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| **Radiocommunication Study Groups** |  |
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| Source: Document 5A/TEMP/240 | **Annex 27 to Document 5A/650-E** |
| **21 November 2017** |
| **English only** |
| Annex 27 to Working Party 5A Chairman’s Report | |
| Elements of sharing and compatibility studies of WAS/RLAN  in the 5 850-5 925 MHz frequency range | |
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*[Editor’s note: This document is a compilation of material presented in contributions submitted to May and November 2016, and the May and November 2017 WP 5A meetings (see source indication below) that the submitting administrations requested to be considered in developing this document. The content of this document need to be supported by corresponding sharing studies. The material contained in this document has not been agreed by WP 5A. The material if agreed could be used to satisfy the objective of agenda item 1.16.]*

# 1 Introduction

This Report includes the sharing and compatibilities studies of WAS/RLAN in the 5 850‑5 925 MHz frequency range.

It is intended to represent the response to *invites ITU-R* *f)* of Resolution **239 (WRC‑15)** under WRC-19 agenda item 1.16.

# 2 Scope of the sharing and compatibility of WAS/RLAN with other services in the 5 850-5 925 MHz range.

The World Radiocommunications Conference 2015 decided on the draft agenda for the upcoming World Radiocommunications Conference scheduled for 2019. Among other items, WRC-19 agenda item 1.16 addresses the need of studies on regulatory actions and possible additional spectrum allocations to the mobile service, including radio local area networks (WAS/RLAN). Indeed, WRC‑19 agenda item 1.16 reads:

*1.16 to consider issues related to wireless access systems, including radio local area networks (WAS/RLAN), in the frequency bands between 5 150 MHz and 5 925 MHz, and take the appropriate regulatory actions, including additional spectrum allocations to the mobile service, in accordance with Resolution****239 (WRC‑15)****.*

The related Resolution **239 (WRC‑15)** to the WRC-19 agenda item 1.16 deals with studies concerning Wireless Access Systems including radio local area networks in the frequency bands between 5 150 MHz and 5 925 MHz. The Resolution invites ITU-R to conduct and complete the following in time for WRC‑19:

a) to study WAS/RLAN technical characteristics and operational requirements in the 5 GHz frequency range;

b) to conduct studies with a view to identify potential WAS/RLAN mitigation techniques to facilitate sharing with incumbent systems in the frequency bands 5 150-5 350 MHz, 5 350-5 470 MHz, 5 725-5 850 MHz and 5 850-5 925 MHz, while ensuring the protection of incumbent services including their current and planned use;

c) to performsharing and compatibility studies between WAS/RLAN applications and incumbent services in the frequency band 5 150-5 350 MHz with the possibility of enabling outdoor WAS/RLAN operations including possible associated conditions;

d) to conduct further sharing and compatibility studies between WAS/RLAN applications and incumbent services addressing:

i) whether any additional mitigation techniques in the frequency band 5 350‑5 470 MHz beyond those analysed in the studies referred to in *recognizing a)* would provide coexistence between WAS/RLAN systems and EESS (active) and SRS (active) systems;

ii) whether any mitigation techniques in the frequency band 5 350-5 470 MHz would provide compatibility between WAS/RLAN systems and radio determination systems;

iii) whether the results of studies under points i) and ii) would enable an allocation of the frequency band 5 350-5 470 MHz to the mobile service with a view to accommodating WAS/RLAN use;

e) to also conduct detailed sharing and compatibility studies, including mitigation techniques, between WAS/RLAN and incumbent services in the frequency band 5 725‑5 850 MHz with a view to enabling a mobile service allocation to accommodate WAS/RLAN use;

f) to also conduct detailed sharing and compatibility studies, including mitigation techniques, between WAS/RLAN and incumbent services in the frequency band 5 850‑5 925 MHz with a view to accommodating WAS/RLAN use under the existing primary mobile service allocation while not imposing any additional constraints on the existing services,

# 3 Overall view of allocations in the 5 850-5 925 MHz range

| **Allocation to services** | | | | | **Expected studies** | |
| --- | --- | --- | --- | --- | --- | --- |
| **Region 1** | **Region 2** | | **Region 3** | |
| **5** **850-5** **925**  FIXED  FIXED-SATELLITE (Earth-to-space)  MOBILE | | **5** **850-5** **925**  FIXED  FIXED-SATELLITE (Earth-to-space)  MOBILE  Amateur  Radiolocation | | **5** **850-5** **925**  FIXED  FIXED-SATELLITE  (Earth-to-space)  MOBILE  Radiolocation | Coexistence between WAS/RLAN under the current MS allocation and FS and FSS. |
| 5.150 | | 5.150 | | 5.150 |

