wireless systems in the fixed service and systems in other services and other sources of interference”;
* Recommendation ITU-R F.1102 “Characteristics of fixed wireless systems operating in frequency bands above about 17 GHz”;
* Recommendation ITU-R F.1336 “Reference radiation patterns of omnidirectional, sectoral and other antennas in point-to multipoint systems for use in sharing studies in the frequency range from 1 GHz to about 70 GHz”;
* Recommendation ITU-R F.1404 “Minimum propagation attenuation due to atmospheric gases for use in frequency sharing studies between systems in the fixed service and systems in the broadcasting-satellite, mobile-satellite and space science services”;
* Recommendation ITU-R F.1704 “Characteristics of multipoint-to-multipoint fixed wireless systems with mesh network topology operating in frequency bands above about 17 GHz”;
* Report ITU-R F.2086 “Technical and operational characteristics and applications of broadband wireless access in the fixed service”.
* Furthermore, Recommendation ERC/REC 25-10 identifies the frequency range 21.2-24.5 GHz with the preferred sub-bands 21.2-21.4 GHz, 22.6-23.0 GHz and 24.25-24.5 GHz for the use by cordless cameras.

For an additional MSS allocation (space-to-Earth) in the frequency band 23.15-23.55 GHz the protection of the receiving stations of land mobile service is ensured by meeting the pfd limits:

Table 5: Hard Limits for the protection of the receiving stations in the Mobile Service

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Frequency band, GHz | Service | Limit in dB(W/m²) for angles of arrival (δ) above the horizontal plane | | | Reference bandwidth |
| 0°–5° | 5°–40° | 40°–90° |
| 23.15–23.55 | Mobile satellite  (space-to-Earth ) | –121 + 0.8\*δ | –125 + 11\*log(δ) | –107 | 1 MHz |

In the frequency band 25.25-25.5 GHz, the estimation results show that a distance of 1.5 to 40 km is required to protect a receiving mobile station from a transmitting MES. The application of No. 9.17 provides protection for the receiving stations of the mobile service from the transmitting MES in this band.

No explicit sharing/compatibility studies for other frequency bands have been performed yet.

### Sharing with the Radio Astronomy Service

The frequency bands 22.21-22.5 GHz and 23.6-24 GHz are allocated on a primary basis to the radio astronomy service (RAS). Furthermore No. 5.149 urges administrations when making assignments to stations of others radio services in the frequency bands 22.01-22.21 GHz, 22.21-22.5 GHz, 22.81-22.86 GHz and 23.07-23.12 GHz to take all practicable steps to protect the RAS from harmful interference in these bands. Member States shall also recognise that no emissions are allowed in the frequency band 23.6-24 GHz (see No 5.340).

The frequency band 22.21-22.5 GHz is used by the RAS for both continuum observations as well as spectroscopic line observations of the water molecule, whose spectroscopic band in this frequency range is one of the most important for radio astronomy (see Recommendation ITU-R RA.314, Table 40 and the List of Important Spectral Lines of the International Astronomical Union). The water molecule transitions in this band are observed using both single-dish and VLBI techniques.

Although the frequency range 22-24.5 GHz is of great interest to radio astronomers, protection of the radio astronomy service should be considered at least in the frequency bands mentioned in No. 5.149, which are extensively used by the radio astronomy service in Europe. Currently the protection of this service is granted through the application of No. 5.149.

Recommendation ITU-R RA.769 specifies the protection criteria for radio astronomical observations and gives threshold levels of detrimental interference for primary radio astronomy bands.

For the frequency bands 22.21-22.5 GHz and 23.6-24 GHz, the pfd threshold limit given in Recommendation ITU‑R RA.769 for single-dish line observations made using a channel bandwidth (one of the spectrometer channels) of 250 kHz is –162 dB(W/m²) and -161 dB(W/m²), respectively. Pfd threshold limits of –146 dB(W/m²) and -147 dB(W/m²) are defined for single-dish continuum observations in these bands, across the entire 290 MHz bandwidth or 400 MHz, respectively.

VLBI observations, where signals from widely separated antennas are recorded and correlated after the observations, are much less susceptible to local interference. This is reflected in the threshold pfd level for VLBI observations in this band, –129 dB(W/m²), for a bandwidth of 250 kHz. However, within the footprint of a satellite there may be several radio astronomy stations that may experience the same interference.

