



# CEPT Report 80

Report from CEPT to the European Commission in response to the Mandate

“to review the harmonised technical conditions for certain EU-harmonised frequency bands and to develop least restrictive harmonised technical conditions suitable for next-generation (5G) terrestrial wireless systems”

Report B: Channelling arrangements and least restrictive technical conditions suitable for ECS including 5G terrestrial wireless systems in the 900 MHz and 1800 MHz frequency bands, in compliance with the principles of technology and service neutrality

**Report approved on 2 July 2021 by the ECC**

## 0 EXECUTIVE SUMMARY

This Report is the response (Report B) to Task 2 of the Mandate from the European Commission “to review the harmonised technical conditions for certain EU-harmonised frequency bands and to develop least restrictive harmonised technical conditions suitable for next-generation (5G) terrestrial wireless systems”, addressing the 900 MHz and 1800 MHz frequency bands.

According to the schedule set out in the Mandate, this Report addresses Task 2 to develop channeling arrangements and least restrictive technical conditions (LRTCs) for the 900 MHz and 1800 MHz frequency bands. CEPT Report 72 (Report A) [1] addressed Tasks 1 to 3 in full for the paired terrestrial 2 GHz and 2.6 GHz frequency bands, as well as the aspects of Task 1 related to the usage feasibility of 900/1800 MHz for 5G, and Task 3 related to cross-border coordination guidance for these frequency bands. This Report B provides additional clarification in response to Task 3 (cross-border coordination), with respect to the new technology neutral BEM and the handling of GSM.

This Report assumes that ECS use only non-AAS BS in the 900 MHz frequency band and may use either non-AAS BS or AAS BS in the 1800 MHz frequency band. Analysis has been developed under this assumption. No recommendation is provided for usage of AAS BS in the 900 MHz frequency band.

AAS does not apply to user terminals in the 900 MHz or 1800 MHz frequency bands.

CEPT agreed not to include GSM in the technology neutral LRTCs and to recommend keeping the GSM definition (as in current EC decision through reference to GSM ETSI HS listed in Article 2 of EC Decision 2009/766/EC [2]). EC-GSM-IoT is protected as GSM with the proposed technology neutral LRTC.

The following definitions for ECS Narrowband (NB) and ECS Wideband (WB) systems respectively apply in this CEPT Report:

- ECS NB systems are systems operating in 200 kHz channels, excluding GSM and EC-GSM-IoT;
- ECS WB systems are systems operating in channels larger than 200 kHz.

CEPT recommends a harmonised band plan for both the 900 MHz and 1800 MHz frequency bands with a block size multiple of 200 kHz (see section 3.3). Various factors have been taken into due consideration in order to derive this harmonised band plan:

- GSM and standalone NB IoT;
- Wideband systems (such as 5G New Radio (NR)) with typical block size of 5 MHz or more;
- IoT (non-standalone) systems covered with the 5 MHz block size or more;
- Migration towards 5G (NR);
- Uplink and downlink mode operations;
- Guard band at the edge of the 900/1800 MHz harmonised bands;
- Options on how to implement frequency separation at national level.

Concerning NB systems and WB systems, CEPT agreed to derive the BEM from unwanted emissions based on ETSI technical specifications (core requirements) resulting in a single BEM defined for non-AAS NB systems and WB systems and a single BEM defined for AAS WB systems (see section 3.4).

CEPT recognises that ETSI Harmonised Standards that are referred to in the annex of current ECC and EC Decisions, available during development of this Report, are based on conformance requirements (including test tolerance) and assumes that ETSI will continue using conformance requirements as such when developing ETSI HS in the future (including necessary test tolerance).

Although the following systems: UMTS, WiMAX, NR, NB-IoT and LTE, excluding GSM, could be covered by a common set of LRTCs which are compliant with the principle of technology neutrality (a common BEM) there is still a need to differentiate between NB systems and WB systems in the LRTC for implementation of the frequency separation.

According to national context, there is a need for a 200 kHz frequency separation between the nominal channel edges of adjacent NB and WB ECS systems, and between the nominal channel edges of two different adjacent NB ECS systems' (including GSM/EC-GSM-IoT).

For the relevant NB system operating in a guard band mode of a relevant WB system, a frequency separation of 200 kHz or more is necessary, between the channel edge of this NB system and the edge of the operator's block, taking into account existing guard bands between operators' block edges or the edge of the operating band (adjacent to other services). This guard band NB system operates only in channel bandwidths of 10 MHz or higher.

The above frequency separations are required to ensure coexistence in the absence of bilateral or multilateral agreements between neighbouring networks without precluding less stringent technical parameters if agreed among the operators of such networks.

The implementation of this 200 kHz frequency separation needs to be addressed by regulatory measures at national level in order to maintain spectrum efficiency. Various approaches could be implemented either separately or simultaneously depending on the spectrum edges of adjacent ECS networks.

CEPT agreed to avoid new additional studies in order to derive the LRTC, including the coexistence with all adjacent services. CEPT also agreed to avoid additional constraints to systems deployed under the current regulatory framework. Therefore, the proposed approach to be followed, to ensure coexistence with the relevant adjacent band systems while avoiding additional studies, is as follows:

- Identify the appropriate ECC/CEPT Reports which were used to confirm coexistence between existing MFCN technologies in the 900/1800 MHz bands and the relevant adjacent services;
- Demonstrate how the new technology neutral LRTC (including new technologies) can ensure that this coexistence remains for all systems that comply with these technology neutral LRTCs;
  - Recalling that the technology neutral out-of-block limits (baseline and transitional) have been derived from ETSI TS unwanted emissions of an existing MFCN technology (see section 3.4.4.1). Unless an additional baseline limit is defined, these out-of-block limits also apply in out-of-band domain;
  - Recalling that the new technology neutral LRTC are compatible with all existing MFCN technologies (UMTS, WiMAX, LTE and NB-IoT), which have already been studied to ensure coexistence with the relevant adjacent band systems;
  - Using these facts to demonstrate that coexistence remains for all systems that comply with the new technology neutral LRTCs (including new technologies);
- Recall the various coexistence conditions resulting from the ECC/CEPT Reports to confirm coexistence between MFCN systems complying with the proposed technology neutral LRTC and all relevant adjacent services.

This is the same approach that was used in this report to ensure coexistence between the technology neutral LRTC and GSM in-band (see section 3.2).

Coexistence between ECS systems in the 900 MHz and 1800 MHz frequency bands and the following services in adjacent bands have been analysed:

- 900 MHz adjacent systems: GSM-R/E-GSM-R, FRMCS, PMR/PAMR, aeronautical radio navigation (DME/L-DACS), aeronautical mobile service communication systems and MIDS (Military NATO);
- 1800 MHz adjacent systems: DECT, MetSat (weather satellite), fixed telemetry (defence), radio microphones and fixed service.

This CEPT Report defines an additional baseline power limit for non-AAS BS to protect adjacent services in addition to the out-of-block limits between ECS.

Depending on the national context and relevant deployment of ECS NB or WB and RMR (encompasses GSM-R and its successor(s), including FRMCS), there may also be a need for a 200 kHz frequency separation between channel edges of networks adjacent in frequency at 925 MHz in the following cases: RMR NB<sup>1</sup> vs.

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<sup>1</sup> RMR NB systems are RMR systems operating in 200 kHz channels

ECS WB, RMR WB<sup>2</sup> vs. ECS NB and, when the ECS NB and RMR NB systems are different, RMR NB vs. ECS NB. This frequency separation should be addressed by regulatory measures at a national level in order to maintain spectrum efficiency.

In response to Task 3, CEPT confirms that cross-border co-ordination can be addressed through existing and, where appropriate, further to be developed bilateral and multilateral procedures, supported by ECC Recommendations as appropriate.

In addition, when there is no market demand to use other standards than 5G NR and those listed in the current Annex of the EC Decision, there is no need to update national regulatory frameworks. This leaves some flexibility for the date of implementation by the EU Member States of the future EC Decision containing the proposed LRTCs based on this CEPT Report. Varying dates for implementation of the updated EC framework should not impact the rollout of 5G NR in 900/1800 MHz bands in Europe.

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<sup>2</sup> RMR WB systems are RMR systems operating in channels larger than 200 kHz

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## LIST OF ABBREVIATIONS

<b>Abbreviation</b>	<b>Explanation</b>
<b>5G</b>	5 <sup>th</sup> Generation of mobile networks
<b>AAS</b>	Active Antenna System
<b>ALD</b>	Assistive Listening Devices
<b>BEM</b>	Block Edge Mask
<b>BS</b>	Base Station
<b>CBW</b>	Carrier Bandwidth
<b>CEPT</b>	European Conference of Postal and Telecommunications Administrations
<b>DCA</b>	Dynamic Channel Allocation
<b>DECT</b>	Digital Enhanced Cordless Telecommunications
<b>DME</b>	Distance Measuring Equipment
<b>EC</b>	European Commission
<b>EC-GSM-IoT</b>	Extended Coverage GSM-IoT
<b>ECC</b>	Electronic Communications Committee
<b>ECO</b>	European Communications Office
<b>ECS</b>	Electronic Communication Services
<b>EFIS</b>	ECO Frequency Information System
<b>e.i.r.p.</b>	Equivalent Isotropically Radiated Power
<b>eMTC</b>	Enhanced MTC
<b>ETSI</b>	European Telecommunications Standards Institute
<b>ETSI HS</b>	ETSI Harmonised Standard
<b>EU</b>	European Union
<b>E-UTRA</b>	Evolved Universal Terrestrial Radio Access
<b>GMSK</b>	Gaussian Minimum Shift Keying
<b>FRMCS</b>	Future Railway Mobile Communications System
<b>GSM</b>	Global System for Mobile Communication
<b>GSM-R</b>	GSM-Railway
<b>HS</b>	Harmonised Standard
<b>IMT</b>	International Mobile Telecommunications
<b>IoT</b>	Internet of Things
<b>JTIDS</b>	Joint Tactical Information Distribution System
<b>L-DACS</b>	L-band Digital Aeronautical Communications System
<b>LRTCs</b>	Least Restrictive Technical Conditions
<b>LTE</b>	Long Term Evolution
<b>MCA</b>	Mobile Communications on board Aircraft
<b>MCV</b>	Mobile Communication services on Board Vessels
<b>MetSat</b>	Meteorological Satellite
<b>MFCN</b>	Mobile/Fixed Communications Networks
<b>MIDS</b>	Multifunctional Information Distribution System
<b>MSR</b>	Multi-Standard Radio

<b>MTC</b>	Machine Type Communications
<b>non-AAS</b>	non-Active Antenna Systems
<b>NATO</b>	North Atlantic Treaty Organization
<b>NB</b>	Narrowband
<b>NB-IoT</b>	Narrowband-IoT
<b>NR</b>	New Radio
<b>PAMR</b>	Public Access Mobile Radio
<b>PMR</b>	Private Mobile Radio
<b>PMSE</b>	Programme Making and Special Events
<b>PP</b>	Portable Part
<b>QoS</b>	Quality of Service
<b>RAT</b>	Radio Access Technology
<b>RF</b>	Radio Frequency
<b>RFP</b>	Radio Fixed Part
<b>RMR</b>	Railways Mobile Radio
<b>RIB</b>	Radio Interface Boundary
<b>SA NB-IoT</b>	Standalone Narrowband-IoT
<b>SCS</b>	Sub-Carrier Spacing
<b>SEM</b>	Spectrum Emission Mask
<b>SDL</b>	Supplemental Downlink
<b>SRD</b>	Short Range Device
<b>SSR</b>	Secondary Surveillance Radar
<b>SUL</b>	Supplemental Uplink
<b>TACAN</b>	Tactical Air Navigation System
<b>TDD</b>	Time Division Duplex
<b>TRP</b>	Total Radiated Power
<b>UE</b>	User Equipment
<b>UMTS</b>	Universal Mobile Telecommunications System
<b>UTRA</b>	Universal Terrestrial Radio Access
<b>VLBI</b>	Very Long Baseline Interferometry
<b>WB</b>	Wideband
<b>WiMAX</b>	Worldwide Interoperability for Microwave Access



## 1 INTRODUCTION

This Report is the response (Report B) to Task 2 of the Mandate from the European Commission “to review the harmonised technical conditions for certain EU-harmonised frequency bands and to develop least restrictive harmonised technical conditions suitable for next-generation (5G) terrestrial wireless systems” (see ANNEX 1) addressing the 900 MHz and 1800 MHz frequency bands.

This Report informs on the planned update of the current ECC existing framework in the 900 MHz and 1800 MHz frequency bands based on the proposed revision of the harmonised technical conditions. The revision includes channelling arrangements and least restrictive technical conditions under the form of a technology neutral block edge mask and relevant frequency separation, where needed, as an approach to technical harmonisation in the 900 MHz and 1800 MHz bands, in replacement of the current existing technical framework based on references to ETSI standards for both bands.

This Report is based on the principles and objectives detailed in ANNEX 4.

This Report assesses the technical challenges for GSM (including EC-GSM-IoT) when developing the technology neutral LRTC for the 900 MHz and 1800 MHz bands based on existing CEPT Reports and ECC Reports. It explains why the new LRTC cannot be applied to GSM and how protection of GSM is to be managed vis-à-vis the new BEM, while delivering a solution which ensures availability and efficient use of the spectrum for next-generation terrestrial wireless systems in line with the Union’s spectrum policy priorities.

This Report also demonstrates how the proposed least restrictive harmonised technical conditions suitable for 5G NR terrestrial wireless systems (and when applicable AAS technologies) ensure appropriate compatibility with current systems and protection of adjacent services, based on existing CEPT Reports and ECC Reports, which is under the responsibility of administrations.

This Report also provides additional clarification in response to Task 3 (cross-border coordination), with respect to the new technology neutral BEM and the handling of GSM, and provides explanations on the lack of impact of varying dates for implementation of the updated EC framework with LRTCs on the rollout of 5G NR in Europe.

## 2 EXISTING REGULATORY FRAMEWORK FOR 900 MHz AND 1800 MHz BANDS

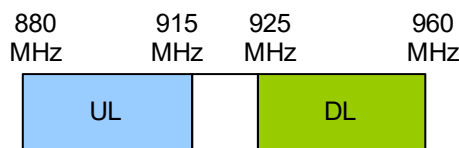
The existing regulatory framework for the 900 MHz and 1800 MHz frequency bands are specified in EC Decision 2009/766/EC [2] amended by EC Decision 2011/251/EU [16] and EC Decision (EU) 2018/637 [20].

### 2.1 EXISTING BAND PLAN

The existing regulatory framework refers to the following definitions:

- The '900 MHz band' means the 880-915 MHz and 925-960 MHz frequency bands.
- The '1800 MHz band' means the 1710-1785 MHz and 1805-1880 MHz frequency bands.

Existing ECS usage in 900 MHz and 1800 MHz band is based on the following FDD band plan:



**Figure 1: 900 MHz band plan**



**Figure 2: 1800 MHz frequency band plan**

In total there are 2 x 35 MHz in 900 MHz frequency band and 2 x 75 MHz in 1800 MHz frequency band.

The current ECC framework refers also to the same band plan.

### 2.2 EXISTING TECHNICAL CONDITIONS

CEPT noted that the last update of EC framework (on the basis of CEPT Report 66 targeting cellular IoT systems) and ECC framework (amended ECC Decision (06)13 on the basis of ECC Report 297<sup>3</sup>) in these bands has been done in 2019. Current frameworks are based on a list of ETSI standards approach and relevant frequency separation requirements between systems where appropriate.

CEPT plans to update during 2021 harmonised technical conditions on the basis of frequency arrangement and BEM for both frequency bands as long-term regulatory approach. The work will be done on the basis of this CEPT Report and in particular on the proposed harmonised technical conditions for updating the EC framework 900 MHz and 1800 MHz in order to ensure consistency between technical harmonised conditions of both frameworks EC and ECC.

CEPT noted that the current EC framework requests Member States to ensure that systems listed in EC Decision and others not listed give appropriate protection to systems in adjacent bands. Coexistence between ECS systems in the 900 MHz and 1800 MHz frequency bands and the relevant services in adjacent bands have been analysed in this Report.

<sup>3</sup> See ECC Report 297, section 2.1.2 on existing MFCN regulatory framework prior this update

The table below lists the relevant CEPT/ECC/EU documents for 900 MHz and 1800 MHz MFCN frequency bands.

**Table 1: Band specific regulatory framework**

Band	Report	ECC Decision	EC Decision based on CEPT Reports	Cross-border coordination
900 MHz	ECC Report 82 [8] ECC Report 96 [9] ECC Report 146 [7] ECC Report 229 [6] ECC Report 266 [5]	ERC/DEC/(94)01 [13] ERC/DEC/(97)02 [14] ECC/DEC/(06)13 (Amended 8 March 2019) [15]	Decision (EU) 2018/637 [20]	ECC/REC(05)08 [17] ECC/REC(08)02 [18]
1800 MHz	ECC Report 297 [3] CEPT Report 40 [4] CEPT Report 41 [12] CEPT Report 42 [11] CEPT Report 66 [10] CEPT Report 72 [1]	ERC/DEC/(95)03 [19] ECC/DEC/(06)13 (Amended 8 March 2019) [15]		

### 3 RECOMMENDED TECHNOLOGY NEUTRAL FRAMEWORK FOR 900 MHZ AND 1800 MHZ BANDS

#### 3.1 REQUIREMENTS FOR UPDATED EC AND ECC DECISIONS

CEPT has analysed how to transpose the current harmonised technical conditions, based on a list of technologies identified by the previous EC regulatory framework: UMTS, WiMAX, NR, NB-IoT and LTE, to a common set of LRTCs which are compliant with the principle of technology neutrality.

CEPT confirmed the need to replace the current technical framework based on references to ETSI harmonised standards for both bands in order to implement the LRTCs approach suitable for long term development of various mobile systems (NB/WB, non-AAS, AAS) in the 900/1800 MHz bands.

Furthermore, it should ensure coexistence with the GSM system in the 900/1800 MHz frequency bands, pursuant to the GSM Directive (Council Directive 87/372/EEC as amended by Directive 2009/114/EC of the European Parliament and of the Council [21]), while delivering a solution, which ensures availability and efficient use of the spectrum for next-generation terrestrial wireless systems in line with the Union's spectrum policy priorities.

#### 3.2 RECOMMENDED APPROACH ON GSM

In this Report, CEPT agreed not to consider GSM when developing the technology neutral LRTC and to recommend keeping the GSM definition (as in current EC decision through reference to GSM ETSI HS listed in Article 2 of EC Decision (2009/766/EC) [2]).

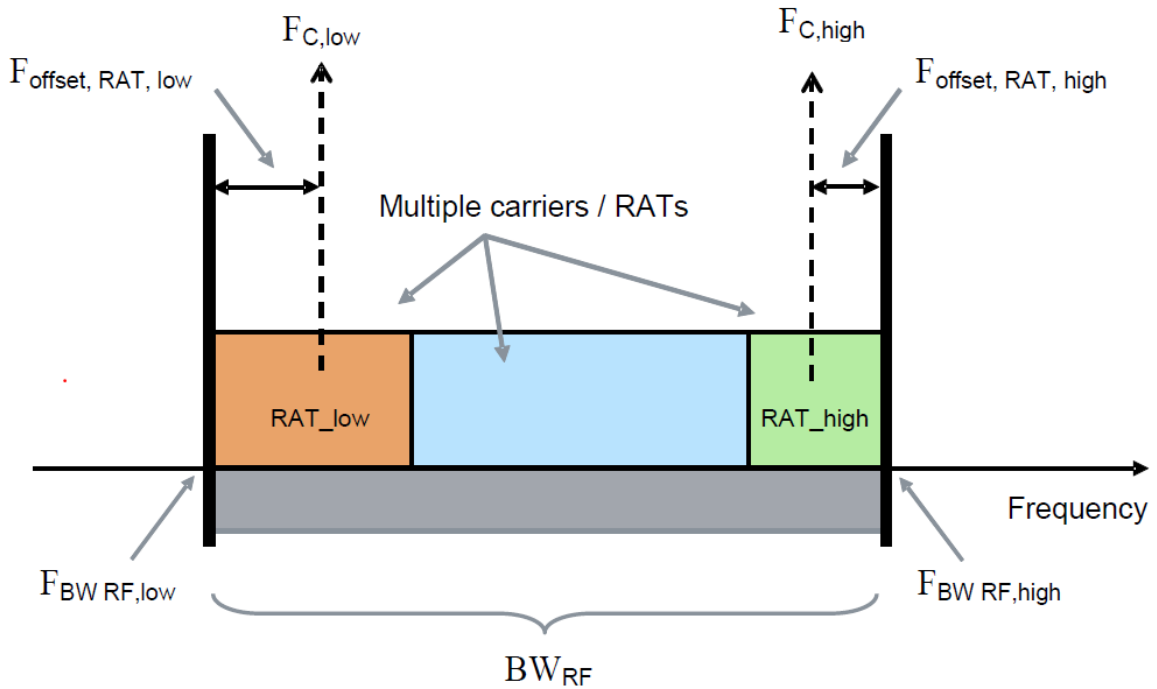
##### 3.2.1 Why CEPT agreed to exclude GSM from the technology neutral BEM

CEPT took into consideration the following technical challenges justifying the exclusion of GSM in the technology neutral LRTCs for the 900 and 1800 MHz bands:

Concerning NB systems and WB systems, CEPT agreed to derive the BEM from unwanted emissions based on the following ETSI technical specifications:

**For non-AAS BS:** ETSI TS 137.104 version 15.10.0 [22] provides the core requirements for MSR non-AAS BS in Table 6.6.2.2-1 and 6.6.2.2-2 which is the same as the ETSI core requirements of the standalone NB-IoT system provided in the ETSI TS 136.104 V 15.3.0 [23] (table 6.6.6.2E-1). CEPT agreed to derive a single BEM for non-AAS NB systems and WB systems on that basis (see also section 3.4 for more details/explanations).

**Note:** For the MSR non-AAS BS the unwanted emissions are defined by combining two tables, with the second table giving a relaxation for cases when a GSM/EDGE, standalone NB-IoT or LTE 1.4 MHz or 3 MHz carrier is adjacent to the BS RF bandwidth edge ( $F_{BW\text{ RF, high}}$  and  $F_{BW\text{ RF, low}}$  in Figure 3). On the other hand, the standalone NB-IoT BS unwanted emissions are defined in a single table.



