CEPT ECC
Electronic Communications Committee

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

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0 EXECUTIVE SUMMARY

In its 5G roadmap, the CEPT highlights the need to assess the technical conditions for the 900 MHz and 1800 MHz frequency bands, with the goal to ensure their suitability for 5G use and when applicable Active Antenna Systems (AAS).

This Report assessed the suitability of the current ECC Decision (06)13 [1] regulatory framework for the possible future usage of:

- 900 MHz frequency band for 5G non-AAS technology including supplemental uplink (SUL) mode of operation. AAS technology is not considered for the 900 MHz frequency band in this Report as non-AAS only is considered in the foreseeable future in 900 MHz;
- 1800 MHz frequency band for 5G (AAS[1] and non AAS) including SUL mode of operation;
- 1800 MHz frequency band for LTE-AAS.

The compatibility of such new technologies with current systems listed in the annexes 1 and 2 of the ECC Decision (06)13 (GSM, UMTS, LTE, WiMAX and IoT cellular technologies) and adjacent band systems in 900/1800 MHz frequency bands have been evaluated in this Report and confirmed to be possible on similar basis as those concluded for LTE non-AAS in CEPT Report 40 [2], CEPT Report 41 [3], CEPT Report 42 [4] and CEPT Report 66 [5] and in ECC Report 266 [6]. The development of this Report followed the methodology used in previous ECC and CEPT Reports and in particular CEPT Report 40, CEPT Report 41 and CEPT Report 66.

It also accounted for the development of Active antenna systems support for both LTE and 5G NR base stations (BSs).

Non-AAS (non-active antenna systems) refers to MFCN base station transmitters that provide one or more antenna connectors, which are connected to one or more separately designed passive antenna elements to radiate radio waves. The amplitude and phase of the signals to the antenna elements is not continually adjusted in response to short term changes in the radio environment.

AAS (Active Antenna Systems) refers to MFCN base stations and antenna system where the amplitude and / or phase between antenna elements is continually adjusted resulting in an antenna pattern that varies in response to short term changes in the radio environment. This is intended to exclude long-term beam shaping such as fixed electrical down tilt.

This Report does not consider or propose a Block Edge Mask (BEM) approach to technical harmonisation for 900/1800 MHz frequency band. This first step in a two-part ECC process follows the current approach to reference the 5G NR standard in order to enable a timely update to the technical conditions. The second step, planned for completion in June 2020, will introduce a technology neutral block edge mask to replace the existing technology references.

In light of the results of the compatibility analyses, this Report recommends an updated ECC regulatory framework (ECC Decision 06(13)) based on reference to ETSI harmonised standard of 5G (AAS and non-AAS) including SUL mode of operation and ETSI harmonised standard of LTE-AAS.

[1] AAS technology applies only to the BS side and not to the UE.

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
3GPP	3rd Generation Partnership Project
AAS	Active Antenna System
ACIR	Adjacent Channel Interference Ratio
ACLR	Adjacent Channel Leakage Ratio
ACS	Adjacent Channel Selectivity
ALD	Assistive Listening Device
BEM	Block Edge Mask
BS	Base Station
CBW	Channel Bandwidth
CDF	Cumulative Distribution Function
CEPT	European Conference of Postal and Telecommunications Administrations
CW	Continuous Wave
DCA	Dynamic Channel Allocation
DCS	Dynamic Channel Selection
DECT	Digital Enhanced Cordless Telecommunications
DL	Downlink
DME	Distance Measuring Equipment
e.i.r.p.	Equivalent Isotropically Radiated Power
EC	European Commission
ECA	European Common Allocation
ECC	Electronic Communications Committee
E-GSM-R	Extended GSM-R
E-UTRA	Evolved Universal Terrestrial Radio Access
FRC	Fixed Reference Channel
FDD	Frequency Division Duplex
FS	Fixed Service
GB	Guard Band
GSM	Global System for Mobile Communications
GSM-R	GSM - Railway
IMT	International Mobile Telecommunications
IoT	Internet of Things
ISD	Inter-Site Distance

