**Cover note for the Public Consultation on Draft ECC Report 298**

**Cover note for the Public Consultation on Draft ECC Report 298**

**Analysis of the suitability and update of the regulatory technical conditions  
for 5G MFCN and AAS operation in the 1920-1980 MHz and 2110-2170 MHz band**

This draft ECC Report 298 provides analysis of the changes needed to the technical conditions in ECC Decision (06)01 to enable the use of 5G and AAS in the 2 GHZ MFCN band.

ECC decided in its meeting #47 on a work item for PT1 concerning the need for updating the technical conditions in ECC Decision (06)01 to enable a timely introduction of 5G and AAS, while ensuring adequate protection of other services and applications.

In line with the timeline defined by ECC, aiming at final approval of the revised Decision in March 2019, ECC PT1 finalised at its 60th meeting in Dublin, 17-21 September 2018, the draft revision of the ECC Decision (06)01, which has been submitted to ECC #49 for approval for public consultation.

In addition to updating the ECC Decision (06)01 ECC PT1 submitted to ECC #49 this draft ECC Report on the same topic for public consultation. Whereas the deliverable defined by ECC in the work item did not contain any specification of such a report, ECC believes that a companion report for the ECC Decision will be useful in explaining the modifications introduced in that document. It will also serve as an important basis for the future work on a CEPT report on the same topic in response to the new Commission mandate on this subject.

ECC wishes to highlight that Section 5.1 of this draft ECC Report considers the band plan, which includes 300 kHz guard bands at the lower and upper frequency boundaries. The analysis used the assumption from previous sharing studies in 1999, incl. the assumption of a 300 kHz guard band according to the current band plan and the report suggests that any potential removal of the guard bands should be assessed at the national level, although it should be noted that some of the adjacent frequency bands have allocations to space services. However, there may be other regulatory means than explicit guard bands to ensure the protection of those services. It is also noted that the 2 GHz MFCN band plan in many CEPT countries is based on block sizes in the range from 4.8 MHz to 5 MHz, and has to accommodate the 200 kHz raster of W-CDMA.

Views on the text of the ECC Report in particular on this aspect are requested during the public consultation.

Analysis of the suitability and update of the regulatory technical conditions for 5G MFCN and AAS operation in the 1920-1980 MHz and 2110-2170 MHz band

approved DD Month YYYY

ECC Report 298

# Executive summary

The development of this Report was triggered in March 2018 by the need to assess the technical conditions in ECC Decision (06)01 [1] to enable a timely introduction of 5G and AAS, while maintaining adequate protection of other services and applications and to adapt them accordingly. This ECC report assessed the suitability for 5G of the harmonised technical conditions defined for the 1920-1980 MHz and 2110-2170 MHz band in CEPT Report 39 [2] and adopted in the ECC Decision (06)01 amended in November 2012 ("ECC/DEC/(06)01 (rev. 2012)" hereafter) [1].

Three main areas were studied:

* Assessment of the suitability of existing band plan and BEM for 5G in the 1920-1980 MHz and 2110-2170 MHz band;
* Coexistence with other services below 2110 MHz (space services in particular) and above 2170 MHz (MSS/CGC and space services);

The development of this Report followed the following steps:

1. Review of the regulatory framework, including existing band plan and BEM requirements, for 5G in the 1920-1980 MHz and 2110-2170 MHz band. Chapter 2 " Existing Regulatory framework for MFCN systems".
2. Analysis of the existing BEM and identification of required amendments - Chapter 3 " Suitability of the current technical framework for 5G";
3. Assessment of the coexistence with other adjacent services to the 2110-2170 MHz band – Chapter 4 “Coexistence Studies”
4. Annex 1 “MFCN parameter values and assumptions for simulations” containing the assumptions and parameters that were agreed as basis for the coexistence studies;

The report concludes on the need to update regulatory framework to support the introduction of 5G in the 1920-1980 MHz and 2110-2170 MHz band.

CEPT concluded that there is no need to updated current band plan 1920-1980 MHz and 2110-2170 MHz band except for referencing supplemental uplink mode of operation of NR.

This analysis confirms that the current BEM remains applicable for non-AAS systems and the need for additional BEM for AAS systems. Identification of required amendments to the existing BEM for AAS MFCNs are given in Chapter 5 "Recommended Framework”.

TABLE OF CONTENTS

[0 Executive summary 3](#_Toc528662350)

[1 Introduction 7](#_Toc528662351)

[2 Existing Regulatory framework for MFCN systems 8](#_Toc528662352)

[2.1 Existing Band plan 8](#_Toc528662353)

[2.2 Existing technical conditions – BEM requirements 8](#_Toc528662354)

[2.2.1 In-block limits for MFCN 8](#_Toc528662355)

[2.2.2 Out-of-block limits for MFCN 9](#_Toc528662356)

[3 Suitability of the current technical framework for 5G 11](#_Toc528662357)

[3.1 suitability for non-aas MFCN Base stations 11](#_Toc528662358)

[3.2 suitability for AAS MFCN 11](#_Toc528662359)

[3.3 suitability for NR SUpplemental Uplink Mode of Operation 11](#_Toc528662360)

[4 coexistence studies 13](#_Toc528662361)

[4.1.1 Band allocations 13](#_Toc528662362)

[4.1.2 Adjacent bands Coexistence 13](#_Toc528662363)

[4.1.2.1 Introduction 13](#_Toc528662364)

[4.1.2.2 MSS 14](#_Toc528662365)

[4.1.2.3 Fixed Service 17](#_Toc528662366)

[4.1.2.4 Space Services 18](#_Toc528662367)

[5 Recommended Framework 24](#_Toc528662368)

[5.1 Band plan 24](#_Toc528662369)

[5.2 Applicable technical conditions 24](#_Toc528662370)

[5.2.1 In- block power limits 24](#_Toc528662371)

[5.2.2 Out-of-block power limits: Interference between FDD MFCNs 24](#_Toc528662372)

[6 Conclusions 26](#_Toc528662373)

[ANNEX 1: MFCN PARAMETER VALUES AND ASSUMPTIONS FOR SIMULATIONS 27](#_Toc528662374)

[6.1 non-AAS MFCN 27](#_Toc528662375)

[6.2 AAS MFCN 27](#_Toc528662376)

[ANNEX 2: List of References 28](#_Toc528662377)

