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Working Group 2

PROPOSED MODIFICATIONS TO THE DRAFT CPM REPORT

AGENDA ITEM 1.12

(WP 7C / WP 7B, WP 7D, WP 5A, WP 5B, WP 5C)

1.12 to consider an extension of the current worldwide allocation to the Earth exploration-satellite (active) service in the frequency band 9 300-9 900 MHz by up to 600 MHz within the frequency bands 8 700-9 300 MHz and/or 9 900-10 500 MHz, in accordance with ***Resolution 651 (WRC-12)****;*

Resolution **651 (WRC-12):** *Possible extension of the current worldwide allocation to the Earth exploration-satellite (active) service in the frequency band 9 300-9 900 MHz by up to 600 MHz within the frequency bands 8 700-9 300 MHz and/or 9 900-10 500 MHz*

2/1.12/1 Executive summary

In accordance with Resolution **651 (WRC-12)**, ITU-R has performed studies of possible extension of the current worldwide allocation to the EESS (active) within the frequency bands 8 700-9 300 MHz and/or 9 900-10 500 MHz, taking into account compatibility studies with stations of incumbent services.

Report ITU-R RS.2274 shows that an EESS additional spectrum requirement is for consecutive 600 MHz. Sharing studies were performed for all incumbent services and were based on characteristics of future wideband EESS synthetic-aperture radars (SAR) as described in Recommendation ITU-R RS.2043.

The results of sharing studies with the RDS are contained in Report ITU-R RS.2313. The results of sharing studies with the FS, MS, ARS, and ARSS are contained in Report ITU-R RS.2314. The results of compatibility studies related to unwanted emissions into the SRS, RAS, EESS (passive), and SRS (passive) are contained in Report ITU-R RS.2308.

The following methods to satisfy the agenda item have been developed:

- Method A - Primary EESS (active) allocation in the frequency band 9 900-10 500 MHz with 2 options: Method A1 (with two sub-options) and Method A2.
- Method B - Primary EESS (active) allocation in the frequency bands 9 200-9 300 MHz and 9 900-10 400 MHz with 2 options: Method B1 and Method B2.

- Method C - Primary EESS (active) allocation in the frequency bands 9 200-9 300 MHz and 10 000-10 100 MHz, and secondary allocation in the frequency band 9 900-10 000 MHz.
- Method D - No change to the Radio Regulations (NOC).

Methods A, B and C would impose that systems operating in the new EESS (active) allocation shall not cause harmful interference to, nor claim protection from radars operating in the radio determination service. In addition, the extension frequency band shall only be used by EESS (active) systems requiring a bandwidth of more than 600 MHz. The protection of stations of the RAS in adjacent frequency bands is addressed in Recommendation ITU-R RS.2066. The protection of stations of the SRS in adjacent frequency bands is addressed in Recommendation ITU-R RS.2065.

2/1.12/2 Background

The growing demand for higher resolution radar images to satisfy global environmental monitoring raises the need to further increase the bandwidth used for linear FM chirp radar transmission of the next generation of EESS SAR.

Resolution **651 (WRC-12)** invites ITU-R to conduct and complete compatibility studies addressing EESS (active) and existing services in the frequency bands 8 700-9 300 MHz and 9 900-10 500 MHz, and unwanted emissions from stations operating in the EESS (active) in these frequency bands into stations operating in the frequency bands 8 400-8 500 MHz and 10.6-10.7 GHz.

During the study cycle for WRC-07, studies were performed by ITU-R under WRC-07 agenda item 1.3 to investigate the conditions for the extension of EESS (active) allocation by 200 MHz above or below the former allocation 9 500-9 800 MHz (prior to WRC-07). Based on the results and conclusions in Report ITU-R RS.2094, WRC-07 decided to extend the allocation to the frequency band 9 300-9 900 MHz. This was possible because the overall sharing conditions were found to be acceptable if certain conditions are obeyed. These conditions are regulated by RR Nos. **5.475A**, **5.476A**, **5.477**, **5.478**, **5.478A**, and No. **5.478B** to protect other radio service in countries mentioned in these footnotes.

Space-borne radars operating in the EESS (active) in the band 9 300-9 900 MHz have demonstrated their important contributions to a large number of scientific and geoinformation applications, which is also recognized in Resolution **673 (Rev.WRC-12**).

2/1.12/3 Summary of technical and operational studies, including a list of relevant ITU-R Recommendations

ITU-R Recommendations: ITU-R RS.1166, ITU-R RS.1280, ITU-R RS.1859, ITU-R RS.1861, ITU-R RS.1883, ITU-R RS.2017, ITU-R RS.2043, ITU-R RS.2065, ITU-R RS.2066; ITU-R SA.509, ITU-R SA.609, ITU-R SA.1016, ITU-R SA.1020, ITU-R SA.1022, ITU-R SA.1157, ITU-R SA.1743; ITU-R RA.517, ITU-R RA.611, ITU-R RA.769, ITU-R RA.1513, ITU-R RA.1631; ITU-R M.628, ITU-R M.629, ITU-R M.1041, ITU-R M.1044, ITU-R M.1372, ITU-R M.1461, ITU-R M.1583, ITU-R M.1732, ITU-R M.1796, ITU-R M.1824, ITU-R M.1849, ITU-R M.1851; ITU-R F.699, ITU-R F.758, ITU-R F.1108, ITU-R F.1245, ITU-R F.1336, ITU-R F.1403, ITU-R F.1777.

ITU-R Reports: ITU-R M.2050, ITU-R M.2076, ITU-R M.2081, ITU-R M.2128, ITU-R RS.2094, ITU-R RS.2178, ITU-R RS.2274, ITU-R RS.2308, ITU-R RS.2313, ITU-R RS.2314, ITU-R SM.337, ITU-R SM.1138, ITU-R SM.1535, ITU-R SM.1541, ITU-R SM.1542.

2/1.12/3.1 Estimated spectrum requirements

The studies on EESS (active) spectrum requirements in the frequency range around 9 600 MHz are summarized in Report ITU-R RS.2274. The amount of estimated spectrum required for the next generation of EESS (active) synthetic aperture radars (SAR) systems around 9 600 MHz is a contiguous 1 200 MHz.

2/1.12/3.2 Possible frequency bands for extension of the Earth exploration-satellite (active) service allocation

The ITU-R has examined feasibility of allocation of the frequency bands 8 700-9 300 MHz and 9 900-10 500 MHz for the EESS (active) in all or portions of these frequency bands and carried out sharing studies with respect to incumbent services.

2/1.12/4 Analysis of the results of studies

2/1.12/4.1 Sharing studies with incumbent services

It is important to note that EESS radars using the high-resolution mode transmit in the direction of the measured object only for very short time intervals, i.e. for less than seven seconds per exposure. It has been shown that the next generation of wideband spaceborne radar systems will have transmission characteristics similar to those already used in the current allocation. It is assumed that the conditions for sharing with radiolocation and other services within the existing allocation of 9 300-9 900 MHz will be close to that in the candidate extension bands.

2/1.12/4.1.1 Sharing between EESS SAR and systems operating in the radiodetermination service

The frequency range 8 700-10 500 MHz is used by many different types of radars: airborne radars, shipborne radars, and beacon/ground-based radars. It is important to note that Report ITU-R RS.2094 provides results, which demonstrate the compatibility between spaceborne SAR systems and radars operating in the frequency bands 9 300-9 500 MHz and 9 800-10 000 MHz with radar system characteristics described in Recommendation ITU-R M.1796 (2007 version), and that EESS (active) systems have been operating in the frequency band 9 300-9 900 MHz with no report of interference. Radar systems, characterized in Recommendation ITU-R M.1796, that operate on frequencies anywhere within the frequency band of 9 300-10 000 MHz are assumed to be compatible with EESS (active) systems.

