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| **Radiocommunication Study Groups** |  |
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| Annex 23 to Working Party 5A Chairman’s Report |
| PRELIMINARY DRAFT NEW REPORT ITU-RM.[252-296 GHZ.LMS.FS.COEXIST] |
| Coexistence between land-mobile and fixed service applications operatingin the frequency range 252-296 GHz |

(Question ITU-R 256-1/5, ITU-R 257-1/5)

# 1 Introduction

Radio Regulations No. **5.565** identifies the specific frequency bands for the radio astronomy service, the Earth exploration-satellite service (passive), and the space research service (passive) in the frequency range 275-1 000 GHz. Although the use of the frequency range 275-1 000 GHz by the passive services does not preclude the use of this range by active services, administrations wishing to make frequencies in the 275-1 000 GHz range available for active service applications are urged to take all practicable steps to protect these passive services from harmful interference.

WRC-19 modified RR Article **5** above 275 GHz in accordance with the results of WRC-19 agenda item 1.15. The new footnote RR No. **5.564A** was added in the Table of Frequency Allocations to identify the frequency bands 275-296 GHz, 306-313 GHz, 318-333 GHz and 356-450 GHz for use by administrations for the implementation of land mobile service (LMS) and fixed service (FS) applications, where no specific conditions are necessary to protect Earth exploration-satellite service (passive) applications.

In the Table of Frequency Allocations, the frequency bands 252-265 GHz and 265-275 GHz have already been allocated to the mobile and fixed services. If these bands and the newly identified band 275-296 GHz are simultaneously used for mobile and fixed service applications, coexistence operation of those applications in the total frequency band of 44 GHz should be examined using the technical and operational characteristics provided by Reports ITU-R M.2417 and ITU-R F.2416.

# 2 Scope

This Report provides the coexistence scenarios between LMS and FS applications operating in the frequency range 252-296 GHz for possible operation in the co-frequency and adjacent frequency bands.

# 3 Related Recommendations and Reports

|  |  |
| --- | --- |
| Recommendation [ITU-R F.758](http://www.itu.int/rec/R-REC-F.758/en) | System parameters and considerations in the development of criteria for sharing or compatibility between digital fixed wireless systems in the fixed service and systems in other services and other sources of interference |
| Recommendation [ITU-R F.699](http://www.itu.int/rec/R-REC-F.699/en) | Reference radiation patterns for fixed wireless system antennas for use in coordination studies and interference assessment in the frequency range from 100 MHz to 86 GHz |
| Recommendation [ITU-R P.2109](http://www.itu.int/rec/R-REC-P.2109/en) | Prediction of building entry loss |
| Report [ITU-R F.2239](http://www.itu.int/pub/R-REP-F.2239/en) | Coexistence between fixed service operating in 71-76 GHz, 81-86 GHz and 92-94 GHz bands and passive services |
| Report [ITU-R F.2416](http://www.itu.int/pub/R-REP-F.2416/en) | Technical and operational characteristics and applications of the point-to-point fixed service applications operating in the frequency band 275-450 GHz |
| Report [ITU-R M.2417](http://www.itu.int/pub/R-REP-M.2417/en) | Technical and operational characteristics of land-mobile service applications in the frequency range 275-450 GHz |
| Report [ITU-R SM.2450](http://www.itu.int/pub/R-REP-SM.2450/en) | Sharing and compatibility studies between land-mobile, fixed and passive services in the frequency range 275-450 GHz |

# 4 List of acronyms and abbreviations

|  |  |
| --- | --- |
| BBU | Baseband unit |
| CPMS | Close proximity mobile system |
| FS | Fixed service |
| LMS | Land mobile service |
| RRH | Remote radio head |