LIST OF ABBREVIATIONS

|  |  |  |
| --- | --- | --- |
| Abbreviation | Explanation | |
| 3GPP | 3rd Generation Partnership Project |
| AAS | Active Antenna System | |
| ACLR | Adjacent Channel Leakage Ratio | |
| BEM | Block Edge Mask | |
| BS | Base Station | |
| CGC | Complementary Ground Component | |
| CEPT | European Conference of Postal and Telecommunications Administrations | |
| DL | Downlink | |
| EC | European Commission | |
| ECA | European Common Allocation | |
| ECC | Electronic Communications Committee | |
| **EESS** | Earth Exploration Satellite Services | |
| e.i.r.p. | Equivalent Isotropically Radiated Power | |
| E-UTRA | Evolved Universal Terrestrial Radio Access | |
| FDD | Frequency Division Duplex | |
| FS | Fixed Service | |
| CGC | Complementary Ground Component | |
| IMT | International Mobile Telecommunications | |
| LTE | Long Term Evolution | |
| LRTC | Least Restrictive Technical Conditions | |
| MFCN | Mobile/Fixed Communications Network | |
| MSS | Mobile Satellite Services | |
| MES | Mobile Earth Station | |
| MS | Mobile Service | |
| NLOS | Non Line of Sight | |
| NR | New Radio | |
| OOB | Out of Band | |
| OOBE | Out of Band Emissions | |
| OTA | Over The Air | |
| RAN | Radio Access Network | |
| SEM | Spectrum Emission Mask | |
| **SRS** | Space Research Services | |
| SOS | Space Operation Services | |
| SUL | Supplemental Uplink | |
| TRP | Total Radiated Power | |
| TSG | Technical Specification Group | |
| UE | User Equipment | |
| UEM | Unwanted Emission Mask | |
| UL | Uplink | |
| UMTS | Universal Mobile Telecommunications System | |

# Introduction

This Report evaluates the suitability for 5G and AAS of the existing least restrictive technical conditions in the 1920-1980 MHz and 2110-2170 MHz band as defined in CEPT Report 39 [2] and implemented in ECC Decision (06)01 [1]. The analysis of this Report accounts for the introduction of 5G new radio (5G NR) as well as Active antenna systems (AAS) in this frequency band. Modifications to the existing least restrictive technical conditions are suggested as applicable.

The analysis assumes that the current technical conditions will also remain as part of the regulatory framework to ensure that current and future deployments of non-AAS MFCN will not be impacted.

Compatibility of AAS MFCN with other services in the adjacent bands to 2110-2170 MHz has been assessed by examining the difference in the antenna gains for non-AAS and AAS MFCN BS in different scenarios. Also, elements from the methodology used in previous CEPT Report 39 and ERC Report 65 [3] have been incorporated in the compatibility analysis. Based on the assessment, the report identifies amendments to the existing least restrictive technical conditions in terms of updated of the BEM.

# Existing Regulatory framework for MFCN systems

## Existing Band plan

ECC/DEC/(06)01 [1] includes a harmonised spectrum scheme for MFCN including terrestrial IMT systems for the frequency band 1920-1980 MHz paired with 2110-2170 MHz for FDD operation. The duplex direction for FDD carriers in these bands is mobile transmit within the lower band and base station transmit within the upper band. The bands 1920-1980 MHz and 2110-2170 MHz, are divided into twelve paired blocks and the minimum block size should be in the range 4.8 MHz to 5.0 MHz.

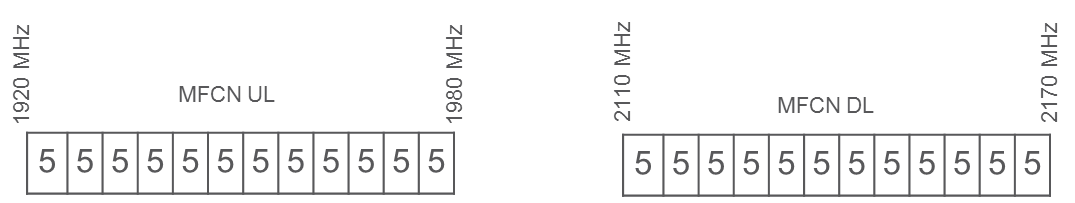


Figure 1 Existing Band Plan

Additionally in Annex 1 of ECC/DEC/(06)01 [1], the following conditions to ensure coexistence between MFCN systems and other applications operating in adjacent bands are given:

* The block edge nearest to 1920 MHz should start at 1920.3 MHz or above. Where necessary, this frequency can be lowered to 1920.0 MHz for consistency with conditions of some existing authorisations;
* The block edge nearest to 1980 MHz should end at 1979.7 MHz or below. Where necessary, this frequency can be raised to 1980.0 MHz for consistency with conditions of some existing authorisations;
* The block edge nearest to 2110 MHz should start at 2110.3 MHz or above. Where necessary, this frequency can be lowered to 2110.0 MHz for consistency with conditions of some existing authorisations;
* The block edge nearest to 2170 MHz should end at 2169.7 MHz or below. Where necessary, this frequency can be raised to 2170.0 MHz for consistency with conditions of some existing authorisations.

## Existing technical conditions – BEM requirements

The harmonised technical conditions are given in ECC Decision 06(01) [1] are in the form of Block Edge Masks (BEMs) based on CEPT Report 39 [2] and the compatibility studies in ERC Report 65 [1].

### In-block limits for MFCN

An in-block limit for base stations is not obligatory. An in-block e.i.r.p. limit for MFCN FDD BS is not necessary as long as the “BS FDD to BS TDD” scenario does not need to be addressed. However, administrations may choose to set an e.i.r.p. limit between 61 dBm/(5 MHz) and 65 dBm/(5 MHz) in the FDD downlink band if needed on a national or local basis. Furthermore, this limit can be increased for specific deployments, e.g. in areas of low population density provided that this does not significantly increase the risk of terminal station receiver blocking.

An in-block emission limit for terminal stations in the FDD uplink band is specified in Decision 2012/688/EU [5]. A maximum mean in-block power of 24 dBm e.i.r.p. for fixed or installed terminal stations and 24 dBm TRP for terminal stations designed to be mobile or nomadic. Member States may relax this limit for specific deployments, e.g. fixed terminal stations in rural areas provided that protection of other services, networks and applications is not compromised and cross-border obligations are fulfilled.

### Out-of-block limits for MFCN

The BEM levels are built up by combining the values listed in Table 1 in such a way that the limit at any frequency is given by the highest (least stringent) value of a) the transition requirements, and b) the in-block requirements (where appropriate). The BEMs are applicable only to base stations within the sub-band 2110-2170 MHz. Notice that BEM values were derived for macro base stations only, and might not be appropriate for all other classes of base stations.

Currently, the BEM levels correspond to the power radiated by the relevant device irrespective of the number of transmit antennas, except for the case of MFCN base station transition requirements which are specified per antenna. Table 1 defines the out-of-block BEM requirements for FDD MFCN base stations within the spectrum licensed to operators of MFCN networks. The emission limits are all specified as e.i.r.p., and consist of two so-called ”transitional region" limits and a baseline limit, which addresses the matter of base station to base station interference between FDD MFCNs. BEM values are based on 3GPP unwanted emission mask given in 3GPP TS 36.104 [6]. More specifically, the out-of-block emission limits within the FDD band has been derived by numerical integration of PSDs of the E-UTRA BS specified in 3GPP TS 36.104. It should be noted that these requirements have been derived from the characteristics of macro base stations, with the assumption of an in-block e.i.r.p. limit of 61 dBm/5 MHz.