ITU-R has reviewed in Report ITU-R RS.2313, the proposed SAR characteristics in Recommendation ITU-R RS.2043 and the SAR characteristics in Report ITU-R RS.2094, and determined that those characteristics are similar with similar effect on radar receivers. It was, therefore, not necessary to repeat these studies performed in the frequency bands 9 300-9 500 MHz and 9 800-10 000 MHz. The studies in Report ITU-R RS 2313, under WRC-15 agenda item 1.12 focused on radars, identified in Recommendation ITU-R M.1796-2, operating in the frequency bands 8 700-9 300 MHz and 10 000-10 500 MHz, which were not considered in previous studies in Report ITU-R.RS 2094.

It is also shown in the Report ITU-R RS.2313 that the sharing conditions remain similar for any EESS SAR chirp transmission bandwidth of between 600 and 1 200 MHz, and also remain similar to the sharing conditions of current EESS SAR systems in space operating at lower chirp bandwidth in the existing EESS (active) allocation in 9 300-9 900 MHz.

Recommendation ITU-R RS.1280 is about the selection of active spaceborne sensor emission characteristics to mitigate the potential for interference to terrestrial radars operating in frequency bands 1-10 GHz. Sensor transmitter power, antenna gain pattern, pulse width, pulse repetition

frequency, and chirp bandwidth (if frequency modulation is used) are all possible characteristics that can be adjusted during the design of the spaceborne sensor to improve compatibility with terrestrial radars.

In the frequency band 9 000-9 200 MHz, airport surface detection equipment radars, operating in the ARNS, are used to aid air traffic controllers in preventing collisions on the airport surface and reducing runway incursions. These safety of life critical systems require special measures to ensure their freedom from harmful interference in accordance with RR Nos. **1.59** and **4.10**.

The aggregate average I/N of –6 dB should be used as the required protection level for radiodetermination radars from all interference sources, including the proposed SAR. However, the effect of pulsed interference on incumbent systems is difficult to quantify and the interference level is strongly dependent on receiver-processor design and mode of system operation. In general, some radar features can help suppress low effective duty-cycle pulsed interference (of the order of 1%[19] in the radar receiver). Techniques for suppression of low-duty-cycle pulsed interference are described in Recommendation ITU-R M.1372.

Test results provided in Report ITU-R M.2081 show that some radars can tolerate high peak I/N low-duty cycle pulsed interference like those produced by SAR systems or other radars systems, but the report should not be considered as a replacement for the interference protection criteria in Recommendation ITU-R M.1796.

The results of those peak interference measurements are also summarized in the CPM Report developed under WRC-07 agenda item 1.3 as follows:

> "The test and analysis results show representative radionavigation and radiolocation radars do not suffer any degradation to their performance from representative EESS (active) waveforms at an I/N of +40 dB for shipborne systems, I/N of +54 dB for airborne systems, I/N of +50 dB for ground-based systems, and an I/N of +28 dB for ground-based meteorological radars."

This shows that the improvement through radar processing gain could be significant.

It should be noted that the test measurements for some ARNS radars did not take into account the required probability of detection and displayed occasional strobes on the radar screen at I/N of +50 dB. Since the effects of pulsed linear chirp SARs into RDS system receivers are difficult to quantify and are dependent on receiver/processor design and mode of operation, and further, due to the safety critical aspects of ARNS radars in the frequency band 9 000-9 200 MHz, more radar performance measurements are required to adequately model these systems.

The method provided in Recommendation ITU-R RS.1280 should be used to assess the SAR pulsed interference to the RDS radars. In the case of no available measured data and to comply with the safety aspect requirements, this Recommendation recommends using a 0 dB value for the radar processing gain.

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[19] As shown in Report ITU-R M.2081 values of up to 2.5% have also been observed for maritime radars.

2/1.12/4.1.1.1 Sharing of the Earth exploration-satellite (active) service with the radiolocation service

The sharing studies focused on RLS radars G20 and A12 in the frequency band 8 700-9 300 MHz, and RLS radars G4, A4 and S2 in the frequency band 9 900-10 500 MHz described in Recommendation ITU-R M.1796-2.

2/1.12/4.1.1.1.1 Effect of radiolocation systems on the new generation of EESS SAR

In the frequency bands 8 700-9 300 MHz and 10 000-10 500 MHz, the simulations results show that in any case the impact of radiolocation systems into the new generation of SAR is more than 13 dB below the interference protection criterion.

2/1.12/4.1.1.1.2 Effect of EESS SAR on radiolocation systems in the frequency band 8 700-9 300 MHz

Dynamic simulation results have shown that in case of main-beam to main-beam coupling the peak I/N can reach values as high as 60 dB. However, these values are obtained for very low percentages of time in the order of 0.00001% over 11 days.

The radiolocation systems identified by ITU-R for sharing studies (system A12 and G20), which operate in the frequency band below 9 300 MHz, operate also in the current allocation in the frequency band 9 300-9 900 MHz. Therefore for comparison, simulations have also been performed with SAR-2 (EESS systems already using the current EESS frequency band 9 300-9 900 MHz). EESS SAR systems using chirp transmission bandwidth of between 600 and 1 200 MHz would create up to 3 dB higher interference. Therefore, if no interference has been noticed until today on either radars A12 or G20, it may be expected that no harmful interference event will be observed after the extension of the allocation to EESS (active).

2/1.12/4.1.1.1.3 Effect of EESS SAR on radiolocation systems in the frequency band 10.0-10.5 GHz

ITU-R studies show that all considered radiolocation radars would be affected with interference levels that significantly exceed the specified I/N threshold value of I/N = -6 dB in the worst case radar location and when the radar is pointing toward EESS SAR with the maximum possible gain and when SAR conducts measurements into the radar location point at times when the distance between SAR and the radar would be minimal. Probable excess would be between 29.3 dB and 74.6 dB. This study shows that threshold maybe exceeded in any moment when SAR is over the radio horizon. The value of exceedance will depend on the location of the radar and measurement points and the percentage of time it will occur is low and will be even lower taking processing gain into account as shown in Table 2/1.12/4-1.

The results of the dynamic study presented in Report ITU-R RS.2313 and summarized in Table 2/1.12/4-1 are showing the probability of such event to occur.

TABLE 2/1.12/4-1

Summary of studies results in the frequency band 10-10.5 GHz

	10-10.5 GHz
Service affected	RLS
Maximum $I/N_{average}$	68.6 dB-PG
% of time that maximum average I/N occurs over 11 days	0.00001 x n
% of time that I/N_{av}-PG= -6dB is exceeded over 11 days	0.005 x n

% of time that I/N_{av}= -6dB is exceeded over 11 days	Much lower than 0.005 x n (depending on PG)
PG : radar receiver processing gain in dB (the effect of pulsed interference is difficult to quantify and is strongly dependent on radar receiver-processor design and mode of system operation. In general, numerous features of radars can be expected to help suppress low duty-cycle pulsed interference. Techniques for suppression of low-duty-cycle pulsed interference are contained in Recommendation ITU R M.1372 (see also Recommendation ITU-R M.1461 and Report ITU-R M.2081). Report ITU-R RS.2094 show that such processing gain can be significant). **n**: number of wideband SAR (SAR-4) systems operating in the considered frequency band	

2/1.12/4.1.1.2 Sharing between the Earth exploration-satellite (active) service and the radionavigation service

The RNS comprises allocations particularly dedicated to the MRNS and the ARNS.

2/1.12/4.1.1.2.1 Frequency band 9 000-9 200 MHz

There is a lack of ITU guidance as to how much processing gain the radars that operate in the frequency band 9 000-9 200 MHz can achieve and, due to the safety critical aspects of ARNS radars in the 9 000-9 200 MHz frequency band, it is difficult to ensure the protection of those systems based on the sharing studies in Report ITU-R RS.2313. Therefore this frequency band is no longer considered for the extension of EESS (active) allocation.