For detrimental interference from non-GSO systems, the protection criteria and the relevant methodologies are described in Recommendations ITU-R RA.769 and ITU-R RA.1513, as well as in Recommendation ITU-R S.1586 for FSS systems and in Recommendation ITU‑R M.1583 for MSS and RNSS systems.

The thresholds of detrimental interference levels to the RAS as defined and calculated in Recommendation ITU-R RA.769 are protection criteria above which radio astronomical data are degraded and may be eventually obliterated. In principle, under rather idealised circumstances, if these levels are very slightly exceeded then it may be possible to compensate at the radio astronomy observatory by increased observing time. In doing so, the channel capacity of the telescope is reduced, with a corresponding reduction in scientific throughput. If the level of interference, under the assumptions of Recommendation ITU-R RA.769 (e.g. antenna performance, etc.), becomes 10 dB or more above the Recommendation ITU-R RA.769 definition, then increased observing time will no longer be effective in ensuring that valid scientific data are provided to the scientist. The radio astronomy station will be unable to operate in an affected frequency band, and its ability to provide service will have been lost if no appropriate mitigation techniques can be applied.

A number of initial compatibility studies were provided to Working Party 4C only at the very last moment.

One initial study regarding the potential impact of unwanted emissions from MSS (s-E) in the frequency band 23.15-23.4 GHz on RAS in the frequency bands 23.07-23.12 GHz and 22.81-22.86 GHz was provided but CEPT administrations and other administrations expressed concerns about the results of the study.

CEPT administrations and other administrations expressed even more concerns about another initial study and its conclusions regarding compatibility between MSS (s-E) operations in the band 23.15-23.4 GHz and the RAS in the “passive” band 23.6-24 GHz.

The same harsh concerns were expressed by CEPT administrations and other administrations regarding the conclusions on the initial study on compatibility between MSS (s-E) operations in the band 24.25-24.45 GHz and the RAS in the “passive” band 23.6-24 GHz.

The same administration expressed their concerns also with regard to the conclusions on the initial studies performed for a potential up- or downlink in the frequency band 24.25- 24.45 GHz and the RAS in the “passive” band 23.6-24 GHz.

The concerns expressed were regarding the lack of expertise in radio astronomy service issues available within the Working Party 4C, responsible for the MSS sharing and compatibility report, to assess the assumptions and methodologies used in this analysis, and some administrations are not prepared to support conclusions regarding the initial studies performed so far. Further, these studies addressing sharing between the MSS and the radio astronomy service were incorporated into the MSS sharing and compatibility report without the opportunity for Working Party 7D experts to review and comment on the contents or conclusions of this study prior to WRC 15.

However, the CPM-Report provides some methods where additional MSS allocations are proposed that are separated from the frequency bands used by the radio astronomy service by 30 MHz only. One method (C1b) proposes an additional MSS downlink in the frequency band 22.65-22.95 MHz even completely covers the frequency band 22.81-22.86 GHz mentioned in RR 5.149 and used by the radio astronomy service. 5.149 also states that emissions from spaceborne or airborne stations can be particularly serious sources of interference to the radio astronomy service.

### Sharing with the Radionavigation Service

The frequency band 24.25-24.65 GHz is allocated to the radionavigation service in Regions 2 and 3.

No sharing/compatibility studies have been performed yet.

### Sharing with the Radiolocation Service

The frequency band 24.05-24.25 GHz is allocated to the radiolocation service in Regions 2 and 3.

No sharing/compatibility studies have been performed yet.

### Sharing with the Radiolocation-Satellite Service

In Region 2 the frequency band 24.65-24.75 (Earth-to-space) is allocated the radiolocation-satellite service on a primary basis.

No sharing/compatibility studies have been performed yet.

### Sharing with the Space Research Service

The frequency bands 22.12-22.5 GHz and 23.6-24 GHz are allocated to the space research service (SRS)(passive) on a primary basis while the frequency band 22.55-23.15 GHz (Earth-to-space) and 25.5-27 GHz (space-to-Earth) are allocated to the SRS.

