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| **Radiocommunication Study Groups** |  |
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| Source: Document 5A/TEMP/169 | **Annex 25 to****Document 5A/469-E** |
| **12 June 2017** |
| **English only** |
| Annex 25 to Working Party 5A Chairman’s Report |
| WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW REPORT ITU-R M.[RLAN Mitigation] |
| Study of proposed additional mitigation techniques to facilitate sharingbetween RLAN systems and incumbent services |

***[Editor’s Note****: Document* [*5A/114*](http://www.itu.int/md/R15-WP5A-C-0114/en)[*Annex 23*](https://www.itu.int/md/dologin_md.asp?lang=en&id=R15-WP5A-C-0114!N23!MSW-E) *“Compilation of technical information on techniques that could be used in RLAN deployments to facilitate sharing” provides details and initial comments with regard to various proposed additional mitigation techniques, Administrations, should consider that Annex as a resource when providing input to this working document. Additionally, text is needed for the introduction explaining why focus is given on the three additional mitigation techniques contained in the current draft.]*

# 1 Introduction

[Emission masks, transmitter power control (TPC), dynamic frequency selection (DFS), and indoor operation are being used to facilitate sharing WAS including RLANs with incumbent services.]

Under Resolution **229 (WRC-12)**, RLANs can operate in the 5 250-5 350 MHz and 5 470‑5 725 MHz frequency ranges on a co-primary basis with radar systems. Prior to operation, RLANs in those frequency ranges must use specific regulatory provisions and DFS to enable the RLAN networks to protect the incumbent radiolocation systems. The mobile systems must also vacate RLAN channels when new radiolocation systems come into operation on any portion of those channels[[1]](#footnote-1).

Although the techniques specified in Resolution **229 (WRC-12)** enable effective sharing in these frequency ranges, additional mitigation techniques or modifications to DFS may be needed to facilitate sharing in other frequency ranges to ensure protection of co-primary users, including aeronautical radiolocation systems, ground-based and maritime radars, and EESS (active). Research is underway to investigate the possibility to mitigate interference to incumbents in the 5 350‑5 470 MHz band in a practical manner so that RLANs would protect incumbent services.

*[Editor’s Note: please specify what mitigation techniques (described in the Report) applies to what band/service]*

Resolution **229 (WRC-12)** also allows the operation, [on a non-interference basis,] of Radio Local Area Networks (RLANs) through a Co-Primary allocation in the band 5150-5250 MHz with the RLANs restricted to indoor only deployment with the maximum mean e.i.r.p. limited to 23 dBm and 10 mW per MHz. These indoor deployment and power limit restrictions have permitted operation of both RLANs and mobile-satellite service (MSS) feeder links in the same band without interference to satellite receivers. Section 7 of this Report provides information on the consequences of relief of the indoor only deployment restriction.

[With regard to the implementation of mitigation measures the following should be taken into consideration:

*Resolution* **229 (Rev. WRC-12)** *resolves*

*5 that administrations may exercise some flexibility in adopting other mitigation techniques, provided that they develop national regulations to meet their obligations to achieve an equivalent level of protection to the EESS (active) and the SRS (active) based on their system characteristics and interference criteria as stated in Recommendation ITU‑R RS.1632;*

Resolution **239 (WRC-15)** *recognizing*

*a)* that the compatibility studies performed by ITU-R in preparation for this conference
indicate that when assuming the use of WAS/RLAN mitigation measures limited to the regulatory provisions of Resolution **229 (Rev.WRC-12)**, sharing between WAS/RLAN and the EESS (active) systems in the frequency bands 5 350 to 5 470 MHz would not be feasible, as well as being insufficient to ensure protection of certain radar types in this frequency band; for these cases, sharing may only be feasible if additional WAS/RLAN mitigation measures are implemented, however, no agreement was reached on the applicability of any additional WAS/RLAN mitigation techniques.