2/1.12/4.1.1.2.2 Frequency band 9 200-9 300 MHz

The frequency band 9 200-9 500 MHz is used for the global maritime distress and safety system (GMDSS) in most countries which needs to be protected in accordance with RR Nos. **1.59** and **4.10**.

Systems used in the MRNS in the frequency band 9 200-9 300 MHz are also operated in the current EESS (active) allocation in the frequency band 9 300-9 500 MHz without any reported interference. ITU-R studies show that the sharing conditions remain similar for any SAR chirp transmission bandwidth between 600 and 1 200 MHz in the frequency band 9 200-9 300 MHz and that they are similar to the sharing conditions of SAR systems operating at lower chirp bandwidth in the frequency band 9 300-9 900 MHz.

Report ITU-R M.2081 includes test results between specific RNS and RLS systems and EESS systems in the frequency band 8 500-10 000 MHz. The results of studies with an MRNS radar in the frequency band 9 200-9 500 MHz show that it is compatible with EESS systems represented by the test waveforms at peak I/N level of 40 dB. Other test results documented in Recommendation ITU-R M.1796 confirm these results for maritime radars. The simulation results contained in Report ITU-R RS.2313 show that the peak I/N would never exceed 37 dB in such radars, which corresponds to an average I/N of 26.8 dB.

The frequency band 9 200-9 500 MHz is currently used by GMDSS Search and Rescue Transponders (SART). Administrations who intend to use this frequency band for EESS (active) will need to provide all necessary measures for protection of the SART systems.

The compatibility of EESS (active) with Search and Rescue Transponders (SART) operating under the GMDSS in the band 9 200-9 500 MHz (see RR No. **5.474**) has been assessed. It has been shown that the EESS (active) emissions are below the trigger level of the SART transponder and therefore sharing with SART in the band 9 200-9 300 MHz is feasible.

2/1.12/4.1.1.2.3 Frequency band 9 900-10 000 MHz

RR No. **5.478** additionally allocates to the RNS in some countries the frequency band 9 900-10 000 MHz. As mentioned in section 2/1.12/4.1.1 above, the current studies are focused on radars, identified in Recommendation ITU-R M.1796-2 and operating above 10 GHz, which were not considered in previous studies (Report ITU-R RS.2094).

2/1.12/4.1.1.2.4 Effect of radionavigation systems on the new generation of EESS SAR

In the frequency bands 8 700-9 300 MHz, the simulation results presented in Report ITU-R RS.2313 show that the impact of RNS systems into the new generation of SAR (called SAR-4 in the studies) is more than 46 dB below the interference protection criteria.

2/1.12/4.1.1.3 Summary of studies with the radio determination service

Studies showed that in the frequency band 9 000-9 200 MHz sharing would be difficult due to the safety aspects of the relevant services. Since the band 9 000-9 200 MHz is excluded from consideration to satisfy the contiguous spectrum requirement for EESS SAR, an allocation in the frequency range 8 700-9 000 MHz would not provide a contiguous extension to the current EESS (active) allocation. Therefore this summary addresses the frequency band above 9 200 MHz only.

Studies showed that, in the frequency band 9 200-9 300 MHz, compatibility between radars and EESS SAR is feasible, assuming the radar parameters in Report ITU-R RS.2313, and the sharing conditions are similar to the ones in the band 9 300-9 500 MHz.

The frequency band 9 200-9 500 MHz is currently used by GMDSS SART. Administrations who intend to use this frequency band for EESS (active) will need to provide all necessary measures for protection of the SART systems.

Compatibility studies between EESS (active) and the SART, operating under the GMDSS in the band 9 200-9 500 MHz, show that the EESS (active) emissions will be below the trigger level of the SART transponder and therefore sharing with SART in the band 9 200-9 300 MHz is feasible. The sharing conditions are similar to the ones in the band 9 300-9 500 MHz.

In the band 9.9-10 GHz, sharing conditions have already been studied before WRC-12 and conclusions are still applicable to SAR systems with chirp bandwidth between 600 MHz and 1.2 GHz.

ITU-R studies show that, in the frequency band 10-10.5 GHz, all considered radiolocation radars would be affected with interference levels that significantly exceed the specified I/N threshold value of I/N = -6 dB in the worst case radar location, when the radar is pointing toward EESS SAR with the maximum possible gain and when SAR conducts measurements into the radar location point at times when the distance between SAR and the radar would be minimal. Probable excess would be between 29.3 dB and 74.6 dB. This study shows that the threshold may be exceeded in any moment when SAR is over the radio horizon. The value of exceedance will depend on the location of the radar and measurement points, and the percentage of time it will occur is low and will be even lower taking processing gain into account as shown in Table 2/1.12/4-1.

Table 2/1.12/4-2 summarizes the overall results of the effects of EESS SAR systems into RDS radar receivers. The percentage of time given in this table is based on the dynamic analyses and its assumptions provided in Report ITU-R RS.2313.

In case of multiple SAR systems (where n = number of SAR systems) operating in the frequency bands 9 200-9 300 MHz and/or 10-10.5 GHz, the probabilities calculated in the studies have to be multiplied by n to obtain the aggregate probability as the probabilities corresponding to each SAR system are statistically uncorrelated.

TABLE 2/1.12/4-2

Summary of studies results

	9 200-9 300 MHz	**9.3-10 GHz**	**10-10.5 GHz**
Services affected	RNS	RNS/RLS	RLS
Maximum $I/N_{average}$	26.8 dB-PG	Sharing condition already studied before WRC-12 and conclusions still applicable to SAR systems with chirp bandwidth between 600MHz and 1.2 GHz	68.6 dB-PG
% of time that maximum I/N average occurs (over 11 days)	0.00001 x n		0.00001 x n
% of time that I/N_{av}-PG= -6dB is exceeded (over 11 days)	0.00004 x n		0.005 x n
% of time that I/N_{av}= -6dB is exceeded (over 11 days)	Never		Much lower than 0.005 x n (depending on PG)
PG : radar receiver processing gain in dB (the effect of pulsed interference is difficult to quantify and is strongly dependent on radar receiver-processor design and mode of system operation. In general, numerous features of radars can be expected to help suppress low duty-cycle pulsed interference. Techniques for suppression of low-duty-cycle pulsed interference are contained in Recommendation ITU R M.1372 (see also Recommendation ITU-R M.1461 and Report ITU-R M.2081). Report ITU-R RS.2094 shows that such processing gain can be significant). **n** : number of wideband SAR satellite systems operating in the considered frequency band			

2/1.12/4.1.2 Sharing between EESS SAR and systems in the fixed service

The conditions for sharing with the FS have already been determined for the frequency band 9 800-9 900 MHz resulting in RR Nos. **5.477** and **5.478B.** Sharing studies have been performed with the FS allocated in the frequency bands 8 700-8 750 MHz and 10-10.5 GHz (see Report ITU-R RS.2314).

2/1.12/4.1.2.1 Effect of EESS SAR on systems operating in the fixed service

The studies basically confirm the results obtained in Report ITU-R RS.2094, showing that stations of the FS would be protected with large margins from 16 to 20 dB. Only when the FS station is pointing towards high elevation angles (higher than 30°) and the azimuth pointing angle is around 90° or 270° the fractional degradation performance criterion of 10% would be exceeded, due to main-beam to main-beam coupling possibilities. However, statistics provided to the ITU-R by several administrations for the frequency ranges around 8 GHz and 10/11 GHz indicate that the elevation angle for those frequency bands would not exceed 24°.

Taking into account Recommendation ITU-R F.699, containing description of FS antenna gain pattern some administrations propose the following limits for pfd created by EESS (active) space station near the Earth's surface:

-129 dB(W/m^2) in 1 MHz, for $0° \le \alpha \le 5°$;

-113 dB(W/m^2) in 1 MHz, for $5° < \alpha \le 6°$;

$-112 + 25 \cdot \log(\alpha - 5)$ dB(W/m^2) in 1 MHz, for $6° < \alpha \le 53°$;

-69.6 dB(W/m^2) in 1 MHz, for $\alpha > 53°$;

where:

α: arrival angle of interference caused by EESS (active) space station.