Table 1: Transition requirements – BS BEM out-of-block e.i.r.p. limits per antenna1

|  |  |  |
| --- | --- | --- |
| Frequency range | Non AAS e.i.r.p. power limit per antenna | Measurement bandwidth |
| -5 to 0 MHz offset from lower block edge  0 to 5 MHz offset from upper block edge | 16.3 dBm | 5 MHz |
| -10 to -5 MHz offset from lower block edge 5 to 10 MHz offset from upper block edge | 11 dBm | 5 MHz |
| Other blocks | 9 dBm | 5 MHz |
| 1 The BEM level for base stations is defined as per antenna. It is applicable to base station configurations with up to four antennas per sector | | |

ECC Decision 06(01) [1] assumes, in line with 3GPP, the compliance with the BEM is sufficient to ensure coexistence of FDD MFCN BSs. Table 2 describes the relationship between the baseline and transitional power limits defined in ECC Decision 06(01) [1] and the 3GPP unwanted emission mask given in 3GPP TS 36.104.

Table 2: ECC limits and the 3GPP unwanted emission mask

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| From TS 36.104 Table 6.6.2.1-1:  Wide Area BS operating band unwanted emission mask (UEM) | | | | Comparison between 3GPP  and ECC limits | | | |
| Frequency offset (MHz) | 3GPP unwanted emission mask | Average Tx power | Units | 3GPP:  Tx Power  (dBm/(5 MHz)) | | 3GPP: e.i.r.p. (1) (dBm/(5 MHz)) | ECC e.i.r.p. (2) limits (dBm/(5 MHz)) |
| 0 to 0.2 | -14 | -14.0 | dBm/30kHz | 8.2 | -0.9 | 16.1 | 16.3 |
| 0.2 to 1 | -14 to -26 | -16.7 | dBm/30kHz | 2.5 |
| 1 to 5 | -13 | -13.0 | dBm/1MHz | -6.0 |
| 5 to 10 | -13 | -13.0 | dBm/1MHz | -6.0 | -6.0 | 11 | 11 |
| 10 to 15 | -15 | -15.0 | dBm/1MHz | -8.0 | -8.0 | 9 | 9 |

Notice that ECC/DEC/(06)01(rev. 2012) [1] does not specify any out-of-band requirement for FDD MFCN. Additionally, ERC Recommendation 01-01 [4] may be considered as reference for cross-border coordination for MFCN in the frequency bands: 1920-1980 MHz and 2110-2170 MHz

# Suitability of the current technical framework for 5G

## suitability for non-aas MFCN Base stations

The term non-AAS (short for non-active antenna systems) refers to MFCN base station transmitters which are manufactured and supplied separately from the antenna systems. For non-AAS MFCN BS, including 5G, the antenna connector would most likely be connected to a passive antenna array, meaning that the resulting antenna gain is fairly invariant (between different implementations and between wanted and unwanted signals). Given the passive nature of the antenna array, setting requirements for non-AAS MFCN BS in terms of e.i.r.p. is appropriate.

Non-AAS MFCN base stations comply with existing LRTC in least in ECC/DEC/(06)01 [1], given that those requirements were derived from the analysis of the sum of the radiated powers across multiple antenna connectors.. Furthermore, non-AAS MFCN BS keep the same unwanted emissions requirements as the ones given in 3GPP TS 36.104 which were used as basis for deriving existing limits in ECC/DEC/(06)01 (rev.2012) [1].

Based on the need to avoid disrupting the usage rights that have been already assigned for non-AAS MFCN in the 1920-1980 MHz and 2110-2170 MHz range, it is proposed to maintain the existing out-of-block BEM e.i.r.p. limits as specified in ECC/DEC/(06)01 and reported in Section 3.

## suitability for AAS MFCN

AAS (short for active antenna systems) is one of the key features for 5G NR and LTE evolution products. According to Recommendation ITU-R M.2101 [7][, an IMT system using an AAS will actively control all individual signals being fed to individual antenna elements in the antenna array in order to shape and direct the antenna emission diagram to a wanted shape, e.g. a narrow beam towards a user. An AAS MFCN BS continually adjusts the amplitude and / or phase between antenna elements resulting in an antenna pattern that varies in response to short term changes in the radio environment. This is intended to exclude long term beam shaping such as fixed electrical down tilt.

With the introduction of AAS MCFN BS, the antenna arrays are included in the base station without an accessible interface between AAS systems and base station. Contrary to the case of non-AAS MFCN BS, AAS MCFN BS do not have the possibility to install additional external filter between the base station antenna connector and the antenna. This implies that the BEM regulatory requirements must be met by product design, as it has been discussed in ECC Report 281 [8] and CEPT Report 67 [9]. Thus, ECC Report 281 concluded that the unwanted emissions are to be specified as over-the-air (OTA), rather than as conducted requirement. The OTA emission limits will be expressed in terms of Total Radiated Power (TRP[[1]](#footnote-1)) rather than e.i.r.p. This conclusion is in line with 3GPP approach described in ECC Report 281, which consider TRP as the most appropriate metric for specifying the ACLR and out-of-block emission limits in the context of interference between adjacent channel mobile networks.

Based on the above observations, suitable technical conditions (BEM in TRP) should be incorporated in the current ECC/DEC/(06)01 to account for the introduction of AAS MFCN base stations.

## suitability for NR SUpplemental Uplink Mode of Operation

NR systems in frequency bands 1920-1980 MHz may operate in Supplemental uplink mode (SUL), i.e. NR Uplink operation without paired downlink NR spectrum (No paired transmissions from the BS to the UE in the same band). This corresponds to 3GPP NR band n84.

SUL bands are meant to be aggregated to another NR band e.g. TDD band (3.4-3.8GHz ECC DEC (11) 06) that includes a DL direction.

The NR UE technical characteristics for SUL mode of operation as specified in TS38.101-1 are aligned with those of an NR FDD UE. In particular, the UE maximum output power (i.e. 23dBm), the supported channel bandwidths (range from 5 to 20MHz) and the unwanted emissions limits for SUL (1920-1980 MHz) are all the same as per the non-AAS MFCN UE in FDD operation mode (1920-1980 MHz paired with 2110-2170 MHz).

Therefore, sharing conditions between MFCN UL and adjacent services remains the same whether the SUL mode of operation or the FDD MFCN operation is used. Therefore the current harmonised framework for 2.1GHz band is considered suitable for NR SUL mode of operation. This of course accounts for the fact that no AAS is considered at the NR UE side.