# 5 Technical and operational characteristics

## 5.1 Technical and operational characteristics of LMS applications operating in the frequency range 252-296 GHz

TABLE 1

Technical and operational characteristics of land mobile service applications
operating in the frequency range 252-296 GHz

| Parameters | Values |
| --- | --- |
| Frequency band (GHz) | 252-296 |
| Tx output power density (dBm/GHz) | −4.1….6.6 |
| Max. e.i.r.p. density(dBm/GHz) | 25.9…...36.6 |
| Duplex Method | FDD/TDD |
| Modulation | OOK/BPSK/QPSK/16QAM/64QAMBPSK-OFDM/QPSK-OFDM/ 16QAM-OFDM/32QAM-OFDM/64QAM-OFDM |
| Average distance between CPMS fixed and mobile devices (m) | 0.1 |
| Maximum distance between CPMS fixed and mobile devices (m) | 1 |
| Antenna height (m) | 1…2 |
| Antenna beamwidth (degree) | 3…10 |
| Antenna elevation (degree) | ±90 |
| Frequency reuse  | 1 |
| Antenna type | Horn |
| Antenna pattern  | Gaussian |
| Antenna polarization  | Linear |
| Indoor CPMS fixed device deployment (%) | 100 |
| Feeder loss (dB) | 2 |
| Maximum CPMS fixed/mobile device output power (dBm) | 10 |
| Channel bandwidth (GHz) | 2.16/4.32/8.64/12.96/17.28/ 25.92 |
| Transmitter spectrum mask  | Report ITU-R M.2417 |
| Maximum CPMS fixed device antenna gain (dBi) | 30 |
| Maximum CPMS mobile device antenna gain (dBi) | 15 |
| Maximum CPMS fixed device output power (e.i.r.p.) (dBm) | 40 |
| Maximum CPMS mobile device output power (e.i.r.p.) (dBm) | 25 |
| Average activity factor (%) | 0.76 |
| Average CPMS fixed device power (dBm (e.i.r.p)) | 20 |
| Receiver noise figure typical (dB) | 15 |

## 5.2 Technical and operational characteristics of FS operating in the frequency range 252-296 GHz

TABLE 2

Technical and operational characteristics of the fixed service applications planned to operate

| Parameter | Values |
| --- | --- |
| Frequency band (GHz) | 252-296 |
| Duplex Method | FDD/TDD |
| Modulation  | BPSK/QPSK/8PSK/8APSK/16QAM/32QAM/64QAMBPSK-OFDM/QPSK-OFDM/ 16QAM-OFDM/32QAM-OFDM/64QAM-OFDM |
| Channel bandwidth (GHz)  | 2…..25 (FDD)2…..50 (TDD) |
| Spectrum mask | See Section 5.3 |
| Tx output power range (dBm)  | 0….20 |
| Tx output power density range (dBm/GHz) | −17……17 |
| Feeder/multiplexer loss range (dB)  | 0 … 3 |
| Antenna gain range (dBi)  | 24 … 50 |
| e.i.r.p. range (dBm) | 44…..70 |
| e.i.r.p. density range (dBm/GHz)  | 30……67 |
| Antenna pattern | Recommendation ITU-R F.699 |
| Antenna type | Parabolic Reflector |
| Antenna height (m) | 6-25 |
| Antenna elevation (degree) | ±20 (typical) |
| Receiver noise figure typical (dB)  | 15 |
| Receiver noise power density typical (dBm/GHz) | −69 |
| Normalized Rx input level for 1 × 10-6 BER (dBm/GHz) | −61 … −54 |
| Link length (m) | 100 … 300 |
| I/N protection criteria | Recommendation ITU-R F.758 |

# 6 Interference scenarios from LMS to FS applications operating in the frequency range 252-296 GHz

## 6.1 Interference scenarios from LMS to FS applications operating in the band 252‑296 GHz

The two interference scenarios between LMS and FS applications are listed in Table 3 and shown in Figure 1. Since the close proximity mobile system is one of LMS applications indicated in Report ITU-R M.2417, this section studies the interference-to-noise ratio value of FS receivers which will be used for backhaul/fronthaul applications indicated in Report ITU-R F.2416. Table 3 summarizes interference scenarios between CPMS and fronthaul applications. The fronthaul consists of RRH covering a small cell and BBU accomplishing baseband signal processing functions of radio access networks. Since the interference to RRH from CPMS may be worse than that of BBU from CPMS due to a lower antenna height of RRH than that of BBU in general, the study focuses on the interference from CPMS to RRH.

