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| STEERING GROUP ON RADIO FREQUENCY COORDINATION (SG-RFC) |
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| SG-RFC Focal Points on EESS (active) Issues**Report on EESS (active) Issues** |

**Introduction**

This document provides a status update on issues affecting active remote sensing that may be of interest to SG-RFC members. Agenda items for the 2015 World Radiocommunication Conference (WRC-15) include AI 1.1, AI 1.6.1, AI 1.6.2, AI 1.12, and AI 1.17. Recent work within Working Party 7C of the ITU-R Study Group 7 is also summarized. Finally, any items currently outside of the ITU-R are also discussed.

**WRC-15 Agenda Item 1.1**

This agenda item deals with consideration of additional spectrum allocations to the mobile service and identification of additional frequency bands for International Mobile Telecommunications (IMT) and to facilitate the development of terrestrial mobile broadband applications, likely to concentrate on bands below 6 GHz. The EESS (active) band below 6 GHz being considered is the 5350-5470 MHz band. Work is being done in the ITU-R in Study Group 7 and the JTG 4-5-6-7 to follow this action item, with sharing studies for the affected EESS (active) band 5350-5470 MHz in the JTG 4-5-6-7 in the PDN Report RS.[EESS RLAN 5GHZ]. In the final JTG 4-5-6-7 report, draft CPM text for 5350-5470 MHz band shows “no change” (NOC) as the only method.

**WRC-15 Agenda Item 1.6.1**

This agenda item deals with consideration of possible additional primary allocations to the fixed-satellite service (Earth-to-space and space-to-Earth) of 250 MHz in the range between 10 GHz and 17 GHz in Region 1. The EESS (active) band between 10 and 17 GHz so far likely to be affected includes the 13.25-13.75 GHz band. Work is being done in the ITU-R in Study Group 7 to follow this action item with sharing studies for the affected EESS (active) band 13.25-13.75 GHz. Studies examining random data availability criteria of Recommendation ITU-R RS.1166-4 have concluded in WP 4A with some studies showing compatibility between EESS (active) and FSS (Earth-to-space) while other studies showed incompatibility. All studies examining the systematic data availability criteria of Recommendation ITU-R RS.1166-4 have concluded incompatibility between EESS (active) and FSS (Earth-to-space). Many studies examining the compatibility of FSS (space-to-Earth) with EESS (active) have concluded that proposed FSS (space-to-Earth) operations would not impact EESS (active) operations; however, the studies of one administration found these proposed FSS (space-to-Earth) operations to be incompatible with EESS (active) operations. Many studies examining the compatibility of FSS (space-to-Earth) with EESS (active) have concluded that proposed FSS (space-to-Earth) operations would not impact EESS (active) operations; however, the studies of one administration found these proposed FSS (space-to-Earth) operations to be incompatible with EESS (active) operations. Due to the lack of time at the last WP 4A meeting, the method E2 providing for a EESS (Earth-to-space) allocation in the 13.5-13.75 GHz did not include an Advantages or Disadvantages section; instead, an informal viewpoints section was included. If this viewpoints section is transformed into a Advantages and Disadvantages section at the 2015 CPM-2 meeting is TBD.

In September 2014, Study Group 7 approved Revised Report ITU-R RS.2068-2: Current and Future Use of the Band 13.25-13.75 GHz by Spaceborne Active Sensors” as shown in the following section “ITU-R Working Party 7C”.

**WRC-15 Agenda Item 1.6.2**

This agenda item deals with consideration of possible additional primary allocations to the fixed-satellite service (Earth-to-space) of 250 MHz in Region 2 and 300 MHz in Region 3 within the range 13-17 GHz. The EESS (active) band between 13 and 17 GHz so far to be affected includes the 13.25-13.75 GHz band. Work is being done in the ITU-R in Study Group 7 to follow this action item with sharing studies for the affected EESS (active) band 13.25-13.75 GHz. Again, as for AI 1.6.1, Study Group 7 in September 2014 approved Revised Report ITU-R RS.2068-2: Current and Future Use of the Band 13.25-13.75 GHz by Spaceborne Active Sensors” as shown in the following section “ITU-R Working Party 7C”.

The studies and methods for solution of Agenda item 1.6.2 mirror those of Agenda item 1.6.1 with the exception of the studies for FSS (space-to-Earth).