Taking into account the short-term nature of the interference and Recommendation ITU-R F.1245, some other administrations propose the following limits for pfd created by EESS (active) space station near the Earth's surface:

-113 dB(W/m^2) in 1 MHz, for $0° \le \alpha \le 5.7°$;

$-109 + 25 \cdot \log(\alpha - 5)$ dB(W/m^2) in 1 MHz, for $5.7° < \alpha \leq 53°$;

-66.6 dB(W/m^2) in 1 MHz, for $\alpha > 53°$;

where:

α: arrival angle of interference caused by EESS (active) space station.

Some other administrations are of the view that no pfd limits are needed.

Some other administrations need more time to think about the exact value for a pfd limit.

2/1.12/4.1.2.2 Effect of fixed service stations on systems in the Earth exploration-satellite (active) service

Study results in Report ITU-R RS.2314 show that the SAR receiver protection criterion would be met with a margin between 8 and 13 dB depending on the frequency band, when considering a deployment of several thousands of FS links. The margin obtained is lower than the margin obtained in Report ITU-R RS.2094 due to the larger number of FS links considered, the SAR mode of operation, as well as the SAR characteristics.

2/1.12/4.1.2.3 Conclusion on compatibility between stations of the fixed service and EESS SAR

Sharing between the EESS (active) and the FS is feasible with appropriate sharing conditions.

2/1.12/4.1.3 Sharing between EESS SAR and systems operating in the mobile service

The MS is allocated in the frequency bands 8 650-8 750 MHz and 10.0-10.5 GHz and through RR Nos. **5.468** and **5.469** as well as Nos. **5.480** and **5.481** in the upper and lower extension frequency band, respectively. The only identified usage of these frequency bands by the MS is with regard to ENG/OB in the frequency band 10-10.5 GHz.

2/1.12/4.1.3.1 Effect of EESS SAR on systems operating in the mobile service

The studies in Report ITU-R RS.2314 show that the protection criterion for electronic news gathering/outside broadcasting (ENG/OB), which is limited to a long-term criterion, would be met, due to the low percentage of emission activity of the SAR system. An additional short-term protection criterion was also considered, and would be also met with margins in the order of 22 dB, even when considering the worst case azimuth and elevation angles up to 40°.

Details on timing and corresponding geometries can be found in the Recommendation ITU-R RS.2043.

2/1.12/4.1.3.2 Effect of systems operating in the mobile service on EESS SAR

Study results show that the SAR receiver protection criterion would be met with a margin of 16 dB when considering a deployment of several hundreds of ENG/OB transmitting at full power.

2/1.12/4.1.3.3 Conclusion on compatibility between systems in the mobile service and EESS SAR

Sharing between the EESS (active) and the MS is feasible.

2/1.12/4.1.4 Sharing between EESS SAR and stations operating in the amateur and amateur-satellite services

The amateur service is allocated in the frequency band 10.0-10.5 GHz and the amateur-satellite service in the frequency band 10.45-10.5 GHz. Both services are allocated on a secondary basis.

With regard to the amateur service, the study of effect of EESS (active) emissions into amateur station receivers indicates that the interference may exceed an I/N of –6 or –10 dB, but for a very limited period of time in the order of 10 times 4 seconds over 11 days, which in total represents 0.004% of the time.

The study of the impact of amateur transmitters into the SAR receivers shows a margin of 24 dB.

With regard to the amateur-satellite service, the study of the influence of an EESS (active) sensor into an amateur-satellite receiving earth station indicates that the interference may exceed an *I/N* of –6 or –10 dB, but for a very limited period of time representing 0.0015% of the total simulation time of 11 days, which represents two periods of about six seconds every five to six days. The studies of the impact of the EESS (active) sensor into the amateur-satellite receiver, as well as of the amateur-satellite transmitter or the amateur earth station transmitter into the SAR receiver indicate very large margins.

Sharing between the EESS (active) and the amateur service/amateur satellite service is feasible.

2/1.12/4.2 Compatibility studies related to unwanted emissions

2/1.12/4.2.1 Studies on unwanted emissions into stations of the space research service

A total of 15 earth stations are operating in the frequency band 8 400-8 450 MHz under the SRS (deep space) worldwide. There are also earth stations operating in the frequency band 8 450-8 500 MHz under the SRS (near-Earth) in some countries.

Besides sharing with radio services potentially affected by an extension, studies in Report ITU-R RS.2308 deal with compatibility conditions of unwanted emissions from wideband EESS systems into nearby SRS systems in the adjacent frequency band 8 400-8 500 MHz.

Recommendation ITU-R SA.1157 gives the protection criterion of deep space SRS earth stations at –221 dB (W/Hz) for the 8 400-8 450 MHz frequency band. Recommendation ITU-R SA.609 gives the protection criterion of near-Earth SRS earth stations at –216 dB (W/Hz) in the frequency range 1-20 GHz.

Dynamic analyses show that unwanted emissions need to be attenuated by 74 dB for routine operations of deep space SRS missions, and 31 dB for all operations of near-Earth SRS missions in order to meet the protection criteria given in relevant ITU-R Recommendations related to SRS systems. Additional 44 dB of attenuation to EESS (active) OOBE is needed to protect SRS (deep space) missions during the critical events.

In addition, unwanted emissions from EESS (active) systems can exceed the SRS receiver damage threshold by:

a) 71 dB if the extension is in the frequency band 8 700-9 300 MHz;

b) 9 dB if the extension is in the frequency bands 9 000-9 300 MHz and the 9 900 MHz-10.2 GHz; and

c) 2 dB if the extension is the frequency band 9.9-10.5 GHz.

Thus, as shown above, damage to the SRS receivers is a serious concern if the additional 600 MHz frequency band is in the entire frequency band 8 700-9 300 MHz.

The attenuation needed to protect SRS (deep space) operations and to protect the SRS receivers from damages should be computed based on the OOB characteristics of actual EESS (active) hardware and not on the theoretical OOB characteristics.

Mitigation techniques have been proposed to avoid any harmful interference to the SRS receivers, particularly during critical events, or to reduce the risk of damaging or saturating the receivers.

They are defined in Recommendation ITU-R RS.2065. In case the mitigation techniques are not effective, operational coordination will be needed between SRS and EESS operators for which the mechanism is described in the same Recommendation.

2/1.12/4.2.2 Studies on unwanted emissions into stations of the radio astronomy service

There are RAS stations operating in the frequency band 10.6-10.7 GHz in some countries. Threshold levels of interference detrimental to the RAS are given in Recommendation ITU-R RA.769. The threshold for harmful interference in the frequency band 10.6-10.7 GHz with an antenna gain of 0 dBi is the spectral pfd of –240 dB (W/(m² Hz)) for 2 000 s integration time. Recommendation ITU-R RA.1513 recommends a criterion of 2% be used for data loss to radio astronomy observations of the RAS due to interference from any one network for evaluation of interference.

The percentage of data loss was assessed for cases when a SAR-4 system illuminates a RAS observatory whenever a satellite is in visibility of the RAS station. The percentage of data loss, under technically feasible attenuation conditions rejecting unwanted emissions in the order of 30 to 40 dB, may exceed the 2% criterion in the first worst case situation; but it would never and under any circumstances exceed 2.7%. This assumes that SAR performs an acquisition over the RAS station any time it is possible, which would never be the case in practice, as an image of the same area is taken once in a while. Therefore, in reality, the 2% criteria will probably never be exceeded.

Reducing the data loss to 2%, as required by Recommendation ITU-R RA.1513, would make it necessary to attenuate the unwanted emissions by 63 dB with regard to the peak envelope power of the SAR pulse. If this would be impossible, particularly in the case of an extension into frequencies above the current allocation, additional mitigation techniques would become necessary. One of these possible mitigation techniques would consist in limiting the number of image acquisitions of areas where RAS observatories performing observations in the 10.6-10.7 GHz frequency band are located.