# 4 Assumptions on technical and operational elements for the sharing and compatibility of WAS/RLAN with other services

## 4.1 Technical and operational characteristics of the WAS/RLAN operating in the 5 850-5 925 MHz ranges

Option 1

*[RUS* [*5A/196*](https://www.itu.int/md/R15-WP5A-C-0196/en)*]*

*[Editor’s note: The text below needs to be verified after finalization of the document Report ITU-R M.[RLAN REQ-PAR].]*

Technical and operational characteristics of RLANs are presented in Recommendation ITU-R M.1450 «Characteristics of broadband radio local area networks». e.i.r.p. spectral densities specified in Recommendation ITU-R М.1450 shows that it addresses RLANs having carrier bandwidth of 20 MHz. However taking in account the achievements in RLANs development such as IEEE standard 802.11ac, the considered Report includes analysis of networks having carrier bandwidth of both 20 MHz and 160 MHz.

*[UK and ESA* [*5A/246*](https://www.itu.int/md/R15-WP5A-C-0246/en)*,* [*5A/96*](https://www.itu.int/md/R15-WP5A-C-0096/en)*]*

Option 2

### 4.1.5 Characteristics of RLAN in 5 850-5 925 MHz band

*[ESA/EUMETSAT 5A/*[*96*](https://www.itu.int/md/R15-WP5A-C-0096/en)*,* [*97*](https://www.itu.int/md/R15-WP5A-C-0097/en)*]*

RLAN parameters used in the studies with EESS are those agreed in the previous study period and given in the preliminary draft new Report ITU-R RS.[EESS RLAN 5 GHz] (see Annex 35 to Document [4-5-6-7/715](http://www.itu.int/md/R12-JTG4567-C-0715/en) (Chairman’s Report)). They are also reiterated in the current working document towards a preliminary draft Report ITU-R M.[RLAN REQ-PAR] and concern:

– e.i.r.p. distributions

– indoor/outdoor ratio

– channel bandwidth distribution

– propagation conditions

– antenna gain/discrimination

– number of active RLAN.

## 4.2 Technical and operational characteristics of the Fixed service operating in the 5 850-5 925 MHz

*[TBD]*

## 4.3 Technical and operational characteristics of the Fixed Satellite service operating in the 5 850‑5 925 MHz

*[WP 4A* [*5A/181*](https://www.itu.int/md/R15-WP5A-C-0181/en)*,* [*5A/462*](https://www.itu.int/md/R15-WP5A-C-0462/en)*]*

Note: The material in the table below is derived from contributions received by WP 4A at its September/October 2016 meeting and May 2017 meeting.

Table 1

FSS uplink parameters (interfered with)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency range | GHz | 5.725-5.925 | 5.725-5.925 | 5.725-5.925 |
| Carrier | Carrier name | Carrier #11 | Carrier #12 | Carrier #48 |
| Noise bandwidth | MHz | 4.0-20 | 4.0-20 | 4.0-54 |
| **Space station** | | | | |
| Peak receive antenna gain | dBi | 20 | 36.4 | 41.6 |
| Antenna receive gain pattern and beamwidth | – | Section 1.1 of Annex 1 of Rec. ITU‑R S.672-4 LS = –25 | Section 1.1 of Annex 1 of Rec. ITU-R S.672-4 LS = –25 | "Section 1.1 of Annex 1 of Rec. ITU-R S.672-4  LS = –25 Beamwidth:1.5" |
| System receive noise temperature | K | 400 | 400 | 400 -500 |
| **Interference protection criteria** | | | | |
| Interference to noise ratio *I/N* | dB | [–12.2] | [–12.2] | [–12.2] |
| **Other** | | | |  |
| Additional notes |  | – |  |  |