The allocations to the SRS (Earth-to-space) the frequency band 22.55-23.15 GHz and 25.5 -27 GHz (space-to-Earth) support various missions including referenced lunar missions, Lagrangian missions and other near-Earth space research missions. The number of SRS earth stations transmitting in this band will be small. Rather than building new SRS earth stations, upgrading selected existing SRS earth stations will predominate. The upgrade of earth stations depends on a number of factors, including the type of mission to be supported. The number of SRS earth station sites capable of supporting referenced lunar and/or L2 missions is not expected to exceed ten to fifteen on a global basis over the next few decades.

For the specific case of a mobile satellite service uplink into a space research service earth station receiver operating with a satellite in non-geostationary orbit, aggregate I/N exceeded protection criteria by 23dB. This case involves interference from one earth station into another. In such a case, a coordination zone can be calculated to be larger than 330 km to avoid interference from a MSS user terminal into an SRS earth station.

In the two specific cases of mobile satellite service downlinks from satellites operating in geostationary satellite orbit into space research service earth stations receiving wanted transmissions from the geostationary and non-geostationary satellite orbits, the interference criterion given in Recommendation ITU-R SA.1155 was exceeded by 30 dB and 10 dB respectively. In the specific case of interference to space research service satellite downlinks from geostationary satellite orbits, harmful interference could only be avoided if the space research service and mobile satellite service satellites maintained an orbital separation on the order of 31 degrees. In the specific case of interference to space research service downlinks from non-geostationary satellite orbits, no methods for avoiding exceedance of the interference criterion could be identified.

### Sharing with the Standard Frequency and Time Signal-Satellite Service

The frequency band 25.25-27 GHz is allocated to the standard frequency and time signal-satellite on a secondary basis.

Currently the stations of the standard frequency and time signal-satellite service are not notified in the frequency band 25.25-25.5 GHz. No ITU-R Recommendation contains the technical characteristics of stations in the standard frequency and time signal-satellite service in the frequency band 25.25-25.5 GHz. Therefore, since there are no systems in the standard frequency and time signal-satellite service in the frequency band 25.25-25.5 GHz, no compatibility issue exists at this time; however, it may not be the case if in the future new standard frequency and time signal-satellite systems operate in this frequency band.

## Conclusions on Sharing and Compatibility Issues

* Passive bands: An allocation to the MSS in the frequency band 23.6-24 GHz is not feasible because of the passive allocations to several radio services. This band needs also to be protected from out-of-band emissions;
* Fixed Service: The results of studies indicate that with an appropriate pfd-hard limit sharing would be feasible in the space-to-Earth direction without causing harmful interference to the FS. The operation of MES will require separation distances up to several tens of kilometres. To avoid interference impacts from FS transmitting stations to the MSS space station an FS antenna off-pointing from geostationary orbit will required. No. 21.2 has envisaged small off-point of FS transmitting antenna from geostationary orbit only in the frequency band 25.25-27.5 GHz. Taking into account that the ECC Report 173 shows an extensive use of the frequency bands by the fixed service (except for the frequency band 24.25-24.5 GHz) without the requirement to avoid pointing to geostationary orbit during installation (in bands other than 25.25-26.00 GHz band), interference to geostationary MSS receiving stations will be significant. In order to eliminate or reduce such interference, already installed FS antennae would be required to be off-pointed from geostationary orbit that is practically unfeasible. Taking into account that a large number of FS stations operate in some frequency bands it seems appropriate to consider allocations to MSS for Earth-to-space links in the bands with the least number of FS earth stations, such as in the frequency band 24.25-24.5 GHz. (Ed. Note: in the frequency band 25.25-25.5 GHz only 201 terrestrial station are notified in the MIFR of the ITU.)
* Radiolocation service: MES transmissions would have to protect the radiolocation service in the frequency band 24.05-24.25 GHz and it would not be compatible with fixed service in the frequency band 24.25-24.45 GHz.
* Fixed-satellite service: FSS (Earth-to-space) transmissions and FS operate across the frequency band 24.65-25.25 GHz, these preclude MSS at least for Earth-to-space transmissions.
* Inter-satellite service: Extremely difficult compatibility issues, co-ordination and operation against NGSO Inter-satellite links in the frequency bands 22.55-23.15 GHz, and 25.5-26 GHz. The results of the studies indicate that MSS operations in the bands 22.55-23.15 GHz and 25.5-26 GHz will create a potential for harmful interference to ISS links supporting the SRS, EESS, and non-GSO MSS applications. The results of studies with regard to MSS uplink operations indicate that in the bands 23.15-23.55 GHz it will create a potential for harmful interference to ISS links supporting the SRS, EESS, and non-GSO MSS applications. It has been suggested that these compatibility issues be addressed by application of the current provisions of Article 9 and also by meeting the e.i.r.p. limits to protect NGSO to NGSO ISS links, and that compatibility of MSS (Earth-to-space) in the frequency band 25.25-25.5 GHz can be provided by application of the current provisions of Article 9. However, on the basis of the current rules of procedure, No. 9.7 coordination does not address the protection of ISS NGSO receivers operating in the direction from GSO to NGSO from MSS GSO satellite emissions in the 23.15-23.55 GHz band nor the protection of DRS GSO receivers operating in the direction from NGSO to GSO from MSS earth station emissions in the 25.25-25.5 GHz band since inter-satellite links between GSO data relay satellites and the NSGO DRS user satellites are not subject to coordination under Section II of RR Article 9.
* Earth exploration-satellite service and space research service: In the band 22.55-23.15 GHz, sharing with the space research service (Earth-to-space) would not be feasible. Harmful interference from the mobile satellite service would exceed the space research service protection criteria by as much as 31.6 dB, and harmful interference from the space research service would exceed the interference threshold for the mobile satellite service by as much as 48.2 dB. In the specific case of mobile satellite service earth station uplinks, no methods could be identified for avoiding exceedance of the interference criteria for space research service receivers on non-geostationary satellites. Harmful interference from the mobile satellite service would exceed the space research service protection criteria by as much as 30 dB. In the specific case of harmful interference to space research service downlinks from non-geostationary satellite orbits, no methods could be identified for avoiding exceedance of the interference criteria. See also passive bands above. In the band 25.5-26 GHz, sharing with the Earth exploration-satellite and space research services (space-to-Earth) would not be feasible.
* Radio astronomy service: The RAS in the frequency band 22.21-22.5 GHz and the additional frequency bands mentioned in No. 5.149 need to be protected. See also passive bands above.