**Figure 3: Illustration of multiple carriers/radio access technologies (RATs) for Multi-Standard Radio (MSR) Base Stations (BS)**  
 (Source: ETSI TS 137.104 version 15.10.0 [22])

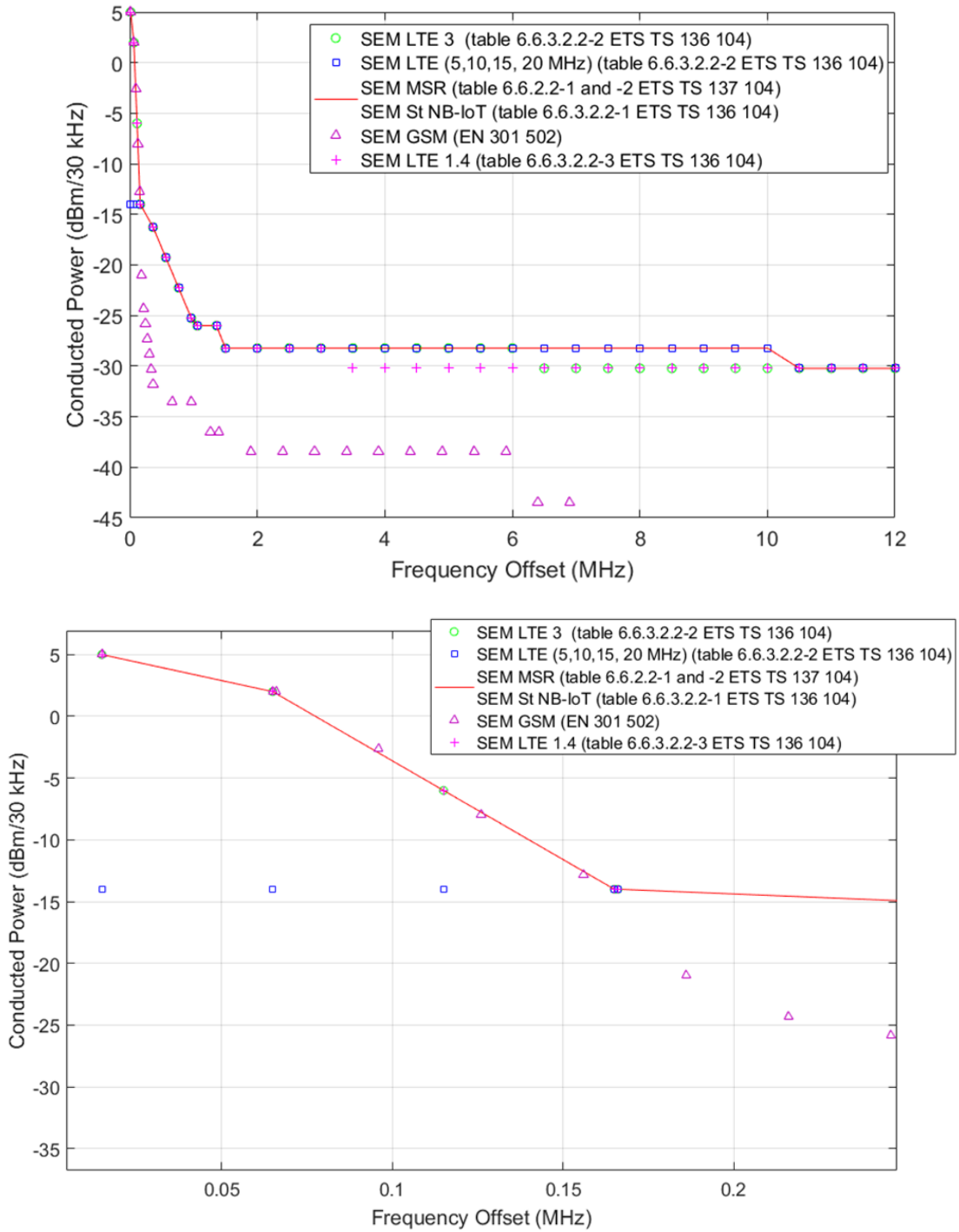
**For AAS BS:** ETSI TS 137.105 version 15.8.0 [24] provides the core requirements for MSR AAS BS in Table 9.7.5.2.3-1 and 9.7.5.2.3-2. CEPT agreed to derive a single BEM for AAS WB systems on that basis (see also section 3.4 for more details/explanations).

This results in:

- a single BEM for non-AAS NB systems and WB systems for which the limits are the same as the out-of-block limits of standalone NB-IoT; and
- a single BEM for AAS WB systems for which the limits are the same as the out-of-block limits of AAS LTE.

Even if GSM is also a NB system, such as standalone NB-IoT, operating with the same 200 kHz channel bandwidth, CEPT identified that GSM systems have different unwanted emission characteristics compared to standalone NB-IoT and to WB systems:

- GSM BS and UE technical characteristics as defined in ETSI EN 301 502 [25] and EN 301 511 [26] are different from the technical characteristics of Standalone NB-IoT as defined in the core specifications (ETSI TS 136 104 [23] for BS and ETSI TS 136 101 [27] for UE);
- Due to its continuous phase modulation, GMSK (Gaussian Minimum Shift Keying), GSM presents unwanted emissions limits that are different from the unwanted emission limits of the proposed BEM and different from those of the other systems as shown in Figure 4, in particular after the first 165 kHz where GSM presents much lower limits.



**Figure 4: Unwanted emission limits (ETSI core Specifications for GSM, NB-IoT, MSR, LTE 1.4, 3, 5, 10, 15, 20 MHz)**

Therefore, it is difficult to find technology neutral LRTCs covering both GSM and other NB/WB systems. In practice, an LRTCs which covers both GSM and other NB/WB systems would relax the requirements for GSM, which could impact coexistence with other systems and with adjacent services or constrain the requirements for the other systems as authorised today through the EC framework (see the figures above).

In addition, GSM systems have been deployed in the field for many years based on the GSM ETSI Harmonised standard. Replacement of current GSM definition with technology neutral LRTCs might raise the risk of backward incompatibility with existing deployments and coexistence with adjacent band services.

Based on the technical assessments above, and in order to avoid the need for new additional studies to derive the LRTCs, this Report recommends maintaining the current regulatory framework applicable to GSM based on ETSI EN 301 502 [25] and EN 301 511 [26].

By not applying the new single BEM to GSM, all existing coexistence frameworks between GSM and adjacent services based on previous ECC/CEPT reports will remain valid.

### 3.2.2 GSM coexistence with NB systems and WB systems that comply with the proposed technology neutral LRTCs

The technology neutral LRTC/BEM recommended in this Report (see section 3.4) were derived on the basis of core ETSI Technical Specifications. As it has been mentioned previously, this results in a single BEM for non-AAS BS and a single BEM for AAS, excluding GSM.

Coexistence between Standalone NB-IoT- and GSM has been studied and proven to be feasible in CEPT Report 66 [10] and EC Decision 2018/637 (amending Decision 2009/766/EC) [20]. CEPT Report 66 concludes in its section 4.3.2 that a 200 kHz separation between the standalone NB-IoT channel edge and the GSM channel edge, where GSM includes EC-GSM-IoT, is needed, subject to coordination between operators.

The conclusions of this Report remains valid and GSM protection is ensured as the requirement above is being maintained in the proposed technology neutral LRTCs for non-AAS BS (see section 3.4) which are the same as those of Standalone NB-IoT.

Regarding AAS WB systems, CEPT Report 72 [1] concludes in its section 3.1.1 based on ECC Report 297 [x] that the in-band compatibility conclusions from CEPT Report 40 [4] applicable to LTE non-AAS systems in 900/1800 MHz frequency bands are also applicable to both LTE/5G NR AAS systems in 1800 MHz frequency band and to 5G NR non-AAS systems in 900/1800 MHz frequency bands.

CEPT Report 72 concludes in its section 4.1 that, in order to ensure coexistence with GSM in the 900/1800 MHz frequency bands, the following requirements apply to 5G NR (AAS or non-AAS) and for LTE(AAS):

- Frequency separation of 200 kHz or more between the 5G NR channel edge and the GSM carrier's channel edge when such networks are operated in an uncoordinated manner. This requirement is already covered by the ETSI standard due the channel characteristics of 5G NR (5 MHz or above channel bandwidth). The same applies to coexistence between 5G NR system and EC-GSM-IoT systems;

The conclusions of this Report remains valid and GSM protection is ensured as the requirement above is maintained in the proposed technology neutral LRTCs for AAS BS (see section 3.4) which are the same as those for LTE AAS BS.

GSM protection has also been taken into consideration in ETSI standardisation when new systems have been introduced.

The proposed technology neutral LRTCs for AAS BS and non-AAS BS (including implementation of required frequency separation) as described in this Report will ensure that GSM remains protected.

MFCN Systems (excluding GSM) already authorised under current EC/ECC framework in the 900/1800 MHz bands, comply with the recommended technology neutral LRTC.

This Report also describes how the necessary frequency separation between GSM and NB systems/WB systems could be managed at the edge of operators' blocks (see section 3.4.5).

### 3.2.3 EC-GSM-IoT

GSM includes EC-GSM-IoT, which is therefore also not considered in the LRTC.

ECC Report 266 [5] mentions the following:

"EC-GSM-IoT is an evolution of the existing GSM air interface with a channel bandwidth of 200 kHz. EC-GSM-IoT is part of the GSM system for carrying IoT traffic. Since EC-GSM-IoT is part of the GSM system, the BS and UE spectrum masks are the same as a normal GSM systems.

...

An EC-GSM-IoT system is deployed in a standalone mode and/or in-band mode in the 900 and 1800 MHz bands, EC-GSM-IoT uses the same frequency planning as GSM, e.g. either with fixed frequency reuse or with frequency hopping. Some of the GSM network's radio resource (time slots) is dynamically allocated IoT."

CEPT confirms that all the above analysis developed for GSM are also valid for EC-GSM-IoT.

### 3.3 RECOMMENDED BAND PLAN

In total there are 2 x 35 MHz in 900 MHz band and 2 x 75 MHz in 1800 MHz frequency band:

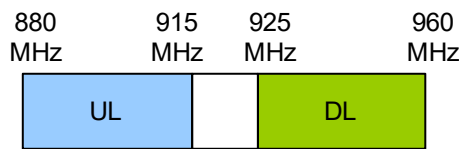


Figure 5: 900 MHz band plan



Figure 6: 1800 MHz band plan

#### 3.3.1 GSM and standalone NB-IoT

When such bands are used for GSM including EC-GSM-IoT and/or standalone NB-IoT, there is a need for 200 kHz blocks. This is already harmonised in current ECC Decision (06)13 [15] with related ETSI HS (see Annex 2 of the ECC Decision (06)13). As mentioned in CEPT Report 72 [1], there is no visibility of a GSM switch off.

In addition, even in case of GSM switch off, standalone NB-IoT may also continue to be developed in future including in the 1800 MHz band. NB-IoT in standalone mode is different from NB-IoT in-band mode or NB-IoT in guard band mode in the sense that the IoT carrier is deployed independently, in its own narrowband spectrum.

It is noted that the UMTS channel raster is 200 kHz, which means that the centre frequency must be an integer multiple of 200 kHz. The channel raster for NB-IoT in standalone operation is 100 kHz. Both GSM900 and GSM1800 have channel raster of 200 kHz, as described in ETSI EN 301 502 [25]. This is a relevant consideration for administrations.

#### 3.3.2 Wideband systems (such as 5G New Radio (NR)):

For wideband systems (such as 5G New Radio (NR)), a minimum block size of 5 MHz is recommended. This is consistent with the assumptions used in coexistence studies performed in ECC Report 297 [3], CEPT Report 40 [4], CEPT Report 41 [12], CEPT Report 42 [11], ECC Report 82 [8] and ECC Report 96 [9] for NR, LTE, WiMAX and UMTS coexistence.



### 3.3.3 IoT (non-standalone) systems covered with the 5 MHz block size

Some IoT systems such as, LTE-MTC/eMTC and NB-IoT in in-band mode, are totally embedded inside the operator's LTE channel. Therefore they can be covered with a 5 MHz block size. This is already harmonised through the existing ECC Decision (06)13 by reference to related ETSI HS (see ECC Decision (06)13, Annex 2, Table 2).

NB-IoT in guard band mode can also be embedded inside the operator's blocks with the condition that a frequency separation of 200 kHz or more is maintained between the NB-IoT channel edge and the edge of the operator's block, taking into account existing guard bands between operators' block edges or the edge of the operating band (adjacent to other services). The usage of guard band NB-IoT within CEPT is foreseen only for LTE channel bandwidths of 10 MHz or higher. Operators may deploy guard band NB-IoT for smaller channel bandwidth in between their blocks, if agreed (see ECC Report 266 [5]).

### 3.3.4 Migration issues towards 5G (NR)

Current authorisations in force (see ECO Report 03 [28]) reveals that there are a number of authorisations that are not based on multiples of 5 MHz blocks, while some other implemented authorisations are based on multiples of 5 MHz blocks. Therefore, there is a need to maintain flexibility for implementation of technical conditions including the band plan.

### 3.3.5 Uplink only or Downlink only operations

In addition to FDD mode of operation, as long as the respective frequency usage complies with the harmonised technical conditions (compliance to relevant applicable LRTCs), uplink only or downlink only operations are possible.

### 3.3.6 Guard band at the edge of 900/1800 MHz harmonised bands

CEPT notes that different approaches are in place concerning implementation of a 100 kHz guard band at the edge of the harmonised bands. This is explicitly implemented or not depending on national authorisation approaches. This 100 kHz guard band refers to the GSM specification and, in particular at 900 MHz, to the need for 200 kHz frequency separation between the nearest GSM-R channel edge and a wideband system's channel edge (see ECC Report 297 [3]). These different national approaches are compatible with the implementation of the recommended band plan and the requirement to ensure coexistence with adjacent services, in particular at 900 MHz with GSM-R. Such national flexibility to implement 100 kHz guard band/frequency offset at the edge of harmonised bands shall be preserved in the long term where needed. When both ECS and FRMCS operate WB systems such guard band will not be needed anymore.

### 3.3.7 Options for administrations on how to implement frequency separation at national level

In the 900/1800 MHz frequency bands, there is a need to implement a 200 kHz frequency separation between the nominal channel edge<sup>4</sup> of a NB system, including GSM, and the nominal channel edge of a WB system for uncoordinated deployments implementing LRTCs as described in this Report, in order to avoid the blocking effect of the wideband system's receivers by the adjacent narrowband systems. There is also a need to implement a 200 kHz frequency separation between different NB systems when deployed in an uncoordinated manner.

Due to national situations (efficient usage of spectrum, competition etc.), in order to implement the LRTC, various frequency separation approaches could be considered either separately or simultaneously depending on the assigned channel edges of neighbouring authorised mobile networks. Various examples for national implementation are listed in section 3.4.5.3 of this Report.

In one of the national implementation cases, the required frequency separation could result in an unused 100 kHz block at the edge of both neighbouring authorised mobile networks", leaving flexibility to operators to deploy, beyond this 100 kHz, either NB or WB systems at the edge of their assigned blocks. This may also result in a possible assignment of a non-multiple 200 kHz block, at the assigned channel edge of

<sup>4</sup> Nominal channel refers to the nominal channel bandwidth defined in the relevant harmonised standard.

both neighbouring authorised mobile networks,. Such a national implementation case has no impact on cross-border coordination conditions.

### 3.3.8 Recommendations

In addition to the compliance to LRTCs (BEM(s) and frequency separation), the harmonised band plan can be implemented with a combination of the following recommendations:

- A. The 900 MHz band follows an FDD band plan with a block size multiple of 200 kHz. The duplex direction for the carriers in the 880-915 MHz/925-960 MHz<sup>5</sup> frequency bands is mobile transmit within the lower band and base station transmit within the upper band.
- B. The 1800 MHz band follows an FDD band plan with a block size multiple of 200 kHz. The duplex direction for the carriers in the 1710-1785 MHz/1805-1880<sup>6</sup> MHz frequency bands is mobile transmit within the lower band and base station transmit within the upper band.
- C. To support wideband systems (such as 5G NR), the 900 MHz<sup>5</sup> and 1800 MHz<sup>6</sup> bands follow FDD band plans enabling 5 MHz or more of contiguous spectrum according to market demand.

## 3.4 RECOMMENDED APPLICABLE LRTCS

### 3.4.1 Introduction

CEPT has analysed how to transpose the current harmonised technical conditions, based on a list of technologies identified by the EC regulatory framework - UMTS, WiMAX, LTE, NB-IoT and NR, - to a common set of Least Restrictive Technical Conditions (LRTCs) which are compliant with the principle of technology neutrality.

As set out in the current EC Decision, there is a need for a frequency separation between adjacent NB systems and WB systems, and between two different adjacent NB systems. To avoid challenging legal issues at the edge of a licensee's spectrum, there is a need to consider this required frequency separation when generating the LRTCs.

Although the systems listed in the current EC Decision, excluding GSM, could be covered by a common BEM there is still a need to differentiate between NB systems and WB systems in the LRTCs for implementation of the frequency separation. CEPT agreed to consider in this Report the following definitions for NB systems and WB systems respectively:

- NB systems as systems operating in 200 kHz channels, excluding GSM and EC-GSM-IoT;
- WB systems as systems operating in channels larger than 200 kHz.

Therefore, the LRTCs proposed in this CEPT report include various common components of a BEM (applicable for both NB systems and WB systems) and, when appropriate, relevant frequency separation to be applied at the edge of the assigned block from where the LRTCs then applies (see section 3.4.5).

GSM has not been considered when developing the common BEM. Section 3.2 explains why the BEM could not be applied to GSM and how the protection of GSM is to be managed regarding the new BEM.

Under this technology neutral approach, when complying with the LRTCs, licensees should be free to deploy any MFCN technology in the assigned spectrum. This framework will give more flexibility to licensees and thus increase infrastructure competition and stimulate/support 5G development. It will also maintain long term confidence with adjacent bands users.

<sup>5</sup> The 880-915 MHz range or portions thereof, can be used for uplink-only operation without paired spectrum within the 925-960 MHz range; the 925-960 MHz range or portions thereof, can be used for downlink-only operation without paired spectrum within the 880-915 MHz range

<sup>6</sup> The 1710-1785 MHz range or portions thereof, can be used for uplink-only operation without paired spectrum within the 1805-1880 MHz range; the 1805-1880 MHz range or portions thereof, can be used for downlink-only operation without paired spectrum within the 1710-1785 MHz range

To generate LRTCs, CEPT has identified the relevant parameters to derive a BEM and the toolbox for implementation of the required frequency separation between systems (in a technology neutral approach) at national level in order to avoid new studies.

This section defines the components of the LRTCs for NB systems and WB systems. The relevant LRTCs include a common BS BEM consisting of: in-block limits, out-of-block limits, baseline limits, additional baseline as an out-of-band limit to ensure coexistence with adjacent band users where needed. LRTCs also include the relevant frequency separation between adjacent band NB systems and WB systems, and between two different adjacent band's NB systems, as described in section 3.4.5.

A Block Edge Mask (BEM) is an essential component of the LRTCs and provides conditions necessary to ensure co-existence between neighbouring networks, in the absence of bilateral or multilateral agreements between operators of such neighbouring networks.

There is a need to develop one BEM for Base Stations and one BEM for terminal stations including the following possible components, where appropriate (see Figure 7):

Base stations:

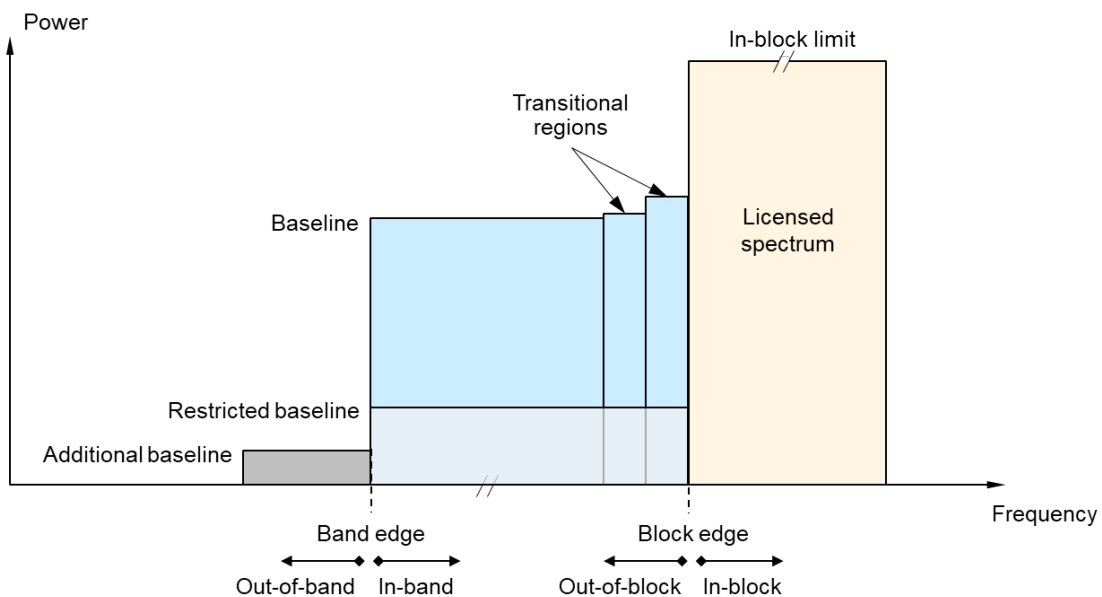
- In-block power limit (to be applied to an assigned block where needed);
- Transitional regions (out-of-block limits);
- Baseline (out-of-block limits);
- Restricted baseline (only if needed, for restricted out-of-block limits).

Ensure coexistence with adjacent systems:

- Additional baseline as an out-of-band limit (to ensure coexistence with adjacent users) where needed if it differs from out-of-block limits;

Terminal Stations:

- In-block power limit (to be applied to an assigned block);
- To assess if other limits are needed to ensure coexistence with adjacent users.



**Figure 7: Base Station Block Edge Mask elements**

The in-block power limit is applied to a block assigned to an operator. The baseline power limit, designed to protect the spectrum of other operators within the 900 and 1800 MHz frequency bands, and the transitional

region power limit, enabling filter roll-off from the in-block to the baseline power limit, represent out-of-block power elements. An additional baseline as an out-of-band limit (to ensure coexistence with adjacent users) could be added where needed if it differs from out-of-block limits.