# coexistence studies

### Band allocations

Figure 2 shows the adjacent channel services adjacent to paired band 1920-1980MHz and 2110-2170 MHz. Notice that the frequency range 1900-1920 MHz was allocated to Direct Air-to-Ground Communication (DA2GC) according to ECC Decision ECC/DEC/(15)02 [10] in 2015; however, ECC Decision (18)01 [11] for the withdrawal of ECC Decision (15)02 on DA2GC was approved at ECC#48 (July 2018). At the moment, Railways is a candidate service to be allocated in 1900-1920 MHz and compatibility studies to ensure protection of MCFN UL and other adjacent services are ongoing. Furthermore, it is worthwhile noticing that the introduction of AAS systems will be only in the MFCN DL band as it is not foreseen in the MFCN UL.

Note that NR systems in frequency bands 1920-1980 MHz may operate in Supplemental uplink mode (SUL) and that the UE technical characteristics relevant to compatibility studies in this case are aligned as per non-AAS MFCN FDD operation. Thus sharing conditions between MFCN UL and adjacent services are expected to be kept the same.

The following section focuses in the in-band and adjacent-band coexistence of MFCN DL band.

1880 MHz

DECT

MFCN UL

MFCN DL

MSS

UMTS-S

MSS

UMTS-S

Fixed Service

Space Services

1900 MHz

1920 MHz

1980 MHz

2010 MHz

2025 MHz

2110 MHz

2170 MHz

2200 MHz

Figure 2: Band allocations for the 2GHz band

### Adjacent bands Coexistence

#### Introduction

The review of technical conditions to enable timely introduction of 5G and, when applicable, AAS, needs to ensure adequate protection of other services and applications.

Compatibility studies are therefore necessary to ensure that AAS systems will not modify the current coexistence conditions with services and applications operating in adjacent bands to the MFCN BS (1920-1980 MHz and 2110-2170 MHz) as it is not foreseen the introduction of AAS systems in the UE side. The UE unwanted emissions remain unchanged whether AAS at BS is used or not. Furthermore, the AAS BS receiver is not expected to be more sensitive compared to non-AAS BS receiver, therefore AAS BS will not claim more protection than non-AAS BS.

CEPT Report 39 provides the analysis for deriving the technical conditions and requirements based on the compatibility studies conducted in ERC Report 65 [3]. As seen Figure 2, the allocated services in the 2GHz band are Fixed Service (2025 -2110MHz), EESS/SRS/SOS services (2025 - 2110 MHz (e-s/e-e) and above 2200 MHz(s-e/e-e)), MSS (2170-2200 MHz). The system parameters and the used sharing criteria for adjacent compatibility studies between IMT and EESS/SRS/SOS services can be seen from ERC Report 065, more specifically in Annex A, B and D. The relevant parts of the ERC Report 065 summary are reproduced in Table 1.

Table 1: Summary of the carrier separations, based on ERC Report 065 (Table 13)

|  |  |  |  |
| --- | --- | --- | --- |
| Adjacent services | Minimum carrier separation | Calculated Extreme  position of the UMTS  carrier centre | “Additional”  guard band(3) |
| 2110 MHz SSS  SSS/UMTS (FDD)  (section 3.3.2 of ERC Report 065) | 3.0- 3.3 MHz (1) | 2112.8 MHz | 0.3 MHz |
| 2110 MHz FS(2)  UMTS(FDD) (see section 3.4 of ERC Report 065) | 8.3 MHz | 2112.8 MHz | - |
| 2170 MHz MSS **(s-E)**  UMTS (FDD)  (see section 3.2.3.1 of ERC Report 065) | <3.5 MHz(4) | 2167.2 MHz | 0.9 MHz |
| (1) These carrier separations would be required for compliance with recommendation ITU-R SA.1154. In view of the specific use of the border regions by the space science services, a separation of 2.8 MHz appears to be sufficient.  (2) This separation distance can be implemented by not utilising the 3 outermost FS.channels (1.75 MHz ch. spacing) or the outermost FS-channel (3.5 and 7 MHz ch spacing) in the upper part of 2025-2110 MHz (ERC Rec T/R 13-01). For the lower part of 2025-2110 MHz all 7 MHz channels can be used. At both edges all FS channels with 14 MHz ch. spacing can be utilised. It is further recommended to use the 2020-2025 MHz and 2110-2115 MHz UMTS channel preferably in micro and pico-cells.  (3) This is the difference between the calculated and nominal extreme UMTS carrier position. The nominal extreme UMTS carrier position is taken to be 2.5 MHz from the UMTS band edge.  (4) This value is applicable for the sub-urban environment for 10% probability and 0.5 dB loss in MSS fade margin. A smaller carrier separation would impact to the ability to operate MSS on the affected channels due to degradation in the fade margin (see section 3.2.3.3 of ERC Report 065). For the rural environment the required spacing is less. | | | |

The following cases are considered:

* EESS/SRS/SOS satellite receivers in the bands 2025-2110 MHz;
* EESS/SRS/SOS receiving earth stations in the band 2200-2290 MHz;
* MSS receiving earth stations and CGC receiver terminals in the band 2170-2200 MHz.

It should finally be noted that the possible use of UAS in MFCN networks in these bands could also have an impact on the coexistence with existing services and applications. This case is not the scope of this Report and it is studied in a separate ECC Report.

The deployment parameters for non-AAS and AAS MFCN 5G/AAS used in compatibility analysis can be found in Annex 1.

#### MSS

ECC Decision ECC/DEC/(06)09 (rev.2007) [12] which designates the bands 1980-2010 MHz (Earth-to-space) and 2170-2200 MHz(space-to-Earth) for use by systems in the Mobile-Satellite Service (MSS) including those supplemented by a Complementary Ground Component (CGC). This Decision followed a number of ECC studies, particularly CEPT Report 13 that was developed in response to the mandate from the European Commission. It should be noted that the provisions (Decides-5) of ECC/DEC/(06)09 requires ‘that mobile satellite systems operating in accordance with this Decision shall ensure compatibility with terrestrial systems operating in the mobile service in the adjacent bands below 1980 MHz and between 2010 MHz and 2170 MHz. Notice that WRC-92 identified the frequency bands 1885-2025 MHz and 2110-2200 MHz for IMT-2000, including 1980-2010 MHz (Earth-to-space) and 2170-2200 MHz (space-to-Earth) for the satellite component of IMT-2000. It should be noted that the lower part of the bands 1980-2010 MHz and 2170-2200 MHz are used throughout Europe for Inmarsat’s European Aviation Network (EAN) which is already operational. The EAN operational system deploys the use of CGC terminals and MESs on aircraft.

Furthermore, the technical and operational characteristics of CGC operating as part of a satellite network in frequency bands 2170-2200 MHz (s-E) and 1980-2010 MHz (E-s) are specified in the harmonised standard ETSI EN 302 574-1 [13].

##### **Compatibility with MSS MES at 2170 MHz**

In the comparison between the current interference situation with non-AAS systems and the future situation where a mixed deployment of AAS and non-AAS system will be introduced, we focus initially on the difference in antenna gain of AAS 5G BS and non-AAS BS. We focus on the Urban case as ERC Report 65 [3] found this scenario as the most challenging, i.e. higher probability of exceeding the interference threshold at MSS MES receivers. The following plot shows the difference in antenna gain from a random MSS MES location at 1.5 m height for two antenna types:

* Non-AAS antenna: ITU-R F.1336-4 [14] (one antenna considered);
* AAS antenna: 8x8 elements (fully correlated).