Abbreviation	Explanation
L-DACS	L-band Digital Aeronautical Communication System
LRTC	Least Restrictive Technical Conditions
LTE	Long Term Evolution
LTE-eMTC	LTE evolved Machine Type Communications
LTE-MTC	LTE Machine Type Communications
M2M	Machine-to-Machine
MCL	Minimum Coupling Loss
MFCN	Mobile/Fixed Communications Networks
MIDS	Multifunctional Information Distribution System
MIMO	Multiple Input Multiple Output
MNO	Mobile Network Operator
MS	Mobile Station
MSR	Multi-Standard Radio
MTC	Machine Type Communications
NB-IoT	Narrowband IoT
NBN	Narrowband Network
NF	Noise Figure
NR	New Radio
OBUE	Operating Band Unwanted Emissions
OOB	Out of Band
OOBE	Out-of-band emission
OTA	Over-the-Air
PAMR	Public Access Mobile Radio
PMR	Private Mobile Radio
PP	Portable Part
PRB	Physical Resource Block
RAN	Radio Access Network
RAT	Radio Access Technology
RB	Resource Block
RF	Radio Frequency
RFID	Radio Frequency Identification
RFP	Radio Fixed Part
RR	Radio Regulations
SA	Standalone
SCS	Sub-Carrier Spacing

Abbreviation	Explanation
SDO	Standards Developing Organisation
SEM	Spectrum Emission Mask
SNR	Signal to Noise Ratio
SRD	Short Range Device
SUL	Supplemental Uplink
TRP	Total Radiated Power
TSG	Technical Specification Group
UE	User Equipment
UEM	Unwanted Emission Mask
UL	Uplink
UMTS	Universal Mobile Telecommunications System
UTRA	Universal Terrestrial Radio Access
WAN	Wide Area Network
WiMAX	Worldwide Interoperability for Microwave Access

1 INTRODUCTION

In this Report, the ECC has evaluated the suitability of 900 MHz and 1800 MHz frequency bands for the following technologies and systems support:

- Suitability of 900/1800 MHz frequency bands for 5G NR assuming non-active antenna systems;
- Suitability of 1800 MHz frequency band for active antenna systems whether deployed with LTE BS or NR BS.

The development of this Report accounted for the development of the new radio interfaces (5G NR) that supports the new capabilities of IMT-2020 along with the enhancement of IMT-2000 and IMT-Advanced systems. It also accounted for the development of active antenna systems support for both LTE and 5G NR BSs.

The compatibility of such new technologies with in-band systems and adjacent band systems in 900/1800 MHz frequency bands has been evaluated. The development of this Report followed the methodology used in previous ECC and CEPT Reports and in particular CEPT Report 40 [2] and CEPT Report 41 [3].

2 EXISTING REGULATORY FRAMEWORK

2.1 EXISTING REGULATORY FRAMEWORK FOR MFCN SYSTEMS

2.1.1 Band plan

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.

2.1.2 Applicable technical conditions

The table below lists the relevant CEPT/ECC/EU documents for 900/1800 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 266 [6] ECC Report 229 [7] ECC Report 146 [8] ECC Report 82 [9] ECC Report 96 [10] CEPT Report 66 [5] CEPT Report 42 [4] CEPT Report 41 [3] CEPT Report 40 [2]	ERC/DEC/(94)01 [11] ERC/DEC/(97)02 [12] ECC/DEC/(06)13 [1]	EC Decision 2011/251/EU [13] EC Decision 2009/766/EC [14]	ECC/REC(05)08 [15] ECC/REC(08)02 [16]
1800 MHz	ECC Report 266 [6] ECC Report 146 [8] ECC Report 82 [9] ECC Report 96 [10] CEPT Report 66 [5] CEPT Report 42 [4] CEPT Report 41 [3] CEPT Report 40 [2]	ERC/DEC/(95)03 [17] ECC/DEC/(06)13 [1]	EC Decision 2011/251/EU [13] EC Decision 2009/766/EC [14]	ECC/REC(05)08 [15] ECC/REC(08)02 [16]

The harmonised technical conditions from ECC and EC decisions applicable to 900 MHz and 1800 MHz MFCN frequency bands are summarised in table below:

Table 2: Overview of technical conditions in MFCN bands

Band	In-band	Adjacent bands
900 MHz + 1800 MHz	EC Decision 2009/766/EC [14] EC Decision 2011/251/EU [13] Carrier separation of 5 MHz or more between two neighbouring UMTS networks. Carrier separation of 2.8 MHz or more between a neighbouring UMTS network and a GSM network. Frequency separation of 200 kHz or more between the LTE channel edge and the GSM carrier's channel edge. No frequency separation between LTE channel edge and the UMTS carrier's channel edge. No frequency separation between LTE channel edges between two neighbouring LTE networks. ECC/DEC/(06)13 [1] LTE MTC/eMTC: No specific requirements in addition to LTE and the applicable harmonised standards NB-IoT Standalone mode: A frequency separation of 200 kHz or more between the standalone NB-IoT channel edge of one network and the UMTS/LTE channel edge of the neighbouring network. A frequency separation of 200 kHz or more between the standalone NB-IoT channel edge of one network and the GSM channel edge of the neighbouring network. NB-IoT In-band mode: No specific requirements in addition to LTE and the applicable harmonised standards. NB-IoT Guard band mode: A frequency separation of 200 kHz or more 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).	No specific emission limits but recommendations on coordination, with the following systems, are available in various ECC/CEPT Reports as listed in the previous table: -PMR/PAMR above 915 MHz; -GSM-R in 876-880 / 921-925 MHz; -Aeronautical systems above 960 MHz; -Fixed Service operating above 1805 MHz.

2.2 ADJACENT BAND ALLOCATION AND USE

The coexistence between LTE and relevant adjacent services was analysed in CEPT Report 41 based on an analogy with UMTS systems. Detailed description systems adjacent to 900 MHz and 1800 MHz frequency bands can be found in CEPT Report 41 [3]:

- 900 MHz adjacent systems: GSM-R/E-GSM-R, PMR/PAMR, Aeronautical Radionavigation (DME/L-DACS), Aeronautical Mobile Service Communication systems and MIDS (Military NATO);
- 1800 MHz adjacent systems: DECT, MetSat/Fixed-Telemetry (Weather Satellite, Defence), radio microphones and fixed services.

3 SUITABILITY OF THE CURRENT TECHNICAL FRAMEWORK FOR 5G

3.1 SUITABILITY OF THE CURRENT FRAMEWORK FOR 5G NON-AAS SYSTEMS

The 900 MHz and 1800 MHz bands are regulated for GSM/UMTS/LTE/WiMAX/IoT through reference to the respective ETSI harmonised standards in both ECC and EC frameworks (ECC DEC 06(13), EC Decision 2011/251/EU).

As detailed in Annex 1, 3GPP generally defined for NR non-AAS system transmit and receive characteristics (UE TS 38.101-1 [18] and BS TS 38.104 [19]) that are generally comparable to those defined for LTE (UE TS 36.101 [1] and BS TS 36.104 [22]) and used in compatibility analyses performed previously in CEPT e.g. CEPT Report, 40 and CEPT Report 41 and ECC Report 266. The only relevant difference identified is the NR higher spectrum utilisation for channel bandwidth (CBW) larger than 5 MHz.

Since the in-band and out-of-band e.i.r.p. of the NR signal transmitted by the NR non-AAS base station does not exceed the limits which apply to LTE carrier, the NR signal does not create more interference, to other services in the same band or to adjacent band services, than an LTE signal occupying the same bandwidth and transmitting at the same power.

Regarding other adjacent services, some studies within the ECC framework already considered the fact that the mobile service does not occupy fully its bandwidth. Therefore, although the overall in-band and out-of-band powers of the signal may not change for NR compared to LTE assuming the same CBW, the higher spectrum utilisation of NR in CBW greater than 5 MHz may be seen as additional source of interference by the victim receiver based on its ACS, in particular if the ACS of the victim receiver is not flat within the whole NR bandwidth. In the annex, it is however shown that the NR higher spectrum utilisation of NR channels larger than 5 MHz fulfils by far the required 200 kHz channel edge frequency separation. Comparing the impact of LTE 5 MHz with NR 5/10/15/20/25/30 MHz on adjacent services, it is concluded that the impact of NR is not greater than the one of LTE 5 MHz and LTE 1.4 MHz, 3 MHz. The available minimum guard band for each NR BS/UE CBW and sub-carrier spacing (SCS) is always larger than 200 kHz. This minimum guard band increases with the CBW and with SCS[2].