Systems may use only non-AAS BS in 900 MHz frequency band and may use either non-AAS BS or AAS BS in the 1800 MHz frequency band. AAS does not apply to user terminals in the 900 MHz and 1800 MHz frequency bands.

For AAS MFCN base stations in the 1800 MHz band, the BEM is expressed in terms of total radiated power (TRP). TRP is defined as the integral of the power radiated by an antenna array system in different directions over the entire radiation sphere. TRP is equal to the total conducted power input into the antenna array system minus any losses in the antenna array system.

CEPT agreed to use the following source reference ETSI TS (Technical Specification of core requirements) to derive the BEM (out-of-block limits):

**For non-AAS BS:**

- a Single BEM is derived based on non-AAS MSR BS unwanted emissions supporting UMTS, LTE (1.4 MHz and 3 MHz, 5 MHz), NR, standalone SA NB-IoT;
- Source for MSR non-AAS BS BEM; ETSI TS 137 104 (version 15.10.0) [22] Table 6.6.2.2-1 and 6.6.2.2-2

**For AAS BS:**

- a Single BEM is derived based on AAS MSR BS unwanted emissions supporting UMTS, LTE (1.4 and 3 MHz, 5 MHz), NR;
- Source for MSR AAS BS BEM: ETSI TS 137 105 (version 15.8.0) [24] Table 9.7.5.2.3-1 and 9.7.5.2.3-2

CEPT recognises that ETSI HS that are referred to in the annex of ECC/EC Decisions today are based on conformance requirements (including test tolerance) and assumes that ETSI will continue using conformance requirements when developing ETSI HS in the future (including necessary test tolerance).

CEPT coexistence studies have been developed based on ETSI TS/3GPP core requirements.

The in-block and out-of-block non-AAS BS e.i.r.p. limits per antenna have been developed under the basis of 18 dBi antenna gain and the conducted power limits from relevant ETSI TS core requirements as referenced above.

Provided that the applicable LRTCs in this CEPT Report are complied with (i.e. in-block requirements, out-of-block power limits, etc.), a higher antenna gain may be used. An example of where this may apply is in the case of a lower conducted power compensated with a higher antenna gain while still fulfilling the LRTCs.

The non-AAS BS e.i.r.p. limits could be relaxed (e.g. higher conducted power and/or antenna gain, which results in higher e.i.r.p., may also be used), either if agreed among all affected operators of such networks or in accordance with national implementation already in place, provided that these systems continue to comply with the technical conditions applicable for the protection of adjacent services, applications or networks and with obligations resulting from cross-border coordination.

**3.4.2 Methodology for deriving out-of-block and out-of-band limits for non-AAS BS**

Annex A3.2 describes in detail how to derive the non-AAS BS out-of-block and out-of-band transitional limits based on the agreed parameter 'X'<sup>7</sup> and agreed antenna gain. . Furthermore, CEPT noted that:

- According to the ETSI TS 137 104 specification [22], the value of the parameter 'X' only applies when a NB carrier is adjacent to the block edge, and in this case the unwanted emissions scale with in-band power for  $\Delta f$  between 0 and 150 kHz.
- ECC studies in relation with standalone NB-IoT and GSM include the following elements:

---

<sup>7</sup> Parameter 'X' is defined in Annex A3.2

- ECC Report 266 [5] referred in its section 5.2 on standalone NB-IoT in-band coexistence in 900 MHz and 1800 MHz bands to the technical studies from 3GPP TR 36.802 [32]. Table 6.2-1 of this 3GPP TR, described simulation assumptions for coexistence studies between NB-IoT and other 3GPP systems. Those assumed parameters in terms of conducted power are: 43 dBm/(200 kHz) for standalone NB-IoT, 46 dBm for LTE and LTE plus NB-IoT guard band, and 43 dBm for UMTS. ECC Report 266 did not perform any additional in-band coexistence studies with higher conducted in-band power. Therefore, it is understood that the values for parameter 'X' in existing in-band coexistence studies are X=0 and X=3.
- ECC Report 266 concludes in its section 5.4 that "*standalone NB-IoT equipment complying with the relevant technical conditions (maximum permitted e.i.r.p and minimum frequency separations from other adjacent services) which apply in the context of GSM, may be deployed in the 900/1800 MHz bands without any increase in the likelihood of harmful interference*".

ECC Report 146 [7] on compatibility between Multi-carrier GSM and adjacent systems at 900 and 1800 MHz assumes a maximum in-band conducted power of 43 dBm and 15 dBi antenna gain (including feeder loss). CEPT administrations reported that some GSM base stations are deployed with higher conducted power up to 55 dBm, which is compliant with the current EC framework and the ETSI HS for GSM. No coexistence issues with adjacent system have been reported in the field after several years of GSM operation. Standalone NB-IoT can be deployed with similar power values in those countries.

CEPT concluded and agreed to use a value for parameter 'X', of X=6, to derive the out-of-block and out-of-band requirements combined with flexibility on a case-by-case basis at national level to allow higher values. The value of X=6 corresponds to a NB conducted transmit power of 49 dBm (80 W), which CEPT has considered reasonable considering existing deployments in 900 and 1800 MHz bands.

This means in detail:

- To ensure that future non-AAS BS NB carriers deployed at the block edge (which may use higher conducted power) shall not have significantly worse unwanted emissions than systems currently in use, the parameter 'X' has been limited to a maximum of 6. This enables non-AAS BS NB carriers adjacent to band edge, complying with ETSI TS 137 104 [22], to use a conducted in-band power of up to 49 dBm (i.e. 80 W). Moreover, as there is no obligatory in-band power limit, higher in-band power is possible, provided the unwanted emissions are compliant with the out-of-block and out-of-band limits defined in this CEPT Report (see section 3.4.4).
- On a case-by-case basis, the non-AAS BS out-of-block e.i.r.p. limits could be relaxed at national level (i.e. higher conducted power and/or antenna gain, resulting in higher e.i.r.p., may also be used), either if agreed among all affected operators of such networks or in accordance with national implementation already in place, provided that these systems continue to comply with the technical conditions applicable for the protection of adjacent services, applications or networks and with obligations resulting from cross-border coordination.
- That there is also a need to include flexibility, on a case-by-case basis at national level for out-of-band limits as follows:
  - Above 960 MHz, below 1805 MHz and above 1880 MHz: On case-by-case basis, at national level, higher out-of-band limits may be applied (see notes in Table 6 for details).
  - Below 925 MHz: On case-by-case basis, at national level, higher out-of-band limits may be applied. This is to align with railway technical conditions in CEPT Report 76 [33] and ECC Decision (20)02 [34].

Based on the above points, CEPT agreed out-of-block transitional limits and out-of-band limits defined in section 3.4.4 of this Report (Table 5 and Table 6).

### 3.4.3 In-block power limits

#### BS in-block requirement

No mandatory limit is defined today in the existing ECC/EC regulatory framework for 900 and 1800 MHz bands nor in ETSI HS relevant to systems authorised in the 900/1800 MHz bands namely GSM (including EC-GSM-IoT), UMTS, LTE, WiMAX, IoT systems, NR.

The same approach is proposed to be kept for the LRTCs when updating ECC/EC regulatory framework. In-block limits for non-AAS BS and AAS BS are not necessary.

However, administrations may choose to set an in-block power limit for the BS if needed on a national or local basis. Optional limits are given below in Table 2 to guide administrations based on practical deployments today.

Practically, 900 and 1800 MHz bands have always been used as coverage bands and because of that, the BS transmit power levels and antenna gains deployed in the field are relatively high. For non-AAS BS in 900 and 1800 MHz bands, the transmit power in areas requiring extended coverage (rural or deep indoor e.g. for IoT) can be in the order of the following levels:

- GSM (including EC-GSM-IoT) and generally NB-IoT carrier: e.i.r.p. of 60-69 dBm/(200 kHz). This is based on conducted power of 42-51 dBm/(200 kHz). Such high power is important to fulfil coverage requirements.
- For UMTS, LTE, and NR carriers: e.i.r.p. of 63-67 dBm/(5 MHz). This is based on conducted power of 45-49 dBm/(5 MHz).

Based on the above, two optional limits for non-AAS BS are proposed, one for narrowband systems based on 200 kHz block/carrier and one for wideband systems based on a 5 MHz block/carrier

For AAS BS, 3GPP specification TS 37.105 [24] clearly states that AAS BS does not support either GSM operation or NB-IoT. For this case an optional limit based on 5 MHz block/carrier is proposed.

**Table 2: Base Station in-block power limits for non-AAS and AAS**

BEM element	Non-AAS e.i.r.p.	AAS TRP power limit (for 1800 MHz band AAS)
In-block	Not obligatory. In case an upper bound is desired by an administration, a value of 63-67 dBm/(5 MHz) per antenna may be applied for wideband systems and a value of 60-69 dBm/(200 kHz) per antenna may be applied for narrowband systems	Not obligatory. In case an upper bound is desired by an administration, a value of 58 dBm/(5 MHz) per cell (note 1) may be applied.

#### Terminal Station in-block requirement

As for the technical condition for terminal stations it is recommended that the in-block TRP for mobile terminal stations does not exceed 25 dBm. This is based on relevant ETSI TS core requirements for terminal stations<sup>8</sup>.

The in-block radiated power limit for fixed/nomadic terminal stations may be agreed on a national basis.

<sup>8</sup> The UE maximum output power including tolerance of up to +2 dB has been derived from the UE maximum output power value and tolerance value defined in ETSI TS 125.101 Table 6.1 (for UMTS terminals) [30], ETSI TS 136.101 Table 6.2.2-1 (for LTE terminals) [27] and ETSI TS 138 101-1 Table 6.2.1-1 (for NR terminals) [31].

**Table 3: In-block power limits for Terminal Stations**

BEM element	Maximum mean power (note 1)
In-block	25 dBm (note 2)
<p>Note 1. The recommended power limit above for mobile terminal stations is specified as TRP. The in-block radiated power limit for fixed/nomadic terminal stations may be agreed on a national basis provided that protection of other services, networks and applications is not compromised and cross-border obligations are fulfilled.</p> <p>Note 2. It is recognised that a possible tolerance of up to +2 dB is included in this value, to take account of operation under extreme environmental conditions and production spread. This value does not include test tolerance.</p>	

CEPT recognises that ETSI HS that are referred to in the annex of ECC/EC decision today are based on conformance requirements (including test tolerance) and CEPT assumes that ETSI will continue using conformance requirements when developing ETSI HS in the future (including necessary test tolerance).

Member States may relax the limit set out in Table 3 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.

### 3.4.4 Out-of-block and out-of-band power limits

#### 3.4.4.1 Recommended out-of-block power limits

The proposed technology neutral BEMs in this Report intends to have no impact on MSR non-AAS BS as defined in ETSI TS 137 104 (version 15.10.0) [22] (Table 6.6.2.2-1 and 6.6.2.2-2), and on MSR AAS BS as defined in ETSI TS 137 105 (version 15.8.0) [24] (Table 9.7.5.2.3-1 and 9.7.5.2.3-2) that were used to derive the BEMs.

**Table 4: Base Station Baseline out-of-block power limit for non-AAS and AAS**

BEM element	Frequency range	Non-AAS maximum mean e.i.r.p per antenna (for 900 MHz and 1800 MHz band)	AAS TRP power limit per cell (note 1) (for 1800 MHz band)
Baseline	FDD DL blocks	3 dBm/MHz	-6 dBm/MHz
<p>Note 1: In a multi-sector base station, the radiated power limit applies to each one of the individual sectors.</p>			

Table 5 gives the out-of-block BEM requirements for non-AAS and AAS BS.



**Table 5: Base Station transitional out-of-block power limits for non-AAS and AAS**

BEM element	Frequency range	Non-AAS maximum mean e.i.r.p per antenna (for 900 MHz and 1800 MHz band) (note 1)	AAS TRP power limit per cell (note 2) (for 1800 MHz band)
Transitional region	0 to 0.2 MHz offset from block edge	32.4 dBm/(0.2 MHz)	17.4 dBm/(0.2 MHz)
	0.2 to 1 MHz offset from block edge	13.8 dBm/(0.8 MHz)	4.7 dBm/(0.8 MHz)
	1 to 5 MHz offset from block edge	5 dBm/MHz	-4 dBm/MHz
	5 to 10 MHz offset from block edge	12 dBm/(5 MHz)	3 dBm/(5 MHz)
<p>Note 1: The non-AAS e.i.r.p. limits could be relaxed at national level, either if agreed among all affected operators of such networks or in accordance with national implementation already in place.</p> <p>Note 2: In a multi-sector base station, the radiated power limit applies to each one of the individual sectors.</p>			

**3.4.4.2 BS out-of-band power limits**

To protect the adjacent services, the additional baseline region limits for non-AAS BS provided in Table 6 are defined.

**Table 6: Base station additional baseline region limits for non-AAS**

Frequency range	Non-AAS maximum mean e.i.r.p per antenna (for 900 MHz and 1800 MHz band) (note 1) and (note 2)
0 to 0.2 MHz offset from block edge	32.4 dBm/(0.2 MHz)
0.2 to 1 MHz offset from block edge	13.8 dBm/(0.8 MHz)
1 to 5 MHz offset from block edge	5 dBm/MHz
5 to 10 MHz offset from block edge	12 dBm/(5 MHz)
<p>Note 1: Provided that adjacent services, applications or networks remain protected above 960 MHz, below 1805 MHz and above 1880 MHz: On case-by-case basis, at national level, higher e.i.r.p. limits may be applied for non-AAS BS: e.i.r.p. limits up to 6 dB higher are allowed in the 0-200 kHz range to support higher NB in-band block conducted power than 49 dBm/(200 kHz(i.e. )up to 55 dBm/(200 kHz), i.e. X = 12; e.i.r.p. limits up to 11 dB higher is allowed in the 0-10 MHz range to support higher antenna gain than 18 dBi (up to 29 dBi).).</p> <p>Note 2: Provided that adjacent services, applications or networks remain protected below 925 MHz: On a case-by-case basis, at national level, higher e.i.r.p. limits may be applied for non-AAS BS.</p>	

**3.4.5 Recommended frequency separations**

In the 900 MHz and 1800 MHz frequency bands, when deployed in an uncoordinated approach, it is necessary to implement a 200 kHz frequency separation between:

- a NB system complying with the BEM and a WB system complying with the BEM;
- different NB systems both complying with the BEM; and,
- GSM (including EC-GSM-IoT) and either a NB or WB system complying with the BEM.

This section of the Report details the basis for this frequency separation (see 3.4.5.1), how it could be transposed in a technology neutral approach (see 3.4.5.2) and how it could be implemented at national level (see 3.4.5.3).



### 3.4.5.1 Frequency separation between WB systems and NB systems and between two different NB systems

According to the current EC/ECC regulatory frameworks, CEPT identified the required frequency separation between NB systems or GSM operating in 200 kHz blocks and WB systems operating in channels larger than 200 kHz.

NB systems refer to systems operating in 200 kHz channels, excluding GSM and complying to the BEM:

- These systems operate in 200 kHz blocks;
- There is no need for frequency separation between two NB systems of the same type;
- There is a need for a frequency separation of 200 kHz or more between NB systems channel edge of a network and the GSM channel edge of the neighbouring network in case of uncoordinated deployments.

WB systems include the following systems: LTE including MTC, eMTC, and NB-IoT in-band, guard band modes), UMTS, WiMAX, 5G NR:

- Those systems could operate with multiples of 5 MHz channel bandwidths, except LTE that can also operate in 1.4 MHz or 3 MHz according to national circumstances;
- A frequency separation of 200 kHz or more is required between 5G NR, LTE, WiMAX and UMTS channel edge of one network and GSM channel edge (including EC-GSM-IoT) or the standalone NB-IoT channel edge of neighbouring networks where wideband and GSM, EC-GSM-IoT or standalone NB-IoT systems are operating in an uncoordinated manner. No frequency separation is required for coordinated operation;
- The usage of guard band NB-IoT within CEPT is foreseen only for LTE channel bandwidths of 10 MHz or higher (Mobile Operators may deploy guard band NB-IoT for smaller channel bandwidth in between their blocks, if agreed. This is outside the scope of this analysis on frequency separation). IoT systems such as LTE-MTC/eMTC and in-band NB-IoT are totally embedded inside the operators LTE channel, therefore they can be covered with the same conditions as per LTE;
- Concerning carrier separation between two neighbouring UMTS networks, and between neighbouring UMTS networks and GSM networks, a separation of 5 MHz between the centre frequencies of two adjacent UMTS networks, and a separation of 2.8 MHz between a GSM network centre frequency and a UMTS network centre frequency is needed if they are operating in uncoordinated manner;
- No frequency separation is needed between an NR/LTE/WiMAX channel edge and a UMTS channel edge;
- No frequency separation is needed between the channel edges of two neighbouring WiMAX networks;
- No frequency separation is needed between the channel edges of two neighbouring LTE networks.

Following CEPT Report 72 [1], ECC Report 266 [5], ECC Report 297 [3] on the suitability for 5G, and the current EC regulatory framework including the latest amendments of 2009/766/EC [2], the above frequency separations shall be applied as an essential component of the conditions necessary to ensure coexistence in the absence of bilateral or multilateral agreements between neighbouring networks, without precluding less stringent technical parameters if agreed among the operators of such networks. This is summarised in Table 7 hereafter.

**Table 7: The required frequency separation between the channel edge of two adjacent systems according to ECC Report 266 [5] and 297 [3] and CEPT Report 40 [4] and implemented in EC/ECC Decisions**

	LTE (channel edge)	WIMAX (channel edge)	UMTS (channel edge) <sup>9</sup>	Standalone NB-IoT (channel edge)	5G NR (channel edge)
GSM (channel edge)	200 kHz	200 kHz	200 kHz	200 kHz	200 kHz
Standalone NB-IoT (channel edge)	200 kHz	200 kHz	200 kHz	0 kHz	200 kHz
WiMAX (channel edge)	0 kHz	0 kHz	0 kHz	200 kHz	0 kHz
UMTS (channel edge)	0 kHz	0 kHz	0 kHz	200 kHz	0 kHz
LTE (channel edge)	0 kHz	0 kHz	0 kHz	200 kHz	0 kHz

**3.4.5.2 Technology neutral approach to frequency separation**

According to the analysis developed in this CEPT Report three different system types could be deployed in the 900 MHz/1800 MHz band; two under a technology neutral approach and GSM as a third one:

- WB systems (operating in channels larger than 200 kHz);
- NB systems (operating in 200 kHz channels), excluding GSM; and,
- GSM, also as a narrowband system.

The following technology neutral approach is recommended to express the required frequency separation between NB systems and WB systems and GSM:

- To avoid the narrowband blocking effect of the wideband system receivers by the adjacent NB systems, a 200 kHz frequency separation is required between the nominal channel edge<sup>10</sup> of an NB system or a GSM system and the nominal channel edge of a WB system<sup>11</sup> where these systems are operating in uncoordinated manner. No frequency separation is required for coordinated operation;
- A frequency separation of 200 kHz or more is required between a NB system and GSM;
- For the relevant NB system operating in a guard band mode of a relevant WB system, a frequency separation of 200 kHz or more is necessary, between the channel edge of this NB system and the edge of the operator's block, taking into account existing guard bands between operators' block edges or the edge of the operating band (adjacent to other services). For an NB system operating in a guard band mode of a WB system, a frequency separation of 200 kHz or more is necessary, between the channel edge of this NB system and the edge of the operator's block, taking into account existing guard bands between operators' block edges or the edge of the operating band (adjacent to other services). This NB system operates only within channel bandwidths of 10 MHz or higher.

The above frequency separations are required to ensure coexistence in the absence of bilateral or multilateral agreements between neighbouring networks, without precluding less stringent technical parameters if agreed among the operators of such networks.

<sup>9</sup> Nominal channel refers to the nominal channel bandwidth defined in the relevant harmonised standard.  
<sup>10</sup> Nominal channel refers to the nominal channel bandwidth defined in the relevant harmonised standard.  
<sup>11</sup> Assuming a nominal channel of 5 MHz for UMTS as defined in the relevant harmonised standard.

### 3.4.5.3 *Toolbox for implementing BEM and the required frequency separation at national level (LRTCs approach)*

The implementation of the frequency separation needs to be further addressed by regulatory measures at national level in order to maintain spectrum efficiency. This chapter provides explanation on how the LRTCs could be implemented at national level with regard to frequency separations between adjacent MFCN systems complying with the BEM as defined in section .

According to the national situation (e.g. efficient usage of spectrum, competition etc.) and in order to transpose required frequency separation while implementing the BEM, various frequency separation approaches could be implemented either separately or simultaneously depending on the edges of neighbouring MFCN spectrum assignments.

Several separation schemes can be considered according to national contexts: recent or planned authorisations, national competitive context, operator investments, etc. It is up to each administration to implement the relevant LRTC (BEM plus required frequency separation where needed) between two neighbouring MFCN operators according to the national situation.