Figure 3: Comparison between antenna gain for AAS and non-AAS system in Urban scenarios (red curve - AAS antenna 8x8 elements and blue curve – single non-AAS antenna)

Figure 3 shows the comparison between the antenna gain for AAS and non-AAS systems for a random location of MES within a sector of 120 degrees and 300 m radius. Results of antenna gain analysis indicate that impact of introducing AAS systems is 1.7% probability of more interference compared to the existing condition.

Similar analysis as shown in Figure 3 was also done for the OOBE by taking into account that for non-AAS the OOBE is defined per antenna in e.i.r.p. and that the maximum number of antennas allowed are 4 (per ECC Decision (06)01 [1]), and taking into account the 9 dB scaling factor that will be applied for the OOBE for AAS which is defined per sector in TRP.

****

Figure 4: Comparison between OOBE for AAS (8x8) and non-AAS (4 antenna) system in Urban scenarios (red curve - AAS antenna 8x8 elements and blue curve –4 non-AAS antenna

Results of total OOBE analysis indicate that impact of introducing AAS systems results in 2.4% probability of more interference compared to the existing condition. Thus, with the assumption described above and assuming that non-AAS BS ACLR being equal to AAS BS ACLR, we can conclude that the compatibility between AAS BS and MSS MES at 2170 MHz is achieved and no further studies are needed.

##### **Compatibility with MSS CGC receivers at 2170 MHz**

We examine the impact of the introduction of AAS BS in the compatibility between IMT and MSS CGC receivers on aeroplanes; for this scenario, we considered two cases, when the aircraft is in flight mode at 1000 metres height and when the aircraft is on the ground. For the second case (aircraft on the ground) this is covered by the study of interference into MES above. For the in-flight case analysis, we focus on the difference in antenna gain for the BS elevation angles within a radius of 10 km radius around the CGC receivers at 1000 metres height for two antenna types:

* Non-AAS antenna: ITU-R F.1336-4 [14] (one antenna considered);
* AAS antenna: 8x8 elements (fully correlated).

Given the similarities with scenario described in Section 4.1.2.4 where compatibility with EESS/SRS/SOS (2025 – 2110 MHz) is analysed, we adopt the same methodology for modelling the AAS system behaviour. That means that we take statistics over 1000 snapshots where user are randomly deployed within the cell radius (urban) and the AAS antenna is steered in elevation and azimuth towards the user. We take average antenna gain across all azimuth angles for each elevation angle.



Figure 5: Antenna gains for different elevation angles for a radius of 300m with the non AAS antenna tilted 5 degree.

From Figure 4, we observe that the average antenna gain for AAS is always lower than the antenna gains for non-AAS case, the differences range between 5 dB to 15 dB (average 12 dB) depending on the elevation angle with respect to the CGC receiver. Furthermore, it is worth noticing that the values for non-AAS antenna correspond to a single antenna and, according to current ECC Decision (06)01 [1], BS can have up to 4 non-AAS antennas. Considering the results in Figure 4 and the similarities with scenario described in Section 4.1.2.4, we can conclude that the impact of the introduction of AAS BS, with proposed out-of-band limits, will not worsen current situation in the compatibility between IMT and MSS CGC receivers at 2170MHz and therefore with the assumptions outlined above, compatibility is achieved and no further studies are needed.

#### Fixed Service

CEPT/ERC Recommendation T/R 13-01 [15] and ITU-R Recommendation F.1098 [16] specify channel arrangements for the Fixed Service which should be used for new 2 GHz fixed service networks in order to avoid overlap with the 2 GHz MSS allocations and ensure coexistence with Mobile Services. According to ERC Report 65 [3] a separation distance of 2 km and a carrier separation of 8.3 MHz is required between FS and MS BS operating in adjacent bands. Therefore a careful deployment and coordination between MS and FS with channel spacing below 14 MHz is needed. Such coordination mechanisms were considered feasible given that Fixed services in the 2GHz band, due to the propagation conditions, mainly will operate in rural areas where long distance links are necessary.

The Recently finalised ECC Report 173 [17] on the “Fixed Service in Europe: Current Use and future trends post 2016” indicates that four subranges are indicated for FS in the 2 GHz band, among them 2025-2110 and 2200-2290 MHz, are open by about 15 administrations. However, only 4 administrations use this band with limited density. Furthermore, about 9200 P-P links and about 4100 base stations have been indicated in operation among the four subranges in the 2 GHz band for FS. Notice that great majority of applications (9100 FS links, all with channel separation) are in one single country (Russia), in the subrange 2400-2483.5 MHz. For other countries addressed in previous questionnaire, the use is reduced (about 300 FS links, no central station). All this information indicates that a very reduced number of FS links are currently deployed in the range 2025-2110 MHz and in just a few CEPT countries. Therefore, coexistence between FS in the band 2025-2110 MHz and MFCN (including AAS systems) in the 2110-2170 MHz can be addressed at national level.

#### Space Services

ITU-R Recommendation SA.1154 [18] provides a compatibility study of space services and high-density land mobile systems sharing the 2025-2110 MHz and 2200-2290 MHz bands. The conclusion of that study is that high density mobile systems should not be introduced in those bands. Thus, these bands cannot be identified as potential IMT bands. ERC Report 65 [3] provides adjacent channel compatibility studies between MFCN systems in the band 2110-2170 MHz and space services in the band 2025-2110 MHz. The conclusion of the study is that a carrier separation of 2.8 MHz is sufficient to protect narrow band receptions of the few systems (Earth to space links) operating near to 2110 MHz.

CEPT administrations developed common guidelines with respect to the compatibility between CGC operating in the band 2170-2200 MHz and EESS/SOS/SRS Earth stations operating in the band 2200-2290 MHz given in ECC Recommendation (10)01 (rev.2010) [19]. It should be noted that the provisions (Considering-e)) of ECC/REC/(10)01 considers “that compatibility between CGC base stations operating in the band 2170-2200 MHz and earth stations in the Earth Exploration Satellite Service, Space Research Service or Space Operation Service in the adjacent band 2200-2290 MHz, can be achieved through a coordinated process between affected operators and administrations;”. Annex 2 to the ECC/REC/(10)01 [19] lists the EESS/SOS/SRS Earth stations deployed in CEPT countries. The introduction of AAS systems in the 2110-2170 MHz does not affect the provisions given in ECC Recommendation 10(01) and the fact that coexistence with EESS/SOS/SRS Earth stations operating in the band 2200-2290 MHz is addressed at national level.