TABLE 3

Interference scenarios

|  |  |  |  |
| --- | --- | --- | --- |
| Scenario | Interfering | Interfered | Propagation model |
| A1 | CPMS MT | RRH | Rec. ITU-R P.452, P.676, P.2108, P.2109 |
| A2 | CPMS FS | RRH | Rec. ITU-R P.452, P.676, P.2108, P.2109 |
| B1 | RRH | CPMS MT | Rec. ITU-R P.452, P.676, P.2108, P.2109 |
| B2 | RRH | CPMS FS | Rec. ITU-R P.452, P.676, P.2108, P.2109 |
| CPMS MT: Close proximity mobile system – Mobile terminalCPMS FS: Close proximity mobile system – Fixed stationRRH: Remote Radio HeadBBU: Base band unit |

FIGURE 1

Illustration of interference scenarios between LMS and FS applications



### 6.1.1 Aggregate interference effect to FS receivers

Report ITU-R M.2417-0 provides deployment density and activity factor of CPMS applications such as Kiosk downloading system. Based on the deployment scenario, CPMS link density within a circle of 300-m radius which is the maximum distance between RRH and BBU provided in Report ITU-R F.2416-0 is estimated to be 2.55 per 0.28 km2. Figure 2 shows the schematic illustration of CPMS distribution within a circle of 300-m radius. This link density is calculated as the worst-case scenario using the total number of convenient stores within the 23 wards of Tokyo whose area is 619 km2. It also becomes 15 times as large as the average link density provided in Report ITU-R M.2417-0. The aggregate maximum received power of RRH/BBU receivers can be calculated using the above link density when the azimuth off-axis angle of RRH antenna is set to zero degree.

FIGURE 2

Schematic illustration of CPMS link distribution within a circle of 300-m radius



### 6.1.2 Aggregate interference effect to CPMS receivers

Report ITU-R F.2416-0 provides deployment scenario of FS applications such as fronthaul/backhaul to be used for some populated cities in Japan. The FS link density of 8.4 is estimated and used for sharing and compatibility studies between FS applications and EESS (passive) in Report ITU-R SM.2450-0. Since the above link density is estimated using some highly populated cities, he interference scenario of aggregate effect to CPMS receivers may be provided by Figure 3. If all of FS links in the area of 1 km by 1 km square are located as closed to CPMS receivers as possible, the additional interference level can be estimated to be as large as about 9.2 dB.

FIGURE 3

Schematic illustration of FS link distribution within 1 km by 1 km square



## 6.2 Protection criterion for coexistence studies in the frequency range 252-296 GHz

### 6.2.1 Protection criterion for FS applications

Recommendation ITU-R F.758-7 provides an interference-to-noise ratio (*I/N*) value of -10 dB as the long-term (no more than 20% of the time) interference protection criterion for the FS in the frequency bands of above 3 GHz.

### 6.2.2 Protection criterion for LMS applications

Protection criterion of *I*/*N* values of –6 dB which are widely used for mobile service devices are applied for LMS applications operating in the frequency range 252-296 GHz. The specified tolerable *I*/*N* is referenced to the mobile receiver input and requires taking into account all sources of interference.

### 6.2.3 Adjacent channel leakage ratio

Report ITU-R M.2417-0 and F.2416-0 define the spectrum mask of LMS and FS applications, respectively. Figure 4 shows two channel arrangement defined by the above Reports. If the channel bandwidth of each system is 17.28 GHz, the adjacent channel leakage ratio is 29.2 dB and then the adjacent channel leakage power -9.2 dBm.