Resolution **239 (WRC-15)** *Invites ITU-R* to conduct and complete the following in time for *WRC‑19:*

*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;

*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;

*[****Editor’s note:*** *Work on RLAN sharing techniques was already initiated during the previous study period of ITU-R WP 5A, in accordance with the ‘invites ITU-R’ of Resolution* ***229 (Rev. WRC-12)*** *and status of this work as of July 2015 can be found in Document 5A/736 (Chairman’s Report).*

The incumbent services which operate in the 5 GHz range have different characteristics which may result in the need for different mitigation techniques. Although one particular technique may not necessarily address all incumbent systems, several techniques could be used in conjunction to mitigate interference.]

# 2 Dedicated Radar Signal Detectors

Dedicated Radar Signal Detectors (DRSDs) are independent detectors that will interact with RLAN access points (APs) to enable authorized use of the APs over a specific geographical area to allow detection of specific radar, for which DFS alone is not a sufficient mitigation technique. The DRSDs detect radar emissions and this information when received by APs allows the latter to dictate to any connected AP devices that use is not allowed while the radar signal is present.

Industry is researching the use of DRSDs. Among the issues being studied are coverage area, connection security, channel authorization methodology (including architecture and interdependencies), detection threshold and required response time. Achievable response time is also being studied, noting that latency of the control network between DRSDs and APs is a factor in achievable minimum channel move times.

## 2.1 DRSD Coverage area

A DRSD could be used to facilitate detection of radar emissions from a distance if mounted outside. For example, DRSDs could be placed on towers or rooftops. Industry is studying the area over which a DRSD could detect a radar signal, and whether that area is sufficient to protect radar operations.

*[Editor’s Note: It is not clear at this time whether DRSD could detect all type of current radars. Question is also raised, how it could be implemented when a new or modified radar with differing technical characteristics and/or scanning pattern is introduced, and whether DRSDs can detect and protect current and future radar pulses that are less than one microsecond, wideband, continuous-wave, and frequency hopping. Both, of which, may result in the DRSD not sensing the radar because it is not transmitting when over the sensor area; but the radar may then become active over the area where the RLANs are located and receive interference from the RLANs]*

## 2.2 Radar data and connection security

DRSD siting and network topologies are also parts of the required studies. For example, each DRSD network could consist of one or more DRSDs capable of providing low latency notifications to access points (APs) in their areas of coverage. DRSDs could be location-aware high sensitivity receivers and could be installed at locations with unobstructed views of the sky and surrounding terrain. The presence of radar emissions could be communicated to the APs over secure methods that ensure against corruption or unauthorized modification of the data. Periodic encrypted contact verification signals between the DRSD network and the APs [required periodicity TBD] could be designed to ensure that RLAN devices timely receive notifications and that their transmissions do not exceed the radar protection level specified.

*[Editor’s Note:Further work is required to define the secure lines between DRSD and APs, such as the maintenance and management of the secure lines (including a mechanism to handle new APs)]*

## 2.3 Channel authorization methodology

RLAN devices would follow instructions from the DRSD network regarding authorized channels when a DRSD detects radar in use: for example, the device might be required to move to a different channel, refrain from initiating on a channel where the radar is operating, or avoid a channel for a specified period.

## 2.4 Response time

As noted above, DRSD-connected RLAN devices would have to ensure that their transmissions comply with procedures established for protection of the incumbent services. Maximum response latencies and minimum delays prior to resumption of transmission following the most recent detection of an incumbent services’ transmission would be specified for each class of incumbent system.

# 3 Database

*[****Editor’s note****: Database use is currently only being examined as a mitigation mechanism,
for purposes of this Working Document, as a means for determining if protecting EESS (active) operations is possible]*

RLANs have used a terrestrial geolocation database to share frequency bands with both fixed broadcast stations and with nomadic wireless PMSE microphones including Electronic Newsgathering (ENG) stations, through the voluntary registration of wireless microphones in a geolocation database for protection from unlicensed RLAN devices at a specific geographic location for a specific time period. A terrestrial-based geolocation database keeps track of the location of licensed terrestrial stations (including wireless microphone devices that are registered on a voluntary basis) and their corresponding spectrum and service areas.

 Industry is currently investigating the ability of RLANs to protect incumbent EESS (active) operations from interference via such a geolocation approach. (see compilation for more detailed proposals and the associated comments and challenges that are unresolved).