##### **Compatibility with EESS/SRS/SOS (2025-2110MHz)**

We aim at understanding the impact of introducing AAS systems in the compatibility with EESS/SRS/SOS. Previous work in ERC Report 65 (Section 3.3.2) [4 calculated the aggregate interference to the space service satellite receiver from all visible UMTS base stations. The parameters assumed in ERC Report 65 as well as proposed required attenuation to meet the protection criteria given in ITU-R S.1154 [18] are shown in Table 3

Table 3: Interference scenario around 2110 MHz (From ERC Report 65 [3])

|  |  |
| --- | --- |
| Parameters | Values |
| Spacecraft height | 250 km (worst-case) |
| Average transmission loss (average BS antenna gain in the satellite direction and free-space path loss from visible cells) | 154.2 dB |
| Polarisation loss | 2 dB |
| Maximum received interference at the spacecraft (note 1) | -217 dBW/Hz. See ITU-R S.1154 Space-to-Space case (worst-case) |
| Average cell radius | 6.8 km |
| Visible earth | 9689313 km2 |
| Number of simultaneous transmitters | 66700 |
| BS power per channel | 41 dBm |
| Power control/remote areas | 6 dB |
| Channel Bandwidth | 3.84 MHz (final results based on 5MHz) |
| Down-tilt | 2.5 |
| Antenna height | 30m |
| Antenna pattern | Annex A |
| Design Margin | 3 dB |
| **Required attenuation** | **43 dB** |
| *Note 1:A For Earth to space links, the protection criterion is 4dB less stringent (-213 dBW/Hz)* | |

Interference Calculation Methodology

We follow similar methodology and parameters assumed in ERC Report 65 for the comparison of Case 1 non-AAS system and Case 2 AAS system. The parameters to be used in the analysis are shown in Table 3 and Table 4. Furthermore, the interference calculation methodology follows ERC Report 65 Annex B where the centre of the terrestrial IMT cells are modelled as lying on concentric rings centred on the satellite point. This assumption simplifies the interference calculations since the elevation angle θ, the slant range and the free space path loss to the satellite are constant for each ring of cells.

Notice that considering the size of the satellite footprint, free-space path loss is a conservative assumption for the rings closer to edge of the satellite footprint which are more likely to be NLOS conditions due to the earth curvature. Also, for simplicity we disregard no-coverage areas. For modelling the AAS system behaviour, we take statistics over 1000 snapshots where user are randomly deployed within the cell radius (urban and rural) and the AAS antenna is steered in elevation and azimuth towards the user.

We take average antenna gain across all azimuth angles for each elevation angle. Aggregated interference at the spacecraft is calculated by the following equation:

Where N is the number of Base station within the satellite footprint, PL (d) is the free space path loss corresponding to the slant distance between BS and spacecraft, G(θ) is the antenna gain in the direction of the spacecraft and L account for all other losses according to Table 3. Finally, the required attenuation to meet the satellite protection criteria is calculated as follows:

Table 4 shows deployment parameters for non-AAS and AAS cases used in the compatibility analysis with EESS/SRS/SOS at 2110 MHz.

Table 4: Deployment parameters

|  |  |  |
| --- | --- | --- |
| Parameter | Case 1: Non-AAS | Case 2: AAS |
| Spacecraft height (km) | 250 km (worst-case) | 250 km (worst case) |
| Maximum received interference at the spacecraft | -217 dBW/Hz. See ITU-R S.1154 Space-to-Space case (worst-case) | -217 dBW/Hz. See ITU-R S.1154 Space-to-Space case (worst-case) |
| Visible earth (km2) | 9689313 | 9689313 |
| Number of simultaneous transmitters | ~70000 | ~70000 |
| Power control/remote areas (dB) | 6 | 6 |
| Cell radius (km) | 6 | 6 |
| Antenna height (m) | 30 | 30 |
| Downtilt (degrees) | 2.5 and 5 | 10 |
| Cell radius |  | 300 metres (Urban)  1500 (sub-urban/rural) |
| Antenna characteristics | ITU-R F.1336-4 *recommends 3.1*  Maximum antenna gain of 18 dBi  3dB beamwidth of 65 degrees | See Annex 1 |
| Losses (dB) | Polarisation loss: 2dB  Design margin: 3dB | Polarisation loss: 2dB  Design margin: 3dB |
| Output power | 41dBm | 41dBm |
| Channel Bandwidth | 5MHz | 5MHz |

In ECC Decision 06(01), the BEM level for non-AAS base stations is defined as per antenna and it is applicable to base station configurations with up to four antennas per sector. Thus, we compared the difference in required attenuation to protect the spacecraft based on the a configuration of four non-AAS antennas and AAS antenna with 8TRx, as shown in Table 5.



Figure 6: Antenna gains for different elevation angles with a downtilt of 5 degrees for non-AAS and 10 degrees for AAS



Figure 7: Antenna gains for different elevation angles with a downtilt of 2.5 degrees for non-AAS and 10 degrees for AAS

Table 5: Required attenuation comparison between non-AAS and AAS case

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Non – AAS Case | | AAS Case | Difference between non-AAS and AAS |
|  | Single Antenna per sector | 4 Antennas per sector | 8x8 Antenna per sector |  |
| Downtilt 2.5 degrees non-AAS (Rural) | 42.2 dB | 48.2 dB | 38.9 dB  (correlated) | 9.3 dB |
| 40.3 dB (uncorrelated) | 7.9 dB |
| Downtilt 5 degrees non- AAS (Urban) | 40.2 dB | 46.2 dB | 33 dB (correlated) | 13.2dB |
| 40.3 dB (uncorrelated) | 5.9dB |

***Conclusion***

Based on the results shown in Table 5, we can conclude that the introduction of AAS will not worsen the interference situation with the adjacent service EESS/SRS/SOS (2025- 2110MHz), even if we consider conservative assumptions in the deployment of the MFCN network within the satellite footprint following previous work in ERC Report 65 [1].

Furthermore, Table 5 shows the difference between non-AAS and AAS for correlated and non-correlated case. Given the small region out-of-band region of 10MHz, it is considered that correlated assumption should hold. Under this assumption, we find that the difference between non-AAS (4 antennas) and AAS case would be in the range of 9.3 and 13.2 dB. The latter value should be more representatives given that majority of Base Stations will be located in urban locations. Thus, out-of-band emissions from AAS systems will still meet the interference levels required to protect the EESS/SRS/SOS at 2110 MHz.

##### **Compatibility with EESS/SRS/SOS at 2200 MHz**

CEPT Report 39 [2] and ERC Report 65 [3] do not include compatibility studies between MFCN and EESS/SRS/SOS at 2200 MHz as these two services are not adjacent. EESS/SRS/SOS allocated at 2200MHz falls within the spurious emission domain which starts 10MHz from the band edge, i.e. 2180 MHz. The limits for spurious emissions follow the values in current ERC Recommendation 74-01 (rev. 2011) [20][[2]](#footnote-2). Also, it is worthwhile noticing that compatibility between CGC base stations operating in the band 2170-2200 MHz and earth stations in the EESS/SRS/SOS in the adjacent band 2200-2290 MHz is achieved through a coordinated process between affected operators and administrations, following the ECC Recommendation 10(01) [19].