With regard to the draft CPM-Report three methods to satisfy the Agenda Item 1.10 are on offer. Method A is a no change to the Radio Regulations while Method B and C provide potential new allocations for the MSS on certain condition.

In Method B it is proposed to allocate the frequency bands 23.15-23.55 GHz (space-to-Earth) and 25.25-25.5 GHz (Earth-to-space) to the MSS. This would provide 400 MHz of spectrum in the direction space-to-Earth and 250 MHz of spectrum in the direction Earth-to-space.

Method C contains a range of proposals for potential new allocations for the MSS. Method C1 contains two proposals for allocations for the MSS in the direction space-to-Earth.

In Option C1a it is proposed to allocate the frequency band 24.25-24.55 GHz for the MSS (space-to-Earth) while in Option C1b it is proposed to allocate the frequency band 22.65-22.95 GHz for the MSS (space-to-Earth). Either option of Method C1 would provide 300 MHz of spectrum for the direction space-to-Earth.

Method C2 contains two proposals for allocations for the MSS in the Earth-to-space direction.

In Option C2a it is proposed to allocate the frequency band 24.25-24.55 GHz for the MSS (Earth-to-space) while in Option 2b it is proposed to allocate the frequency band 25.25-25.5 GHz for the MSS (Earth-to-space). In case of option 2a there will be 300 MHz of allocated spectrum for the MSS while in case of Option 2b there will be 250 MHz of spectrum allocated to the MSS in the direction Earth-to-space.

However, no ITU-R studies have been performed with regard to out-of-band radio compatibility to ensure protection of radio services, active and passive, from unwanted emissions of MSS systems proposed to operate in the potential new MSS allocation nor have detailed studies with some existing radio services been performed to prove in-band radio compatibility.