Current terrestrial geolocation databases are based on all the necessary information on the incumbent service being available on a national basis. In the case of EESS, detail information on the satellite system (e.g., beam location, scanning direction, and velocity of the satellite) would be required to determine the service area coverage that changes dynamically. And this information will not be available on a national basis and would need to be collected on an international basis.

## 3.1 Database Security and Integrity

[Industry has experience in devising geolocation databases to enable opportunistic use of vacant broadcast television spectrum with respect to PMSE and ENG as discussed above. For potential sharing in the 5 350-5 470 MHz band, in addition to the database security that requires additional study, the dynamic nature of EESS satellites should be carefully taken into consideration.
One approach expressed theoretically to date is that the database would rely only on sensing and publicly-available information and would only provide authorization tickets to APs connected to the database.]

*[Editor’s Note: These text need to be reviewed in order to provide an explanation of the needs of database security and integrity but not solutions]*

### 3.1.1 Database security

### 3.1.2 Database integrity

# 4 Device Security and Integrity (DSRD or database components)

Device manufacturers can be required to include security features in RLANs to prevent unauthorized software and hardware changes to ensure that mitigation techniques cannot be disabled, or devices reprogrammed to operate outside parameters for which the RLAN device was certified.

*[Editor’s Note: These text need to be reviewed in order to provide an explanation of the needs of device security and integrity but not solutions]*

These features include: x, y, z *[Editor’s note: manufacturers to list example actions that have been taken to ensure the devices are tamper free]*

## 4.1 Determine availability of data

## 4.2 EESS Data and Connection security

### 4.2.1 Satellite data

### 4.2.2 Satellite Connection Security

## 4.3 RLAN channel authorization methodology

# 5 Update of RLAN devices

# 6 Dynamic Frequency Selection (Access point or DRSD)

RLAN devices seeking to share in other frequency bands with radio determination incumbents may need to have enhanced Dynamic Frequency Selection (DFS) capabilities.

*[Editor’s Note: Some administration require manufacturers of RLAN devices sharing spectrum in the 5 GHz radar frequency ranges take measures to ensure that DFS cannot be disabled. As noted in Section 4 of this Report, prevention of device tampering by consumers requires Administration attention.]*Because DFS parameters need to be matched to the characteristics of the different type of radars to be protected, the required parameters are different for the different radar types.

[In identifying mitigation measures to be implemented in the 5 GHz range, the following should be taken into consideration:

Resolution **229 (Rev. WRC-12)** *Resolves 8* makes DFS implementation by WAS/RLANs mandatory in the bands 5 250-5 350 MHz and 5 470-5 725 MHz.

Recommendation ITU-R M.1652 states the DFS performance requirement in terms of response to detection of an interference signal.

Report ITU-R M.2115 provides information on the procedures in place in various administrations and/or regional groups to test compliance with DFS requirements.]

*[****Editorial note:*** *Annex 34 to Joint Task Group 4-5-6-7 Chairman’s Report (Document 4-5-6-7/715 of August 2014) “Working Document towards PDNR ITU-R M.[RLAN5GHz.SHAR] : Compatibility studies between radio local area network systems and radiodetermination systems in the
5 350-5 470 MHz frequency band” includes RLAN’s Dynamic Frequency Selection (DFS) characteristics. However, studies at the JTG 4-5-6-7 have demonstrated that current DFS designs are not effective in protection of EESS satellites operating in the 5 350-5 470 MHz band.]*

## 6.1 DFS for Meteorological Radars

*[Editor’s Note: The current version of the 1652 is rev 1 (2011). It need to be verified, whether rev. 1 covers current radar characteristics]*

Table 1 provides the DFS requirements for the band 5 350 to 5 470 MHz to protect meteorological radars. These parameters have been proven to allow WAS to avoid interfering with the meteorological radars in the band 5 600 to 5 650 MHz.