In the comparison between the current interference situation with non-AAS systems and the future situation where a mixed deployment of AAS and non-AAS system will be introduced, the only difference will be the antenna gain for these two systems. The following plot shows the difference in antenna gain (at the horizon) for three cases:

* Non-AAS antenna: ITU-R F.1336-4 [14];
* AAS antenna: 8x8 elements (fully correlated);
* AAS antenna: 8x8 elements (uncorrelated).



Figure 8: Comparison between antenna gain for AAS and non-AAS system in Urban scenarios

Figure 8 shows the comparison between the three different cases in an Urban scenario. We notice that the gain from the AAS antenna (correlated) exceeds the 2.5% of time the maximum gain from single non-AAS antenna. Assuming that BS can have up to 4 non-AAS antennas, the maximum gain from the AAS antenna (correlated) will never exceed the combined gain from 4 non-AAS antennas. Also, we noticed that the maximum gain from AAS antenna (non-correlated) is always lower than the gain for single non-AAS antenna.



Figure 9: Comparison between antenna gain for AAS and non-AAS system in Rural scenarios

Figure 9 shows the comparison between the three different cases in a Rural scenario. We noticed that the maximum gain from AAS antenna (non-correlated) is always lower than the gain for single non-AAS antenna. Also, we notice that the gain from the AAS antenna (correlated) exceeds the 11% of time the maximum gain from single non-AAS antenna. Assuming that BS can have up to 4 non-AAS antennas, the maximum gain from the AAS antenna (correlated) will higher than the combined gain from 4 non-AAS antennas only 5% of time.

***Conclusion***

Considering the above elements and the results showing that introduction of AAS will not degrade interference conditions with services in the spurious emission domain we can conclude that no further studies are need for the compatibility between IMT and EESS/SRS/SOS 2200 MHz within the scope of the work to review ECC Decisions for the 2.1 GHz (ECC/DEC/(06)01 [1]). Coordination zones, if needed, will be in the same order of magnitude as for non-AAS case and they can be determined at a national level, as previously done in ECC Recommendation 10(01) [19].

# Recommended Framework

## Band plan

The recommended band plan for the duplex direction for FDD carriers in the bands 1920-1980 MHz and 2110-2170 MHz, considers into twelve paired blocks and the minimum block size should be ranging from 4.8 to 5.0 MHz. The sharing studies were performed with the assumption of this 300 kHz guard band according to the current band plan. Any removal of the 300 kHz guard band should be assessed at the national level.

Considering the current band plan, NR systems in frequency bands 1920-1980 MHz may operate in Supplemental Uplink (SUL) mode, i.e. NR uplink operation without paired downlink NR channel. The analysis conducted in this report confirmed the suitability of the current harmonised technical conditions for Supplemental Uplink (SUL) mode of operation.

This Report confirms that the current above band plan is suitable for 5G.

## Applicable technical conditions

### In- block power limits

As described in Section 2, no mandatory limit was defined in the existing regulatory framework. The same approach will be used also in the updated regulatory framework. For the case of AAS base stations, it is proposed to convert the existing not obligatory in-block e.i.r.p. limit specified in ECC Decision (06)01 [1] to TRP for consistency with the out-of-block limits. This implies the conversion of the existing non-mandatory e.i.r.p. limit of 65 dBm/(5 MHz) per antenna for the non-AAS base station to a corresponding TRP limit (assuming a 17 dBi antenna gain) following guidelines given in 3GPP TS 38.104 [21]. Also, it is proposed to specify the out-of-block TRP limits to a value that correspond to a total of eight beam forming antenna elements.

Table 6: Updated in-block power limit

|  |  |  |  |
| --- | --- | --- | --- |
| BEM element | Frequency range | Non-AAS e.i.r.p limit dBm/5MHz | AAS TRP power limit dBm/(5 MHz) |
| In-block | Block assigned to the operator | Not obligatory.  In case an upper bound is desired by an administration, a value of 65 dBm/(5 MHz) per antenna may be applied. | Not obligatory.  In case an upper bound is desired by an administration, a value of 57 dBm/(5 MHz) per cell/sector may be applied. |

UE In-block requirement

As for the technical condition for user equipment (UEs) it is recommended that the UE maximum mean in-block radiated power (e.i.r.p. for fixed UEs, and TRP for nomadic/mobile UEs) does not exceed 24 dBm [5].

### Out-of-block power limits: Interference between FDD MFCNs

For AAS base stations, TRP is selected as the metric for specifying regulatory power limits. This corresponds to out-of-block power limits in the context of MFCN-to-MFCN interference in the case of FDD networks. In alignment with the specification of unwanted emission conducted power (TRP) for AAS base stations in 3GPP TS 38.104 [21] and the analysis made in ECC Report 281 [8], it is proposed to specify the out-of-block TRP limits to a value that correspond to a total of eight beam forming antenna elements. Table 7shows the proposed out-of-block TRP limits for the update of ECC/DEC/(06)01[1].

Table 7: Proposed out-of-block TRP limits for AAS MFCN Base Stations

|  |  |
| --- | --- |
| Frequency range | AAS TRP power limit per cell(1) |
| -5 to 0 MHz offset from lower block edge  0h to 5 MHz offset from upper block edge | 8dBm/5MHz |
| -10 to -5 MHz offset from lower block edge 5 to 10 MHz offset from upper block edge | 3dBm/5MHz |
| Other blocks | 1dBm/5MHz |
| (1) ) In a multi-sector base station, the radiated power limit applies to each one of the individual sectors. | |

Table 5 describes the relationship between the proposed out-of-block BEM limits and the corresponding 3GPP unwanted emission mask applicable for the 2110-2170 MHz band.

Table 8: ECC limits and the 3GPP unwanted emission mask

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Frequency offset (MHz) | 3GPP unwanted emission mask  (TS 38.104) | Average Tx power | Units | 3GPP:  Tx Power  (dBm/(5 MHz)) | | 3GPP TRP power limits  (dBm/(5 MHz)) | Proposed AAS TRP power limit dBm/5MHz  per cell (1) |
| 0 to 0.2 | -14 | -14.0 | dBm/30kHz | 8.2 | -0.9 | 8.1 | 8 |
| 0.2 to 1 | -14 to -26 | -16.7 | dBm/30kHz | 2.5 |
| 1 to 5 | -13 | -13.0 | dBm/1MHz | -6.0 |
| 5 to 10 | -13 | -13.0 | dBm/1MHz | -6.0 | -6.0 | 3 | 3 |
| 10 to 15 | -15 | -15.0 | dBm/1MHz | -8.0 | -8.0 | 1 | 1 |
| (1) In a multi-sector base station, the radiated power limit applies to each one of the individual sectors | | | | | | | |

# Conclusions

This Report assessed the suitability of existing band plan and BEM for 5G in the 1920-1980 MHz and 2110-2170 MHz band and studied the coexistence of 5G with other services below 2110 MHz (space services in particular) and above 2170 MHz (MSS and space services);

The ECC Report concludes that:

* there is no need to update the harmonised spectrum scheme (1920-1980 MHz and 2110-2170 MHz band as already included, except for adding reference to the supplemental uplink mode of operation of NR;
* the current BEM remains applicable for non-AAS systems;
* on the need for additional BEM for AAS systems.