There may be a risk of damage to sensitive RAS receivers in case of main beam to main beam coupling. The method to avoid damage is described in Recommendation ITU-R RS.2066. It should be noted that the application of this Recommendation will also solve the problem of the exceedance of the 2% of data loss to radio astronomy observations.

Study results are provided in Report ITU-R RS.2308.

2/1.12/4.2.3 Studies on unwanted emissions into stations of the Earth exploration-satellite (passive) and space research (passive) services

The SRS (passive) and the EESS (passive) are also allocated in the frequency band 10.6-10.7 GHz. As SRS (passive) systems are sensors used around other planets, no interference to stations of the SRS (passive) would be possible from space borne SARs, thus, no study required.

Microwave radiometers and microwave radiometer imagers are operating in meteorological satellites under the EESS (passive) in this frequency band in some countries. Recommendation ITU-R RS.2017 provides performance and interference criteria for satellite passive remote sensing. The permissible interference power received by an EESS (passive) sensor is −166 dBW in the reference bandwidth of 100 MHz in the frequency band 10.6-10.7 GHz.

The effect of unwanted emissions of SAR systems using high resolution spotlight mode, which are operated for very small fractions of time, into EESS (passive) sensors used in the frequency band 10.6-10.7 GHz has been analysed in Report ITU-R RS.2308. Due to the attenuation of unwanted emissions, as well as the difference in orbital characteristics of SAR systems compared to EESS

(passive) systems, no effect is expected in EESS (passive) sensors and no specific regulatory conditions would be required.

2/1.12/5 Methods to satisfy the agenda item

2/1.12/5.1 Method A: Primary Earth exploration-satellite (active) service allocation in the frequency band 9 900-10 500 MHz

2/1.12/5.1.1 Method A1: Add a primary allocation to the Earth exploration-satellite (active) service in the frequency band 9 900-10 500 MHz

Option 1

This method will impose that EESS (active) shall not cause harmful interference to, nor claim protection from the RLS allocated in the frequency band 9 900-10 500 MHz. In addition, the extension frequency band shall only be used by EESS (active) systems requiring a bandwidth greater than 600 MHz that cannot be accommodated in the frequency band 9 300-9 900 MHz. The protection of RAS stations in the frequency band 10.6-10.7 GHz will be ensured through Recommendation ITU-R RS.2066 incorporated by reference in the RR.

Option 2

Same as Option 1 with the addition that the amateur-satellite service operating in 10.45-10.5 GHz is provided a transitional time period during which secondary amateur-satellite service systems are afforded equality of rights with EESS (active) for amateur-satellite service systems advanced published prior to the date of entry into force of the primary EESS (active) allocation.

Advantages

– Resolution for spaceborne radars with synthetic aperture will be higher to satisfy global monitoring of environment and increase of mapping system resistance to interference and weather condition changes.

– Provides additional 600 MHz primary allocation for the EESS (active) to be used by EESS (active) systems that need a bandwidth wider than the bandwidth available within the existing allocation in the frequency band 9 300-9 900 MHz.

– Provides explicit protection of RLS stations by a footnote like the current RR No. **5.476A**.

Disadvantages

– Some administrations are concerned about the potential of interference to radiolocation systems in the frequency band 10 000-10 500 MHz despite the explicit regulatory protection by making EESS (active) secondary to RLS.

2/1.12/5.1.2 Method A2: Add a primary Earth exploration-satellite (active) service allocation in the frequency band 9 900-10 500 MHz subject to inclusion of technical and regulatory constraints into the Radio Regulations

Same as Method A1 (Option 1) except that the protection of FS stations is to be ensured through a provision in the RR with a pfd-limit.

Advantages

– Resolution for spaceborne radars with synthetic aperture will be higher to satisfy global monitoring of environment and increase of mapping system resistance to interference and weather condition changes.

– Provides additional 600 MHz primary allocation for the EESS (active) to be used by EESS (active) systems that need a bandwidth wider than the bandwidth available within the existing allocation in the frequency band 9 300-9 900 MHz.

– Provides explicit protection of RLS stations by a footnote like the current RR No. **5.476A**.

– It specifies provisions for the protection of FS stations.

Disadvantages

– The pfd limit for the protection of FS stations may put undue constraints on EESS SARs.

Some administrations are concerned about the potential of interference to radiolocation systems in the frequency band 10 000-10 500 MHz despite the explicit regulatory protection by making EESS (active) secondary to RLS.

2/1.12/5.2 Method B: Primary Earth exploration-satellite (active) service allocation in the frequency bands 9 200-9 300 MHz and 9 900-10 400 MHz

2/1.12/5.2.1 Method B1: Add a primary allocation to the Earth exploration-satellite (active) service in the frequency bands 9 200-9 300 MHz and 9 900-10 400 MHz

Add a primary allocation to the EESS (active) in the frequency bands 9 200-9 300 MHz and 9 900-10 400 MHz. This method will impose that systems of the EESS (active) shall not cause harmful interference to, nor claim protection from the RDS systems using allocations in the frequency bands 9 200-9 300 MHz and 9 900-10 400 MHz. In addition, the extension frequency band shall only be used by EESS (active) systems requiring a bandwidth greater than 600 MHz that cannot be accommodated in the frequency band 9 300-9 900 MHz. The protection of SRS stations in the frequency band 8 400-8 500 MHz will be ensured through the Recommendation ITU-R RS.2065 incorporated by reference in the RR. The protection of RAS stations in the frequency band 10.6-10.7 GHz will be ensured through Recommendation ITU-R RS.2066 incorporated by reference in the RR.

Advantages

– Resolution for spaceborne radars with synthetic aperture will be higher to satisfy global monitoring of environment and increase of mapping system resistance to interference and weather condition changes.

– Provides additional 600 MHz primary allocation for the EESS (active) to be used by EESS (active) systems that need a bandwidth wider than the bandwidth available within the existing allocation in the frequency band 9 300-9 900 MHz.

– Provides explicit protection of RLS and RNS stations by a footnote like the current RR No. **5.476A**.

– As compared to Method A, allocating 600 MHz in the frequency bands 9 200-9 300 MHz and 9 900-10 400 MHz to EESS (active), provides more flexibility for administrations to continue operating and developing more reliably their radiolocation services without any constraints envisioned, in the unallocated frequency band 10 400-10 500 MHz.

– Provides better protection for radio astronomy services by more frequency separation of RAS stations operating in the band 10.6-10.7 GHz from the out-of-band emissions of EESS (active).

– Provides explicit protection from unwanted emissions of EESS (active) systems to SRS stations operating in the band 8 400-8 500 MHz and RAS stations operating in the band 10.6-10.7 GHz.

Disadvantages

Some administrations are concerned about the potential of interference to radiolocation systems in the frequency band 10 000-10 400 MHz despite the explicit regulatory protection by making EESS (active) secondary to RLS.

2/1.12/5.2.2 Method B2: Add a primary Earth exploration-satellite (active) service allocation in the frequency bands 9 200-9 300 MHz and 9 900-10 400 MHz subject to inclusion of technical and regulatory constraints into the Radio Regulations

Same as Method B1 except that the protection of FS stations will be ensured through a provision in the RR with a pfd limit.

Advantages

– Resolution for spaceborne radars with synthetic aperture will be higher to satisfy global monitoring of environment and increase of mapping system resistance to interference and weather condition changes.

– Provides additional 600 MHz primary allocation for the EESS (active) to be used by EESS (active) systems that need a bandwidth wider than the bandwidth available within the existing allocation in the frequency band 9 300-9 900 MHz.

– Provides explicit protection of RLS and RNS stations by a footnote like the current RR No. **5.476A**.

– Provides better protection for radio astronomy services by more frequency separation of RAS stations operating in the band 10.6-10.7 GHz from the out-of-band emissions of EESS (active).