**WRC-15 Agenda Item 1.12**

This agenda item deals with consideration of 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. Work is being done in the ITU-R in Study Group 7 to evaluate compatibility with SRS s-to-E links in the 8400-8500 MHz band and the EESS (passive) in the 10.6-10.7 GHz band. The studies take into account any available mitigation techniques that would reduce the level of unwanted emissions in those two bands, as shown in the following section “ITU-R Working Party 7C”. Study Group 7 approved Report ITU-R RS.2274 – Spectrum requirements for wideband spaceborne synthetic aperture radar (SAR) applications planned in an extended allocation to the Earth exploration-satellite service (EESS) around 9 600 MHz. Study Group 7 approved the following DNRs: Draft new Report ITU-R RS.[EESS-9GHz\_FS/MS/AS] – Sharing analyses of very wideband EESS SAR transmissions with stations in the fixed, mobile, and amateur radio services operating in the frequency bands 8 700 9 300 MHz and 9 900-10 500 MHz; Draft new Report ITU-R RS.[EESS-9GHZ\_OOBE] - RF compatibility of unwanted emissions from 9 GHz EESS synthetic aperture radars (SAR) with the EESS (passive), SRS (passive), SRS and RAS operating in the frequency bands 8.4-8.5 GHz and 10.6-10.7 GHz; Draft new Report ITU-R RS.[EESS-9GHz\_RDS] - Sharing analyses of very wideband EESS SAR transmissions with stations in the radio determination service operating in the frequency bands 8 700-9 300 MHz and 9 900‑10 500 MHz.

**WRC-15 Agenda Item 1.17**

This agenda item deals with consideration of consider possible spectrum requirements and regulatory actions, including appropriate aeronautical allocations, to support wireless avionics intra-communications (WAIC). The EESS (active) bands most likely to be affected include the bands coinciding with “existing worldwide aeronautical mobile service, aeronautical mobile (R) service and aeronautical radionavigation service allocations” below 15.7 GHz such as: 5350-5460 MHz EESS and 13.25-13.4 GHz. Work is being done in the ITU-R in Study Group 7 to follow this action item with sharing studies for the affected EESS (active) bands.

**ITU-R Working Party 7C**

During the 2012-2015 Study Cycle, the work so far concerning active sensors has involved the following from preparing contributions to WP7C:

Modifications to PDR Recommendation ITU-R RS.[EESS\_RNSS\_METH] – “Evaluation method to determine compatibility between terrestrial receivers in the radionavigation-satellite service and spaceborne sensors in the Earth exploration-satellite (active) service in the 1 215‑1 300 MHz band”, with a view to updating the pertinent technical information for both RNSS systems and EESS (active) systems, adding the methodology for compatibility analysis, and updating analysis studies in this PDRR for the 1 215-1 300 MHz band. The methodology section contains allowable degradation ratios for various RNSS receivers as given in PDNR M.[PULSE\_EVAL] ”Evaluation model for pulsed interference from relevant radio sources other than in the radionavigation-satellite service to the radionavigation-satellite service systems and networks operating in the 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz frequency bands”.

Modifications to PDN Report ITU-R RS.[EES-ARNS RADARS 1 215-1 300] – Potential interference from the Earth exploration-satellite (active) spaceborne radars operating in the 1 215-1 300 MHz frequency band to the aeronautical radionavigation surveillance radar receivers in the 1 240-1 370 MHz Frequency band” are considered. Using the characteristics of synthetic aperture radar (SAR 1-6), spaceborne active sensors, provided in PDR Recommendation ITU-R RS.[EESS\_RNSS\_METH], and the characteristics of the ATC air-route surveillance radars provided in Recommendation ITU‑R M.1463-1 (2007), the interference to noise power ratio (I/N) is calculated and compared to the maximum allowable I/N.

Modifications to PDN Report ITU-R RS.[MITIG\_RNSS-EESS] on compatibility measurements between RNSS and EESS (active)- the results of compatibility measurements and possible mitigation measures between several spaceborne active sensors in the EESS (active) and several types of RNSS receivers in the band 1 215-1 300 MHz are presented. The EESS (active) waveforms included those of Scatterometer 2 and SAR 3 from the PDR Recommendation ITU-R RS.1347 and two RNSS receivers from the PDR Recommendation ITU-R RS.[EESS\_RNSS\_METH]. The SNR degradation to the RNSS receivers was measured with the two receivers operating simultaneously for two configurations: 1) receiving live signals from RNSS satellites with receivers in view of the satellites on the rooftop, and 2) receiving simulated signals from a RNSS constellation simulator in the laboratory.

Modifications to PDN Report RS.[EESS RFI SURVEY]: Global Survey of RFI Levels Observed by the Aquarius Scatterometer at 1260 MHz and radiometer at 1 413 MHz- RFI as observed globally by the Aquarius scatterometer at 1 260 MHz and Aquarius radiometer at 1413 MHz is displayed for the Regions 1,2,3. Examples are given of how these data can be used for RFI source analysis. The PDN report is to be further modified to include RFI observations by the SMOS radiometer at 1413 MHz.