Table 1

|  |  |
| --- | --- |
| Parameter | Values for the frequency band5 350 – 5 470 MHz |
| Minimum pulse width (see detailed test signals in Report ITU-R M.2115) | 0.5 μs |
| PRF (see detailed test signals in Report ITU-R M.2115) | Fixed, Staggered and Interleaved |
| Channel Availability Check (CAC) time | 10 minutes |
| Off-Channel CAC (Note 1) | Yes |
| CAC and Off-Channel CAC detection probability (Note 2) | 99.99% |
| In-service monitoring detection probability | 60% |
| CAC for slave devices with power above200 mW (after initial detection by In-service) | Yes |
| Detection Threshold | -62 +10 -EIRP Spectral Density (dBm/MHz) + G (dBi), however the DFS threshold level shall not be lower than -64 dBm assuming a 0 dBi receiveantenna gain |
| Channel Move time | 10s |
| Channel closing time | 1s |
| Non-occupancy period | 30 minutes |
| Possibility to exclude 5 600‑5 650 MHz band from the channel plan or to exclude these channels from the list of usable channels | Yes |
| Requirement that none of the DFS related settings are accessible to the end‑user | Yes |

## 6.2 Other Issues

Additional issues regarding DFS are being studied, including:

1) Potential use for all radar types (Ground (including meteorological radars)/Maritime/EESS/Aeronautical)

 i) Threshold required:

 A Adjustment to DFS threshold value

 B Probability of coincidence

 C Value with and without timing changes

 D Detection of 0.1 µsec to 1 µsec pulse width signals.

 ii) Channel off time Expiration (for dedicated detectors):

 A Define expiration methodology

 B Define expiration time period.

 iii) Channel Move time:

A Define total time (i.e., channel detection, channel closing, etc.).

B Define Channel Move Spacing (to ensure RLAN channel moves are sufficient to ensure no adjacent channel interference to incumbents).

2) Robustness and effectiveness of DFS

# [7 Transmit power control

Transmit power control (TPC) is a mitigation measure that shall be used in specific bands within the 5GHz range, as noted in the following:

Resolution **229 (Rev. WRC-12)** *Resolves 7* makes TPC implementation by WAS/RLANs mandatory in the bands 5 250-5 350 MHz and 5 470-5 725 MHz.

# 8 Emission levels above the horizontal plane

Emission level above the horizontal plane in the bands 5 250-5 350 MHz and 5 470-5 570 must be used as follows:

Resolution **229 (Rev. WRC-12)** *Resolves 4* restricts emission levels above the horizontal plane in the band 5 250-5 350 MHz.Stations in the mobile service (WAS/RLANs) operating above a mean e.i.r.p. of 200 mW, these stations shall comply with an e.i.r.p. elevation angle mask (see 2.2.1).

Recommendation ITU‑R M.1653 *recommends 3* limits the e.i.r.p. spectral density above the local horizontal plane (of the Earth) of the emission of a WAS including RLAN base station transmitter operating outdoor in the band 5 470-5 570 MHz (see 2.2.1).]

# 9 Mitigation of Interference to MSS Feeder Uplinks in the Fixed-Satellite Service (FSS)

*(****Editor’s Note:****)* This sharing study will be expanded to include a baseline case conforming to Resolution **229 (WRC-15)** and taking into account parameters used for ongoing RLAN/FSS sharing studies.

Currently, RLANs operating in the 5 150-5 250 MHz band are governed by Resolution **229** of the Radio Regulations and limited to indoor deployment with a maximum equivalent isotropically radiated power (e.i.r.p.) of “ … 200 mW and a maximum mean e.i.r.p. density of 10 mW/MHz in any 1 MHz band or equivalently 0.25 mW/25 kHz in any 25 kHz band.”

This section provides the results of studies of the potential for compatibility between WAS/RLANs and the feeder uplinks of MSS systems in the fixed-satellite service (FSS) in the 5 150-5 250 MHz band if RLANs were permitted to operate outdoors.

## 9.1 Operations in the 5 150-5 250 MHz Band

At WRC-95, the 5 150-5 250 MHz band was allocated to the fixed-satellite Service (FSS) on a world-wide primary basis in the Earth-to-space direction for the purpose of implementing feeder uplinks for mobile-satellite Service (MSS) systems. This was accomplished via the addition of footnote No. **5.447A** to the Radio Regulations. At WRC-03, the band 5150-5350 MHz was allocated on a primary basis to the mobile Service (MS) for the implementation of wireless access systems (WAS), including radio local area networks (RLANs).