This ECC Report provides the relevant required amendments to the ECC framework in order to include BEM for AAS MFCNs in Chapter 5 "Recommended Framework”.

1. MFCN PARAMETER VALUES AND ASSUMPTIONS FOR SIMULATIONS

## non-AAS MFCN

* Antenna height : 45 m (rural) and 30 m (urban);
* Antenna gain : 18 dBi;
* Antenna tilt : 2.5° (rural) and 5° (urban);
* Antenna pattern : ITU-R F.1336-4 [14] with 3dB beamwidth of 65 degrees;
* Feeder losses : 3 dB;
* Spurious emissions limit: -30 dBm.

## AAS MFCN

* Antenna height : 45 m (rural) and 30 m (urban);
* Cell radius : 1500 m (rural) and 300 m (urban);
* Antenna tilt : 10° (mechanical);
* Spurious emissions limit: -30 dBm.

Table 9: Parameters for AAS system

|  |  |
| --- | --- |
| Parameter | Value |
| Antenna element  directional pattern | According to 3GPP TR 37.840 [22] (section 5.4.4.2) where:   * 3 dB elevation beamwidth θ3dB = 65°; * 3 dB azimuth beamwidth ϕ3dB = 80°; * Front-to-back ratio Am = 30 dB; * Side-lobe ratio SLAV = 30 dB.   NOTE: .  NOTE: Each antenna element is larger in size in the vertical direction, and so θ3dB < ϕ3dB . See 3GPP TR 37.840. |
| Antenna element gain | 8 dBi |
| Number of base station beamforming elements (NV, NH) | (8,8) |
| Element spacing | 0.9λ vertical separation.  0.6λ horizontal separation.  NOTE: Larger vertical spacing provides narrower array beamwidth in elevation. See 3GPP TR 37.840 [22] (Table 5.4.4.2.1-1). |

1. List of References
2. ECC Decision (06)01: “ECC Decision of 24 March 2006 on the harmonised utilisation of the bands1920-1980 MHz and 2110-2170 MHz for mobile/fixed communications networks (MFCN) including terrestrial IMT”, amended on 2 November 2012
3. CEPT Report 39: “Report from CEPT to the European Commission in response to the Mandate to develop least restrictive technical conditions for 2 GHz bands”
4. ERC Report 65: “Adjacent band compatibility between UMTS and other services in the 2 GHz band”
5. ERC Recommendation 01-01: “Cross-border coordination for mobile/fixed communications networks (MFCN) in the frequency bands: 1920-1980 MHz and 2110-2170 MHz”
6. EC Decision 2012/688/EU: “Commission Implementing Decision of 5 November 2012 on the harmonisation of the frequency bands 1920-1980 MHz and 2110-2170 MHz for terrestrial systems capable of providing electronic communications services in the Union”
7. 3GPP TS 36.104: “Technical Specification Group Radio Access Network ”Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception”
8. Recommendation ITU-R M.2101 (02/2017): “Modelling and simulation of IMT networks and systems for use in sharing and compatibility studies”
9. ECC Report 281: “Analysis of the suitability of the regulatory technical conditions for 5G MFCN operation in the 3400-3800 MHz band”
10. CEPT Report 67: “Report A from CEPT to the European Commission in response to the Mandate  
    “to develop harmonised technical conditions for spectrum use in support of the introduction of next-generation (5G) terrestrial wireless systems in the Union” - Review of the harmonised technical conditions applicable to the 3.4-3.8 GHz ('3.6 GHz') frequency band”
11. ECC/DEC/(15)02: “ECC Decision of 3 July 2015 on the harmonised use of broadband Direct Air-to-Ground Communications (DA2GC) systems in the frequency band 1900-1920 MHz, withdrawn July 2018”
12. ECC Decision (18)01: “ECC Decision of 6 July 2018 on the withdrawal of [ECC Decision (15)02](https://www.ecodocdb.dk/document/445) on ‘The harmonised use of broadband Direct Air-to-Ground Communications (DA2GC) systems in the frequency band 1900-1920 MHz”
13. ECC Decision ECC/DEC/(06)09 “ECC Decision of 1 December 2006 on the designation of the bands 1980-2010 MHz and 2170-2200 MHz for use by systems in the Mobile-Satellite Service including those supplemented by a Complementary Ground Component (CGC)”
14. ETSI EN 302 574-1 V2.1.1.: “Satellite Earth Stations and Systems (SES); Harmonised Standard for Mobile Earth Stations (MES) operating in the 1 980 MHz to 2 010 MHz (earth-to-space) and 2 170 MHz to 2 200 MHz (space-to-earth) frequency bands covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 1: Complementary Ground Component (CGC) for wideband systems”
15. Recommendation ITU-R F.1336-4 (02/2014): “Reference radiation patterns of omnidirectional, sectoral and other antennas for the fixed and mobile services for use in sharing studies in the frequency range from 400 MHz to about 70 GHz”
16. Recommendation T/R 13-01: “Preferred channel arrangements for fixed service systems operating in the frequency range 1-2.3 GHz”
17. Recommendation ITU-R F.1098 (10/1995): “Radio-frequency channel arrangements for fixed wireless systems in the 1 900-2 300 MHz band”
18. ECC Report 173: “Fixed Service in Europe Current use and future trends post 2016”
19. Recommendation ITU-R SA.1154 (10/1995): “Provisions to protect the space research (SR), space operations (SO) and Earth exploration-satellite services (EES) and to facilitate sharing with the mobile service in the 2025-2110 MHz and 2200-2290 MHz bands”
20. ECC Recommendation 10(01): “Guidelines for compatibility between Complementary Ground Components (CGC) operating in the band 2170-2200 MHz and EESS/SOS/SRS earth stations operating in the band 2200-2290 MHz”
21. ERC Recommendation 74-01: “Unwanted Emissions in the Spurious Domain”, amended in 2011
22. 3GPP TS 38.104: “NR; Base Station (BS) radio transmission and reception” (Release 15)
23. 3GPP TR 37.840: ”Study of Radio Frequency (RF) and Electromagnetic Compatibility (EMC) requirements for Active Antenna Array System (AAS) base station”

1. TRP is defined as the integral of the power radiated by an antenna array system in different directions over the entire radiation sphere. [↑](#footnote-ref-1)
2. It should be noted that at the moment of drafting this ECC Report, ERC Recommendation 74-01 was undergoing a revision of the spurious emissions limits for AAS systems. [↑](#footnote-ref-2)