To implement the required frequency separation, the BEM is applied from the MFCN operator assigned blocks edge, taking into account this frequency separation where needed. The approaches that could be used to implement the required frequency separation are described as follows according to the national situation:

- In cases where an NB<sup>12</sup> system is adjacent to a WB system:
  1. Case 1: a shared approach between the two systems, where the 200 kHz separation is shared on the side of both the NB systems and WB system. The channel edge of any of the NB system carriers must be at least 100 kHz inside the edge of their permitted frequency block where the neighbouring licensee has deployed or could deploy a WB system, and the channel edge of any of the WB system carriers must be at least 100 kHz inside the edge of their permitted frequency block where the neighbouring licensee has deployed or could deploy an NB system;
  2. Case 2: the 200 kHz separation is imposed only on the NB system. The channel edge of any of the NB system carriers must be at least 200 kHz inside the edge of their permitted frequency block where the neighbouring licensee has deployed or could deploy a WB system;
  3. Case 3: an the 200 kHz separation is imposed only on the WB system. This could mean the channel edge of any of the WB system carriers must be 200 kHz or more inside the edge of their permitted frequency block where the neighbouring licensee has deployed or could deploy an NB system.
- In cases where an NB system is adjacent to GSM:
  4. Case 4: a shared approach between these two systems where the 200 kHz is shared on the side of both the NB system and the GSM system. The channel edge of the NB system carrier must be at least 100 kHz inside the edge of their permitted frequency block where the neighbouring licensee has deployed or could deploy a GSM system, and the channel edge of any of the GSM system carriers must be at least 100 kHz inside the edge of their permitted frequency block where the neighbouring licensee has deployed or could deploy an NB system;
  5. Case 5: The 200 kHz separation is imposed only on the GSM system. The channel edge of any of the GSM system carriers must be at least 200 kHz inside the edge of their permitted frequency block where the neighbouring licensee has deployed or could deploy an NB system;
  6. Case 6: The 200 kHz separation is imposed only on the NB system. The channel edge of any of the NB system carriers must be at least 200 kHz or more inside the edge of their permitted frequency block where the neighbouring licensee has deployed or could deploy a GSM system;
- In the case of system adjacent to those of the same type (i.e. an NB system adjacent to an NB system, a WB system adjacent to a WB system) there is no need for frequency separation. The channel edge of the system carriers can be at the edge of their permitted frequency block;

The above frequency separations are required to ensure coexistence in the absence of bilateral or multilateral agreements between neighbouring networks, without precluding less stringent technical parameters if agreed among the operators of such networks. "

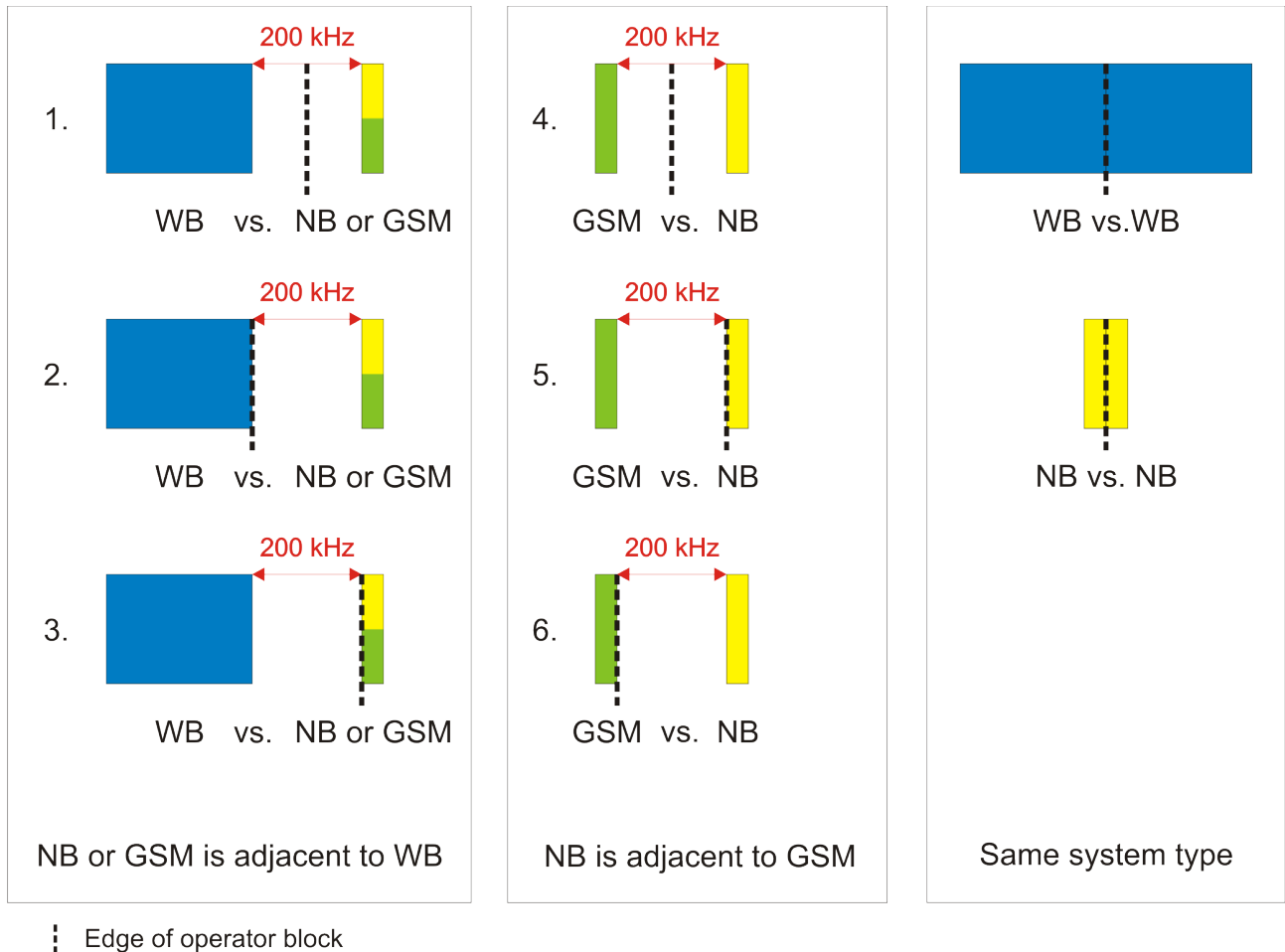
<sup>12</sup> Note: the same approach applies in the case where a GSM system is adjacent to a WB system, as shown in Figure 8.

The following table summarises these cases:

**Table 8: Required minimum frequency separation  $\Delta f$  from edge of a system's permitted frequency block**

Case	System A	System B	System A $\Delta f$	System B $\Delta f$
1	NB or GSM	WB	100 kHz	100 kHz
2			200 kHz	0
3			0	200 kHz
4	GSM	NB	100 kHz	100 kHz
5			200 kHz	0
6			0	200 kHz
Other cases	Same system type (NB vs. NB and WB vs. WB)		0	0

Figure 8 illustrates the different approaches described above.



**Figure 8: Different approaches for frequency separation**

### 3.4.6 Other conditions

The spurious emission domain for base stations in these frequency bands start 10 MHz from the band edge and the corresponding limits are defined in current ERC Recommendation 74-01 [35].

In addition, MFCN networks making use of AAS systems shall not be granted more protection from systems in adjacent and neighbouring bands than experienced with non-AAS systems.

## 3.5 COEXISTENCE WITH SERVICES IN ADJACENT BANDS

The objective of this section is to address the coexistence issues with services in the adjacent bands, in particular below 925 MHz, above 960 MHz, below 1805 MHz and above 1880 MHz, confirming which adjacent services (if any) require additional coexistence conditions (beyond the LRTCs already derived for in-band coexistence) based on existing ECC/CEPT Reports.

### 3.5.1 Approach for the coexistence with services in adjacent bands

CEPT agreed to avoid new additional studies in order to derive the LRTCs, including the coexistence with all adjacent services. CEPT also agreed to avoid additional constraints to systems deployed under the current regulatory framework. Therefore, the proposed approach to be followed to ensure coexistence with the relevant adjacent band systems while avoiding additional studies is as follows:

- Identify the appropriate ECC/CEPT Reports which were used to confirm coexistence between existing MFCN technologies in the 900/1800 MHz bands and the relevant adjacent services;
- Demonstrate how the new technology neutral LRTCs (including new technologies) can ensure that this coexistence remains for all systems that comply with these technology neutral LRTCs;
  - Recalling that the technology neutral out-of-block limits (baseline and transitional) have been derived from ETSI TS unwanted emissions of an existing MFCN technology (see Section 3.4.4.1). Unless an additional baseline limit is defined, these out-of-block limits also apply out-of-band;
  - Recalling that the new technology neutral LRTCs are compatible with all existing MFCN technologies (UMTS, WiMAX, LTE, and NB-IoT), which have already been studied to ensure coexistence with the relevant adjacent band systems;
  - Using these facts to demonstrate that coexistence remains for all systems that comply with the new technology neutral LRTCs (including new technologies);
- Recall the various coexistence conditions resulting from the ECC/CEPT Reports to confirm coexistence between MFCN systems complying with the proposed technology neutral LRTCs and all relevant adjacent services.

This is the same approach that was used in this Report to ensure coexistence between the technology neutral LRTCs and GSM in-band (section 3.2).

### 3.5.2 Adjacent systems coexistence with NB systems and WB systems complying with proposed LRTCs

The technology neutral LRTCs/BEM recommended in this Report (see section 3.4) was derived on the basis of ETSI Technical Specifications (core requirements). As mentioned previously, this results in a single non-AAS BEM and a single AAS BEM excluding GSM.

Coexistence between standalone NB-IoT and services in adjacent bands have been studied and proven to be feasible in CEPT Report 66, ECC Report 266 [5]. CEPT report 66 has been the basis to update EC Decision 2018/637 (amending Decision 2009/766/EC) [20]. In particular, ECC Report 266 concludes in its section 5.4 that *“standalone NB-IoT equipment complying with the relevant technical conditions (maximum permitted EIRPs and minimum frequency separations from other adjacent services) which apply in the context of GSM, may be deployed in the 900/1800 MHz bands without any increase in the likelihood of harmful interference.”*

The conclusions of this Report remain valid and coexistence with adjacent systems is ensured as the requirement above is being maintained in the proposed technology neutral non-AAS LRTCs (see section 3.4), which are the same as those of standalone NB-IoT.

Based on the above assumptions, CEPT identified the relevant additional ECC deliverables to be reused in order to recall the various coexistence conditions resulting from those deliverables as appropriate and to confirm coexistence between MFCN non-AAS systems complying with the proposed technology neutral LRTCs and all adjacent services identified hereafter.

Regarding AAS WB systems, CEPT Report 72 concludes in its section 3.1.1 based on ECC Report 297 [3] that the adjacent bands compatibility conclusions from CEPT Report 41 [12] and CEPT Report 42 [11] applicable to LTE non-AAS systems in 900/1800 MHz frequency band are also applicable to both 5G NR non-AAS 900/1800 MHz systems and to LTE/5G NR AAS 1800 MHz systems.

The conclusions of this Report remain valid and coexistence with adjacent systems is ensured as the requirements above are being maintained in the proposed technology neutral AAS LRTCs (see section 3.4), which are the same as those of AAS LTE.

Based on the above assumptions, CEPT identified the relevant additional ECC deliverables to be reused in order to recall the various coexistence conditions resulting from those deliverables as appropriate and to confirm coexistence between MFCN AAS systems complying with the proposed technology neutral LRTCs and all adjacent services identified hereafter.

ECC Decision (06)13 [15] refers in its introduction and considering parts to the ECC Reports which have been the relevant basis for the update of this deliverable. Most of these CEPT reports are also referred to in relevant recitals of the EC Decision and its amendments. References to CEPT Report 72 and this CEPT Report, which is also considered as the basis for the update of this ECC Decision, need to be added in the next revision of the EC Decision.

The proposed technology neutral LRTCs for AAS and non-AAS (including implementation of required frequency separation) as described in this Report will ensure coexistence with relevant systems in adjacent bands.

MFCN Systems (excluding GSM) already authorised under current EC/ECC framework in 900/1800 MHz bands, comply with the recommended technology neutral LRTCs. Coexistence between MFCN systems in 900/1800 MHz bands and the following services from adjacent bands was studied and confirmed in different CEPT/ECC Reports which have been reused as appropriate in this CEPT Report when considering coexistence with adjacent services listed below:

- 900 MHz adjacent systems: GSM-R/E-GSM-R, FRMCS, PMR/PAMR, aeronautical radio navigation (DME/L-DACS), aeronautical mobile service communication systems and MIDS (Military NATO);
- 1800 MHz adjacent systems: DECT, MetSat (weather satellite), fixed telemetry, (defence), radio microphones and fixed service.

Relevant coexistence conclusions for these systems are extracted and summarised in sections 3.5.3 and 3.5.4 based on existing ECC/CEPT Reports.

Table 9 and Table 10 provide information on allocations and applications for 900/1800 MHz and adjacent bands.

**Table 9: Systems operating in adjacent bands at 900 MHz (extract from EFIS<sup>13</sup>/ECA Table [36])**

Frequency band (MHz)	Allocation	Application
876-880	MOBILE	GSM-R (within the band paired with 921-925 MHz) FRMCS (within the band 874.4-880.0 MHz paired with 919.4-925.0 MHz) Military systems (land and maritime)
880-890	MOBILE	GSM (within the band 880-890 MHz paired with 925-935 MHz) IMT MCV
890-915	MOBILE Radiolocation	GSM (within the band 890-915 MHz paired with 935-960 MHz) IMT Military systems (land and maritime) MCV
915-921	MOBILE Radiolocation	Military systems (land and maritime) Non-specific SRDs RFID FRMCS (within the band 874.4-880.0 MHz paired with 919.4-925.0 MHz)
921-925	MOBILE Radiolocation	GSM-R (within in the bands 876-880 MHz paired with 921-925 MHz) FRMCS (within the band 874.4-880.0 MHz paired with 919.4-925.0 MHz) Military systems (land and maritime)
925-942	MOBILE Radiolocation	GSM (within the band 935-960 MHz paired with 890-915 MHz) IMT Military systems (land and maritime) MCV
942-960	MOBILE	GSM (base station transmits paired with 897-915 MHz) IMT MCV
960-1164	AERONAUTICAL MOBILE AERONAUTICAL MOBILE- SATELLITE AERONAUTICAL RADIONAVIGATION	Aeronautical (including DME and SSR) Aeronautical military systems (includes JTIDS/MIDS and TACAN within 1087.7-1092.3 MHz)

<sup>13</sup> ECO Frequency Information System: <https://efis.cept.org/>



**Table 10: Systems operating in adjacent bands at 1800 MHz (extract from EFIS/ECA Table [36])**

Frequency band (MHz)	Allocation	Application
1700-1710	FIXED METEOROLOGICAL-SATELLITE (SPACE-TO-EARTH) Mobile except aeronautical mobile	Military systems (land and maritime) Meteorological aids (military) Weather satellites
1710-1785	FIXED MOBILE	GSM IMT MCA MCV Radio astronomy (Spectral line observations (e.g. hydroxyl line), VLBI)
1785-1800	FIXED MOBILE	Military systems (land) Land mobile Radio microphones and ALD (within the band 1785-1804.8 MHz)
1800-1805	MOBILE Fixed	Military systems (land) Radio microphones and ALD (within the band 1785-1804.8 MHz)
1805-1880	FIXED MOBILE	GSM IMT MCA MCV
1880-1900	MOBILE Fixed	DECT

### 3.5.3 Adjacent band coexistence issues in 900 MHz frequency bands (non-AAS)

#### 3.5.3.1 RMR (GSM-R/E-GSM-R/FRMCS)

##### 3.5.3.1.1 GSM-R /E-GSM-R

In order to avoid any new studies CEPT reused existing relevant CEPT/ECC deliverables, which are briefly summarised hereafter:

CEPT Report 41 for LTE non-AAS [12]:

CEPT Report 41 concludes in its executive summary that *"introducing LTE and WiMAX into the 900 and 1800 MHz bands should not cause any additional impact on adjacent services."*

CEPT Report 41 also highlighted that for *"For LTE/WiMAX 900, the frequency separation between the nearest GSM-R channel center frequency and LTE/WiMAX channel edge should be at least 300 kHz (at least 200 kHz between channel edges)."*

Conclusions regarding GSM-R/E-GSM-R and LTE are further detailed in the summary table included in the executive summary of CEPT Report 41. For some critical cases recommendations on coordination are proposed.



CEPT Report 66 [10]/ECC Report 266 [5] for NB-IoT:

ECC Report 266 in its section 5.4 concluded that “*standalone NB-IoT equipment complying with the relevant technical conditions (maximum permitted e.i.r.p.s and minimum frequency separations from other adjacent services) which apply in the context of GSM, may be deployed in the 900/1800 MHz bands without any increase in the likelihood of harmful interference.*”

ECC Report 297 for NR non-AAS [3]:

ECC Report 297 mentions in its sections 4.2.1.1 and 4.2.1.2 that:

- “*The results of CEPT Report 41 and ECC Report 266 for compatibility between LTE and LTE + Guard Band IoT and adjacent systems can be extended to the NR system operation in 900/1800 MHz MFCN bands.*”
- “*The co-existence between LTE 900 and GSM-R at 925 MHz was described in CEPT Report 41. CEPT Report 41 concludes that there is no need for additional guard band between LTE 900 and GSM-R, whatever the channelisation or bandwidth considered for LTE 900. Therefore, a frequency separation of 200 kHz between channel edges was considered to be sufficient for the compatibility between LTE 900 and GSM-R.*”
- “*Given that the receiver characteristics of NR are similar to those of regular LTE receivers, it is expected that the behaviour of both receivers is the same. Therefore, the conditions of operation of NR are expected to be similar to those of LTE.*”

ECC Report 297 for 5G NR concluded that “*no specific emission limits but recommendations on coordination, with the GSM-R in 876-880 / 921-925 MHz, are available in various ECC/CEPT Reports*”. The above conclusion of CEPT Report 41 has been extended to 5G NR.

ECC Report 297 does not address FRMCS.

ECC Report 229 on GSM-R cab-radio receiver characteristics [6]:

ECC Report 229 mentions in its Executive Summary section that “*Measurement campaigns performed during 2013-2014 concluded that current GSM-R receivers are affected by intermodulation products generated from a wideband signal such as UMTS/LTE, two narrowband signals such as GSM, or a combination of wideband and narrowband signals. Wideband signals can impact the whole GSM-R downlink frequency range. UMTS, LTE/5MHz and LTE/10MHz have similar interference potential. In order to sustainably mitigate interferences due to blocking and intermodulation, the standard for GSM-R radios has been improved with respect to the receiver characteristics and published in June 2014 as ETSI TS 102 933-1 v1.3.1 [37]. GSM-R radios compliant with this new specification are robust against MFCN emissions in the E-GSM band.*”

ECC Report 229 also mentions in the same section that: “*Before and during the transition period, the coordination/cooperation process is intended to avoid/mitigate issues related to intermodulation or blocking. Nevertheless, improved receivers may still be impacted by MFCN out-of-band emissions falling into the receiving band of the GSM-R radio. Thus the process is also intended to prevent interference from MFCN out-of-band emissions before, during and after the transition period. Visibility and exchange of information between the stakeholders shall remain after the transition period to prevent any further issues.*”

Conclusion:

The conclusions of the above reports (CEPT Report 41, ECC Report 266/CEPT Report 66, ECC Report 297 and ECC Report 229) remain valid and coexistence between GSM-R/E-GSM-R and MFCN (NB and WB) non-AAS systems complying with the technology neutral LRTCs (defined in section 3.4) is ensured as long as:

- Frequency separation between the nearest GSM-R channel edge and MFCN (WB or NB) channel edge is at least 200 kHz;
- This frequency separation should be managed at national level. For example, the same toolbox approach as for MFCN/MFCN frequency separation implementation at national level could be reused (see section 3.4.5.3) for implementation at national level of frequency separation between RMR and MFCN;

- Before and during the transition period until GSM-R receivers are compliant with ETSI TS 102 933-1 v1.3.1, a coordination/cooperation process is intended to avoid/mitigate issues related to intermodulation or blocking (see ECC Report 229).

The proposed coexistence measures above to be implemented at national level do not impact the MFCN LRTCs, ETSI standards or the single market objective.

Below 925 MHz: On case-by-case basis, at national level, higher out-of-band limits may be applied. This is to align with railway technical conditions in CEPT Report 76 and ECC Decision (20)02 [34].

### 3.5.3.1.2 FRMCS

In order to avoid any new studies CEPT reused existing relevant CEPT/ECC deliverables, which are briefly summarised hereafter:

CEPT Report 74 [37], concluded in its section 4.2.1.1, that “*CEPT noted that a 200 kHz frequency separation is required between networks adjacent in frequency in the following cases: GSM vs. WB (i.e. UMTS, LTE or NR), NB-IoT vs. WB and GSM vs. NB-IoT. This issue needs to be further addressed by regulatory measures at national level, consistently with the relevant RMR and MFCN harmonised technical conditions.*”

This Report also highlighted in its introduction that “*only non-AAS FRMCS and ECS have been considered. Additional studies should be performed in case AAS are considered for FRMCS deployments.*”

CEPT Report 76 [33] concluded in its section 3.2.1 that “*To avoid blocking of the mobile terminal by a narrowband interferer adjacent in frequency, a 200 kHz frequency separation may be required between RMR and MFCN. This issue can be addressed at national level.*”

ECC Report 313 [39] mentions that “*When in close vicinity to railway tracks, MFCN BS out-of-band emissions may cause interference to FRMCS cab-radio. In practice, to solve these cases, technical and/or operational measures could be used to ensure the coexistence of both MFCN and FRMCS in parallel.*”

#### Conclusion:

The conclusions of the above reports (CEPT Report 74, CEPT Report 076, ECC Report 313) remain valid and coexistence between FRMCS (WB and NB) and MFCN (WB and NB) non-AAS systems complying with the technology neutral LRTCs (defined in section 3.4) is ensured as long as:

- A 200 kHz frequency separation is implemented between channel edges of networks adjacent in frequency in the following cases: FRMCS NB vs. MFCN WB and FRMCS WB vs MFCN NB;
- This frequency separation should be managed at national level. For example, the same toolbox approach as for MFCN/MFCN frequency separation implementation at national level could be reused (see section 3.4.5.3) for implementation at national level of frequency separation between RMR and MFCN;
- No frequency separation is required between FRMCS WB and MFCN WB systems.

The proposed coexistence measures above to be implemented at national level do not impact the MFCN LRTCs, ETSI standards or the single market objective. It leaves also flexibility for administrations to manage GSM-R – FRMCS migration according to national demands or other policies without impacting the MFCN technology neutral approach.

Below 925 MHz higher out-of-band limits may be applied for MFCN on a case-by-case basis at a national level. This is to align with railway technical conditions in CEPT Report 76 and ECC Decision (20)02 [34].

### 3.5.3.2 PMR/PAMR (above 915 MHz)

CEPT noted that ECC Report 297 [3] for 5G NR concluded no specific emission limits but provided recommendations on coordination with PMR/PAMR above 915 MHz. Conclusions for coexistence with PMR/PAMR are available in various ECC/CEPT Reports:

- CEPT Report 41 [12] includes the studies between LTE (non-AAS) and PMR/PAMR. It concluded in the summary table of its executive summary (entry in row 5.2) that “*The worst interference case is the*

*interference from PMR/PAMR BS to LTE/WiMAX BS.*” It also listed a number of possible coordination and interference mitigation techniques to ensure such compatibility;

- ECC Report 297 [3] concluded in its section 4.2.1.1 that *“The results of CEPT Report 41 and ECC Report 266 for compatibility between LTE and LTE + Guard Band IoT and adjacent systems in 1800/900 MHz bands can be extended to the NR non-AAS systems and the same technical regulatory conditions applicable to LTE should apply to ensure compatibility with NR non-AAS.”*

In consequence, recommendations on coordination with PMR/PAMR as described in CEPT Report 41 remain applicable to NB/WB systems (non-AAS) complying with technology neutral LRTCs as proposed in this report

### 3.5.3.3 Aeronautical Radio navigation (DME/L-DACS)

In order to avoid any new studies CEPT reused existing relevant CEPT/ECC deliverables, which are briefly summarised hereafter.