In the preparations for WRC-03, and later for WRC-12, it was concluded that sharing of the band 5 150-5 250 MHz between WAS and the FSS was feasible under the conditions expressed in Resolution **229 (Rev. WRC-12)**. These conditions included deployment restricted to indoors with a maximum mean e.i.r.p. of 200 mW and a maximum mean e.i.r.p. density of 10 mW/MHz in any 1 MHz band.

WRC-19 agenda item 1.16 invites consideration, inter alia, of interference mitigation techniques between WAS/RLANs and the FSS with the possibility of allowing WAS/RLANs to operate outdoors in the 5 150-5 250 MHz band.

As originally envisioned, RLANs would provide wireless “nomadic” connections to portable computers. The standard for this type of operation was developed under the auspices of the Institute of Electrical and Electronics Engineers (IEEE) as 802.11 with a suffix denoting the different versions of the standard. Progress in electronics has allowed the creation of “smart phones” that allow the user to not only conduct personal telecommunications but also to access the ever-growing variety of “services” available through the Internet. As a result of these developments, if one is in an inhabited area, it is hard to avoid NOT being able to connect to the Internet with one’s “smart phone.” Along with the ability to connect to the Internet, the bandwidth of the WAS/RLAN channels has increased 8 fold in order to accommodate the ever increasing number of “services.” With the increasing usage and number of devices accessing the 5 150-5 250 MHz band comes the increased potential for interference to the feeder uplinks of MSS systems.

## 9.2 Interference Situations

### 9.2.1 Earth Station Transmitter-to-WAS/RLAN Receiver

The FSS uses the 5 150-5 250 MHz band as a feeder uplink and is vulnerable to interference at the spacecraft receiver from the large population of WAS/RLAN transmitters. WAS/RLAN receivers are vulnerable to interference from FSS transmitters located at the feeder link earth stations.

The number of feeder link earth stations in an MSS system is limited to, likely, less than 100, depending upon the system configuration. Since the locations of the earth stations are known it is possible to create an exclusion zone around each earth station to prevent interference to WAS/RLAN receivers. There are well established procedures (see Radio Regulations, Appendix **7**) within the ITU-R for computing the potential interference between transmitting earth station and terrestrial receivers using the same band and deriving a suitable exclusion zone using this information. In the case of RLANs using the 5 850-5 925 MHz band these exclusion zones can avoid the possibility of interference from FSS earth station transmitters.

This interference situation will not be treated further in this document.

## 9.2.2 Aggregate WAS/RLAN Transmitters-to-FSS Spacecraft Receiver

The situation in the feeder uplink (Earth-to-space) direction cannot be handled as easily.
The footprint of the MSS spacecraft receive antenna covers a large area of the Earth’s surface that depends, among other things, on the spacecraft altitude and satellite configuration. This document will treat the case of the MSS system identified among ITU-R registrations as HIBLEO-X and referred to as LEO-D in a number of ITU-R Recommendations and Reports. This system utilizes
48 spacecraft at an altitude of 1414 kilometers and an inclination angle of the orbits of 52 degrees, with respect to the equator. The spacecraft antenna has a full Earth-coverage beam with an approximate radius of 2 900 kilometers on the surface of the Earth.

Due to the Earth-coverage beam, the spacecraft receiver can “see” emissions from very large numbers of WAS/RLAN transmitters. Even though the e.i.r.p. of each individual WAS/RLAN transmitter is relatively small and is further constrained by the mandatory requirement to operate indoors, the large number of WAS/RLANs has the potential to cause significant interference to the feeder uplink transmissions.

The analysis of the WAS/RLAN transmitter-to-FSS spacecraft receiver interference is contained in the following sections of this document.

## 9.3 Interference Analysis

The analysis of the interference situation set out in the previous section was analyzed using a computer simulation that was conducted using the Visualyse simulation tool that is available from Transfinite Systems ([www.transfinte.com](http://www.transfinte.com)).

## 9.3.1 Simulation Description

The use of the 5 GHz band by WAS/RLAN beyond what is contained in the current Radio Regulations was treated as part of WRC-2015 agenda item 1.1 and studies were conducted by Joint Task Group(JTG) 4-5-6-7 during the period between WRC-12 and WRC-15. The outcome of these studies is summarized in Reports from the JTG.

