

## RECOMMENDATION ITU-R RS.1632\*

**Sharing in the band 5 250-5 350 MHz between the Earth exploration-satellite service (active) and wireless access systems (including radio local area networks) in the mobile service**

(Question ITU-R 218/7)

(2003)

The ITU Radiocommunication Assembly,

*considering*

- a) that the frequency band 5 250-5 350 MHz is allocated to the Earth exploration-satellite service (EESS) (active) and to the radiolocation service on a primary basis;
- b) that some administrations have proposed to use the band 5 250-5 350 MHz for low power high speed wireless local area networks (WLANs), or radio local area networks (RLANs);
- c) that these high speed WLANs are proposed to be deployed in the band as unlicensed devices, making regulatory control of their deployment density non-feasible,

*recognizing*

- a) that studies are continuing in ITU-R with a view to facilitating sharing of wireless access systems (including RLANs) with EESS (active),

*noting*

- a) that some administrations have adopted technical limits which permit wireless access systems (including RLANs) to operate with an e.i.r.p. power limit of 1 W, while other administrations have adopted more stringent e.i.r.p. limits,

*recommends*

- 1 that sharing between spaceborne active sensors of the EESS with the characteristics as given in Annex 1 and high speed WLANs in the 5 250-5 350 MHz band is feasible with wireless access systems (including RLANs) having constraints such as those given in Annex 2;
- 2 that the level of protection required for EESS systems as given in Annex 1 may also be achieved using alternative sets of operational and technical limits being studies under *recognizing a).*

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\* Radiocommunication Study Group 7 made editorial amendments to this Recommendation.

## Annex 1

# Technical characteristics of spaceborne active sensors in the 5 250-5 570 MHz band

Technical characteristics of spaceborne active sensors in the 5.3 GHz frequency range are given in Tables 1 and 2.

TABLE 1

## 5.3 GHz typical spaceborne imaging radar characteristics

| Parameter                     | Value                             |                                          |                                          |                                          |
|-------------------------------|-----------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|
|                               | SAR1                              | SAR2                                     | SAR3                                     | SAR4                                     |
| Orbital altitude (km)         | 426 (circular)                    | 600 (circular)                           | 400 (circular)                           | 400 (circular)                           |
| Orbital inclination (degrees) | 57                                | 57                                       | 57                                       | 57                                       |
| RF centre frequency (MHz)     | 5 305                             | 5 405                                    | 5 405                                    | 5 300                                    |
| Peak radiated power (W)       | 4.8                               | 4 800                                    | 1 700                                    | 1 700                                    |
| Polarization                  | Horizontal (HH)                   | Horizontal and vertical (HH, HV, VH, VV) | Horizontal and vertical (HH, HV, VH, VV) | Horizontal and vertical (HH, HV, VH, VV) |
| Pulse modulation              | Linear FM chirp                   | Linear FM chirp                          | Linear FM chirp                          | Linear FM chirp                          |
| Pulse bandwidth (MHz)         | 8.5                               | 310                                      | 310                                      | 40                                       |
| Pulse duration (µs)           | 100                               | 31                                       | 33                                       | 33                                       |
| Pulse repetition rate (pps)   | 650                               | 4 492                                    | 1 395                                    | 1 395                                    |
| Duty cycle (%)                | 6.5                               | 13.9                                     | 5.9                                      | 5.9                                      |
| Range compression ratio       | 850                               | 9 610                                    | 10 230                                   | 1 320                                    |
| Antenna type (m)              | Planar phased array<br>0.5 × 16.0 | Planar phased array<br>1.8 × 3.8         | Planar phased array<br>0.7 × 12.0        | Planar phased array<br>0.7 × 12.0        |

TABLE 1 (*end*)