CEPT Report 41 [12] stated that *“CEPT Report 42 [11] gives results on the compatibility between UMTS and DME/L-DACS-2. Those results have been extended to the compatibility between LTE/WiMAX and DME/L-DACS, based on the similarities between UMTS on one side and LTE/WiMAX on the other side.”* These results are recalled hereafter:

- L-DACS-2 airborne transmitters will not cause any interference to UMTS terminals, when the distance between the aircraft and an outdoor UMTS terminal is greater than 8.6 km, with a L-DACS-2 transmitting frequency of 960.1 MHz. For a L-DACS-2 transmitting frequency of 962.6 MHz, this distance becomes 6.5 km. The limiting factor is currently the selectivity of the UMTS terminal station.
- L-DACS-2 ground stations could cause desensitisation to UMTS terminals at a distance up to 17.5 km, depending on the propagation characteristics in the area considered and the L-DACS 2 ground station antenna height, with an L-DACS-2 transmitting frequency of 960.1 MHz. For an L-DACS-2 transmitting frequency of 962.6 MHz, this distance becomes 14.7 km. The limiting factor is currently the selectivity of the UMTS terminal station.
- No interference from UMTS base stations to DME airborne receivers is expected above 972 MHz. Below 972 MHz some interference, in the order of 3 to 4 dB, may occur at low altitudes for the mixed-urban case.
- L-DACS airborne receivers are no more sensitive to interference than DME.
- UMTS base station transmissions may cause interference to L-DACS ground stations, if these stations are deployed in the lowest part of the band, and if the L-DACS TDD option is selected, in the order of 17–25 dB, depending on the distance from the ground station to the nearest base station. If the FDD (L-DACS-1) option is chosen and the associated ground stations receive at frequencies far above 960 MHz, then the interference from UMTS base stations to these ground stations would be alleviated.

In addition, CEPT Report 41 concludes in its executive summary that *“the LTE and WiMAX BS masks for the 900 MHz bands are aligned with the UMTS900 mask for all the LTE/WiMAX channelisation bandwidth available and are expected to have similar characteristics in terms of average power. Similarly, the protection criteria of LTE and WiMAX terminals is aligned with that of UMTS, and hence the conclusions regarding interference between UMTS and DME/L-DACS should be applicable to the scenarios involving LTE/WiMAX on one side and DME/L-DACS on the other side, for the same signal bandwidth.*

*When considering LTE/WiMAX with higher carrier bandwidth (> 5MHz), the compatibility results should be improved. With a large number of interferers with lower bandwidths (< 5 MHz) the aggregate interference from LTE would increase. However, it is not expected that LTE will be deployed with lower bandwidth. Bandwidth different from 5 MHz for LTE/WiMAX has not been addressed in detail.”*

Moreover the ECC Report 266 [5] in its section 5.4 concluded that *“standalone NB-IoT equipment complying with the relevant technical conditions (maximum permitted e.i.r.p. and minimum frequency separations from other adjacent services) which apply in the context of GSM, may be deployed in the 900/1800 MHz bands without any increase in the likelihood of harmful interference.”*

ECC Report 297 [3] also states in its section 4.2.1.1 that *“3GPP defined for NR BS and UE similar TX and RX requirements as those defined for LTE and used in CEPT Report 41.*

*Regarding the higher spectrum utilisation of NR compared to LTE for CBW >5 MHz, the edge of the transmitted BW is always placed more than 300 kHz away from the NR channel edge. This fulfils the 200 kHz criteria that were set up for LTE in previous studies. NR does not use 1.4 or 3 MHz bandwidth.*

*Therefore, the results of CEPT Report 41 and ECC Report 266 for compatibility between LTE and LTE + Guard Band IoT and adjacent systems can be extended to the NR system operation in 900/1800 MHz MFCN bands.”*

Conclusion:

The conclusions of the above reports (CEPT Report 41, ECC Report 266/CEPT Report 66 [10], ECC Report 297) remain valid and coexistence between DME/L-DACS and MFCN (NB and WB) non-AAS systems complying with the technology neutral LRTCs (defined in section 3.4) is ensured. Therefore:

- No interference from MFCN base stations to DME airborne receivers is expected above 972 MHz. Below 972 MHz some interference, in the order of 3 to 4 dB, may occur at low altitudes for the mixed-urban case. Nevertheless; no interference cases have been reported since the publication of those reports;
- L-DACS airborne receivers are no more sensitive to interference than DME;
- MFCN base station transmissions may cause interference to L-DACS ground stations, if these stations are deployed in the lowest part of the band, and if the L-DACS TDD option is selected, in the order of 17 – 25 dB, depending on the distance from the ground station to the nearest base station. If the FDD (L-DACS 1) option is chosen and the associated ground stations receive at frequencies far above 960 MHz, then the interference from MFCN base stations to these ground stations would be alleviated;
- L-DACS-2 airborne transmitters will not cause any interference to MFCN terminals, when the distance between the aircraft and an outdoor MFCN terminal is greater than 8.6 km, with an L-DACS-2 transmitting frequency of 960.1 MHz. For an L-DACS 2 transmitting frequency of 962.6 MHz, this distance becomes 6.5 km. The limiting factor is currently the selectivity of the MFCN terminal station;
- L-DACS-2 ground stations could cause desensitisation to MFCN terminals at a distance up to 17.5 km, depending on the propagation characteristics in the area considered and L-DACS-2 ground station antenna height, with an L-DACS-2 transmitting frequency of 960.1 MHz. For an L-DACS-2 transmitting frequency of 962.6 MHz, this distance becomes 14.7 km. The limiting factor is currently the selectivity of the MFCN terminal station.

L-DACS and L-DACS-2 RF parameters and assumptions have been documented by aeronautical authorities during the CEPT Reports 41 and 42 studies and have been considered unchanged for the purpose of this report.

It has been also assumed that both mobile industry and civil aviation industry have taken into due consideration the conclusions of those reports when developing future systems to be operated in relevant adjacent bands.

CEPT confirms that the terminal station selectivity performance has remained unchanged in ETSI standards in recent years at the time of writing this report.

#### **3.5.3.4 Aeronautical Mobile Service Communication systems and MIDS**

In order to avoid any new studies CEPT reused existing relevant CEPT/ECC deliverables, which are briefly summarised hereafter.

CEPT Report 41 [12] studied coexistence between MIDS and LTE (non-AAS) and provided in its executive summary a number of coordination guidance and interference mitigation techniques. CEPT noted that the study done under CEPT Report 41 did not take into account the regulatory status of JTIDS/MIDS, which operates in the band 960-1215 MHz under the conditions of provision 4.4 of the Radio Regulations [40].

ECC Report 266 [5] in its section 5.3.3 mentions that *“the propensity of standalone NB-IoT equipment to cause harmful interference – via spectral leakage inside and outside the 900/1800 MHz bands – is no greater than that of GSM equipment”* and *“the propensity of standalone NB-IoT equipment to cause harmful interference – via blocking of radio receivers in adjacent bands to 900/1800 MHz bands – is no greater than that of GSM equipment”*.

ECC Report 297 [3] concluded in its section 4.2.1.1 that “*The results of CEPT Report 41 and ECC Report 266 for compatibility between LTE and LTE + Guard Band IoT and adjacent systems can be extended to the NR non-AAS system operation in 900/1800 MHz MFCN bands and the same technical regulatory conditions applicable to LTE should apply to ensure compatibility with NR non-AAS*”.

The conclusions of the above Reports (CEPT Report 41, ECC Report 266/CEPT Report 66 [10], ECC Report 297) remain valid for coexistence between MIDS systems and MFCN (NB and WB) non-AAS systems complying with the technology neutral LRTCs (defined in section 3.4).

### 3.5.4 Adjacent band coexistence for non-AAS/AAS MFCN system in 1800 MHz frequency bands

In this section coexistence between MFCN non-AAS systems (WB and NB), MFCN AAS systems (WB) and the following adjacent systems are addressed:

- DECT
- MetSat (weather satellite)
- fixed telemetry (defence)
- radio microphones
- fixed service.

In order to avoid any new studies CEPT reused existing relevant CEPT/ECC deliverables, which are briefly summarised hereafter.

#### 3.5.4.1 Adjacent band coexistence for non-AAS MFCN system in 1800 MHz frequency bands

Coexistence between MFCN non-AAS (WB and NB) systems in 1800 MHz band and adjacent systems was studied in the following reports:

CEPT Report 41 for LTE non-AAS [12]:

CEPT Report 41 concludes in its executive summary that introducing LTE and WiMAX into the 900 and 1800 MHz bands should not cause any additional impact on adjacent services. For more details please refer to the summary table included in the executive summary of CEPT Report 41.

ECC Report 191 [41] and CEPT Report 50 [42] on coexistence between MFCN and radio microphones in 1785-1805 MHz:

ECC Report 191/CEPT Report 50 describe coexistence between analogue PMSE operating between 1785-1805 MHz and MFCN LTE non-AAS systems as follows:

- The studies regarding the impact on PMSE show that PMSE is able to find an operational channel with a sufficient QoS with the assumption of certain spatial distances between the PMSE equipment and the MFCN non-AAS equipment. To show the impact of the out-of-band emissions of the LTE non-AAS equipment, the probability of interference was determined;
- For the case that the MFCN LTE non-AAS macro BS and PMSE are both located outdoors a separation distance of 100 m is sufficient to ensure that PMSE has the possibility to find an operational channel. The operation of PMSE equipment in the same room/hall where an MCFN LTE non-AAS pico station is used should be avoided, unless additional mitigation techniques are applied. For frequency offsets larger than 1 MHz and with 100 m separation, the impact of the MFCN LTE non-AAS base station can be neglected. The probability of interference is considerably relaxed, if PMSE is operated indoor and the MFCN LTE non-AAS base station is located outdoors due to the wall attenuation. In that case PMSE could find an operational channel with a sufficient QoS;
- If the frequency separation between LTE UE and the PMSE receiver is more than 10 MHz, the probability of interference from the LTE UE is negligible. The probability of interference from the LTE macro non-AAS BS increases if the frequency separation to the LTE macro non-AAS BS decreases;
- It is important to note that the studied interference scenarios may not happen in most cases where PMSE is looking to be deployed if relevant setup procedures are applied by PMSE users.



The most critical case is if the PMSE receiver is close to a transmitting MFCN pico non-AAS BS. If this separation distance is increased, the probability of interference decreases accordingly. Concerning the impact from MFCN UE into PMSE, real UE will have better out-of-band emission performance than in the published ETSI standards (e.g. through the implementation of duplex filtering) and this will significantly reduce the probability of interference into PMSE receivers.

CEPT Report 66 [10]/ECC Report 266 [5] for wideband and narrowband M2M systems:

ECC Report 266 mentions in its Table 15 that no specific emission limits are defined but there are recommendations on coordination for some systems that are available in relevant ECC/CEPT Reports as summarised in its Table 14.

ECC Report 266 in its section 5.4 concluded that standalone NB-IoT equipment complying with the relevant technical conditions (maximum permitted e.i.r.p.s and minimum frequency separations from other adjacent services) which apply in the context of GSM, may be deployed in the 1800 MHz bands without any increase in the likelihood of harmful interference.

ECC Report 297 for NR non-AAS [3]:

ECC Report 297 concludes in its section 4.2.1.1 and 4.2.1.2 that:

- *“The results of CEPT Report 41 and ECC Report 266 for compatibility between LTE and LTE + Guard Band IoT and adjacent systems can be extended to the NR system operation in 900/1800 MHz MFCN bands”;*
- *“Given that the receiver characteristics of NR are similar to those of regular LTE receivers, it is expected that the behaviour of both receivers is the same. Therefore, the conditions of operation of NR are expected to be similar to those of LTE”.*

Final Conclusions:

The conclusions of ECC Report 266 (NB) complemented by conclusions of CEPT Report 41 and ECC Report 297 (WB) remain valid and coexistence with adjacent systems is ensured as the requirement above is being maintained in the proposed technology neutral non-AAS LRTCs (see section 3.4) which are the same as those of standalone NB-IoT.

The DECT system has the DCA (Dynamic Channel Allocation) mechanism which allows it to avoid efficiently an interfered channel, except if both systems are deployed indoors. No guard band is required between MFCN (WB and NB) non-AAS 1800 MHz and DECT allocations.

For MetSat the potential interference between MFCN (WB and NB) 1800 MHz terminal station and MetSat earth stations is not expected to be a problem.

For radio microphones operating between 1785-1805 MHz, CEPT confirms the conclusions of ECC Report 191 remain valid. PMSE is able to find an operational channel with a sufficient QoS with the assumption of certain spatial distances between the PMSE equipment and the MFCN non-AAS equipment.

No national coordination is needed except for fixed service as highlighted in CEPT Report 41 and ECC Report 297 which both refer to ERC Report 64 [45] and ERC Report 65 [46].

#### **3.5.4.2 Adjacent band coexistence for AAS MFCN system in 1800 MHz frequency bands**

Coexistence between MFCN AAS systems in 1800 MHz band and adjacent systems was studied in the following report:

ECC Report 297 [3] concludes in section 4.2.3 that the main conclusions from CEPT Report 41 [12] for LTE-non-AAS 1800 system and ECC Report 96 [9] for UMTS 1800 MHz compatibility with adjacent systems are considered here to be also applicable to AAS (LTE/NR) 1800 MHz systems. Based on the above, the following conclusions can be made for AAS WB systems in 1800 MHz band:

- **For DECT (Section 4.2.2.1 of ECC Report 297):** No guard band is required between AAS/5G NR 1800 MHz and DECT allocations provided that DECT is able to properly detect interference on closest DECT carriers and escape to more distant carriers. AAS/5G NR macro-cells can be deployed in the same geographical area in co-existence with DECT which is deployed inside of the buildings, as the interference between DECT Radio Fixed Part (RFP) and Portable Part (PP) and macro-cellular AAS WB 1800 MHz BS and UE is not a problem. Potential interference between AAS (LTE/NR) and DECT does not appear to be an obstacle, except for the case where an AAS (LTE/NR) 1800 MHz pico BS is installed in indoor environment close to DECT PP or RFP in which case different interference mitigation techniques could be used. Mitigation techniques like space separation between indoor pico-cell AAS/5G NR BS and DECT RFP or PP of 65 m or more or avoiding the adjacent frequencies of 1880 MHz for indoor pico-cellular AAS/5G NR 1800 BS and DECT or operate with reduced transmitting power could be necessary. In practice, the DECT system has a DCA (Dynamic Channel Allocation) mechanism which allows it to avoid interference except if both systems are deployed indoors;
- **For MetSat (Section 4.2.2.2 of ECC Report 297):** Similar to LTE non-AAS, the analysis indicates that the potential interference between (LTE/NR) 1800 MHz UE and MetSat Earth Stations is not expected to be a problem provided the fact that AAS functionality applies only to the BS side. The UE NR/LTE characteristics remain the same whether the BS uses AAS or not. Besides, the adjacent channel leakage power of 5G NR UE is in the same range as for legacy LTE UE. The potential interference from MetSat DL to LTE/WiMAX1800 MHz UE was not covered in past studies and was left for future further study if it appears necessary, also for NR UE systems;
- **For radio microphones** operating frequency range of 1785-1805 MHz is adjacent to WB system (AAS) 1800 MHz uplink frequency block at 1710-1785 MHz as well as 1800 MHz downlink frequency block at 1805-1880 MHz.

ECC Report 297 studied coexistence between AAS system in the 1800 MHz band and radio microphones operating between 1785-1800 MHz. The following conclusion was derived (section 4.2.2.3 of ECC Report 297):

*“It can be considered that the proposed guard band of 700 kHz in ERC Report 063 [43] [and ERC Recommendation 70-03 [44] for the protection of GSM1800 and legacy LTE/WiMAX 1800 MHz is sufficient for protecting AAS (LTE/NR) 1800 BS receivers. This assumes that the radio microphone maximum transmitting power is limited to 13 dBm (20 mW) for hand-held microphones and 17 dBm (50 mW) for body-worn microphones, as recommended in ERC Report 063 [43] and ERC Recommendation 70-03 [44].”*

**ECC Report 191 [41]/CEPT Report 50 [42]** describe coexistence between analogue PMSE operating between 1785-1805 MHz and MFCN LTE non-AAS system as described above in section 3.5.4.1. Regarding coexistence between MFCN AAS systems in the 1800 MHz band and radio microphones operating between 1800-1805 MHz, it is expected that the same coexistence conditions mentioned in ECC Report 191 with regard to non-AAS MFCN coexistence with radio microphones apply.

- **For fixed service (Section 4.2.2.4 of ECC Report 297):** The fixed service frequency range is adjacent to AAS (LTE/NR) system UL at 1710 MHz and 1785 MHz. Similar to what has been concluded for UMTS and LTE, the sharing situation between AAS (LTE/NR) system and existing fixed services will depend on the exact operational parameters of the AAS (LTE/NR) system and fixed service systems as well as factors such as the terrain features at the particular geographical location under consideration. A comparable interference analysis method as the one used in the two ERC Report 64 [45] and ERC Report 65 [46], can be used by administrations planning deployment or coordination of AAS (LTE/NR) with existing fixed services to derive the separation/coordination distance. As described in these two reports as well as in the ECC Report 297, the potential interference, if any, will be between fixed service and AAS WB 1800 BS at 1805 MHz. The interference between NR UE and fixed service was not considered.

ECC Report 297 concluded that for 5G AAS systems no specific emission limits are needed but recommendations on coordination with the fixed service operating above 1805 MHz, are available in various ECC/CEPT Reports.

Final Conclusions:

The conclusions of ECC Report 297 and the other mentioned reports above remain valid and coexistence with adjacent systems in the 1800 MHz band is ensured as the requirements above are being maintained in the proposed technology neutral AAS LRTCs (see section 3.4) which are the same as those for AAS LTE.

The DECT system has the DCA (Dynamic Channel Allocation) mechanism which allows it to avoid efficiently an interfered channel, except if both systems are deployed indoors. No guard band is required between WB AAS 1800 MHz and DECT allocations.

For MetSat the potential interference between WB system 1800 MHz UE and MetSat earth stations is not expected to be a problem provided that AAS functionality applies only to the BS side

For radio microphones operating between 1785-1805 MHz, CEPT conforms the conclusions of ECC Report 191 remain valid: PMSE is able to find an operational channel with a sufficient QoS with the assumption of certain spatial distances between the PMSE equipment and the MFCN AAS equipment.

No national coordination is needed except for fixed services as highlighted in ECC Report 297 which refers to ERC Report 64 [45] and ERC Report 65 [46].



## 4 CROSS-BORDER COORDINATION

CEPT confirms that cross-border co-ordination can be sufficiently addressed through existing and, if appropriate, further to be developed bilateral and multilateral procedures, supported by ECC Recommendations.

ECC Recommendation (08)02 [18] addresses cross-border coordination in the 900 and 1800 MHz bands and has been updated in February 2019 to address 5G NR systems. This recommendation already covers various systems which are all compatible with the LRTCs (BEMs) proposed in this CEPT Report. In particular, this recommendation refers to :

- NB systems: GSM, EC-GSM-IoT and standalone NB-IoT)
- WB systems: UMTS, LTE, LTE-MTC, LTE-eMTC, LTE in-band NB-IoT, LTE guard band NB-IoT and NR in line with the NB BEM and WB BEM approach developed in this CEPT Report.

This ECC Recommendation could be further updated as appropriate in case of new ECS system operating in these bands. If needed, the ECC Recommendation (05)08 [17] refers to the GSM vs. GSM scenario.

## 5 IMPLEMENTATION OF LRTCS

The LRTC have been developed on the basis of current ETSI core specifications appropriate for NB and WB non-AAS base stations, for WB AAS base stations, and for NB and WB non-AAS terminal stations. Various systems listed in the current EC framework, including UMTS, LTE, and IoT ( NB-IoT, LTE LTE-MTC and LTE-eMTC) comply with the new LRTCs. The only system which is not listed in the current EC Framework is 5G NR.

Nevertheless, the European Commission was informed in CEPT Report 72 [1] that ECC updated its framework in the 900 MHz and 1800 MHz frequency bands (ECC Decision (06)13 – updated in March 2019 [15]) with a reference of the relevant ETSI Harmonised standards for 5G NR. As mentioned in the EC Mandate, “*a transition of the technical conditions to BEM in the 900 MHz and 1800 MHz frequency bands at the EU level, could be facilitated by the specific provision in the Decision 2009/766/EC (as amended) [2], which allows in both bands use of other systems, which are not listed in its Annex, under the condition of ensuring coexistence with the GSM system and the systems listed in that Annex. The aforementioned amendment of the CEPT technical framework will facilitate compliance with this provision in the EU context in order to accommodate evolving 5G standards*”.

CEPT has not identified other systems in 900/1800 MHz bands than those listed in ECC Decision (06)13 updated in March 2019. The current EC framework is based on a list of technologies and does not restrict the introduction of 5G NR as it has been mentioned and described above. There is therefore no need for an update of the EC framework with LRTC in order to ensure that 5G NR could be used in EU Member States. The work carried out when drafting this CEPT Report does not contradict this analysis.

In practice, when there is no market demand to use other standards than 5G NR and those listed in the current Annex of the EC Decision, there is no need to update national regulatory frameworks. This leaves some flexibility for the date of implementation by the EU Member States of the future EC Decision containing the proposed LRTCs based on this CEPT Report. Varying dates for implementation of the updated EC framework should not impact the rollout of 5G NR in the 900 MHz and 1800 MHz bands in Europe.

## 6 CONCLUSIONS

This Report is the response (Report B) to Task 2 of the Mandate from the European Commission “to review the harmonised technical conditions for certain EU-harmonised frequency bands and to develop least restrictive harmonised technical conditions suitable for next-generation (5G) terrestrial wireless systems”, addressing the 900 MHz and 1800 MHz frequency bands.