Table 2

FSS Uplink Parameters (Interferer)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency range | GHz | 5.725-5.925\* | 5.725-5.925\* | 5.725-5.925 |
| **Earth station carrier** |  | Carrier #11 | Carrier #12 | Carrier #48 |
| Antenna diameter | m | 1.8 | 13.2 | 13.2 |
| Peak transmit antenna gain | dBi | 39.9 | 57.2 | 56.4 |
| Peak transmit power spectral density (clear sky) | dBW/Hz | –33 | –33 | –28 |
| Antenna gain pattern (ITU Recommendation) | – | Rec. ITU-R 465-6 | Rec. ITU-R 465-6 | Rec. ITU-R 465-6 |
| Minimum elevation angle of transmit earth station |  | 5 | 5 | 5 |
| **Other** | | | |  |
| Additional Notes |  |  |  |  |
| \* Generic frequency range where the parameters included in this table are applicable for the purpose of sharing studies | | | | |

**4.3.1 Technical characteristics of Fixed satellite service in 5 850-5 925 MHz band**

*[LUX* [*5A/264*](https://www.itu.int/md/R15-WP5A-C-0264/en)*]*

Table A1-19

Typical FSS parameters in the 6 GHz band

|  |  |
| --- | --- |
| Parameter | Typical value |
| Range of operating frequencies | 5 850-6 700 MHz\* |
| Antenna diameters (m) | 1.2, 1.8, 2.4, 3.0, 4.5, 8, 16, 32 |
| Antenna reference pattern | Recommendation ITU-R S.465 |
| Range of emission bandwidths | 40 kHz – 72 MHz |
| Receiving space system figure of merit | +5 ↔ –10 dB/K (The database of Recommendation ITU-R S.1328 provides one example with Gsat = 24.8 dBi and Ts = 400 K, corresponding to a G/T of –1.2 dB/K |
| Earth station deployment | All regions, in all locations (rural, semi-urban, urban) |
| Earth station e.i.r.p. density towards the horizon | In accordance with RR No. **21.8** and Recommendation ITU-R S.524-9 |
| Minimum earth station antenna elevation angle, *h* (degrees) | 5, 15 and 40 |
| \* Generic frequency range where the parameters included in this table are applicable for the purpose of sharing studies | |

*[Editor’s note]*

Sharing studies in 5 850-5 925 MHz should take into account the technical characteristics of FSS networks in all three Regions, e.g., coverage footprints.

*[IARU* [*5A/421*](https://www.itu.int/md/R15-WP5A-C-0421/en)*]*

## 4.4 Technical and operational characteristics of the Amateur Radio service operating in 5 650‑5 925 MHz

*[Editor’s note: RR No.* ***5.453*** *provides an additional allocation to the fixed and mobile service on a primary basis in several countries. As the amateur and amateur-satellite service are allocated on a secondary basis further discussions are required to determine whether or not studies are necessary.]*

The secondary allocation to the amateur radio service is 5 650 to 5 850 MHz in Regions 1 and 3 and to 5 650 to 5 925 MHz in Region 2. The reference document for amateur signal characteristics for sharing studies is Rec. ITU-R M.1732-2 (01/2017).

Amateur radio service activities in this frequency range and in particular in 5 760 to 5 765 MHz include terrestrial and Earth-Moon-Earth (EME) communications and weak-signal communications. These activities are typically not channelized and are very sensitive to increases in noise and interference.

### 4.4.1 Amateur systems (Morse, analogue voice and data)

|  |
| --- |
| Parameter |
| Necessary bandwidth and emission class designator | 150HA1A 150HJ2A 60H0J2B 250HF1B  2K70J3E 11K0F3E 16K0F3E 20K0F3E |
| Transmitter power (dBW) | 3 to 20 |
| Feeder loss (dB) | 1 to 6 |
| Transmitting antenna gain (dBi) | 10 to 42 |
| Typical e.i.r.p. (dBW) | 1 to 45 |
| Antenna polarization | Horizontal, vertical |
| Receiver Noise Figure (dB) | 0.5 to 1 |

While the foregoing parameters principally characterize amateur radio signals in 5 760 to 5 765 MHz, they may be used anywhere in the allocation.

Receiver bandwidths, as indicated in the emission class designators, range from 150 Hz to 20 kHz

### 4.4.2 Amateur Earth-Moon-Earth (EME) systems

|  |
| --- |
| Parameter |
| Necessary bandwidth and emission class designator | 50H0A1A 50H0J2A 1K80F1B  1K50J2D |
| Transmitter power (dBW) | 13 to 20 |
| Feeder loss (dB) | 1 to 4 |
| Transmitting antenna gain (dBi) | 25 to 46 |
| Typical e.i.r.p. (dBW) | 50 to 65 |
| Antenna polarization | Horizontal, vertical, LHCP, RHCP |
| Receiver noise figure (dB) | 1 |

EME systems operating in 5 760 to 5 765 MHz increasingly employ digital “Weak Signal Modes” which are structured for very basic communication with low data rates and narrow bandwidth. The main antenna beam direction can be assumed to be pointing above the horizon; however, the technique is still vulnerable to noise on side lobes.