– It specifies provisions for the protection of FS stations.

Disadvantages

– The pfd limit for the protection of FS stations, may put undue constraints on EESS SARs.

– Some administrations are concerned about the potential of interference to radiolocation systems in the frequency band 10 000-10 400 MHz despite the explicit regulatory protection by making EESS (active) secondary to RLS.

2/1.12/5.3 Method C: Primary Earth exploration-satellite (active) service allocation in the frequency bands 9 200-9300 MHz, and 10 000-10 100 MHz, and a secondary Earth exploration-satellite (active) service allocation in the frequency band 9 900-10 000 MHz

Make a primary EESS (active) allocation in the frequency bands 9 200-9 300 MHz and 10 000-10 100 MHz and a secondary EESS (active) allocation in the frequency band 9 900-10 000 MHz subject to inclusion of technical and regulatory constraints into the RR to ensure protection for the RLS, RNS and the FS having allocations in these frequency bands. The protection of FS stations is also to be ensured through a provision in the RR with a pfd-limit. The protection of RAS stations in the frequency band 10.6-10.7 GHz will be ensured through Recommendation ITU-R RS.2066 incorporated by reference in the RR.

In addition, the extension frequency band shall only be used by EESS (active) systems requiring a bandwidth greater than 600 MHz that cannot be accommodated in the frequency band 9 300-9 900 MHz.

Advantages

– Provides additional 300 MHz allocation, 200 MHz primary allocation and 100 MHz secondary allocation, for the EESS (active) to be used by EESS (active) systems that need a bandwidth wider than the bandwidth available within the existing allocation in the frequency band 9 300-9 900 MHz.

– Provides explicit protection of RLS and RNS stations by a footnote like the current RR No. **5.476A**.

– Allocating 300 MHz in the frequency bands 9 200-9 300 MHz and 9 900-10 100 MHz to EESS (active), provides better protection for radio astronomy services by more frequency separation of RAS stations operating in the band 10.6-10.7 GHz from the out-of-band emissions of EESS (active).

– As compared to Methods A and B, allocating 300 MHz in the frequency bands 9 200-9 300 MHz and 9 900-10 100 MHz to EESS (active), provides more flexibility for administrations to continue operating and developing more reliably their radiolocation services without any constraints envisioned, in the unallocated frequency band 10 100-10 500 MHz.

– Allocating 300 MHz in the frequency bands 9 200-9 300 MHz and 9 900-10 100 MHz to EESS (active), provides more flexibility for administrations to operate and develop more reliably their fixed services without any probable constraints, especially stations with elevation angles near 30°, in the unallocated frequency band 10 100-10 500 MHz.

– It specifies provisions for inclusion of a pfd limit for ensuring the protection of FS stations.

– With additional allocation of 300 MHz (900 total bandwidth) to EESS (active), the spectrum requirement for SAR systems for having picture resolution below 0.3 m is more or less provided.

Disadvantages

– Depending on the value of the pfd limit for the protection of FS stations, it may put undue constraints on EESS SARs.

– This method does not provide adequate spectrum to allow for the implementation of the currently planned systems which are expected to achieve picture resolution of 25 cm or better.

2/1.12/5.3 Method D: No change to the Radio Regulations (NOC)

Advantage

– No effect on incumbent services.

Disadvantage

– Does not meet the requirements for an extension of the current worldwide allocation to the EESS (active) identified in Report ITU-R RS.2274.

2/1.12/6 Regulatory and procedural considerations

2/1.12/6.1 Method A - Primary Earth exploration-satellite (active) service allocation in the frequency band 9 900-10 500 MHz

2/1.12/6.1.1 Method A1: Add a primary allocation to the Earth exploration-satellite (active) service in the frequency band 9 900-10 500 MHz

ARTICLE 5

Frequency allocations

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

Options 1 and 2

MOD

8 500-10 000 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
…		
9 900-10 000	EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION Fixed 5.477 5.478 5.479 ADD 5.B112 ADD 5.C112	

Reasons: Provides an additional 600 MHz allocation to the EESS (active) for high resolution SARs as requested by Resolution **651 (WRC-12)** and justified in Report ITU-R RS.2274.

Option 1

MOD

10-11.7 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
10-10.45 EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 FIXED MOBILE RADIOLOCATION Amateur 5.479 ADD 5.B112 ADD 5.C112	**10-10.45** EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION Amateur 5.479 5.480 ADD 5.B112 ADD 5.C112	**10-10.45** EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 FIXED MOBILE RADIOLOCATION Amateur 5.479 ADD 5.B112 ADD 5.C112
10.45-10.5	EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION Amateur Amateur-satellite 5.481 ADD 5.B112 ADD 5.C112	
…		

Reasons: Provides an additional 600 MHz allocation to the EESS (active) for high resolution SARs as requested by Resolution **651 (WRC-12)** and justified in Report ITU-R RS.2274.

Option 2

MOD

10-11.7 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
10-10.45 EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 FIXED MOBILE RADIOLOCATION Amateur 5.479 ADD 5.B112 ADD 5.C112	**10-10.45** EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION Amateur 5.479 5.480 ADD 5.B112 ADD 5.C112	**10-10.45** EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 FIXED MOBILE RADIOLOCATION Amateur 5.479 ADD 5.B112 ADD 5.C112
10.45-10.5	EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION Amateur Amateur-satellite 5.481 ADD 5.B112 ADD 5.C112 ADD 5.D112	
…		

Reasons: Provides an additional 600 MHz allocation to the EESS (active) for high resolution SARs as requested by Resolution **651 (WRC-12)** and justified in Report ITU-R RS.2274.

Options 1 and 2

ADD

5.A112 The use of the frequency band 9 900-10 500 MHz by the Earth exploration-satellite (active) service is limited to systems requiring a necessary bandwidth greater than 600 MHz that cannot be fully accommodated within the 9 300-9 900 MHz frequency band. (WRC-15)

Reasons: To limit the number of systems as well as the duration of transmission of SAR systems in the extension frequency band.

ADD

5.B112 In the frequency band 9 900-10 500 MHz, stations in the Earth exploration-satellite (active) service shall not cause harmful interference to, nor claim protection from, stations of the radiolocation service. (WRC-15)

Reasons: The EESS (active) primary allocation is made secondary with regard to the RLS allocation in this frequency band, to ensure protection of stations of this service from harmful interference.

ADD

5.C112 Space stations operating in the Earth exploration-satellite (active) service shall comply with Recommendation ITU-R RS.2066-0. (WRC-15)

Reasons: It ensures protection of RAS stations in the frequency band 10.6-10.7 GHz.

Option 2

ADD

5.D112 In the band 10.45-10.5 GHz, stations operating with networks or systems in the amateur-satellite service for which information for advance publication has been received by the Bureau prior to 1 January 2017 shall have an equality of right to operate with stations in the Earth exploration-satellite service (active); after that date, new stations in the amateur-satellite service will operate on a secondary basis. (WRC-15)

Reasons: To ensure that secondary amateur-satellite service operations in the frequency band 10.45-10.5 GHz that are advance published prior to the entry into force date of the primary EESS (active) allocation in 9 900-10 500 MHz are treated on a co-equal basis with EESS (active) operations.

Options 1 and 2

SUP

RESOLUTION 651 (WRC-12)

Possible extension of the current worldwide allocation to the Earth exploration-satellite (active) service in the frequency band 9 300-9 900 MHz by up to 600 MHz within the frequency bands 8 700-9 300 MHz and/or 9 900-10 500 MHz

Reasons: The extension by 600 MHz has been approved by WRC-15.