According to the schedule set out in the Mandate, this Report addresses Task 2 to develop channeling arrangements and least restrictive technical conditions (LRTCs) for the 900 MHz and 1800 MHz frequency bands. CEPT Report 72 (Report A) [1] addressed Tasks 1 to 3 in full for the paired terrestrial 2 GHz and 2.6 GHz frequency bands, as well as the aspects of Task 1 related to the usage feasibility of 900/1800 MHz for 5G, and Task 3 related to cross-border coordination guidance for these frequency bands. This Report B also provides additional clarification in response to Task 3 (cross-border coordination), with respect to the new technology neutral BEM and the handling of GSM.

This Report assumes that ECS use only non-AAS BS in the 900 MHz frequency band and may use either non-AAS BS or AAS BS in the 1800 MHz frequency band. Analysis has been developed under this assumption. No recommendation is provided for usage of AAS BS in the 900 MHz frequency band.

AAS does not apply to user terminals in the 900 MHz or 1800 MHz frequency bands.

CEPT agreed not to include GSM in the technology neutral LRTCs and to recommend keeping the GSM definition (as in current EC decision through reference to GSM ETSI HS listed in Article 2 of EC Decision (2009/766/EC)). EC-GSM-IoT is protected as GSM with the proposed technology neutral LRTCs.

The following definitions for ECS Narrowband (NB) and ECS Wideband (WB) systems respectively apply in this CEPT Report:

- ECS NB systems are systems operating in 200 kHz channels, excluding GSM and EC-GSM-IoT;
- ECS WB systems are systems operating in channels larger than 200 kHz.

CEPT recommends a harmonised band plan for both the 900 MHz and 1800 MHz frequency bands with a block size multiple of 200 kHz (see section 3.3 - Recommended band plan). Various factors have been taken into due consideration in order to derive this harmonised band plan:

- GSM and standalone NB IoT;
- Wideband systems (such as 5G New Radio (NR)) with typical block size of 5 MHz or more;
- IoT (non-standalone) systems covered within the 5 MHz block size or more;
- Migration towards 5G (NR);
- Uplink and downlink mode operations;
- Guard band at the edge of the 900/1800 MHz harmonised bands;
- Options on how to implement frequency separation at national level.

Concerning NB systems and WB systems, CEPT agreed to derive the BEM from unwanted emissions based on ETSI technical specifications (core requirements) resulting in a single BEM defined for non-AAS NB systems and WB systems and a single BEM defined for AAS WB systems (see section 3.4).

CEPT recognises that ETSI Harmonised Standards that are referred to in the annex current ECC and EC Decisions, available during development of this Report, are based on conformance requirements (including test tolerance) and assumes that ETSI will continue using conformance requirements as such when developing ETSI HS in the future (including necessary test tolerance).

Although the following systems: UMTS, WiMAX, NR, NB-IoT and LTE, excluding GSM, could be covered by a common set of LRTCs which are compliant with the principle of technology neutrality (a common BEM) there is still a need to differentiate between NB systems and WB systems in the LRTCs for implementation of the frequency separation.

According to national context, there is a need for a 200 kHz frequency separation between the nominal channel edges of adjacent NB and WB ECS systems, and between the nominal channel edges of two different adjacent NB ECS systems' (including GSM/EC-GSM-IoT).

For the relevant NB system operating in a guard band mode of a relevant WB system, a frequency separation of 200 kHz or more is necessary, between the channel edge of this NB system and the edge of the operator's block, taking into account existing guard bands between operators' block edges or the edge of the operating band (adjacent to other services). This guard band NB system operates only within channel bandwidths of 10 MHz or higher.

The above frequency separations are required to ensure coexistence in the absence of bilateral or multilateral agreements between neighbouring networks, without precluding less stringent technical parameters if agreed among the operators of such networks.

The implementation of this 200 kHz frequency separation needs to be addressed by regulatory measures at national level in order to maintain spectrum efficiency. Various approaches could be implemented either separately or simultaneously depending on the spectrum edges of adjacent ECS networks.

CEPT agreed to avoid new additional studies in order to derive the LRTCs, including the coexistence with all adjacent services. CEPT also agreed to avoid additional constraints to systems deployed under the current regulatory framework. Therefore, the proposed approach to be followed to ensure coexistence with the relevant adjacent band systems while avoiding additional studies, is as follows:

- Identify the appropriate ECC/CEPT Reports which were used to confirm coexistence between existing MFCN technologies in the 900/1800 MHz bands and the relevant adjacent services;
- Demonstrate how the new technology neutral LRTCs (including new technologies) can ensure that this coexistence remains for all systems that comply with these technology neutral LRTCs;
  - Recalling that the technology neutral out-of-block limits (baseline and transitional) have been derived from ETSI TS unwanted emissions of an existing MFCN technology (see Section 3.4.4.1). Unless an additional baseline limit is defined, these out-of-block limits also apply in out-of-band domain;
  - Recalling that the new technology neutral LRTCs are compatible with all existing MFCN technologies (UMTS, WiMAX, LTE, NB-IoT), which have already been studied to ensure coexistence with the relevant adjacent band systems;
  - Using these facts to demonstrate that coexistence remains for all systems that comply with the new technology neutral LRTCs (including new technologies);
- Recall the various coexistence conditions resulting from the ECC/CEPT Reports to confirm coexistence between MFCN systems complying with the proposed technology neutral LRTCs and all relevant adjacent services.

This is the same approach that was used in this report to ensure coexistence between the technology neutral LRTCs and GSM in-band (see section 3.2).

Coexistence between ECS systems in the 900 MHz and 1800 MHz frequency bands and the following services in adjacent bands have been analysed:

- 900 MHz adjacent systems: GSM-R/E-GSM-R, FRMCS, PMR/PAMR, aeronautical radio navigation (DME/L-DACS), aeronautical mobile service communication systems and MIDS (Military NATO);
- 1800 MHz adjacent systems: DECT, MetSat (weather satellite), fixed telemetry (defence), radio microphones and fixed service.

This CEPT Report defines an additional baseline power limit for non-AAS BS to protect adjacent services in addition to the out-of-block limits between ECS.

Depending on the national context and relevant deployment of ECS NB or WB and RMR (encompasses GSM-R and its successor(s), including FRMCS), there may also be a need for a 200 kHz frequency separation between channel edges of networks adjacent in frequency at 925 MHz in the following cases: RMR NB<sup>14</sup> vs.

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<sup>14</sup> RMR NB systems are RMR systems operating in 200 kHz channels

ECS WB, RMR WB<sup>15</sup> vs. ECS NB and, when the ECS NB and RMR NB systems are different, RMR NB vs. ECS NB. This frequency separation should be addressed by regulatory measures at a national level in order to maintain spectrum efficiency.

In response to Task 3, CEPT confirms that cross-border co-ordination can be addressed through existing and, where appropriate, further to be developed bilateral and multilateral procedures, supported by ECC Recommendations as appropriate.

In addition, when there is no market demand to use other standards than 5G NR and those listed in the current Annex of the EC Decision, there is no need to update national regulatory frameworks. This leaves some flexibility for the date of implementation by the EU Member States of the future EC Decision containing the proposed LRTCs based on this CEPT Report. Varying dates for implementation of the updated EC framework should not impact the rollout of 5G NR in 900/1800 MHz bands in Europe.


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<sup>15</sup> RMR WB systems are RMR systems operating in channels larger than 200 kHz

**ANNEX 1: MANDATE TO CEPT**



**EUROPEAN COMMISSION**  
Communications Networks Content & Technology Directorate-General  
Electronic Communications Networks & Services  
**Radio Spectrum Policy**

 Ref. Ares(2018)4780924 - 18/09/2018

Brussels, 12 July  
2018 DG  
CONNECT/B4

**RSCOM18-19rev1**

## **RADIO SPECTRUM COMMITTEE**

### **Working Document**

**Opinion of the RSC**  
**pursuant to Advisory Procedure under Article 4 of Regulation**  
**182/2011/EU and Article 4.2 of Radio Spectrum Decision 676/2002/EC**

**Subject: Mandate to CEPT to review the harmonised technical conditions for certain EU-harmonised frequency bands and to develop least restrictive harmonised technical conditions suitable for next-generation (5G) terrestrial wireless systems**

European Commission, DG Communications Networks Content & Technology, 200 Rue de la Loi, B-1049  
Bruxelles RSC Secretariat, Avenue de Beaulieu 33, B-1160 Brussels - Belgium - Office BU33 7/09  
Telephone: direct line (+32-2)295.6512, switchboard (+32-2)299.11.11. Fax: (+32-2)  
296.38.95 E-mail : [cnect-rsc@ec.europa.eu](mailto:cnect-rsc@ec.europa.eu)

## MANDATE TO CEPT

### TO REVIEW THE HARMONISED TECHNICAL CONDITIONS FOR CERTAIN EU-HARMONISED FREQUENCY BANDS AND TO DEVELOP LEAST RESTRICTIVE HARMONISED TECHNICAL CONDITIONS SUITABLE FOR NEXT-GENERATION (5G) TERRESTRIAL WIRELESS SYSTEMS

#### 1. PURPOSE

It is anticipated that next-generation (5G) terrestrial wireless systems will operate in frequency bands that have already been harmonised in the EU for electronic communications services. While this is already possible today based on technology and service neutrality principles, it is important that the existing harmonised technical conditions of use be reviewed to identify potential constraints, and optimised for next-generation systems. The latter would contribute to a leading Union role in 5G development and deployment.

This Mandate is a follow-up to the Commission's mandate regarding technology-neutral harmonised technical conditions suitable for next-generation (5G) use for the 3.6 GHz and 26 GHz pioneer bands<sup>1</sup>. It should deliver harmonised least restrictive technical conditions, including sharing conditions if needed, for next-generation (5G) terrestrial wireless systems in the EU-harmonised 880-915 and 925-960 MHz frequency bands ('900 MHz band'), 1710-1785 MHz and 1805-1880 MHz frequency bands ('1800 MHz band'), 1920-1980 MHz and 2110-2170 MHz frequency bands ('paired terrestrial 2 GHz band'), and 2500-2690 MHz frequency band ('2.6 GHz band')<sup>2</sup>. These conditions should take into account relevant 5G usage scenarios related to wireless broadband and the Internet of Things, and meet the overarching purpose of ensuring efficient spectrum use.

#### 2. POLICY CONTEXT AND INPUTS

The ITU-R vision for the next-generation mobile telecommunications<sup>3</sup> outlines three major 5G usage scenarios – enhanced mobile broadband (eMBB), massive machine type communications (mMTC), and ultra-reliable and low latency communications (URLLC).

Deliverables of the 5G Public Private Partnership<sup>4</sup> Infrastructure Association indicate that 5G would offer both an evolution of mobile broadband networks ensuring continuous user experience, and new unique network and service capabilities. In particular, 5G would be a key enabler for the Internet of Things and mission-critical services requiring very high reliability, ubiquitous coverage and/or very low latency. In this regard, use cases originating from connectivity to 'verticals' (i.e. vertical sectors such as transport, healthcare or media) are considered as drivers of 5G requirements from the outset with high priority, in particular within frequency bands below 6 GHz.

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<sup>1</sup> Document RSCOM16-40rev3 of 7 December 2016

<sup>2</sup> Subject to Commission Decisions 2009/766/EC as amended by 2011/251/EC and (EU) 2018/637 (900/1800 MHz band), 2012/688/EU (paired terrestrial 2 GHz band), 2008/477/EC (2.6 GHz band)

<sup>3</sup> In the ITU context of "International Mobile Telecommunications for 2020 (IMT2020)", s. ITU Recommendation: [https://www.itu.int/dms\\_pubrec/itu-r/rec/m/R-REC-M.2083-0-201509-I!!PDF-E.pdf](https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2083-0-201509-I!!PDF-E.pdf)

<sup>4</sup> See <https://5g-ppp.eu/>

In its 5G Action Plan<sup>5</sup>, the Commission advances action on the EU-level identification and harmonisation of 5G spectrum regarding pioneer frequency bands as well as **additional** frequency bands, based on the opinion of the Radio Spectrum Policy Group (RSPG).

In its two Opinions on "Strategic Roadmap towards 5G in Europe"<sup>6</sup>, the RSPG asserts the importance of existing EU-harmonised spectrum for the rollout of 5G terrestrial wireless systems in the Union as follows:

- 5G needs to be deployed also in bands already harmonized **below 1 GHz**, in particular the 700 MHz band, in order to enable nation-wide and indoor 5G coverage;
- there is a need to ensure that technical and regulatory conditions for **all bands already harmonized** for mobile networks are fit for 5G use.

In this regard, the 900 MHz and 1800 MHz, the 2.6 GHz and the paired terrestrial 2 GHz frequency bands are relevant EU-harmonised frequency bands for next-generation terrestrial wireless systems. In its 5G roadmap, the CEPT highlights the need to revise the technical conditions for these frequency bands with the goal to ensure their suitability for 5G use. Therefore, technical studies are necessary with view to enabling the use of these bands for next-generation terrestrial wireless systems, which use active antenna systems (AAS) and are capable of providing novel services or applications. These studies should consider terrestrial electronic communications services and other relevant use, and foster a European approach to 5G deployment, which benefits to the extent possible from global harmonisation. The CEPT also concludes in its 5G roadmap that the current technical conditions for the 700 MHz, 800 MHz and 1.5 GHz frequency bands are already suitable for 5G use in the context of technology neutrality and the anticipated lack of AAS deployment in those frequency bands.

In particular, for the 900 MHz and 1800 MHz frequency bands, it is relevant to consider a Block Edge Mask (BEM) approach to technical harmonisation, which is suitable for next-generation terrestrial wireless systems and achieves consistency with the existing minimal and least restrictive technical conditions for other EU-harmonised frequency bands for wireless broadband electronic communications services. Such an approach should replace in the long term the current technical framework based on references to ETSI standards for both bands. Furthermore, it should ensure coexistence with the GSM system in the 900 MHz frequency band, pursuant to the GSM Directive<sup>7</sup>, while delivering a solution, which ensures availability and efficient use of the spectrum for next-generation terrestrial wireless systems in line with the Union's spectrum policy priorities.

In this regard, the CEPT is considering an amendment of the current technical framework for the 900 MHz and 1800 MHz frequency bands in early 2019, in order to reference the latest technical standards covering 5G New Radio. The CEPT plans to adopt harmonised technical conditions on the basis of BEM for both frequency bands as the long-term regulatory approach<sup>8</sup>. Taking account of progressing 5G standardisation, a transition of the

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<sup>5</sup> See: <https://ec.europa.eu/digital-single-market/en/5g-europe-action-plan>

<sup>6</sup> Documents RSPG16-032 final (9 November 2016) and RSPG18-005 final (30 January 2018)

<sup>7</sup> Council Directive 87/372/EEC as amended by Directive 2009/114/EC of the European Parliament and of the Council

<sup>8</sup> See CEPT 5G roadmap (document ECC(18)104 Annex 17) and ECC PT1 revised work programme (document ECC(18)104 Annex 19)



technical conditions to BEM in the 900 MHz and 1800 MHz frequency bands at the EU level, could be facilitated by the specific provision<sup>9</sup> in the Decision 2009/766/EC (as amended), which allows in both bands use of *other systems*, which are not listed in its Annex, under the condition of ensuring coexistence with the GSM system and the systems listed in that Annex. The aforementioned amendment of the CEPT technical framework will facilitate compliance with this provision in the EU context in order to accommodate evolving 5G standards.

### 3. JUSTIFICATION

Pursuant to Article 4(2) of the Radio Spectrum Decision<sup>10</sup> the Commission may issue mandates to the CEPT for the development of technical implementing measures with a view to ensuring harmonised conditions for the availability and efficient use of radio spectrum necessary for the functioning of the internal market. Such mandates shall set the tasks to be performed and their timetable. Pursuant to Article 1 of the Radio Spectrum Decision, activities under the Decision must facilitate policy making with regard to the strategic planning and harmonisation of radio spectrum use as well as ensure the effective implementation of radio spectrum policy in the EU while serving the aim of coordination of policy approaches. Furthermore, they shall take due account of the work of international organisations related to spectrum management such as ITU or 3GPP.

The Radio Spectrum Policy Programme (RSPP) requires Member States, in cooperation with the Commission, to take all steps necessary to ensure that sufficient spectrum for coverage and capacity purposes is available within the Union, in order to enable the Union to have the fastest broadband speeds in the world, thereby making it possible for wireless applications and European leadership in new services to contribute effectively to economic growth, and to achieving the target for all citizens to have access to broadband speeds of not less than 30 Mbps by 2020. Furthermore, the RSPP calls on Member States and the Commission to ensure spectrum availability for the Internet of Things (IoT) and to foster the development of standards and the harmonisation of spectrum allocation for IoT communications.

Advances in international standardisation at 3GPP and ITU, as well as rapid international developments regarding 5G trials and spectrum use until 2020, call for a swift and coordinated EU-level process on delivering sufficient and appropriate 5G spectrum in the Union according to anticipated deployment of 5G usage scenarios.

### 4. TASK ORDER AND SCHEDULE

CEPT is herewith mandated to develop harmonised least restrictive technical conditions for the 900 MHz, 1800 MHz, the 2.6 GHz and the paired terrestrial 2 GHz and frequency bands in line with the principles of technology and service neutrality, suitable for *next-generation (5G) terrestrial wireless systems* in line with the policy priorities set out in this Mandate and taking into account relevant needs for shared spectrum use with incumbent uses. CEPT should give utmost consideration to overall EU spectrum policy objectives such as effective and efficient spectrum use and take utmost account of applicable principles established in EU law such as those relating to service and technological neutrality, non-discrimination and proportionality insofar as technically possible.

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<sup>9</sup> Article 5 of Decision 2009/766/EC (as amended)

<sup>10</sup> Decision 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the European Community, OJ L 108 of 24.4.2002

CEPT is requested to collaborate actively with the European Telecommunications Standardisation Institute (ETSI), which develops harmonised standards for conformity under the Radio Equipment Directive. In particular, CEPT should take into consideration emerging technologies and ETSI harmonised standards, which define 5G systems, facilitate shared spectrum use or foster economies of scale.

More specifically, CEPT is mandated to perform the following tasks with view to creating sufficiently precise conditions for the development of EU-wide equipment:

1. Review the EU-harmonised technical conditions for use of the 900 MHz, 1800 MHz, paired terrestrial 2 GHz, and 2.6 GHz frequency bands with view to their suitability for 5G terrestrial wireless systems<sup>11</sup> which provide electronic communications services as well as other relevant services or applications, and assess the approach to adapting the EU-harmonised technical conditions for 5G use, if needed.

In particular, for the 900 MHz frequency band, such assessment should address any potential constraints (e.g. regarding efficient spectrum use), which result from the requirement to ensure co-existence with the GSM system, pursuant to the GSM Directive<sup>7</sup>.

2. Based on the results under Task 1, develop channelling arrangements and common and minimal (least restrictive) technical conditions<sup>12</sup> for the aforementioned frequency bands, which are suitable for 5G terrestrial wireless systems in compliance with the principles of technology and service neutrality.

These conditions should be sufficient to mitigate interference and ensure co-existence with incumbent radio services/applications in the same band or in adjacent bands, in line with their regulatory status, including at the EU outer borders.

3. Develop guidance for cross-border coordination.

Overall, the CEPT should provide deliverables under this Mandate according to the following schedule:

<b>Delivery date</b>	<b>Deliverable</b>	<b>Subject</b>
March 2019	Draft Report(s) from CEPT to the Commission <sup>13</sup> regarding the paired terrestrial 2 GHz frequency band, and the 2.6 GHz frequency band.  Information on the usage feasibility of the 900 MHz and 1800 MHz frequency bands, including any limitations of the GSM Directive.	Description of the work undertaken and the results.

<sup>11</sup> Such as based on the usage of active antenna systems

<sup>12</sup> Such as the definition of appropriate Block Edge Masks (BEMs)

<sup>13</sup> Subject to subsequent public consultation

July 2019	Final Report(s) from CEPT to the Commission regarding the paired terrestrial 2 GHz frequency band, and the 2.6 GHz frequency band, taking into account the outcome of the public consultation.	Description of the work undertaken and the results.
July 2020	Draft Report(s) from CEPT to the Commission <sup>13</sup> regarding the 900 MHz and 1800 MHz frequency bands.	Description of the work undertaken and the results.
October 2020	Final Report(s) from CEPT to the Commission regarding the 900 MHz and 1800 MHz frequency bands, taking into account the outcome of the public consultation.	Description of the work undertaken and the results.

CEPT is requested to report on the progress of its work pursuant to this Mandate to all meetings of the Radio Spectrum Committee taking place during the course of the Mandate.

The Commission, with the assistance of the Radio Spectrum Committee and pursuant to Article 4 of the Radio Spectrum Decision, may consider applying the results of this mandate in the Union taking into account any relevant guidance of the RSPG.

## ANNEX 2: UPDATES TO EC DECISION

### A2.1 INTRODUCTION

This annex proposes relevant harmonised technical conditions in order to update the 900 MHz and 1800 MHz EC framework assuming that EC framework on GSM remains unchanged. According to national situation, there may be a need to implement on a national basis a 200 kHz frequency separation between ECS systems and between ECS and RMR (encompasses GSM-R and its successor(s), including FRMCS) systems as described hereafter.

### A2.2 CHANNELLING ARRANGEMENT AND LEAST RESTRICTIVE HARMONISED TECHNICAL CONDITIONS

The following definitions for ECS narrowband (NB) and ECS wideband (WB) systems respectively apply in this Annex:

- ECS NB systems are systems operating in 200 kHz channels, excluding GSM and EC-GSM-IoT;
- ECS WB systems are systems operating in channels larger than 200 kHz.