Receiver bandwidths, as indicated in the emission class designators, range from 50 Hz to 2 kHz.

### 4.4.3 Amateur systems (digital voice, data and multimedia)

Amateur mesh networks, e.g., Broadband HamNet (BBHN) systems, are implemented within the 5 725 to 5 875 MHz range shared with ISM users. However, in 5 760 to 5 765 MHz, narrowband weak signal terrestrial and EME operation is given priority.

|  |
| --- |
| Parameter |
| Necessary bandwidth and emission class designator | 2K70G1D 6K00F7D 16K0D1D 150KF1W 10M5G7W |
| Transmitter power (dBW) | 3 to 20 |
| Feeder loss (dB) | 1 to 6 |
| Transmitting antenna gain (dBi) | 10 to 42 |
| Typical e.i.r.p. (dBW) | 1 to 45 |
| Antenna polarization | Horizontal, vertical |
| Receiver noise figure (dB) | 0.5 to 1 |

Receiver bandwidths, as indicated in the emission class designators, range from 2.7 kHz to 10 MHz.

### 4.4.4 Earth-to-space uplinks for amateur satellites

The amateur service allocation in 5 GHz, particularly in 5 760 to 5 765 MHz, is also being considered for uplinks to planned geosynchronous amateur satellites.

|  |
| --- |
| Parameter |
| Necessary bandwidth and class of  emission (emission designator) | 150HA1A 150HJ2A  2K70J3E 2K70J2E 16K0F3E 44K2F1D  88K3F1D 350KF1D 10M0G7W |
| Transmitter power (dBW) | 3 to 20 |
| Feeder loss (dB) | 1 to 10 |
| Transmitting antenna gain (dBi) | 10 to 42 |
| Typical e.i.r.p. (dBW) | 3 to 45 |
| Antenna polarization | Horizontal, vertical, RHCP, LHCP |
| Satellite receiver noise figure (dB) | 1 to 3 |

The receiver bandwidth of an amateur radio satellite is usually as wide as its uplink frequency band unless the transponder is equipped for demodulation and re-modulation. However, the required signal bandwidths, as indicated in the emission class designators, range from 150 Hz to 10 MHz.

# 5 Sharing studies per service

## 5.1 Sharing and compatibility of Fixed Service versus WAS/RLAN in the 5 850‑5 925 MHz

*[TBD]*

## 5.2 Sharing and compatibility of Fixed Satellite Service versus WAS/RLAN in the 5 850‑5 925 MHz

### 5.2.2 Sharing and compatibility in 5 850-5 925 MHz band

*[YAHSAT* [*5A/449*](https://www.itu.int/md/R15-WP5A-C-0449/en)*]*

[Editor’s Note: Further clarification for the text below is needed in the future meetings]

At worldwide level, there may be geographical areas where population densities are higher than in Europe, such as in Africa and Asia. Therefore, densities for RLAN access points should take these geographical areas as well in the studies.

*[LUX* [*5A/264*](https://www.itu.int/md/R15-WP5A-C-0264/en)*]*

Studies have been conducted by interested Administrations (for example, within CEPT SE 24) to estimate the levels of interference which FSS space receivers could absorb without generating a harmful level of interference into FSS space receivers. Extracts of such studies are provided in Doc. [5A/246](http://www.itu.int/md/R15-WP5A-C-0246/en) [UK] and included here as Study 2. The general conclusions reached indicate that sharing of WAS/RLAN and FSS space receivers would be very difficult and additional techniques should be developed to mitigate the risk of harmful interference created by the aggregate interfering signals originated by transmitting WAS/RLAN stations. Indeed, the agenda item 1.16 called for studies on suitable mitigation techniques (*resolves b)*). [At the lack of reliable mitigation techniques which could be implemented at affordable costs for WAS/RLAN networks, assumptions on the RLAN characteristics are based on Annex 24 of the WP 5A Chairman´s Report from May 2016 meeting.]