| Parameter                                                             | Value                                        |                                              |                                              |                                              |
|-----------------------------------------------------------------------|----------------------------------------------|----------------------------------------------|----------------------------------------------|----------------------------------------------|
|                                                                       | SAR1                                         | SAR2                                         | SAR3                                         | SAR4                                         |
| Antenna peak gain (dBi)                                               | 42.2                                         | 42.9                                         | 42.7/38 (full focus/beamspoiling)            | 42.7/38 (full focus/beamspoiling)            |
| Antenna median side lobe gain (dBi)                                   | −5                                           | −5                                           | −5                                           | −5                                           |
| Antenna orientation (degrees from nadir)                              | 30                                           | 20-38                                        | 20-55                                        | 20-55                                        |
| Antenna beamwidth (degrees)                                           | 8.5 (El), 0.25 (Az)                          | 1.7 (El), 0.78 (Az)                          | 4.9/18.0 (El), 0.25 (Az)                     | 4.9/18.0 (El), 0.25 (Az)                     |
| Antenna polarization                                                  | Linear horizontal/vertical                   | Linear horizontal/vertical                   | Linear horizontal/vertical                   | Linear horizontal/vertical                   |
| Receiver front end 1 dB compression point ref to receiver input (dBW) | −62 input                                    | −62 input                                    | −62 input                                    | −62 input                                    |
| Allowable density of configuration saturation ref to receiver input   | −114/−54 dBW input at 71/11 dB receiver gain | −114/−54 dBW input at 71/11 dB receiver gain | −114/−54 dBW input at 71/11 dB receiver gain | −114/−54 dBW input at 71/11 dB receiver gain |
| Receiver input max. power handling (dBW)                              | +7                                           | +7                                           | +7                                           | +7                                           |
| Operating time (%)                                                    | 30 the orbit                                 | 30 the orbit                                 | 30 the orbit                                 | 30 the orbit                                 |
| Minimum time for imaging (s)                                          | 9                                            | 15                                           | 15                                           | 15                                           |
| Service area                                                          | Land masses and coastal areas                | Land masses and coastal areas                | Land masses and coastal areas                | Land masses and coastal areas                |
| Image swath width (km)                                                | 50                                           | 20                                           | 16/320                                       | 16/320                                       |

TABLE 2

**5.3 GHz typical spaceborne radar altimeter characteristics**

| <b>Jason mission characteristics</b>        |                         |
|---------------------------------------------|-------------------------|
| Lifetime                                    | 5 years                 |
| Altitude                                    | 1 347 km $\pm$ 15 km    |
| Inclination                                 | 66°                     |
| <b>Poseidon 2 altimeter characteristics</b> |                         |
| Signal type                                 | Pulsed chirp. linear FM |
| C band pulse repetition frequency (PRF)     | 300 Hz                  |
| Pulse duration                              | 105.6 $\mu$ s           |
| Carrier frequency                           | 5.3 GHz                 |
| Bandwidth (BW)                              | 320 MHz                 |
| Emission RF peak power                      | 17 W                    |
| Emission RF mean power                      | 0.54 W                  |
| Antenna gain                                | 32.2 dBi                |
| 3 dB aperture                               | 3.4°                    |
| Side lobe level/maximum                     | −20 dB                  |
| Backside lobe level/maximum                 | −40 dB                  |
| Beam footprint at −3 dB                     | 77 km                   |
| Interference threshold                      | −118 dBW                |

TABLE 3

**5.3 GHz typical spaceborne scatterometer characteristics**

| <b>Parameter</b>       | <b>Value</b>                               |                                  |
|------------------------|--------------------------------------------|----------------------------------|
| System name            | Scatterometer 1                            | Scatterometer 2                  |
| Orbital altitude (km)  | 780                                        | 800                              |
| Inclination (degrees)  | 98.5                                       | 98.5                             |
| Centre frequency (GHz) | 5.3                                        | 5.255                            |
| Pulse width            | 70 $\mu$ s (mid)<br>130 $\mu$ s (fore/aft) | 8 ms (mid)<br>10.1 ms (fore/aft) |
| Modulation             | Interrupted CW                             | Linear FM (chirp)                |
| Transmitter BW (kHz)   | 15                                         | 500                              |
| PRF (Hz)               | 115 (mid)<br>98 (fore/aft)                 | 29.4                             |
| Antenna type           | Slotted waveguide                          | Slotted waveguide                |

TABLE 3 (*end*)

| Parameter                              | Value                                                |                                                              |
|----------------------------------------|------------------------------------------------------|--------------------------------------------------------------|
| Antenna gain (dBi)                     | 31 (mid)<br>32.5 (fore/aft)                          | 28.5 (mid)<br>29.5 (fore/aft)                                |
| Antenna mainbeam orientation (degrees) | Incidence angles:<br>18-47 (mid)<br>24-57 (fore/aft) | Incidence angles:<br>25.0-54.5 (mid)<br>33.7-65.3 (fore/aft) |
| Antenna beamwidth (−3 dB), elevation   | 24° (mid)      26° (fore/aft)                        | 23.6° (mid)      23.9° (fore/aft)                            |
| Azimuth beamwidth                      | 1.3°      0.8°                                       | 1.1°      0.8°                                               |
| Instrument elevation angle (degrees)   | 29.3                                                 | 37.6                                                         |
| Antenna polarization                   | Vertical                                             | Vertical                                                     |
| Transmitter peak power                 | 4.8 kW                                               | 120 W                                                        |
| Receiver noise temperature (dB)        | Noise factor: 3                                      | Noise factor: 3                                              |
| Service area                           | Oceanic and coastal areas, land masses               | Oceanic and coastal areas, land masses                       |