2/1.12/6.1.2 Method A2: Add a primary Earth exploration-satellite (active) service allocation in the frequency band 9 900-10 500 MHz subject to inclusion of technical and regulatory constraints into the Radio Regulations

ARTICLE 5

Frequency allocations

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

MOD

8 500-10 000 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
…		
9 900-10 000	EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION Fixed 5.477 5.478 5.479 ADD 5.B112 ADD 5.C112 ADD 5.D112	

Reasons: Provides an additional 600 MHz allocation to the EESS (active) for high resolution SARs as requested by Resolution **651 (WRC-12)** and justified in Report ITU-R RS.2274.

MOD

10-11.7 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
10-10.45 EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 FIXED MOBILE RADIOLOCATION Amateur 5.479 ADD 5.B112 ADD 5.C112 ADD 5.D112	**10-10.45** EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION Amateur 5.479 5.480 ADD 5.B112 ADD 5.C112 ADD 5.D112	**10-10.45** EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 FIXED MOBILE RADIOLOCATION Amateur 5.479 ADD 5.B112 ADD 5.C112 ADD 5.D112
10.45-10.5	EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION Amateur Amateur-satellite 5.481 ADD 5.B112 ADD 5.C112 ADD 5.D112	
…		

Reasons: Provides an additional 600 MHz allocation to the EESS (active) for high resolution SARs as requested by Resolution **651 (WRC-12)** and justified in Report ITU-R RS.2274.

ADD

5.A112 The use of the frequency band 9 900-10 500 MHz by the Earth exploration-satellite (active) service is limited to systems requiring a necessary bandwidth greater than 600 MHz that cannot be fully accommodated within the 9 300-9 900 MHz frequency band. (WRC-15)

Reasons: To limit the number of systems as well as the duration of transmission of SAR systems in the extension frequency band.

ADD

5.B112 In the frequency band 9 900-10 500 MHz, stations in the Earth exploration-satellite (active) service shall not cause harmful interference to, nor claim protection from, stations of the radiolocation service. (WRC-15)

Reasons: The EESS (active) primary allocation is made secondary with regard to the RLS allocations in these frequency bands, to ensure protection of systems of these services from harmful interference.

ADD

5.C112 Space stations operating in the Earth exploration-satellite (active) service shall comply with Recommendation ITU-R RS.2066-0. (WRC-15)

Reasons: It ensures protection of RAS stations in the frequency band 10.6-10.7 GHz.

ADD

5.D112 In order to protect the systems of the fixed service the power flux-density values produced on the surface of the Earth by a space station of the Earth exploration-satellite (active) service shall not exceed the following values:

-129 dB(W/m^2) in 1 MHz, for $0° \le \alpha \le 5°$;

-113 dB(W/m^2) in 1 MHz, for $5° < \alpha \le 6°$;

$-112 + 25 \cdot \lg(\alpha - 5)$ dB(W/m^2) in 1 MHz, for $6° < \alpha \le 53°$;

-69.6 dB(W/m^2) in 1 MHz, for $\alpha > 53°$;

in any 1 MHz of the frequency band 9 900-10 500 MHz for the indicated angle of arrival α, assuming free-space propagation conditions. (WRC-15)

SUP

RESOLUTION 651 (WRC-12)

Possible extension of the current worldwide allocation to the Earth exploration-satellite (active) service in the frequency band 9 300-9 900 MHz by up to 600 MHz within the frequency bands 8 700-9 300 MHz and/or 9 900-10 500 MHz

Reasons: The extension by 600 MHz has been approved by WRC-15.

2/1.12/6.2 Method B - Primary Earth exploration-satellite (active) service allocations in the frequency bands 9 200-9 300 MHz and 9 900-10 400 MHz

2/1.12/6.2.1 Method B1: Add a primary allocation to the Earth exploration-satellite (active) service in the frequency bands 9 200-9 300 MHz and 9 900-10 400 MHz

ARTICLE 5

Frequency allocations

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

MOD

8 500-10 000 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
	…	
9 200-9 300	EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION MARITIME RADIONAVIGATION 5.472 5.473 5.474 ADD 5.B112 ADD 5.C112 ADD 5.D112	
…		
9 900-10 000	EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION Fixed 5.477 5.478 5.479 ADD 5.C112 ADD 5.E112	

Reasons: Provides an additional 600 MHz allocation to the EESS (active) for high resolution SARs as requested by Resolution 651 (WRC-12) and justified in Report ITU-R RS.2274.

MOD

10-11.7 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
10-10.4 EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 FIXED MOBILE RADIOLOCATION Amateur 5.479 ADD 5.C112 ADD 5.E112	**10-10.4** EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION Amateur 5.479 5.480 ADD 5.C112 ADD 5.E112	**10-10.4** EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 FIXED MOBILE RADIOLOCATION Amateur 5.479 ADD 5.C112 ADD 5.E112
-10.4-10.45 FIXED MOBILE RADIOLOCATION Amateur	**10.4-10.45** RADIOLOCATION Amateur 5.480	**10.4-10.45** FIXED MOBILE RADIOLOCATION Amateur
…		

Reasons: Provides an additional 600 MHz allocation to the EESS (active) for high resolution SARs as requested by Resolution 651 (WRC-12) and justified in Report ITU-R RS.2274.

ADD

5.A112 The use of the frequency bands 9 200-9 300 MHz and 9 900-10 400 MHz by the Earth exploration-satellite (active) service is limited to systems requiring a necessary bandwidth greater than 600 MHz that cannot be fully accommodated within the 9 300-9 900 MHz frequency band. (WRC-15)

Reasons: To limit the number of systems as well as the duration of transmission of SAR systems in the extension frequency band.

ADD

5.B112 In the frequency band 9 200-9 300 MHz, stations in the Earth exploration-satellite (active) service shall not cause harmful interference to, nor claim protection from, stations of the radionavigation and radiolocation services. (WRC-15)

ADD

5.C112 Space stations operating in the Earth exploration-satellite (active) service shall comply with Recommendation ITU-R RS.2066-0. (WRC-15)

Reasons: It ensures protection of RAS stations in the frequency band 10.6-10.7 GHz.

ADD

5.D112 Space stations operating in the Earth exploration-satellite (active) service shall comply with Recommendation ITU-R RS.2065-0. (WRC-15)

Reasons: It ensures protection of SRS systems in the frequency band 8 400-8 500 MHz.

ADD

5.E112 In the frequency band 9 900-10 400 MHz, stations in the Earth exploration-satellite (active) service shall not cause harmful interference to, nor claim protection from, stations of the radiolocation service. (WRC-15)

Reasons: The EESS (active) primary allocation is made secondary with regard to the RLS allocations in these frequency bands, to ensure protection of stations of these services from harmful interference.

SUP

RESOLUTION 651 (WRC-12)

Possible extension of the current worldwide allocation to the Earth exploration-satellite (active) service in the frequency band 9 300-9 900 MHz by up to 600 MHz within the frequency bands 8 700-9 300 MHz and/or 9 900-10 500 MHz

Reasons: The extension by 600 MHz has been approved by WRC-15.

2/1.12/6.2.2 **Method B2: Add a primary Earth exploration-satellite (active) service allocation in the frequency bands 9 200-9 300 MHz and 9 900-10 400 MHz subject to inclusion of technical and regulatory constraints into the Radio Regulations**

ARTICLE 5

Frequency allocations

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

MOD

8 500-10 000 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
…		
9 200-9 300	EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION MARITIME RADIONAVIGATION 5.472 5.473 5.474 ADD 5.B112 ADD 5.C112 ADD 5.D112	
…		
9 900-10 000	EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION Fixed 5.477 5.478 5.479 ADD 5.C112 ADD 5.E112	

Reasons: Provides an additional 600 MHz allocation to the EESS (active) for high resolution SARs as requested by Resolution **651 (WRC-12)** and justified in Report ITU-R RS.2274.