The technical requirements of WAS/RLANs in the 5 GHz frequency range have been captured in a subsequent document from ITU-R Working Party 5A, “Working document towards a preliminary draft new Report ITU-R M.[RLAN REQ-PAR] – *Technical characteristics and operational requirements of WAS/RLAN in the 5 GHz frequency range*; (Annex 24 to Document [5A/243](https://www.itu.int/md/R15-WP5A-C-0243/en)).
The RLAN parameters used in this study are derived from that document.

The assumption was made that interference from WAS/RLAN would be primarily from RLANs and more specifically from access points in RLAN systems. The WAS/RLAN parameters given below are based upon this assumption. As there are potentially millions of RLAN access points in the 5150-5250 MHz band, it is impossible to simulate each access point as an individual interferer. Hence, the power from the individual access points has been aggregated and this aggregation has been used as the output power from a single terrestrial station.

The computer simulation focused on the European region since it has a large population for RLANs and the area easily falls within the footprint of the MSS spacecraft antenna. For the purpose of the simulation it was assumed that Europe consists of 45 countries. A terrestrial station representing the total number of access points deployed either in an urban or rural area has been used. There were, thus, a total of 90 different terrestrial stations, 45 urban and 45 rural, that could be used.

In this preliminary version of the simulation, results were recorded for the 10 largest European countries which implies a total of 20 terrestrial stations used in this simulation. The effect of clutter loss was taken account of by using a modified antenna pattern based on a vertically polarized
full-wave dipole having a maximum gain at the horizon of 3.7 dBi. These antenna patterns are described in the WAS/RLAN following section.

The power output for each station that simulates either the urban or rural population of WAS/RLAN devices is determined using the power output per inhabitant, given in the next section, multiplied by the number of inhabitants of each country that live in either the urban or rural portion of that country. Population data was obtained from data on the Internet
(see [www.worldometers.info/population/countries-in-europe-by-population](http://www.worldometers.info/population/countries-in-europe-by-population).

## 9.3.2 WAS/RLAN Parameters

The parameters of WAS/RLANs used in the computer simulation were based on Annex 24 to Document 5A/114. These parameters are summarized in the Table 1 below.

TABLE 2

WAS/RLAN Parameters

|  |  |
| --- | --- |
| Parameter | Value |
| RLAN Access Point e.i.r.p. (mW) | 200 |
| Percentage of Population that are Access Points (%) | 20 |
| Channel Bandwidth (MHz) | 20 |

The WAS/RLAN device density was taken from Document [5A/114](https://www.itu.int/md/R15-WP5A-C-0114/en) (Annex 24) under “Option D2.” Since access points, emitting 200 mW e.i.r.p., constituted 19% of the WAS/RLAN device population it was assumed that there were 0.0015 active devices per inhabitant. The HIBLEO-X channel bandwidth for the feeder uplink is 1.23 MHz. Currently, the maximum e.i.r.p. density is 10 mW/MHz. Using this density the corresponding output power from an WAS/RLAN device in this bandwidth is 12.3 mW or -19.1 dBW. Coupling this value with the number of devices per inhabitant yields a -47.3 dBW per inhabitant output power. In order to model clutter for the urban situation, a clutter loss factor of 20 dB was included. This is a value similar to that contained in Document [5A/114](https://www.itu.int/md/R15-WP5A-C-0114/en), Annex 24. Combining this loss value with the e.i.r.p. per inhabitant of -67.3 for simulated urban stations. These levels were then applied to antennas shown below in order to have the correct emissions for the simulation.

Feeder link earth stations in the HIBLEO-X system start to acquire spacecraft rising over the horizon at an earth station elevation angle of 6 degrees. To account for clutter loss in rural areas,
it was assumed that there would be no WAS/RLAN emissions below an elevation angle of
6 degrees in order to account for the sparse population density and distribution of structures.
When using this antenna the WAS/RLAN emission is -47.5 dBW per inhabitant.

## 9.3.3 FSS Feeder link parameters

As mentioned above, the parameters of the feeder uplinks of the HIBLEO-X MSS system were used in the computer simulation. These are summarized in the Table below.