*[IRAN]*

[Any Mitigation Techniques proposed under Agenda Item 1.16 as a possible measure to facilitate compatibility between RLAN should be accompanied by clear implementation steps so as a) to ensure its efficiency, effectiveness and its practicality of use. Such technique(s) should be implementable without any technical, logistical and operational burden to the administrations/operators of incumbent services/applications to which the band is allocated. RLAN administration(s)/operator(s) should undertake the due diligence to fully respect the above-mentioned conditions and course of actions.]

*[LUX* [*5A/442*](https://www.itu.int/md/R15-WP5A-C-0442/en)*]*

Without reliable mitigation techniques to be proposed, sharing of FSS and RLAN in this band is very difficult. This conclusion takes account that all scenarios considered so far by the ECC Report 244 are valid and realistic and most of the cases studies will present sharing difficulties. Indeed, some previous considerations on the conservativeness of assumptions adopted by the ECC Report 244 have not been endorsed by the recent studies of WP3K/WP3M and, in particular, these WPs (22-29 March 2017) concluded that the analysis of the clutter loss and building entry loss models provided in the ITU Draft New Recommendations show that:

– Working Party 5A should not use the clutter component of P.452

– The clutter loss model of DNR P. [Clutter], currently applicable from 10 GHz to   
100 GHz, could be extended to the 5G Hz range

– This clutter model would provide lower values for clutter losses at 5 GHz than those currently assumed in ECC Report 244.

– For the building entry loss model, applicable from 80 MHz to 100 GHz, the average values obtained for the building entry loss at 30 degrees elevation angle is 14 dB at 5.8 GHz and 13.4 dB at 2.4 GHz, which is only a 0.6 dB difference. Some airborne measurements submitted previously to WP 5 A showed a difference of 6.1 dB (8.4 dB at 2.4 GHz and 14.5 dB at 5 GHz).

Building entry losses. It was concluded that indoor/outdoor attenuation (currently estimated as 12 and 17 dB) should be considered as very similar at 2.4 GHz and 5 GHz and not a difference of 8,4 dB at 2,4 GHz and 14,5 dB at 5 GHz. Instead, the building losses are actually 13.4 dB at 2.4 GHz and 14.5 dB at 5 GHz, almost no significant difference.

The following table provides a summary of the conclusions of the studies for three selected representative scenarios (out of the 27 scenarios considered).