MOD

10-11.7 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
10-10.4 EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 FIXED MOBILE RADIOLOCATION Amateur 5.479 ADD 5.C112 ADD 5.E112 ADD 5.F112	**10-10.4** EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION Amateur 5.479 5.480 ADD 5.C112 ADD 5.E112 ADD 5.F112	**10-10.4** EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 FIXED MOBILE RADIOLOCATION Amateur 5.479 ADD 5.C112 ADD 5.E112 ADD 5.F112
10.4-10.45 FIXED MOBILE RADIOLOCATION Amateur	**10.4-10.45** RADIOLOCATION Amateur 5.480	**10.4-10.45** FIXED MOBILE RADIOLOCATION Amateur
…		

Reasons: Provides an additional 600 MHz allocation to the EESS (active) for high resolution SARs as requested by Resolution **651 (WRC-12)** and justified in Report ITU-R RS.2274.

ADD

5.A112 The use of the frequency bands 9 200-9 300 MHz and 9 900-10 400 MHz by the Earth exploration-satellite (active) service is limited to systems requiring a necessary bandwidth greater than 600 MHz that cannot be fully accommodated within the 9 300-9 900 MHz frequency band. (WRC-15)

Reasons: To limit the number of systems as well as the duration of transmission of SAR systems in the extension frequency band.

ADD

5.B112 In the frequency band 9 200-9 300 MHz, stations in the Earth exploration-satellite (active) service shall not cause harmful interference to, nor claim protection from, stations of the radionavigation and radiolocation services. (WRC-15)

ADD

5.C112 Space stations operating in the Earth exploration-satellite (active) service shall comply with Recommendation ITU-R RS.2066-0. (WRC-15)

Reasons: It ensures protection of RAS stations in the frequency band 10.6-10.7 GHz.

ADD

5.D112 Space stations operating in the Earth exploration-satellite (active) service shall comply with Recommendation ITU-R RS.2065-0. (WRC-15)

Reasons: It ensures protection of SRS systems in the frequency band 8 400-8 500 MHz.

ADD

5.E112 In the frequency band 9 900-10 400 MHz, stations in the Earth exploration-satellite (active) service shall not cause harmful interference to, nor claim protection from, stations of the radiolocation service. (WRC-15)

Reasons: The EESS (active) primary allocation is made secondary with regard to the RDS allocations in these frequency bands, to ensure protection of stations of these services from harmful interference.

ADD

5.F112 In order to protect the systems of the fixed service the power flux-density values produced on the surface of the Earth by a space station of the Earth exploration-satellite (active) service shall not exceed the following values:

-113 dB(W/m^2) in 1 MHz, for $0° \le \alpha \le 5.7°$;

$-109 + 25 \cdot \log(\alpha - 5)$ dB(W/m^2) in 1 MHz, for $5.7° < \alpha \le 53°$;

-66.6 dB(W/m^2) in 1 MHz, for $\alpha > 53°$;

in any 1 MHz of the frequency band 9 900-10 400 MHz for the indicated angle of arrival α, assuming free-space propagation conditions. (WRC-15)

Reasons: It ensures protection of FS stations in the frequency band 9 900-10 400 MHz.

SUP

RESOLUTION 651 (WRC-12)

Possible extension of the current worldwide allocation to the Earth exploration-satellite (active) service in the frequency band 9 300-9 900 MHz by up to 600 MHz within the frequency bands 8 700-9 300 MHz and/or 9 900-10 500 MHz

Reasons: The extension by 600 MHz has been approved by WRC-15.

2/1.12/6.3 Method C - Primary Earth exploration-satellite (active) service allocations in the frequency bands 9 200-9 300 MHz and 10 000-10 100 MHz and secondary Earth exploration-satellite (active) service allocations in the frequency band 9 900-10 000 MHz

ARTICLE 5

Frequency allocations

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

MOD

8 500-10 000 MHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
…		
9 200-9 300	EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION MARITIME RADIONAVIGATION 5.472 5.473 5.474 ADD 5.B112 ADD 5.C112 ADD 5.D112	
…		
9 900-10 000	Earth exploration-satellite (active) ADD5.A112 RADIOLOCATION Fixed 5.477 5.478 5.479 ADD 5.C112 ADD 5.F112	

Reasons: Provides an additional 300 MHz allocation to the EESS (active) for high resolution SARs as requested by Resolution **651 (WRC-12)**, taking into account that with such additional allocation (900MHz total) picture resolution below 0.3 m is more or less provided.

MOD

10-11.7 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
10-10.1 EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 FIXED MOBILE RADIOLOCATION Amateur 5.479 ADD 5.C112 ADD 5.E112 ADD 5.F112	**10-10.1** EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 RADIOLOCATION Amateur 5.479 5.480 ADD 5.C112 ADD 5.E112 ADD 5.F112	**10-10.1** EARTH EXPLORATION-SATELLITE (active) ADD 5.A112 FIXED MOBILE RADIOLOCATION Amateur 5.479 ADD 5.C112 ADD 5.E112 ADD 5.F112
10.1-10.45 FIXED MOBILE RADIOLOCATION Amateur	**10.1-10.45** RADIOLOCATION Amateur 5.480	**10.1-10.45** FIXED MOBILE RADIOLOCATION Amateur
…		

Reasons: Provides an additional 300 MHz allocation to the EESS (active) for high resolution SARs as requested by Resolution **651 (WRC-12)**, taking into account that with such additional allocation (900 MHz total) picture resolution below 0.3 m is more or less provided.

ADD

5.A112 The use of the frequency bands 9 200-9 300 MHz and 9 900-10 100 MHz by the Earth exploration-satellite (active) service is limited to systems requiring a necessary bandwidth greater than 600 MHz that cannot be fully accommodated within the 9 300-9 900 MHz frequency band. (WRC-15)

Reasons: To limit the number of systems as well as the duration of transmission of SAR systems in the extension frequency band.

ADD

5.B112 In the frequency band 9 200-9 300 MHz, stations in the Earth exploration-satellite (active) service shall not cause harmful interference to, nor claim protection from, stations of the radionavigation and radiolocation services. (WRC-15)

ADD

5.C112 Space stations operating in the Earth exploration-satellite (active) service shall comply with Recommendation ITU-R RS.2066-0. (WRC-15)

Reasons: It ensures protection of RAS stations in the frequency band 10.6-10.7 GHz.

ADD

5.D112 Space stations operating in the Earth exploration-satellite (active) service shall comply with Recommendation ITU-R RS.2065-0. (WRC-15)

Reasons: It ensures protection of SRS systems in the frequency band 8 400-8 500 MHz.

ADD

5.E112 In the frequency band 10 000-10 100 MHz, stations in the Earth exploration-satellite (active) service shall not cause harmful interference to, nor claim protection from, stations of the radiolocation service. (WRC-15)

Reasons: The EESS (active) primary allocation is made secondary with regard to the RLS allocations in these frequency bands, to ensure protection of stations of these services from harmful interference.

ADD

5.F112 In order to protect the systems of the fixed service the power flux-density values produced on the surface of the Earth by a space station of the Earth exploration-satellite (active) service shall not exceed xxx(*) dB(W/m^2) in any 1 MHz of the frequency band 9 800-10 100 MHz for any angle of arrival, assuming free-space propagation conditions. (WRC-15)

Note: (*) value should be provided to WRC-15.

Reasons: It ensures protection of FS stations in the frequency band 9 900-10 100 MHz.

SUP

RESOLUTION 651 (WRC-12)

Possible extension of the current worldwide allocation to the Earth exploration-satellite (active) service in the frequency band 9 300-9 900 MHz by up to 600 MHz within the frequency bands 8 700-9 300 MHz and/or 9 900-10 500 MHz

Reasons: The extension by 300 MHz has been approved by WRC-15.

2/1.12/6.3 Method D: No change to the Radio Regulations (NOC)

SUP

RESOLUTION 651 (WRC-12)

Possible extension of the current worldwide allocation to the Earth exploration-satellite (active) service in the frequency band 9 300-9 900 MHz by up to 600 MHz within the frequency bands 8 700-9 300 MHz and/or 9 900-10 500 MHz