# List of relevant documents

ITU documentation

* WRC-15/3 CPM Report to the 2015 World Radiocommunication Conference
* 4C/435 Report of the 15th Meeting of Working Party 4C (incl. Annex 02)
* 4/100 Draft new Report ITU-R M.[MSS SHARE] - Sharing between GSO MSS and other services in the allocations in the 22-26 GHz range (approved by SG4 in 26 June 2015)Report ITU-R S.2223 Technical and operational requirements for GSO FSS earth stations on mobile platforms in bands from 17.3 to 30.0 GHz
* Report ITU-R S.2357 Technical and operational guidelines for earth stations on mobile platforms communicating with geostationary space stations in the fixed-satellite service in the frequency bands 19.7-20.2 GHz and 29.5-30.0 GHz

CEPT and/or ECC documentation

* CEPT Report 38 in response to the EC Permanent Mandate on the ”Annual update of the technical annex of the Commission Decision on the technical harmonisation of radio spectrum for use by short range devices” (as of 11 March 2011)
* CEPT Report 37 Report from CEPT to the European Commission in response to Part 2 of the Mandate on “Automotive Short-Range Radar systems (SRR)” (as of 25 June 2010)
* CEPT Report 36 Report from CEPT to the European Commission in response to Part 1 of the Mandate on ”Automotive Short Range Radar systems (SRR)” (as of 25 June 2010)
* ECC/DEC/(11)02 on industrial Level Probing Radars (LPR) operating in frequency bands 6 - 8.5 GHz, 24.05 - 26.5 GHz, 57 - 64 GHz and 75 - 85 GHz (as of 11 March 2011);
* ECC/DEC/(04)10 The frequency bands to be designated for the temporary introduction of Automotive Short Range Radars (SRR) (as of 1 June 2012);
* ECC/DEC/(13)01 The harmonised use, free circulation and exemption from individual licensing of Earth Stations On Mobile Platforms (ESOMPs) within the frequency bands 17.3-20.2 GHz and 27.5-30.0 GHz
* ECC/REC/(11)01 Guidelines for assignment of frequency blocks for fixed wireless systems in the bands 24.5-26.5 GHz, 27.5-29.5 GHz AND 31.8-33.4 GHz
* ERC/REC 25-10 Frequency ranges for the use of temporary terrestrial audio and video SAP/SAB links (Incl. ENG/OB);
* ERC/REC 70-03 (Tromsø 1997 and subsequent amendments) Relating to the use of short range devices (SRD) (as of 07 May 2012)
* REC T/R 13-02 Preferred channel arrangements for fixed service systems in the frequency range 22.0 - 29.5 GHz;
* ECC Report 173 Fixed service in Europe; current use and future trends post 2011, March 2012
* ERC Report 25 The European table of frequency allocations and applications in the frequency range 9 kHz to 3000 GHz (ECA Table), Lille 2011

EU documentation

* Commission Implementing Decision 2011/485/EU of 29 July 2011 amending Decision 2005/50/EC on the harmonisation of the 24 GHz range radio spectrum band for the time-limited use by automotive short-range radar equipment in the Community (OJ L 198, 30.07.2011, p. 71);
* Commission Decision 2010/368/EU of 30 June 2010 amending Decision 2006/771/EC on harmonisation of the radio spectrum for use by short-range devices (OJ L 166, 01.07.2010, p. 33);
* Commission Decision 2006/771/EC of 9 November 2006 on harmonisation of the radio spectrum for use by short-range devices (OJ L 312, 11.11.2006, p. 66);
* Commission Decision 2005/50/EC of 17 January 2005 on the harmonisation of the 24 GHz range radio spectrum band for the time-limited use by automotive short-range radar equipment in the Community (OJ L 21, 25.01.2005, p. 15);

NATO documentation

NATO Joint Civil/Military Frequency Agreement (NJFA) 2014

# Actions to be taken

none

# Relevant information from outside CEPT (examples of these are below)

## European Union (date of proposal)

N/A

## Regional telecommunication organisations

APT (August 2015)

APT Members support Method A of the CPM Report (i.e. No Change), which also includes the suppression of Resolution 234 (WRC-12) as a consequence.

ATU (September 2015)

Method A (Coordinator’s note: No change)

Arab Group (August 2015)

* NOC

CITEL (September 2015)

Method A

* NOC to Article 5 as sharing with incumbent services in all cases is either not feasible or will require technical and operational constraints that will be impractical for use by the MSS
* SUP Resolution 234 (WRC-12)

RCC (April 2015)

1. The RCC Administrations consider that an additional spectrum allocation to the mobile-satellite service within the frequency range from 22 GHz to 26 GHz is possible only if sharing with the existing terrestrial and space services is ensured in the same and adjacent frequency bands (taking into account Nos 5.149 and 5.340), and if such allocations to MSS do not impose additional constraints on the existing services. Also, unwanted emissions from earth and space stations in the MSS networks shall not cause harmful interference to EESS systems (passive), SRS (passive) and RAS in the frequency bands 23.6-24.00 GHz; 22.01-22.21 GHz; 22.21-22.5 GHz; 22.81-22.86 GHz and 23.07-23.12 GHz.