The following definitions for RMR narrowband (NB) and RMR wideband (WB) systems respective apply in this Annex:

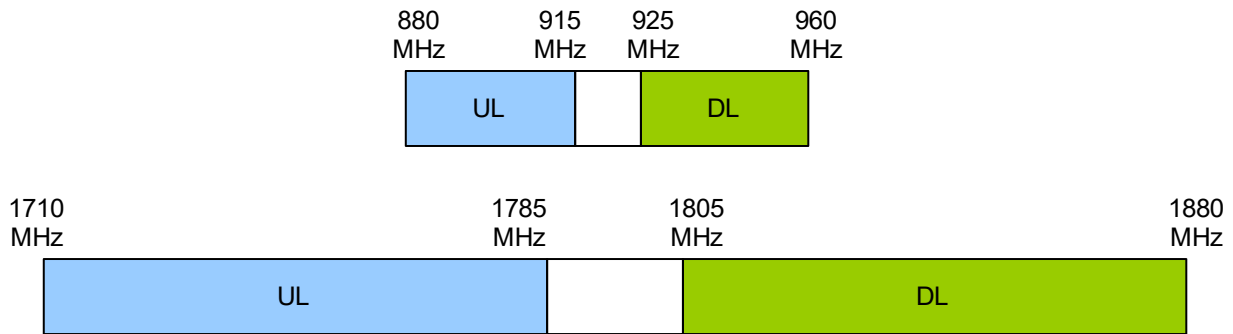
- RMR NB systems are RMR systems operating in 200 kHz channels;
- RMR WB systems are RMR systems operating in channels larger than 200 kHz.

#### A2.2.1 ECS HARMONISED BAND PLAN

- 1 The 900 MHz band follows an FDD band plan with a block size multiple of 200 kHz. The duplex direction for the carriers in 880-915 MHz/925-960 MHz<sup>16</sup> frequency bands is mobile transmit within the lower band and base station transmit within the upper band.
- 2 The 1800 MHz band follows an FDD band plan with a block size multiple of 200 kHz. The duplex direction for the carriers in 1710-1785 MHz/1805-1880 MHz<sup>17</sup> frequency bands is mobile transmit within the lower band and base station transmit within the upper band.
- 3 To support wideband systems (such as 5G NR), the 900 MHz<sup>16</sup> and 1800 MHz<sup>17</sup> bands follow FDD band plans enabling 5 MHz or more of contiguous spectrum according to market demand.
- 4 The ECS band plans for the 900 and 1800 MHz bands are depicted in Figure 9.

<sup>16</sup> The 880-915 MHz range or portions thereof can be used for uplink-only operation without paired spectrum within the 925-960 MHz range; the 925-960 MHz range or portions thereof, can be used for downlink-only operation without paired spectrum within the 880-915 MHz range.

<sup>17</sup> The 1710-1785 MHz range or portions thereof, can be used for uplink-only operation without paired spectrum within the 1805-1880 MHz range ; the 1805-1880 MHz range or portions thereof, can be used for downlink-only operation without paired spectrum within the 1710-1785 MHz range.



**Figure 9: Harmonised band plan**

**A2.2.2 FREQUENCY SEPARATION BETWEEN ADJACENT ECS SYSTEMS**

When deployed in an uncoordinated approach, it is necessary to implement a 200 kHz frequency separation between the nominal channel edges of:

- An ECS NB system complying with the BEM and an ECS WB system complying with the BEM;
- different ECS NB systems both complying with the BEM; and,
- GSM (including EC-GSM-IoT) and either an ECS NB system or ECS WB system complying with the BEM;

Implementation of such frequency separation refers to a national context.

For an ECS NB system operating in guard band mode of a relevant ECS WB system, a frequency separation of 200 kHz or more is necessary between the channel edge of this ECS NB system and the edge of the operator's block, taking into account existing guard bands between operators' block edges or the edge of the operating band (adjacent to other services). Such ECS NB systems operate only in channel bandwidths of 10 MHz or higher.

The above frequency separations are required to ensure coexistence in the absence of bilateral or multilateral agreements between neighbouring networks, without precluding less stringent technical parameters if agreed among the operators of such networks.

Where needed, the implementation of this 200 kHz frequency separation needs to be addressed on a national basis in order to maintain spectrum efficiency. Various approaches could be implemented either separately or simultaneously depending on the spectrum edges of adjacent ECS networks.

Depending on the national context and relevant deployment of ECS NB or WB and RMR (encompasses GSM-R and its successor(s), including FRMCS), there may also be a need for a 200 kHz frequency separation between channel edges of networks adjacent in frequency at 925 MHz in the following cases: RMR NB vs. ECS WB, RMR WB vs. ECS NB and, when the ECS NB and RMR NB systems are different, RMR NB vs. ECS NB. This frequency separation should be addressed by regulatory measures at a national level in order to maintain spectrum efficiency.

**A2.2.3 LEAST RESTRICTIVE TECHNICAL CONDITIONS**

A Block Edge Mask (BEM) is an essential component of conditions necessary to ensure co-existence between neighbouring networks, in the absence of bilateral or multilateral agreements between operators of such neighbouring networks. Less stringent technical parameters, if agreed among all affected operators of such networks, may also be used provided that these operators continue to comply with the technical conditions applicable for the protection of other services, applications or networks and with obligations resulting from cross-border coordination.

The technical conditions presented in this Annex, which apply to all systems except] GSM/EC-GSM-IoT, are in the form of a Block Edge Mask (BEM) for base stations and an in-band power limit for terminal stations.

BEMs are related to authorisation of spectrum rights of use and the avoidance of interference between users which benefit from such authorisation.

**A2.2.4 TECHNICAL CONDITIONS FOR BASE STATIONS – BLOCK EDGE MASK**

The BEM consists of several elements as given in Table 11. The in-block power limit is applied to a block assigned to an operator. The baseline power limit, designed to protect the spectrum of other operators within the respective frequency band, and the transitional region power limit, enabling filter roll-off from the in-block to the baseline power limit, represent out-of-block power elements.

The additional baseline power limit is an out-of-band power limit which is used for the protection of systems above and below the band edge, where needed.

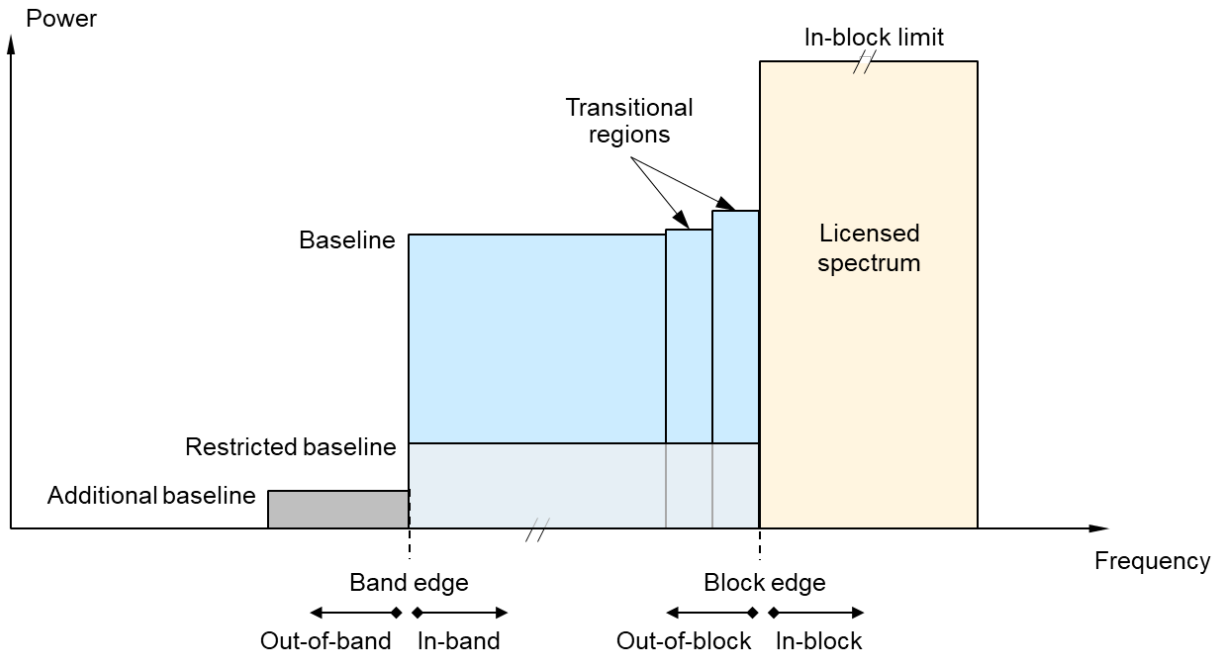
Power limits are provided separately for non-AAS and AAS (active antenna system) base stations.. Non-AAS base stations may be used in the 900 MHz and 1800 MHz frequency bands, hence the non-AAS base station power limits apply to both bands. For non-AAS base stations, the power limits are expressed as mean equivalent isotropically radiated power (e.i.r.p ). AAS base stations may only be used in the 1800 MHz frequency band, hence the AAS base station power limits only apply to this band. For AAS base stations, the power limits are expressed as mean total radiated power (TRP). TRP is defined as the integral of the power radiated by an antenna array system in different directions over the entire radiation sphere. TRP is equal to the total conducted power input into the antenna array system, less any losses in the antenna array system. The mean e.i.r.p. or mean TRP are measured by averaging over a time interval and over a measurement frequency bandwidth. In the time domain, the mean e.i.r.p. or mean TRP is averaged over the active portions of signal bursts and corresponds to a single power control setting. In the frequency domain, the mean e.i.r.p. or mean TRP is determined over the measurement frequency bandwidth as given in Table 12 to Table 15 below. In general, and unless stated otherwise, the BEM power limits correspond to the aggregate power radiated by the relevant device including all transmit antennas, except in the case of baseline and transition requirements for non-AAS base stations, which are specified per antenna.

Systems may use only non-AAS BS in the 900 MHz frequency band and may use either non-AAS BS or AAS BS in the 1800 MHz frequency band.

In general, and unless stated otherwise, the BEM levels correspond to the power radiated by the relevant device irrespective of the number of transmit antennas, except for the case of non-AAS base station transitional requirements which are specified per antenna.

**Table 11: ECS Base Station Block Edge Mask elements**

BEM element	Definition
In-block	Applies to a block assigned to an operator
Baseline	Applies in spectrum used for ECS, except from the operator block in question and corresponding transitional regions
Transitional regions	Applies in regions adjacent to the operator block in question
Additional baseline	Applies in adjacent bands (out-of-band) where specific limits for protection of other services are necessary



**Figure 10: Block edge mask elements**

**A2.2.4.1 In-band power limits**

In-band power limits for Base Stations are provided in Table 12, Table 13 and Table 14.

**Table 12: Base Station in-block power limit for non-AAS and AAS**

BEM element	Non-AAS e.i.r.p.	AAS TRP power limit (for 1800 MHz band AAS)
In-block	Not obligatory. In case an upper bound is desired by an administration, a value of 63-67 dBm/(5 MHz) per antenna may be applied for wideband systems and a value of 60-69 dBm/(200 kHz) per antenna may be applied for narrowband systems.	Not obligatory. In case an upper bound is desired by an administration, a value of 58 dBm/(5 MHz) per cell (note 1) may be applied.
<p>Note: For locations where coordination procedure with adjacent services applies an upper bound on output power can be set by administrations.</p> <p>Note 1: In a multi-sector base station, the radiated power limit applies to each one of the individual sectors.</p>		

**Table 13: Base Station Baseline out-of-block power limit for non-AAS and AAS**

BEM element	Frequency range	Non-AAS maximum mean e.i.r.p per antenna (for 900 MHz and 1800 MHz band)	AAS TRP power limit per cell (note 1) (for 1800 MHz band)
Baseline	FDD DL blocks	3 dBm/MHz	-6 dBm/MHz
<p>Note 1: In a multi-sector base station, the radiated power limit applies to each one of the individual sectors.</p>			

**Table 14: Base Station Transitional out-of-block power limits for non-AAS and AAS**

BEM element	Frequency range	Non-AAS maximum mean e.i.r.p per antenna (for 900 MHz and 1800 MHz band) (note 1)	AAS TRP power limit per cell (note 2) (for 1800 MHz band)
Transitional region	0 to 0.2 MHz offset from block edge	32.4 dBm/(0.2 MHz)	17.4 dBm/(0.2 MHz)
	0.2 to 1 MHz offset from block edge	13.8 dBm/(0.8 MHz)	4.7 dBm/(0.8 MHz)
	1 to 5 MHz offset from block edge	5 dBm/MHz	-4 dBm/MHz
	5 to 10 MHz offset from block edge	12 dBm/(5 MHz)	3 dBm/(5 MHz)
<p>Note 1: The non-AAS e.i.r.p. limits could be relaxed at national level, either if agreed among all affected operators of such networks or in accordance with national implementation already in place.</p> <p>Note 2: In a multi-sector base station, the radiated power limit applies to each one of the individual sectors.</p>			

**A2.2.4.2 Out-of-band power limits**

To protect the adjacent services, the additional baseline region limits for non-AAS BS provided in the below table are defined.

**Table 15: Base Station Additional baseline region power limits for non-AAS**

Frequency range	Non-AAS maximum mean e.i.r.p. per antenna (for 900 MHz and 1800 MHz band) (note 1 and note 2)
0 to 0.2 MHz offset from block edge	32.4 dBm/(0.2 MHz)
0.2 to 1 MHz offset from block edge	13.8 dBm/(0.8 MHz)
1 to 5 MHz offset from block edge	5 dBm/MHz
5 to 10 MHz offset from block edge	12 dBm/(5 MHz)
<p>Note 1: Provided that adjacent services, applications or networks remain protected above 960 MHz, below 1805 MHz and above 1880 MHz: On case-by-case basis, at national level, higher e.i.r.p. limits may be applied for non-AAS BS: e.i.r.p. limits up to 6 dB higher are allowed in the 0-200 kHz range to support higher ECS NB in-band block conducted power than 49 dBm/(200 kHz) i.e. up to 55 dBm/(200 kHz); e.i.r.p. limits up to 11 dB higher is allowed in the 0-10 MHz range to support higher antenna gain than 18 dBi (up to 29 dBi).)</p> <p>Note 2: Provided that adjacent services, applications or networks remain protected below 925 MHz: On case-by-case basis, at national level, higher e.i.r.p. limits may be applied for non-AAS BS.</p>	

**A2.2.4.3 Other conditions**

The spurious emission domain for the base station in these frequency bands start 10 MHz from the band edge and the corresponding limits are defined in current ERC Recommendation 74-01 [35].

In addition, ECS networks making use of AAS systems shall not be granted more protection from systems in adjacent and neighbouring bands than experienced with non-AAS systems.

**A2.2.5 TECHNICAL CONDITIONS FOR TERMINAL STATIONS**

In-block power limits for terminal stations are provided in Table 16.



**Table 16: In-block power limits for Terminal Stations**

BEM element	Maximum mean power (note 1)
In-block	25 dBm (note 2)
<p>Note 1: The recommended power limit above for mobile terminal stations is specified as TRP. The in-block radiated power limit for fixed/nomadic terminal stations may be agreed on a national basis provided that protection of other services, networks and applications is not compromised and cross-border obligations are fulfilled.</p> <p>Note 2: It is recognised that this value includes a possible tolerance of up to +2 dB, to take account of operation under extreme environmental conditions and production spread. This value does not include test tolerance..</p>	

## ANNEX 3: ETSI TS CORE SPECIFICATIONS

### A3.1 DEFINITIONS, SYMBOLS AND ABBREVIATIONS FROM ETSI TS CORE SPECIFICATIONS

Relevant definitions are extracted below from Chapter 3 (Definitions, symbols and abbreviations) of ETSI TS 137 105 V15.8.0 [24]:

#### “3.1 Definitions

**Band category:** group of operating bands for which the same MSR scenarios apply

**Base Station RF Bandwidth:** bandwidth in which a base station transmits and/or receives single or multiple carrier(s) and/or RATs simultaneously within a supported operating band

NOTE: In single carrier operation, the Base Station RF Bandwidth is equal to the channel bandwidth.

**Base Station RF Bandwidth edge:** frequency of one of the edges of the Base Station RF Bandwidth

**Inter-band gap:** frequency gap between two supported consecutive operating bands

**Inter RF Bandwidth gap:** frequency gap between two consecutive Base Station RF Bandwidths that are placed within two supported operating bands

**Multi-band RIB:** operating band specific RIB associated with a transmitter or receiver that is characterized by the ability to process two or more carriers in common active RF components simultaneously, where at least one carrier is configured at a different operating band than the other carrier(s) and where this different operating band is not a sub-band or superseding-band of another supported operating band in which the same RAT is operated.

**Sub-block:** one contiguous allocated block of spectrum for use by the same Base Station

NOTE: There may be multiple instances of sub-blocks within a Base Station RF Bandwidth.

**Sub-block gap:** frequency gap between two consecutive sub-blocks within a Base Station RF Bandwidth, where the RF requirements in the gap are based on co-existence for un-coordinated operation”

#### “3.2 symbols

$\Delta f_{\text{OBUE}}$  Maximum offset of the operating band unwanted emissions mask from the downlink operating band edge

$F_{\text{DL\_low}}$  The lowest frequency of the downlink operating band

$F_{\text{DL\_high}}$  The highest frequency of the downlink operating band”

### A3.2 ASSUMPTIONS FOR DERIVING LRTCS FOR NON-AAS BS FROM ETSI TS CORE SPECIFICATIONS

CEPT agreed on the following assumptions in order to derive the LRTCs for non-AAS MFCN BS in the 900/1800 MHz band:

- Derive e.i.r.p. limits under the basis of 18 dBi antenna gain;
- Derive a single BEM for NB and WB non-AAS systems, based on the ETSI TS core requirements for MSR non-AAS BS (ETSI TS 137 104 version 15.10.0 [22]). Unwanted emissions supporting UMTS, LTE (1.4 MHz, 3 MHz, 5 MHz and wider), NR and standalone NB-IoT, are defined in Table 17 (ETSI TS 137 104 Table 6.6.2.2-1) and Table 18 (ETSI TS 137 104, Table 6.6.2.2-2) according to this ETSI technical specification;
  - For UMTS, LTE and NR systems of 5 MHz and wider, the transitional out-of-block limits defined in Table 17 are applied for  $\Delta f$  from 0 MHz to 10 MHz from the block edge;

- For NB systems (including standalone NB-IoT) and LTE systems of 1.4 and 3 MHz adjacent to the Base Station RF Bandwidth edge, the transitional out-of-block limits defined in Table 18 are applied for  $\Delta f$  from 0 kHz to 150 kHz from the block edge, and the transitional out-of-block limits defined in Table 17 are applied for  $\Delta f$  from 150 kHz to 10 MHz from the block edge;
- Table 18 includes a parameter 'X', which is used in the definition of the transitional out-of-block emissions for  $\Delta f$  from 0 kHz to 150 kHz from the block edge: In case the carrier adjacent to the RF bandwidth edge is a NB carrier, the value of  $X = P_{NB \text{ carrier}} - 43$ , where  $P_{NB \text{ carrier}}$  is the power level of the NB carrier adjacent to the RF bandwidth edge. In other cases,  $X = 0$ .
- The unwanted emission limits defined in Table 17 for  $\Delta f$  of 10 MHz and more (beyond the transitional region) apply within the band as baseline out-of-block limit.

**Table 17: Wide Area operating band unwanted emission mask (UEM) for BC2 for BS not supporting NR (except for BS operating in Band 3 or 8 in Europe) or (irrespective of NR support) BS with standalone NB-IoT at the BS RF bandwidth edge (ETSI TS 137 104 Table 6.6.2.2-1 [22])**

Frequency offset of measurement filter – 3 dB point, $\Delta f$	Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$	Minimum requirement (Note 2, 3)	Measurement bandwidth (Note 7)
$0 \text{ MHz} \leq \Delta f < 0.2 \text{ MHz}$ (Note 1)	$0.015 \text{ MHz} \leq f_{\text{offset}} < 0.215 \text{ MHz}$	-14 dBm	30 kHz
$0.2 \text{ MHz} \leq \Delta f < 1 \text{ MHz}$	$0.215 \text{ MHz} \leq f_{\text{offset}} < 1.015 \text{ MHz}$	-14 dBm – $15 \cdot (f_{\text{offset}}/\text{MHz} - 0.215) \text{ dB}$ (Note 4)	30 kHz
(Note 6)	$1.015 \text{ MHz} \leq f_{\text{offset}} < 1.5 \text{ MHz}$	-26 dBm (Note 4)	30 kHz
$1 \text{ MHz} \leq \Delta f \leq \min(\Delta f_{\text{max}}, 10 \text{ MHz})$	$1.5 \text{ MHz} \leq f_{\text{offset}} < \min(f_{\text{offset}_{\text{max}}}, 10.5 \text{ MHz})$	-13 dBm (Note 4)	1 MHz
$10 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$	$10.5 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$	-15 dBm (Note 4, 8)	1 MHz

Note 1: For operation with a GSM/EDGE or standalone NB-IoT or an E-UTRA 1.4 or 3 MHz carrier adjacent to the Base Station RF Bandwidth edge, the limits in Table 18 apply for  $0 \text{ MHz} \leq \Delta f < 0.15 \text{ MHz}$ .

Note 2: For MSR BS supporting non-contiguous spectrum operation within any operating band the minimum requirement within sub-block gaps is calculated as a cumulative sum of contributions from adjacent sub-blocks on each side of the sub-block gap, where the contribution from the far-end sub-block shall be scaled according to the measurement bandwidth of the near-end sub-block. Exception is  $\Delta f \geq 10 \text{ MHz}$  from both adjacent sub-blocks on each side of the sub-block gap, where the minimum requirement within sub-block gaps shall be -15dBm/MHz (for MSR BS supporting multi-band operation, either this limit or -16dBm/100kHz with correspondingly adjusted  $f_{\text{offset}}$  shall apply for this frequency offset range for operating bands <1GHz).

Note 3: For MSR BS supporting multi-band operation with Inter RF Bandwidth gap  $< 2 \cdot \Delta f_{\text{OBUE}}$  operation the minimum requirement within the Inter RF Bandwidth gaps is calculated as a cumulative sum of contributions from adjacent sub-blocks or RF Bandwidth on each side of the Inter RF Bandwidth gap, where the contribution from the far-end sub-block or RF Bandwidth shall be scaled according to the measurement bandwidth of the near-end sub-block or RF Bandwidth.

Note 4: For MSR BS supporting multi-band operation, either this limit or -16dBm/100kHz with correspondingly adjusted  $f_{\text{offset}}$  shall apply for this frequency offset range for operating bands <1GHz.

Note 6: This frequency range ensures that the range of values of  $f_{\text{offset}}$  is continuous.

Note 7: As a general rule for the requirements in the present subclause, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

Note 8: The requirement is not applicable when  $\Delta f_{\text{max}} < \Delta f_{\text{OBUE}}$ .