## Annex 2

### Sharing constraints between spaceborne active sensors and high speed WLANs in the 5 250-5 350 MHz band

#### 1 Introduction

This Annex presents the results of three sharing analyses for the band 5 250-5 350 MHz between the spaceborne active sensors and the high speed WLANs, or RLANs. The first study, given in § 2 of this Annex, uses high performance RLAN (HIPERLAN) type 1 classes B and C and HIPERLAN type 2 characteristics for the RLANs and uses SAR4 characteristics for the SAR. In this study, it is feasible for the indoor only HIPERLAN type 1 class B and HIPERLAN type 2 to share the 5 250-5 350 MHz band with SAR4, but is not feasible for the HIPERLAN type 1 class C to share the band, nor for any HIPERLAN type designed to be operated outdoors with the technical characteristics assumed in the study.

The second study, as given in § 3 of this Annex, uses three RLAN types, RLAN1, RLAN2, and RLAN3, and uses SAR2, SAR3, and SAR4 characteristics for the SARs. In this study, for the single transmitter deployed outdoors, the RLAN1 high speed WLAN transmitter interference was above the acceptable level for SAR4, the RLAN2 high speed WLAN transmitter interference was above the acceptable levels for both SAR3 and SAR4, and the RLAN3 high speed WLAN transmitter interference was above the acceptable level for SAR4. For indoors/outdoors RLAN deployment, it is feasible for the RLAN1, based on an assumption of only 12 active transmitters per km<sup>2</sup> within the

SAR (footprint) and a single frequency channel for the RLAN1, to share with SAR2, SAR3, and SAR4, but it is not feasible for the RLAN2, based on an assumption of 1 200 active transmitters per office space and 14 channels across a 330 MHz band, to share with SAR2, SAR3, and SAR4. For an indoor deployment and considering the interference from the RLAN3 configuration of high speed WLANs to the SARs, the analysis shows that any surface density less than 37-305 transmitters/km<sup>2</sup>/channel will yield acceptable interference levels into the SAR, depending on the imaging SAR pixel  $S/N$  for an imaging SAR. The anticipated mean density is estimated to 1 200 transmitter/large office area and 250 transmitters/industrial area. The anticipated high density assumes 14 channels, each 23.6 MHz wide, over a 330 MHz band. For interference from the RLAN3 configuration of high speed WLANs to the SARs, the analysis shows that only for a surface density less than 518 to 4 270 transmitters/km<sup>2</sup> over 14 channels, will local area networks (LANs) yield acceptable interference levels into the SAR. For RLAN3 interference into SAR2 and SAR4, this would correspond to about 3 to 12 large office buildings or 15 to 60 industrial areas within the SAR footprint, depending on the SAR pixel  $S/N$ .

The third study, as given in § 4 of this Annex, uses the more critical HIPERLAN type 1 characteristics for the RLANs and uses the altimeter characteristics as given in Table 2 for the altimeter. The radar altimeter operation with a 320 MHz bandwidth around 5.3 GHz is compatible with HIPERLANs.

The fourth study, as given in § 5 of this Annex, uses the HIPERLAN type 2 characteristics for the RLANs and uses the scatterometer characteristics as given in Table 3 for the scatterometer. The scatterometer operation around 5.3 GHz is compatible with HIPERLANs operated indoors.

## 2 Study of HIPERLANs types 1 and 2 and SARs

### 2.1 Technical characteristics of the two systems

The technical characteristics of the WLANs used for the sharing analysis are those of the HIPERLAN type 1 and type 2, for which the European Telecommunications Standards Institute (ETSI) in Europe has published the relevant specifications: EN 300 652 for type 1 and TS 101 683 for type 2. For other study parameters (building attenuation, operational activity duty cycle, HIPERLAN density, etc.) the values used are those agreed by ETSI ERM for these studies in Europe.

#### *HIPERLAN type 1:*

It provides high speed RLAN communications that are compatible with wired LANs based on Ethernet and Token-ring Standards ISO 8802.3 and ISO 8802.5.

HIPERLAN/1 parameters:

e.i.r.p. (high bit rate (HBR), in 23.5 MHz, low bit rate (LBR), in 1.4 MHz):

class A: 10 dBm maximum e.i.r.p.

class B: 20 dBm maximum e.i.r.p.

class C: 30 dBm maximum e.i.r.p.