| Scenario | Antenna discr.  (dB) | Building  loss (dB) | Band 5 725-5 850 MHz | Band 5 850 5 925-MHz |
| --- | --- | --- | --- | --- |
| “Optimistic” scenario (Case 1 above) | 4 | 17 | FSS protection criteria satisfied for all FSS groups 1, 2 and 4 (margin ranges 1.3 to 12 dB) | FSS protection criteria satisfied  for all FSS groups 1, 2, 3, 4 and  5 (margin ranges 0.1 to 10.3 dB) |
| 4 | 12 | FSS protection criteria satisfied for FSS groups 1 and 2 (margin ranges 2.6 to 9.9 dB). FSS protection criteria exceeded for other FSS group 4 (exceeding of 0.9 dB) | FSS protection criteria satisfied for FSS groups 1 2 and 3 (margin ranges 0.6 to 8.1 dB). FSS protection criteria exceeded for other FSS groups 4 and 5 (exceeding ranges 0.2 to 2.1 dB) |
| 0 | 17 | FSS protection criteria satisfied for FSS groups 1 and 2 (margin ranges 0.8 to 8 dB):  FSS protection criteria  exceeded for other FSS group 4 (exceeding of 2.7 dB) | FSS protection criteria satisfied for FSS groups 1 and 2 (margin ranges 0.8 to 6.3 dB).  FSS protection criteria exceeded for other FSS groups 3, 4 and 5 (exceeding ranges 0 to 3.9 dB) |
| 0 | 12 | FSS protection criteria satisfied for FSS group 1 (margin ranges 5.2 to 5.9 dB). FSS protection criteria exceeded for other FSS groups 2 and 4 (exceeding ranges 1.4 to 4.9 dB) | FSS protection criteria satisfied  for FSS groups 1  (margin ranges 0 to 4.1 dB)  and Satellite N (28.5 dBi)  with a margin of 0 dB.  FSS protection criteria exceeded  for other FSS groups 2  (except satellite N), 3, 4 and 5  (exceeding ranges 0.2 to 6 dB) |
| “Medium” scenario (Case 14 above) | 4 | 17 | FSS protection criteria satisfied for FSS group 1 (margin ranges 2.2 to 2.9 dB). FSS protection criteria exceeded for other FSS groups 2 and 4 (exceeding ranges 4.4 to 7.9 dB) | FSS protection criteria satisfied for FSS group 1 (margin ranges 0.5 to 1.1 dB).  FSS protection criteria exceeded for other FSS groups 2, 3, 4 and 5 (exceeding ranges 3 to 9.1 dB) |
| 4 | 12 | FSS protection criteria satisfied for FSS group 1 (margin ranges 0 to 0.7 dB). FSS protection criteria exceeded for other FSS groups 2 and 4 (exceeding ranges 6.5 to 10.1 dB) | FSS protection criteria exceeded for all FSS groups 1, 2, 3, 4 and 5 (exceeding ranges 1.1 to 11.2 dB) |
| 0 | 17 | FSS protection criteria  exceeded for all FSS groups 1, 2 and 4 (exceeding ranges 1.1 to 11.9 dB) | FSS protection criteria exceeded for all FSS groups 1, 2, 3, 4 and 5 (exceeding ranges 2.9 to 13.1 dB) |
| 0 | 12 | FSS protection criteria  exceeded for all FSS groups 1, 2 and 4 (exceeding ranges 3.3 to 14.1 dB) | FSS protection criteria exceeded for all FSS groups 1, 2, 3, 4 and 5 (exceeding ranges 5.1 to 15.2 dB) |
| “Pessimistic”  scenario  (Case 27 above) | 4 | 17 | FSS protection criteria exceeded for all FSS groups  1, 2, 3, 4 and 5 (exceeding ranges 4.5 to 15.3 dB) | FSS protection criteria exceeded for all FSS groups 1, 2 and 4 (exceeding ranges 6.3 to 16.5 dB) |
| 4 | 12 | FSS protection criteria exceeded for all FSS groups  2, 3, 4 and 5 (exceeding ranges 6.7 to 17.4 dB) | FSS protection criteria exceeded for all FSS groups 1, 2 and 4 (exceeding ranges 8.4 to 18.6 dB) |
| 0 | 17 | FSS protection criteria  exceeded for all FSS groups 1,  3, 4 and 5 (exceeding ranges 8.5 to 19.2 dB) | FSS protection criteria exceeded for all FSS groups 1, 2 and 4 (exceeding ranges 10.3 to 20.4 dB) |
| 0 | 12 | FSS protection criteria  exceeded for all FSS groups 1,  2, 3, 4 and 5 (exceeding  ranges 10.7 to 21.4 dB) | FSS protection criteria exceeded for all FSS groups 1, 2 and 4 (exceeding ranges 12.4 to 22.6 dB) |

#### 5.2.2.1 Estimation of interference from WAS/RLAN through empirical methods

As a potential way forward to estimate the interference from WAS/RLAN, an innovative contribution was made available to WP 5A (Doc. [5A/91](http://www.itu.int/md/R15-WP5A-C-0091/en)) suggesting the estimation of interference through an empirical method consisting on airborne measurements. A separate report on measurements on interference created by RLAN using airborne is under elaboration.

A detailed analysis on the set of airborne measurements has been made. In general these airborne measurements are potentially interesting to:

– Achieve a better understanding of the study models before the actual RLAN deployment, with a view to determine the actual interference level observed and compare it with calculated results of studies;

– To measure and control, including on the long term, the aggregate interference into FSS space stations when RLAN deployment is developing.

Preliminary conclusions on the airborne measurements do not allow at this stage characterisation of the interference environment and do not allow quantitative conclusions to be drawn. Additional measurements campaigns from airplanes (including in other geographical areas) would be necessary before being able to draw any conclusions from such measurements.

Furthermore, the following issues should be investigated and clarified on possible future airborne measurements:

– Measurements are made locally at low altitude (few kms) whereas FSS space stations cover wide geographic areas and operate from the GSO orbit in space.

– It is not clear how measurements at 2.4 GHz (for which the reference point is not clear, is it less congested than expected?) can help characterise the interference environment at 5 GHz, especially since measurements at 5 GHz are close the noise floor.

– Measurements should be made during busy hours.

– It is not clear how space and time dynamics of an airplane is comparable with the case of GSO satellites (which are seen from the Earth as static in the sky).