Approved Report ITU-R RS.2273 “Potential interference from EESS (active) scatterometers into ARNS systems in the frequency band 1 215-1 300 MHz”- the results of simulation of interference from one spaceborne scatterometer transmitter into several types of ARNS in the band 1215-1300 MHz are presented. The EESS (active) transmit waveforms are those of a spaceborne scatterometer with two chirps of 1 MHz bandwidths with 3 MHz separation in frequency. The radiolocation radar receivers included those of System 1, System 2 and System 7 in Table 1, Annex 1, of the Recommendation ITU-R M.1643.

Approved Recommendation ITU-R RS.2042 “Typical technical and operating characteristics for spaceborne radar sounder systems using the 40-50 MHz band” - A spaceborne radar sounder is proposed to provide remote sensing in the vicinity of 40-50 MHz for remote measurements of the Earth’s subsurface. The spaceborne radar sounder provides radar maps of subsurface scattering layers with the intent to locate water/ice/deposits using active spaceborne sensors. The preferred frequency band selection rationale, and the technical and operating characteristics of an active sensor at 40-50 MHz are described. The power flux density (PFD) level and spectral PFD levels are calculated.

Approved draft new Report ITU-R RS.[EESS-9GHz\_RDS] – “Sharing analyses of very wideband EESS SAR transmissions with stations in the radio determination service operating in the frequency bands 8 700-9 300 MHz and 9 900‑10 500 MHz” (WRC-15 Agenda item 1.12) - A wideband SAR in the EESS (active) is proposed to operate in a 1.2 GHz band, using a 600 MHz extension of the frequency band 9.3–9.9 GHz allocated to the Earth exploration-satellite service EESS (active). A preliminary dynamic analysis investigates the potential impact of unwanted emissions, if a synthetic aperture radars (SAR) is operated with a total RF bandwidth of 1 200 MHz, This contribution addresses the sharing study results between proposed EESS (active) space-based radars in the frequency band 8 700-9 300 MHz and the existing ARNS airport surface surveillance radars operating in the frequency band 9 000-9 200 MHz.

Approved Recommendation ITU-R RS.2043 – Characteristics of synthetic aperture radars operating in the Earth exploration-satellite service (active) around 9 600 MHz - WRC-15 agenda item 1.12. Characteristics of a wideband SAR in the EESS (active) is proposed to operate in a 1.2 GHz band, using a 600 MHz extension of the frequency band 9.3–9.9 GHz allocated to the Earth exploration-satellite service EESS (active).

Approved Report ITU-R RS.2068-1: Current and Future Use of the Band 13.25-13.75 GHz by Spaceborne Active Sensors- Revisions are made to the PDRR for the scatterometers, altimeters, and precipitation radars in the band 13.25-13.75 GHz showing bandwidth requirements, feasibility of using other bands and continued need for operation in the band.

Approved Draft New Report ITU-R RS.[EESS\_RLS 35 GHZ]: Worst-case interference levels from mainlobe-to-mainlobe antenna coupling of systems operating in the radiolocation service into active sensor receivers operating in the 35.5-36 GHz band - several typical EESS (active) systems and a typical RLS system at 35 GHz are presented and the potential interference from RLS into the EESS (active) receivers at 35.5-36.0 GHz is analyzed statically and dynamically for worst case conditions of mainlobe-to-mainlobe coupling. The EESS (active) system designers can be advised of potentially high peak RFI levels into the receiver front end from which the EESS (active) receivers must be protected.

Modifications to Preliminary draft new Recommendation ITU-R RS.[ACTIVE\_CHAR] – Typical technical and operational characteristics of Earth exploration-satellite service (active) systems using allocations between 432 MHz and 238 GHz. Typical technical and operational characteristics are given for EESS (active) systems in bands between 432 MHz and 238 GHz to support sharing studies with other services.

Approved draft new Report ITU-R RS.[EESS-9GHz\_FS/MS/AS] – Sharing analyses of very wideband EESS SAR transmissions with stations in the fixed, mobile, and amateur radio services operating in the frequency bands 8 700 9 300 MHz and 9 900-10 500 MHz.