**Table 18: Wide Area operating band unwanted emission limits for operation in BC2 with GSM/EDGE or standalone NB-IoT or E-UTRA 1.4 or 3 MHz carriers adjacent to the Base Station RF Bandwidth edge (ETSI TS 137 104 Table 6.6.2.2-2 [22])**

Frequency offset of measurement filter –3dB point, $\Delta f$	Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$	Minimum requirement (Note 1, 2, 3,4, 5)	Measurement bandwidth (Note 7)
$0 \text{ MHz} \leq \Delta f < 0.05 \text{ MHz}$	$0.015 \text{ MHz} \leq f_{\text{offset}} < 0.065 \text{ MHz}$	Max(5 dBm – $60 \cdot (f_{\text{offset}}/\text{MHz} - 0.015)$ dB + X dB, –14 dBm)	30 kHz
$0.05 \text{ MHz} \leq \Delta f < 0.15 \text{ MHz}$	$0.065 \text{ MHz} \leq f_{\text{offset}} < 0.165 \text{ MHz}$	Max(2 dBm – $160 \cdot (f_{\text{offset}}/\text{MHz} - 0.065)$ dB + X dB, –14 dBm)	30 kHz

Note 1: The limits in this table only apply for operation with a GSM/EDGE or standalone NB-IoT or an E-UTRA 1.4 or 3 MHz carrier adjacent to the Base Station RF Bandwidth edge.

Note 2: For MSR BS supporting non-contiguous spectrum operation within any operating band the minimum requirement within sub-block gaps is calculated as a cumulative sum of contributions from adjacent sub blocks on each side of the sub block gap.

Note 3: For MSR BS supporting multi-band operation with Inter RF Bandwidth gap  $< 2 \cdot \Delta f_{\text{OBUE}}$  the minimum requirement within the Inter RF Bandwidth gaps is calculated as a cumulative sum of contributions from adjacent sub-blocks or RF Bandwidth on each side of the Inter RF Bandwidth gap.

Note 4: In case the carrier adjacent to the Base Station RF Bandwidth edge is a GSM/EDGE carrier, the value of X = PGSMcarrier – 43, where PGSMcarrier is the power level of the GSM/EDGE carrier adjacent to the Base Station RF Bandwidth edge. In other cases, X = 0.

Note 5: In case the carrier adjacent to the RF bandwidth edge is a NB-IoT carrier, the value of X = PNB-IoTcarrier – 43, where PNB-IoTcarrier is the power level of the NB-IoT carrier adjacent to the RF bandwidth edge. In other cases, X = 0.

Note 7: As a general rule for the requirements in the present subclause, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

**A3.3 ASSUMPTIONS FOR DERIVING LRTCS FOR AAS BS FROM ETSI TS CORE SPECIFICATIONS**

For AAS:

CEPT agreed to derive a single BEM for AAS BS based on AAS MSR BS unwanted emissions supporting UMTS, LTE (1.4 and 3 MHz, 5 MHz), NR;

Source for ETSI TS core requirements for MSR AAS BS: ETSI TS 137 105 (version 15.8.0), Table 9.7.5.2.3-1 (see Table 19 below) and 9.7.5.2.3-2 (see Table 20 below).

The following included extracts from ETSI TS 137 105 V15.8.0 are relevant for the definition of technology neutral LRTCs for 1800 MHz AAS BS.

The following section includes relevant parts of the definition of AAS BS operating band unwanted emissions from chapter 9.7.5 (OTA Operating band unwanted emission) of ETSI TS 137 105 V15.8.0 [24]:

**"9.7.5.1 General**

*Unless otherwise stated, for E-UTRA single band and MSR the operating band unwanted emission limits are defined from  $\Delta f_{\text{OBUE}}$  below the lowest frequency of each supported downlink operating band to the lower Base Station RF Bandwidth edge located at FBW RF,low and from the upper Base Station RF Bandwidth edge located at FBW RF,high up to  $\Delta f_{\text{OBUE}}$  above the highest frequency of each supported downlink operating band. The values of  $\Delta f_{\text{OBUE}}$  are defined in table 9.7.1-1.*

*The requirements shall apply whatever the type of transmitter considered and for all transmission modes foreseen by the manufacturer's specification.*

*The operating band unwanted emissions minimum requirements are quoted as TRP per RIB unless otherwise stated.*

*The requirements shall apply whatever the type of RIB is considered (single carrier or multi-carrier) and for all transmission modes foreseen by the manufacturer's specification. In addition, for a RIB operating in non-contiguous spectrum, the requirements apply inside any sub-block gap. In addition, for a multi-band RIB the requirements apply inside any Inter RF Bandwidth gap.*

*The unwanted emission limits in the part of the downlink operating band that falls in the spurious domain are consistent with ITU-R Recommendation SM.329 [48].*

*Emissions shall use the minimum requirements specified in the tables below, where:*

- *$\Delta f$  is the separation between the channel edge frequency and the nominal -3dB point of the measuring filter closest to the carrier frequency;*
- *$f_{\text{offset}}$  is the separation between the channel edge frequency and the centre of the measuring filter;*
- *$f_{\text{offset}_{\text{max}}}$  is the offset to the frequency  $\Delta f_{\text{OBUe}}$  MHz outside the downlink operating band;*
- *$\Delta f_{\text{max}}$  is equal to  $f_{\text{offset}_{\text{max}}}$  minus half of the bandwidth of the measuring filter.”*

The following tables are extracted from ETSI TS 137 105 chapter 9.7.5.2.3 (Minimum requirement for MSR operation, Band Category 2):

**Table 19: Wide Area operating band unwanted emission mask (UEM) for BC2 for BS not supporting NR or BS supporting NR in Band n3 or n8 (ETSI TS 137 105 Table 9.7.5.2.3-1 [24])**

Frequency offset of measurement filter – 3dB point, $\Delta f$	Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$	Minimum requirement (Note 2, 3)	Measurement bandwidth (Note 5)
$0 \text{ MHz} \leq \Delta f < 0.2 \text{ MHz}$ (Note 1)	$0.015 \text{ MHz} \leq f_{\text{offset}} < 0.215 \text{ MHz}$	-5 dBm	30 kHz
$0.2 \text{ MHz} \leq \Delta f < 1 \text{ MHz}$	$0.215 \text{ MHz} \leq f_{\text{offset}} < 1.015 \text{ MHz}$	-5 dBm – $15 \cdot (f_{\text{offset}}/\text{MHz} - 0.215)$ dB	30 kHz
(Note 4)	$1.015 \text{ MHz} \leq f_{\text{offset}} < 1.5 \text{ MHz}$	-17 dBm	30 kHz
$1 \text{ MHz} \leq \Delta f \leq \min(\Delta f_{\text{max}}, 10 \text{ MHz})$	$1.5 \text{ MHz} \leq f_{\text{offset}} < \min(f_{\text{offset}_{\text{max}}}, 10.5 \text{ MHz})$	-4 dBm	1 MHz
$10 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$	$10.5 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$	-6 dBm (Note 6)	1 MHz

Note 1: For operation with an E-UTRA 1.4 or 3 MHz carrier adjacent to the Base Station RF Bandwidth edge, the limits in Table 20 apply for  $0 \text{ MHz} \leq \Delta f < 0.15 \text{ MHz}$ .

Note 2: For MSR RIB supporting non-contiguous spectrum operation within any operating band the minimum requirement within sub-block gaps is calculated as a cumulative sum of contributions from adjacent subblocks on each side of the sub-block gap, where the contribution from the far-end sub-block shall be scaled according to the measurement bandwidth of the near-end sub-block. Exception is  $\Delta f \geq 10\text{MHz}$  from both adjacent sub-blocks on each side of the sub-block gap, where the minimum requirement within sub-block gaps shall be -6dBm/MHz.

Note 3: For a MSR multi-band RIB with Inter RF Bandwidth gap  $< 2 \times \Delta f_{\text{OBUE}}$  operation the minimum requirement within the Inter RF Bandwidth gaps is calculated as a cumulative sum of contributions from adjacent subblocks or Base Station RF Bandwidth on each side of the Inter RF Bandwidth gap, where the contribution from the far-end sub-block or Base Station RF Bandwidth shall be scaled according to the measurement bandwidth of the near-end sub-block or Base Station RF Bandwidth.

Note 4: This frequency range ensures that the range of values of  $f_{\text{offset}}$  is continuous.

Note 5: As a general rule for the requirements in the present subclause, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

Note 6: The requirement is not applicable when  $\Delta f_{\text{max}} < 10 \text{ MHz}$ .

**Table 20: Wide Area operating band unwanted emission limits for operation in BC2 with E-UTRA 1.4 or 3 MHz carriers adjacent to the Base Station RF Bandwidth edge (ETSI TS 137 105Table 9.7.5.2.3-2 [24])**

Frequency offset of measurement filter – 3dB point, $\Delta f$	Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$	Minimum requirement (Note 2, 3)	Measurement bandwidth (Note 4)
$0 \text{ MHz} \leq \Delta f < 0.05 \text{ MHz}$	$0.015 \text{ MHz} \leq f_{\text{offset}} < 0.065 \text{ MHz}$	$\text{Max}(14 \text{ dBm} - 60 \cdot (f_{\text{offset}}/\text{MHz} - 0.015) \text{ dB}, -5 \text{ dBm})$	30 kHz
$0.05 \text{ MHz} \leq \Delta f < 0.15 \text{ MHz}$	$0.065 \text{ MHz} \leq f_{\text{offset}} < 0.165 \text{ MHz}$	$\text{Max}(11 \text{ dBm} - 160 \cdot (f_{\text{offset}}/\text{MHz} - 0.065) \text{ dB}, -5 \text{ dBm})$	30 kHz

Note 1: The limits in this table only apply for operation with an E-UTRA 1.4 or 3 MHz carrier adjacent to the Base Station RF Bandwidth edge.

Note 2: For MSR RIB supporting non-contiguous spectrum operation within any operating band the minimum requirement within sub-block gaps is calculated as a cumulative sum of contributions from adjacent sub blocks on each side of the sub-block gap.

Note 3: For a MSR multi-band RIB with Inter RF Bandwidth gap  $< 2 \times \Delta f_{\text{OBUe}}$  the minimum requirement within the Inter RF Bandwidth gaps is calculated as a cumulative sum of contributions from adjacent sub-blocks or Base Station RF Bandwidth on each side of the Inter RF Bandwidth gap.

Note 4: As a general rule for the requirements in the present subclause, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

## ANNEX 4: HIGH LEVEL PRINCIPLES USED IN THIS REPORT

This Report has been developed according to the following high level principles and objectives” agreed by CEPT ECC:

- 1 A Block Edge Mask (BEM) is an essential component of LRTCs and provides conditions necessary to ensure co-existence between neighbouring networks, in the absence of bilateral or multilateral agreements between operators of such neighbouring networks;
- 2 To develop BEM for base stations and terminal stations including the following possible components, where appropriate:
  - Base stations:
    - In-block power limit (to be applied to an assigned block where needed);
    - Transitional region (out-of-block limits);
    - Baseline (out-of-block limits);
    - Restricted baseline (only if needed, for restricted out-of-block limits);
    - Out-of-block limit (coexistence between mobile operators);
  - Ensure coexistence with adjacent systems:
    - Out-of-band limits (to ensure coexistence with adjacent users) where needed if it differs from out-of-of-block limits;
    - Additional baseline (if needed to ensure coexistence with adjacent services);
  - Terminal Stations:
    - In-block power limit (to be applied to an assigned block);
    - To assess if other limits are needed to ensure coexistence with adjacent users;
- 3 To express and implement the required frequency separation between NB systems and WB systems and between different NB systems under a technology neutral approach. Today the frequency separation is implemented in the EC framework on a technology based approach: GSM, LTE, WiMAX, UMTS, and all IoT technologies (including standalone and non-standalone NB-IoT);
- 4 To implement a technology neutral BEM approach for NB systems and WB systems including, if needed, required frequency separation. Such approach should be derived as toolbox to be implemented at national level in order to respond;
- 5 GSM will not be considered in the development of the BEM. The CEPT Report explains why the BEM could not be applied to GSM and how protection of GSM is to be managed regarding the new BEM<sup>18</sup>;
- 6 To avoid new additional studies in order to derive the LRTCs including the coexistence with adjacent services;
- 7 To confirm adjacent services to be considered as listed in ECC Report 297 [3]. FRMCS is also included on the understanding that (1) no additional studies are required and (2) it should lead to no additional constraints for MFCN in the adjacent band. To address the coexistence issue in particular below 925 MHz, above 960 MHz, below 1805 MHz and above 1880 MHz;
- 8 To decide and justify which source should be used to derive LRTCs limits: either ETSI HS referred to in EC/ECC Decisions annexes or other references used in ECC studies such as ETSI TS core requirements or 3GPP TS core requirements;
- 9 To assess how to improve the EC (ECC) current framework while avoiding additional constraints for systems deployed under the current regulatory framework;
- 10 To preserve spectrum efficiency when implementing frequency separation under technology neutral approach;
- 11 Specific coordination issues, where needed, should still be handled on a national case-by-case basis.

<sup>18</sup> See EC Decision 2009/766/EC [2], amended by 2011/251/EU [16] and 2018/637/EU [20], as well as ERC Decision (94)01 [13], ERC Decision (95)03 [19], ERC Decision (97)02 [14] and ECC Decision (06)13 [15].



**ANNEX 5: LIST OF REFERENCES**

- [1] CEPT Report 72: Report from CEPT to the European Commission in response to the Mandate “to review the harmonised technical conditions for certain EU-harmonised frequency bands and to develop least restrictive harmonised technical conditions suitable for next-generation (5G) terrestrial wireless systems”  
Report A: Review of technical conditions in the paired terrestrial 2 GHz and the 2.6 GHz frequency bands, and the usage feasibility of the 900 MHz and 1800 MHz frequency bands, approved July 2019
- [2] 2009/766/EC: Commission Decision of 16 October 2009 on the harmonisation of the 900 MHz and 1800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications services in the Community
- [3] ECC Report 297: “Analysis of the suitability and update of the regulatory technical conditions for 5G MFCN and AAS operation in the 900 MHz and 1800 MHz bands”, approved March 2019
- [4] CEPT Report 40: “Report from CEPT to European Commission in response to Task 2 of the Mandate to CEPT on the 900/1800 MHz bands  
“Compatibility study for LTE and WiMAX operating within the bands 880-915 MHz / 925-960 MHz and 1710-1785 MHz / 1805-1880 MHz (900/1800 MHz bands)”, approved November 2010
- [5] ECC Report 266: “The suitability of the current ECC regulatory framework for the usage of Wideband and Narrowband M2M in the frequency bands 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2.1 GHz and 2.6 GHz”, approved June 2017
- [6] ECC Report 229: “Guidance for improving coexistence between GSM-R and MFCN in the 900 MHz band”, approved May 2015
- [7] ECC Report 146: “Compatibility between GSM MCBTS and other services (TRR, RSBN/PRMG, HC-SDMA, GSM-R, DME, MIDS, DECT) operating in the 900 and 1800 MHz frequency bands”, approved July 2010
- [8] ECC Report 82: “Compatibility study for UMTS operating within the GSM 900 and GSM 1800 frequency bands”, approved June 2006
- [9] ECC Report 96: “Compatibility between UMTS 900/1800 and systems operating in adjacent bands”, approved April 2007
- [10] CEPT Report 66: “Report from CEPT to the European Commission in response to the Mandate “to review the harmonised technical conditions for use of the 900 MHz and 1800 MHz frequency bands for terrestrial wireless broadband electronic communications services in support of the Internet of Things in the Union””, approved March 2018
- [11] CEPT Report 42: “Report from CEPT to European Commission in response to Task 3 of the Mandate to CEPT on the 900/1800 MHz bands.  
Compatibility between UMTS and existing and planned aeronautical systems above 960 MHz, approved November 2010
- [12] CEPT Report 41: “Report from CEPT to European Commission in response to Task 2 of the Mandate to CEPT on the 900/1800 MHz bands  
Compatibility between LTE and WiMAX operating within the bands 880-915 MHz / 925-960 MHz and 1710-1785 MHz / 1805-1880 MHz (900/1800 MHz bands) and systems operating in adjacent bands”, approved November 2010
- [13] ERC Decision (94)01: “The frequency bands to be designated for the coordinated introduction of the GSM digital pan-European communications system”, approved October 1994
- [14] ERC Decision (97)02: “The extended frequency bands to be used for the GSM Digital Pan-European Communications System”, approved March 1997
- [15] ECC Decision (06)13: “Designation of the bands 880-915 MHz, 925-960 MHz, 1710-1785 MHz and 1805-1880 MHz for terrestrial UMTS, LTE, WiMAX and IoT cellular systems”, amended 8 March 2019
- [16] 2011/251/EU: Commission Implementing Decision of 18 April 2011 amending Decision 2009/766/EC on the harmonisation of the 900 MHz and 1800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications services in the Community
- [17] ECC Recommendation (05)08 on frequency planning and cross-border coordination between GSM Land Mobile Systems (GSM 900, GSM 1800, and GSM-R), approved February 2006 amended on 3 February 2017
- [18] ECC Recommendation (08)02: “Cross-border coordination for Mobile/Fixed Communications Networks (MFCN) in the frequency bands 900 MHz and 1800 MHz excluding GSM vs. GSM systems, approved February 2008, latest amended on 8 February 2019
- [19] ERC Decision (95)03: “ERC Decision of 1 December 1995 on the frequency bands to be designated for the introduction of DCS 1800”, approved December 1995

- [20] Commission Implementing Decision (EU) 2018/637 of 20 April 2018 amending Decision 2009/766/EC on the harmonisation of the 900 MHz and 1800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications services in the Community as regards relevant technical conditions for the Internet of Things
- [21] Council Directive 87/372/EEC as amended by Directive 2009/114/EC of the European Parliament and of the Council
- [22] ETSI TS 137 104 version 15.10.0: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; NR, E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) radio transmission and reception (3GPP TS 37.104 version 15.10.0 Release 15)"
- [23] ETSI TS 136 104 V 15.3.0 LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception (3GPP TS 36.104 version 15.3.0 Release 15)"
- [24] ETSI TS 137 105 V 15.8.0: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; NR, E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) radio transmission and reception (3GPP TS 37.104 version 15.8.0 Release 15)"
- [25] ETSI EN 301 502: "Global System for Mobile communications (GSM); Base Station (BS) equipment; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU"
- [26] ETSI EN 301 511: "Global System for Mobile communications (GSM); Mobile Stations (MS) equipment; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU"
- [27] ETSI TS 136 101: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception (3GPP TS 36.101 version 15.9.0 Release 15)"
- [28] ECO Report 03: "The Licensing of "Mobile Bands" in CEPT"
- [29] ECC PT1(19)101 Annex 27: "LS to ETSI on SDL-SUL pairing"
- [30] ETSI TS 125.101 V12.6.0: "Universal Mobile Telecommunications System (UMTS); User Equipment (UE) radio transmission and reception (FDD)"
- [31] ETSI TS 138 101-1 V16.4.0: 5G; NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone
- [32] 3GPP TR 36.802 V13.0.0: "Evolved Universal Terrestrial Radio Access (E-UTRA); NB-IOT; Technical Report for BS and UE radio transmission and reception"
- [33] CEPT Report 76: "Report from CEPT to the European Commission in response to the Mandate on spectrum for the future railway mobile communications system, Report B: EU-harmonised technical conditions for the future railway mobile radio communications system (Task 5), approved November 2020"
- [34] ECC Decision (20)02: "Harmonised use of the paired frequency bands 874.4-880.0 MHz and 919.4-925.0 MHz and of the unpaired frequency band 1900-1910 MHz for Railway Mobile Radio (RMR)", approved November 2020
- [35] ERC Recommendation 74-01 of 1998 on unwanted Emissions in the Spurious Domain, latest amendment on 29 May 2019
- [36] ERC Report 25: "The European table of frequency allocations and applications in the frequency range 8.3 kHz to 3000 GHz", updated November 2020
- [37] ETSI TS 102 933-1 v1.3.1: "Railway Telecommunications (RT); GSM-R improved receiver parameters; Part 1: Requirements for radio reception"
- [38] CEPT Report 74: "Report from CEPT to the European Commission in response to the Mandate on spectrum for the future railway mobile communications system Report A: Spectrum needs and feasibility (tasks 1 to 4), approved July 2020"
- [39] ECC Report 313: "Technical study for co-existence between RMR in the 900 MHz range and other applications in adjacent bands", approved May 2020
- [40] ITU Radio Regulations Edition of 2020
- [41] ECC Report 191: "Adjacent band compatibility between MFCN and PMSE audio applications in the 1785-1805 MHz frequency range", approved September 2013
- [42] CEPT Report 50: "Report A from CEPT to the European Commission in response to the Mandate "On technical conditions regarding spectrum harmonisation options for wireless radio microphones and cordless video-cameras (PMSE equipment)". Technical conditions for the use of the bands 821-832 MHz and 1785-1805 MHz for wireless radio microphones in the EU, approved March 2013"
- [43] ERC Report 63: "Introduction of radio microphone applications in the frequency range 1785 - 1800 MHz", approved May 1998
- [44] ERC Recommendation 70-03 of 1997 on relating to the use of Short Range Devices (SRD), latest amended on 23 October 2020

- [45] ERC Report 64: "Frequency sharing between UMTS and existing fixed services", approved May 1999
- [46] ERC Report 65: "Adjacent band compatibility between UMTS and other services in the 2 GHz band", approved November 1999
- [47] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC
- [48] Recommendation ITU-R SM.329-12 (09/2012): "Unwanted emissions in the spurious domain"
- [49] ECC Decision (06)01: "The harmonised utilisation of the bands 1920-1980 MHz and 2110-2170 MHz for mobile/fixed communications networks (MFCN) including terrestrial IMT systems", amended 8 March 2019
- [50] ETSI TS 137 141 V15.8.0 (2019-10), "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; NR, E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) conformance testing (3GPP TS 37.141 version 15.8.0 Release 15)", Table 6.6.2.5.2-1 and Table 6.6.2.5.2-2
- [51] ETSI TS 138 141-2 V15.3.0: "5G; NR; Base Station (BS) conformance testing Part 2: Radiated conformance testing (3GPP TS 38.141-2 version 15.3.0 Release 15)", Table 6.7.4.5.1.3-1