FIGURE 4

Two channels of spectrum mask defined in Report ITU-R M.2417-0



## 6.3 Propagation characteristics

In the frequency range 252-296 GHz following propagation mechanisms should be considered:

– free space basic transmission loss;

– attenuation by atmospheric gases;

– clutter loss where appropriate;

– BEL where appropriate.

For the terrain-obstructed cases, due to the very high diffraction losses at these frequencies any contribution from non-light-of-sight interferers could be neglected.

Paths with a dominant line-of-sight component are not likely to be subject to any clutter loss at these frequencies.

The extrapolated characteristics of BEL up to the frequency of 1 000 GHz are provided in Annex 1 for the future coexistence study between LMS and FS applications.

## 6.4 Simulation results

### 6.4.1 Methodology of single entry interference calculations

The interference has been calculated using the following equations:

(a) For scenarios A1 and A2: $I/N=P\_{LMS}+G\_{LMS\rightarrow FS}+G\_{FS\rightarrow LMS}-PL\left(d\_{0}\right)-N\_{FS}$

(b) For scenarios B1 and B2: $I/N=P\_{FS}+G\_{FS\rightarrow LMS}+G\_{LMS\rightarrow FS}-PL\left(d\_{0}\right)-N\_{LMS}$

where:

 *P*LMS: power of LMS transmitter in the bandwidth of FS receiver;

 *P*FS: power of FS transmitter in the bandwidth of LMS receiver;

 *G*LMS→FS: gain of LMS antenna in the direction of FS receiver;

 *G*FS→LMS: gain of FS antenna in the direction of LMS receiver;

 *G*FS→LMS: gain of FS antenna in the direction of LMS transmitter;

 *G*LMS→FS: gain of LMS antenna in the direction of FS transmitter;

 *PL:* basic transmission loss (see Section 6.3);

 *NFS:* thermal noise power of FS receiver.

 *NLMS:* thermal noise power of LMS receiver.

The polarization loss be included depending on the type of linear or circular polarized antennas to be used in transmitters and receivers.

### 6.4.2 Layout of RRH and CPMS transceivers

Figure 5 shows the simulation parameters of the azimuth off-axis angle  between RRH and CPMS transceivers, and the elevation angle  of RRH transceivers. Although Report ITU-R F.2416-0 specifies the elevation angle within ±20 degrees of FS stations in the urban areas where the height of FS station is in the range 6-25 m and the distance between FS stations in the range 100-300 m, as shown in Table 2, the elevation angle of ±30 degrees of FS stations is taken into account as a worst-case scenario, as proposed in Report ITU-R F.2239-0.

FIGURE 5

Layout of RRH and CPMS for simulation

|  |  |
| --- | --- |
| **(a) CPMS is located at an azimuth off-axis angle of **** | **(b) Elevation angle ** of RRH antenna** |
|  |  |

### 6.4.3 CPMS interfering scenario

#### 6.4.3.1 Co-channel analysis

According to interference scenarios illustrated in Figure 1, *I/N* of RRH receiver is calculated using the equations in section 6.3.1. Figure 6 shows the relationship between *I/N* of RRH receiver and distance between CPMS MT transmitter and RRH receiver. It is clearly indicated that the peak *I/N* of RRH receiver is determined from the distance between CPMS MT transmitter and RRH receiver and the height difference of CPMS MT transmitter and RRH receiver, as well as the elevation angle of RRH antenna.

FIGURE 6

*I/N* of RRH receiver as a function of distance between RRH and CPMS MT whose antenna heights are 6 m and 2 m, respectively, at the frequencies of 252 GHz, 275 GHz and 296 GHz

(a) f=252 GHz

(b) f=275 GHz

(c) f=296 GHz

#### 6.4.3.2 Adjacent channel analysis

*I/N* of RRH receiver is calculated using the adjacent channel leakage ratio given in section 6.2.3. Figure 7 shows the relationship between *I/N* of RRH receiver and distance between CPMS MT/FS transmitters and RRH receiver. It is clearly indicated that the peak *I/N* of RRH receiver is determined from the distance between CPMS MT/FS transmitters and RRH receiver and the height difference of CPMS MT/FS transmitters and RRH receiver, as well as the elevation angle of RRH antenna.