Channel spacing: 30 MHz

Antenna directivity: omnidirectional

Minimum useful receiver sensitivity:  $-70$  dBm

Receiver noise power (23.5 MHz):  $-90$  dBm

$C/I$  for BER  $10^{-3}$  at HBR: 20 dB

Effective range (class C): 50 m.

Only classes B (100 mW maximum e.i.r.p.) and C (1 W maximum e.i.r.p.) are considered for this study.

#### *HIPERLAN type 2:*

It provides high speed RLAN communications that are compatible with wired LANs based on ATM and IP standards.

HIPERLAN/2 parameters:

e.i.r.p.: 0.2 W (in the 5 250-5 350 MHz band)

Channel bandwidth: 16 MHz

Channel spacing: 20 MHz

Antenna directivity: omnidirectional

Minimum useful receiver sensitivity:  $-68$  dBm (at 54 Mbit/s) to  $-85$  dBm (at 6 Mbit/s)

Receiver noise power (16 MHz):  $-93$  dBm

$C/I$ : 8-15 dB

Effective range: 30-80 m.

In European countries, in the band 5 250-5 350 MHz, the e.i.r.p. is limited to 200 mW and the use of HIPERLANs is only allowed when the following mandatory features are realized:

- transmitter power control (TPC) to ensure a mitigation factor of at least 3 dB;
- dynamic frequency selection (DFS) associated with the channel selection mechanism required to provide a uniform spread of the loading of the HIPERLANs across a minimum of 330 MHz.

Currently HIPERLAN/1 does not support these two features.

The DFS does not only provide a uniform load spread, but it allows also each HIPERLAN system to detect interference from other systems and therefore is able to avoid co-channel operation with other systems, notably radar systems. The system senses which channel is free for use and automatically switches to it. This allows large numbers of HIPERLAN systems to operate in the same office environment.

It is to be noted that the numbers given in the deployment scenarios are based on the assumption of the availability of a total of 330 MHz band for WLANs. Assuming that this bandwidth will be available in two sub-bands (5 150-5 350 MHz and 130 MHz above 5 470 MHz) and given the channel spacing and the need to create a guardband at the boundaries of the two sub-bands, the assumed number of channels used in the study is 8 for type 1 and 14 for type 2.

Other HIPERLAN parameters used for this study are those agreed by ETSI:

- average building attenuation towards EESS instruments: 17 dB;
- active/passive ratio: 5%;
- percentage of outdoor usage: 15%;
- deployment scenarios: 1 200 systems for large office buildings, 250 systems for industrial sites.

For the spaceborne active sensors are taken from the SAR characteristics in Annex 1 of this Recommendation. The SAR4 type is taken as example for the analysis of the interference from HIPERLAN into SAR, but similar results can be obtained for the other types. SAR types 2-4 have been used for the analysis of the interference from SAR into HIPERLAN.

## 2.2 Sharing analysis (from WLAN into SAR)

The sharing analysis is given in Table 4 for the three cases considered: HIPERLAN type 1 (class B and class C) and type 2.

Given the expected HIPERLAN density (1 200 systems per large office building and 250 for industrial sites) the outdoor only or mixed indoor-outdoor cases do not represent a feasible sharing scenario for any of the three cases considered.

For the indoor use only, sharing is not feasible for the high power type 1 class C, while the type 1 class B and type 2 cases require further considerations.

In fact the 440 systems limit indicated in Table 4 for type 2 indoor only is per channel. Considering the DFS mechanism described above, one can make the hypothesis that the HIPERLAN type 2 systems can be spread across the 14 channels available, giving a theoretical upper limit of 6 160 systems within the 76.5 km<sup>2</sup> of the SAR footprint. Type 1 class B gives an upper limit of 5 208 systems.

TABLE 4

### Permissible active HIPERLAN capacity in channels shared with SAR4

| HIPERLAN type                       | Type 1/Class B |        | Type 1/Class C |        | Type 2 |        |
|-------------------------------------|----------------|--------|----------------|--------|--------|--------|
| Parameter                           | Value          | dB     | Value          | dB     | Value  | dB     |
| Max transmitted power (W)           | 0.1            | −10    | 1              | 0      | 0.2    | −7     |
| TPC effect on average               | Not available  |        | Not available  |        |        | −3     |
| Distance (km) and free space loss   | 425.7          | −159.5 | 425.7          | −159.5 | 425.7  | −159.5 |
| Additional transmit path loss (dB): |                |        |                |        |        |        |
| – Outdoor only                      |                | 0      |                | 0      |        | 0      |
| – Indoor only                       |                | −17    |                | −17    |        | −17    |
| – Mixed (15% outdoor)               |                | −7.8   |                | −7.8   |        | −7.8   |
| Antenna gain, transmitter (dB)      |                | 0      |                | 0      |        | 0      |