TABLE 3

MSS Feeder Link Parameters

|  |  |
| --- | --- |
| Parameter | HIBLEO-X |
| Satellite orbit altitude *h* (km) | 1 414 |
| Satellite Inclination (degrees) | 52 |
| Frequency Range (MHz) | 5 091-5 250  |
| Satellite receiver bandwidth *B* (MHz) | 1.23 |
| I/N (dB) | -12.2 |
| Satellite receiver noise temperature *T* (K) | 550 |
| Pnoise, add  (dBW) | -140.3 |
| Iadd (dBW) | -152.5 |
| Polarization discrimination *Lp* (dB) | 1 |

The spacecraft receive antenna is an “iso-flux” antenna and the gain pattern is shown below.

Figure 3

Spacecraft Receive Antenna Pattern

Please note that the parameters shown above are suitable, as a revision, to be included in what is now Section 4.2 of Document [5A/298](https://www.itu.int/md/R15-WP5A-C-0298/en) (Annex 27),” Working document towards a preliminary draft new Report ITU-R M.[RLAN SHARING] - Sharing and compatibility studies of WAS/RLAN in the 5 GHz frequency range.”

***(Editor’s Note:)*** *The feeder link parameters, including I/N, given above are subject to confirmation by ITU-R Working Party 4A*

## 9.4 Computer simulation description

The simulation determined the level of interference that would be experienced by a feeder link carrier that was uplinked from the earth station in Assaguel, France, near Toulouse. This uplink carrier was switched from one spacecraft to another based on whichever spacecraft was the closest to the earth station. The interference was recorded as an interference-to-noise ratio (I/N).

The simulation time step in this preliminary version of the simulation was 10 Seconds. A 10 Second interval implied that the area under the footprint changed by 0.139%. The simulation was run for two simulation days or 17 280 time steps. This simulated period approximates the ground track repeat for two successive orbital planes of the MSS.

## 9.5 Computer simulation results

The results of this preliminary simulation are shown in Figure 4. It can be seen that even for this representation of a limited number of WAS/RLAN devices, the interference to the MSS system feeder links is significant.

It is worthwhile to note that interference from European WAS/RLAN will exceed a 6% delta T/T (I/N = -12.2 dB) threshold 82% of the time for approximately 75% of the population of Europe. Based on the device density assumed, the total number of access points simulated is approximately 671,000.

## 9.6 Summary

Computer simulation of the likely effect of outdoor RLAN access points has shown that significant interference would be caused to the feeder uplinks of MSS systems. Figure 5 shows the “footprint” of the feeder uplink antenna of the HIBLEO-X systems. It is apparent that the spacecraft will “see” all of the RLAN traffic in the European region.

The level of interference to feeder uplinks from co-band 5 GHz RLANs will depend on the total number of RLAN devices that are deployed, their e.i.r.p. and whether they are permitted to operate outdoors. This contribution concentrated on interference due to outdoor RLAN Access Points and has computed the potential interference due to those devices.

Figure 5

HIBLEO-X MSS System European Feeder Uplink Coverage



The level of the potential interference can be limited by limiting the e.i.r.p. of the access points above a given elevation angle.

In spite of such mitigation techniques, it is likely that the proliferation of these devices will, at some time, result in unacceptable interference to MSS feeder uplinks. At that time, the only recourse left will be to stop the outdoor deployment of access points. If no records of the deployment of outdoor access points are maintained by Administrations, there will be no knowledge of from where the interference to the feeder uplinks is emanating and no way to mitigate it.

The use of outdoor access points would require Administrations to maintain records of deployment so that when interference occurs, remedial action can be taken by the correct Administration. Without maintaining a database of deployment, limits on the number of outdoor deployed access points will be required.

Noting the results of this preliminary study, it would appear that one way of ensuring reasonable ongoing protection of the worldwide non-GSO MSS feeder uplinks would be to make no change in the provisions of Resolution **229 (Rev.WRC-12)**.

1. Recommendation [ITU-R M.1652](http://www.itu.int/rec/R-REC-M.1652/en). [↑](#footnote-ref-1)