FIGURE 7

*I/N* of RRH receiver as a function of distance between RRH and CPMS whose antenna heights are 6 m and 2 m, respectively, at the frequency of 275 GHz

(a) CPMS MT interfering RRH

(b) CPMS FS interfering RRH

### 6.4.4 FS interfering scenario

#### 6.4.4.1 Co-channel analysis

According to interference scenarios illustrated in Figure 1, *I/N* of CPMS MT receiver is calculated using the equations in section 6.3.1. Figure 8 shows the relationship between *I/N* of CPMS MT receiver and distance between RRH transmitter and CPMS MT receiver. It is clearly indicated that the peak *I/N* of CPMS MT receiver is determined from the distance between RRH transmitter and CPMS MT receiver and the height difference of RRH transmitter and CPMS MT receiver, as well as the elevation angle of RRH antenna.

FIGURE 8

*I/N* of CPMS MT receiver as a function of distance between RRH and CPMS MT whose antenna heights are 6 m and 2 m, respectively, at the frequencies of 252 GHz, 275 GHz and 296 GHz

(a) f=252 GHz

(b) f=275 GHz

(c) f=296 GHz

#### 6.4.4.2 Adjacent channel analysis

*I/N* of CPMS MT/FS receivers is calculated using the adjacent channel leakage ratio given in section 6.2.3. Figure 9 shows the relationship between *I/N* of CPMS MT/FS receivers and distance between RRH transmitter and CPMS MT/FS receivers. It is clearly indicated that the peak *I/N* of CPMS MT/FS is determined from the distance between RRH transmitter and CPMS MT/FS receivers and the height difference of RRH transmitter and CPMS MT/FS receivers, as well as the elevation angle of RRH antenna.

FIGURE 9

*I/N* of CPMS MT/FS receivers as a function of distance between RRH and CPMS whose antenna heights are 6 m and 2 m, respectively, at the frequency of 275 GHz

1. RRH interfering CPMS MT
2. RRH interfering CPMS FS

# 7 Summary

Interference study indicates that LMS applications could not coexist with FS applications if both applications are operated in the same channel. However, as shown in Figure A2-1, either LMS or FS applications can be designed to operate in different channels by proper channel allocation schemes. In this regard, LMS applications could coexist with FS applications if both applications are operated in the adjacent channels without clutter loss and BEL. This Report does not include additional losses in the interference study such as clutter loss and BEL due to no data from P-series Recommendations. Those data should be taken into account in the coexistence study between LMS and FS applications when available.

Annex 1

Extrapolation of building entry loss from Recommendation ITU-R P.2109

This Annex provides extrapolated estimation of the median building entry loss (BEL) in accordance with Recommendations [ITU-R P.2109](http://www.itu.int/rec/R-REC-P.2109/en), provided that the correction for the probabilities other than median should not be used. Figure A1-1 shows the extrapolated building loss in the frequency range 10-1 000 GHz. Those values may be used for the future coexistence studies between LMS and FS applications in the frequency range 252-296 GHz if the frequency range covered by Recommendation ITU-R P.2109 could be extended up to terahertz frequencies.

FIGURE A1-1

Extrapolated median building entry loss using Recommendation ITU-R P.2109



Annex 2

Channel arrangement in the frequency range 252-296 GHz

The channel arrangement whose channel bandwidth of 2.16 GHz, 4.32 GHz, 8.64 GHz, 12.96 GHz, 17.28 GHz and 25.92 GHz is shown in Figure A2-1.

FIGURE A2-1

Channel Arrangement in the Frequency Range 252-296 GHz based on IEEE Std. 802.15.3dTM-2017