– These measurements have considered two elevation angles (30 and 90 degrees). It would seem useful to specifically conduct measurements at elevation and azimuths corresponding to the GSO orbit, since the GSO orbit as seen from the Earth is a particular path in the sky, from 0-degree elevation angle at horizon for the most western and eastern azimuths to about 48 degrees elevation angle at south azimuths, from London.

#### 5.2.2.2 Potential mitigation techniques for WAS/RLAN

It can be noted sufficient details on potential mitigation techniques are lacking, despite the fact that previous studies concluded on the need of such mitigation techniques. It is understood that further specific sharing studies WAS/RLAN and FSS will be conducted as part of the AI 1.16 work plan; presumably, these studies will conclude on the need of adequate mitigation techniques. See, for example, the conclusions reached by JTG at the previous study cycle for similar sharing studies (Example: Doc. 2357).

For protection of the FSS, two possible mitigation techniques can be identified:

– Limitation of RLAN deployment to indoor only.

– Placing a limit on the maximum e.i.r.p. of RLAN APs. The appropriate value can be determined through additional studies for RLAN under WRC-19 agenda item 1.16 (noting a value of 10 to 15 dBm/20 MHz has been determined by the ITU in the context of studies between IMT and the FSS, with an interference configuration similar to the RLAN case, see Report ITU-R [S.2367](http://www.itu.int/pub/R-REP-S.2367)).

– [downward tilting antenna.]

These [two] mitigation techniques seem relatively simple to implement but are sometimes difficult to enforce for the RLAN type of equipment (e.g. indoor only, or non-compliant equipment). The impact of such mitigation techniques on the RLAN deployment and operations (e.g. RLAN eirp distribution and the resulting limitations on data rates possible), should be studied.

#### 5.2.2.3 Additional compatibility studies in adjacent bands

Compatibility studies for Regions in which FSS is allocated on a primary basis in 5 725-5 925 MHz between RLAN operating in any of the sub-bands within 5 725-5 925 MHz and the FSS operating in adjacent sub-bands are necessary.

#### 5.2.2.4 Protection of FSS

The protection criterion for FSS is to accept an increase of the equivalent temperature greater than x% due to interference signals on the noise temperature of the satellite receiver in clear sky conditions without interference, i.e.: Δ*T/T*≤ x%. This criterion is applicable for interference scenarios when the interfering signal is time invariant, which is assumed the case for the aggregate interference levels created by WAS/RLAN in this uplink satellite band, because coverage areas are large (hemispheric or global) and there is no mobility aspect due to the fact that main interference is from RLAN access points which are fixed.

The values of *x* is 6%, generally applicable for sharing in the case of two co-primary services, e.g. the FSS and the MS as co-primary services without service apportionment, and *x* = 1%, generally applicable to interference from a non-primary service into FSS, or to interference from several co‑primary services, e.g. the MS and FS, into FSS.

Apportionment of interference allowance

To apportion these FSS protection criteria among the potential sources of interference, an apportionment scheme should be considered where interference from RLANs is limited to half of the Δ*T/T* = 6% criterion i.e. the Δ*T/T* objective is reduced to a value of 3%. In addition, geographic apportionment could also be applied depending on the satellite’s coverage and the assumptions for the RLAN deployment.

# 6 Conclusions of sharing and compatibility studies per service

## 6.1 General considerations

## 6.2 Sharing and compatibility results in the band 5 850-5 925 MHz

*[LUX 5A/442]*

Sharing of RLAN and FSS is difficult. Development of suitable mitigation techniques to be applied by new RLAN systems are required, noting the nature of the typical deployment of RLAN services under unlicensed conditions.

The general conclusions from previous studies conducted by the CEPT (example: CEPT Report 57) were that it was not possible at this time to specify any appropriate mitigation techniques and/or operational compatibility and sharing conditions that would allow WAS/RLANs to be operated in the band 5 725-5 925 MHz while ensuring relevant protection of FSS services in this band.

Considering studies conducted by CEPT (and reported in the ECC 244 Report), conclusions are derived:

− Sharing between WAS/RLAN and FSS is not possible. Specific mitigation techniques needs be investigated.

− Empirical methods to estimate the interference levels from aggregate transmissions from WAS/RLAN will require further studies and analysis (including possibly other the scenarios of interference representing closer the cumulative interference from WAS/RLAN into FSS receiver.

− Before considering the introduction of RLAN in any of the sub-bands within 5 725‑5 925 MHz specific compatibility analysis between RLAN and the FSS operating in adjacent sub-bands are necessary.

List of References

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