The RCC Administrations support additional allocation of 250 MHz for the MSS in every direction:

in the band 23.15-23.55 GHz or 24.25-24.55 GHz (space-to-Earth),

in the band 25.25-25.5 GHz or 24.25-24.55 GHz (Earth-to-space).

## International organisations

IARU (September 2014)

Above 440 MHz, the band 24.0-24.05 GHz is the lowest frequency primary allocation to the amateur and amateur-satellite services. The next lowest primary allocation is at 47.0-47.2 GHz. The 24.05-24.25 GHz band is allocated to the amateur service on a secondary basis. While the designation of the 24.0-24.25 GHz band for ISM applications and the high water vapor absorption at this order of frequency create challenges, amateurs are actively pursuing experimentation in this band. Maintaining the primary allocation and assuring that any new services introduced into the band are compatible with the amateur and amateur-satellite services is essential for the continuing contribution by radio amateurs to the body of experience and knowledge of microwave equipment construction, operation, and propagation research.

IATA (date of proposal)

N/A

ICAO (June 2015)

To oppose any new mobile satellite service allocation unless it has been demonstrated through agreed studies that there will be no impact on aviation use in the 24.25 - 24.65 GHz frequency band in Regions 2 and 3.

IMO (date of proposal)

N/A

NATO (September 2015)

NATO supports no change for the frequency bands 24.05-24.25 GHz and 25.25-26 GHz.

SFCG (August 2015)

SFCG supports the protection of all the space science bands in the range 22-26 GHz considered under this agenda item.

The main frequency bands at risk for SFCG member agencies are:

1. The SRS Earth-to-space allocation in the band 22.55-23.15 GHz
2. The Inter-satellite band 22.55-23.55 GHz and the first 750 MHz of the Inter-satellite band 25.25-27.5 GHz.

No new allocations to the MSS should be made, since the sharing studies are either missing or show that there may be unacceptable limitations to the existing services therefore SFCG supports Method A (NOC).

WMO (December 2014)

Based on the ITU-R study results, noting in particular that no out-of-band compatibility studies have been performed to ensure protection of EESS (passive) systems from unwanted emissions of MSS systems, WMO opposes new allocation of the frequency bands between 22 GHz and 26 GHz to the MSS and supports no change to the Radio Regulations (i.e. Method A in Draft CPM Report).

## Regional organisations

ASFCG (September 2015)

Support ICAO Positions

CRAF (September 2015)

As noted in the disadvantages to methods that would allocate such spectrum, “MSS spectrum requirements in the 22-26 GHz band have not been studied. There has not been any justification for a 300 MHz allocation. It is noted that in the immediate vicinity to the frequency band 22-26 GHz there are already MSS allocations with a significant amount of spectrum for the implementation of new MSS systems that is currently largely unused.”

As noted in a liaison statement from WP 4C to WP 7D (Document 7D/127), and in the CPM text at 4.2.1.10/4.bis and 4.2/1.10/4.11, no sharing or compatibility studies were conducted with regard to either of the two bands used by the RAS in the 22 - 26 GHz range, including the RAS bands 23.6 - 24 GHz (subject to RR. 5.340) or 22.21 - 22.5 GHz (RR 5.149). For this reason no allocation to MSS should be made that might affect either of the RAS bands.

CRAF approves Method A: no change to the Radio Regulations.

CRAF strongly opposes the following methods:

Method B: To allocate the frequency bands 23.15-23.55 GHz (space-Earth) and 25.25-25.5 GHz (Earth-space) to MSS

Methods C1: Allocations for MSS in the space-to-Earth direction.

Methods C2: Allocations for MSS in the Earth-to-space direction

ESA (September 2014)

Support SFCG positions

EUMETNET (September 2014)

Support WMO positions

Eurocontrol (date of proposal)

N/A