TABLE 4 (*end*)

| HIPERLAN type                                                                                                      | Type 1/Class B |        | Type 1/Class C |        | Type 2 |        |
|--------------------------------------------------------------------------------------------------------------------|----------------|--------|----------------|--------|--------|--------|
| Parameter                                                                                                          | Value          | dB     | Value          | dB     | Value  | dB     |
| Antenna gain, receiver (dB)                                                                                        |                | 42.7   |                | 42.7   |        | 42.7   |
| Polarization loss (dB)                                                                                             |                | −3     |                | −3     |        | −3     |
| SAR interference threshold<br>( $I/N = -6$ dB), (dB(W/Hz))                                                         |                | −205.4 |                | −205.4 |        | −205.4 |
| Power received (dB(W/channel))<br>(channel: 23.5 MHz type<br>1/16 MHz type 2):                                     |                |        |                |        |        |        |
| – Outdoor only                                                                                                     |                | −129.8 |                | −119.8 |        | −129.8 |
| – Indoor only                                                                                                      |                | −146.8 |                | −136.8 |        | −146.8 |
| – Mixed (15% outdoor)                                                                                              |                | −137.6 |                | −127.6 |        | −137.6 |
| Power received (dB(W/Hz)):                                                                                         |                |        |                |        |        |        |
| – Outdoor only                                                                                                     |                | −203.5 |                | −193.5 |        | −201.8 |
| – Indoor only                                                                                                      |                | −220.5 |                | −210.5 |        | −218.8 |
| – Mixed (15% outdoor)                                                                                              |                | −211.3 |                | −201.3 |        | −209.6 |
| Margin dB/(Hz <sup>−1</sup> ):                                                                                     |                |        |                |        |        |        |
| – Outdoor only                                                                                                     |                | −1.9   |                | −11.9  |        | −3.6   |
| – Indoor only                                                                                                      |                | 15.1   |                | 5.1    |        | 13.4   |
| – Mixed (15% outdoor)                                                                                              |                | 5.9    |                | −4.1   |        | 4.2    |
| SAR antenna footprint (km <sup>2</sup> )                                                                           | 76.5           | 18.8   | 76.5           | 18.8   | 76.5   | 18.8   |
| Permissible active HIPERLAN<br>density (/km <sup>2</sup> /ch):                                                     |                |        |                |        |        |        |
| – Outdoor only                                                                                                     | 0.0085         | −20.7  | 0.00085        | −30.7  | 0.0058 | −22.4  |
| – Indoor only                                                                                                      | 0.43           | −3.7   | 0.043          | −13.7  | 0.29   | −5.4   |
| – Mixed (15% outdoor)                                                                                              | 0.051          | −12.9  | 0.0051         | −22.9  | 0.034  | −14.6  |
| Active/passive ratio                                                                                               | 5%             | 13     | 5%             | 13     | 5%     | 13     |
| Permissible total (active + passive)<br>HIPERLAN density (/km <sup>2</sup> /ch):                                   |                |        |                |        |        |        |
| – Outdoor only                                                                                                     | 0.17           | −7.7   | 0.017          | −17.7  | 0.11   | −9.4   |
| – Indoor only                                                                                                      | 8.51           | 9.3    | 0.851          | −0.7   | 5.75   | 7.6    |
| – Mixed (15% outdoor)                                                                                              | 1.02           | 0.1    | 0.102          | −9.9   | 0.69   | −1.6   |
| Maximum number of active +<br>passive HIPERLAN per channel<br>within the SAR footprint<br>(76.5 km <sup>2</sup> ): |                |        |                |        |        |        |
| – Outdoor only                                                                                                     | 13             |        | 1              |        | 8      |        |
| – Indoor only                                                                                                      | 651            |        | 65             |        | 440    |        |
| – Mixed (15% outdoor)                                                                                              | 78             |        | 8              |        | 53     |        |

These values correspond to roughly five large office buildings in the 76.5 km<sup>2</sup> of the SAR footprint and, although far from being a worst case, can be considered a reasonable assumption for urban and suburban areas.

It can therefore be concluded that, although marginally, the two services can share the band when systems with the HIPERLAN type 2 or type 1 class B systems are deployed indoor.

The DFS mechanism will provide a uniform spread of the load across the available channels. If the channel selection is not based on a random choice, this hypothesis is likely to be incorrect and the conclusion needs to be revised.