Approved draft new Report ITU-R RS.[EESS-9GHZ\_OOBE] - RF compatibility of unwanted emissions from 9 GHz EESS synthetic aperture radars (SAR) with the EESS (passive), SRS (passive), SRS and RAS operating in the frequency bands 8.4-8.5 GHz and 10.6-10.7 GHz

Modifications to Preliminary draft new Report ITU-R RS.[EESS-RNSS] – Dynamic simulation results of aggregate RFI from ALOS-2 SAR and SMAP scatterometer on the SBAS ground reference receiver operating in the 1 215‑1 300 MHz frequency band

Approved Draft new Question ITU-R [SPACE-WEATHER], “Space weather observations”- Studies to determine 1) what are the radio service(s) applicable for space weather sensors, 2) which part of the existing frequency allocations in RR Article **5** are suitable for use by space weather observations, 3) typical technical and operational characteristics of space weather sensors, 4) protection necessary for the operation of these systems

Modifications to Preliminary Draft New Question ITU-R [RAD\_SND]/7, “Compatibility between spaceborne radar sounders and incumbent services operating in the 40-50 MHz frequency range”- Studies to determine performance criteria of spaceborne radar sounder systems that could be used to conduct compatibility studies with incumbent services in the 40-50 MHz frequency range and to determine the feasibility of compatibility between the spaceborne radar sounder systems and incumbent services operating in the 40-50 MHz frequency range

**ITU-R Reports:**

[**RS.2068-2**](http://www.itu.int/pub/R-REP-RS.2068)  “Current and Future Use of the Band 13.25-13.75 GHz by Spaceborne Active Sensors”

[**RS.2178**](http://www.itu.int/pub/R-REP-RS.2178-2010)  “The essential role and global importance of radio spectrum use for Earth observations and for related applications”

[**RS.2273**](http://www.itu.int/pub/R-REP-RS.2273)  “Potential interference from EESS (active) scatterometers into ARNS systems in the frequency band 1 215-1 300 MHz”

[**RS.2274**](http://www.itu.int/pub/R-REP-RS.2274)  “Spectrum requirements for spaceborne synthetic aperture radar applications planned in an extended allocation to the Earth exploration-satellite service around 9 600 MHz”

**Recommendations:**

[**RS.1859**](http://www.itu.int/rec/R-REC-RS.1859-0-201001-I/en) “Use of remote sensing systems for data collection to be used in the event of natural disasters and similar emergencies”

[**RS.1883**](http://www.itu.int/rec/R-REC-RS.1883-0-201102-I/en) “Use of remote sensing systems in the study of climate change and the effects thereof”

[**RS.2042**](http://www.itu.int/rec/R-REC-RS.2042/en) “Typical technical and operating characteristics for spaceborne radar sounder systems using the 40-50 MHz band”

[**RS.2043**](http://www.itu.int/rec/R-REC-RS.2043/en) “Characteristics of synthetic aperture radars operating in the Earth exploration-satellite service (active) around 9 600 MHz “

**Other Active Sensing Issues**

Other items affecting active remote sensing spectrum arose from SFCG contributions:

Active Sensing below P-band- NASA is interested in active sensing in frequency bands lower than the lowest frequency band currently allocated to the EESS (active) at 432-438 MHz. The bands 40-50 MHz, 137-138 MHz, and 6 MHz around 290 MHz were all of scientific interest to NASA. ESA is interested in future EESS (active) allocations at low frequencies (below P-band) and that there is an increasing interest in new applications of low frequency radar sensors on LEO Earth Observation satellites to improve our knowledge of the atmosphere, land surface and cryosphere. ESA is particularly interested in the 40-50 MHz band for subsurface remote sensing.

NI-SAR RFI from Terrestrial Radars-There was presented a preliminary analysis of the interference levels from radars in the aeronautical radionavigation service (ARNS) and the radiolocation service (RLS) into the receiver of spaceborne active sensor NI-SAR in the EESS (active) in the 1215-1300 MHz band allocated to EESS (active); the possible interference from the NI-SAR system into radiolocation, radionavigation and RNSS systems has not yet been studied.

Impact of RLANs in 5350 – 5470 MHz- Analyses were presented from the previous SFCG meeting based on both static and dynamic methodologies to address the compatibility between radio local area networks (RLANs) and EESS (active) in the 5350-5470 MHz band, resulting in that RLANs cannot share the band 5350 – 5470 MHz with EESS (active) and that any introduction of RLANs into this band will endanger the operation of current and planned EESS systems, and in particular narrowband SAR instruments (such as the ESA Sentinel-1 mission (3 satellites) and the Canadian missions Radarsat-2 and upcoming Radarsat-RCM (3 satellites)). This study is related to that study submitted to the JTG 4-5-6-7 PDN Report RS.[EESS RLAN 5GHZ].

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