A review of relevant existing adjacent band compatibility studies is described in the following section following similar logic used in ECC Report 266 for the evaluation of 900/1800 MHz MFCN bands suitability for IoT.

3.2 INTRODUCTION OF AAS BS AND TRP-BASED EMISSION REQUIREMENTS

The analyses in this section apply to 1800 MHz frequency band but not to 900 MHz as non-AAS only is considered in the foreseeable future in 900 MHz frequency band.

CEPT Report 67 [20] was published in July 2018. Studies have been performed to understand and better quantify the behaviour of AAS systems.

It was concluded that LTE and 5G AAS BSs are similar from a compatibility standpoint.

As already stated in CEPT Report 67, considerable efforts have been made by 3GPP to assess the effects of the AAS unwanted emissions on other mobile networks and to identify the appropriate metric for their characterisation. The different characteristics of the AAS systems in comparison with traditional sector or omnidirectional antennas were analysed in detail. 3GPP RAN4 technical group has therefore been considering the following approaches for AAS:

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[2] See Annex 1 section A1.4 for the detailed table of minimum guard band for each NR BS/UE CBW and sub-carrier spacing (SCS)

- In case of AAS In the context of E-UTRA, the existing single transceiver conducted unwanted emission masks in TS 37.104 [27] are scaled for the multi transceiver AAS in accordance with a value N, where N is a function of the number of active transmitter units per cell/sector and is capped at the value of 8. This approach is to align the AAS requirements to be equivalent to a multi-transceiver 8 way MIMO non-AAS system and is described in Section 6.6.5 of TS 37.105 [26];
- In case of AAS in the context of 5G New Radio and LTE evolution, the unwanted emission masks are specified in TS 38.104 as over-the-air (OTA). Furthermore, the OTA emission limits are specified as TRP. This is because 3GPP studies have indicated that harmful interference to adjacent mobile systems is primarily dictated by the TRP (rather than the e.i.r.p.) of a base station in any given cell or sector.

The AAS work in 3GPP has been captured in the technical report TR 37.842 [29]. Analysis was done assuming fully correlated interference (same case as non-AAS), completely de-correlated interference and half way in between.

The throughput impact of emissions from an AAS network to a legacy (non-AAS) victim network was analysed using simulations for the specific class of antenna arrays with specific elements spacing (that is described in section 5.4 of 3GPP TR 37.842). Different correlation properties between transmitters were simulated and the level of the AAS unwanted emissions were varied in order to observe the effect of correlation and emissions level of an AAS on a legacy (non-AAS) victim network. With the simulation assumptions used for the studies, 100% correlation implies that the unwanted emissions are beam-formed in the same manner as the wanted signal. Such correlation is likely only in very basic AAS systems and was included to ensure all cases were studied. 0% correlation implies that the unwanted emissions are not beam-formed but are radiated with the individual antenna element pattern.

It was found that the aggressor (AAS BS) total radiated unwanted emissions power was directly proportional to the victim network throughput degradation, independently of the correlation and hence the spatial pattern of the unwanted emissions. The results of these studies showed that, the level of correlation (and hence the spatial pattern of the emissions) does not impact the coexistence performance. Simulations have shown that the TRP would be an appropriate metric in assessing harmful interference since it would be independent of the effect of correlation level.

In other words, different BS implementations may lead to the same impact on a given victim system, meaning that limiting the BS implementation would not bring any benefit to the victim system and would only lead to less flexible and less efficient antenna solutions. Hence, the requirements should be independent of the correlation level of the unwanted emissions.

Based on the above it can be concluded that the impact of introduction of AAS in 1800 MHz frequency band should be analysed only for BSs to other systems. There is no impact on UE to other systems.

3.3 OUTLINE OF TARGET REGULATORY FRAMEWORK

3.3.1 5G non-AAS system

3GPP generally defined for NR non-AAS system transmit and receive characteristics (UE TS 38.101-1 [18] and BS TS 38.104 [19]) that are generally comparable to those defined for LTE (UE TS 36.101 [1] and BS TS 36.104 [22]) and used in compatibility analyses performed previously in CEPT e.g. CEPT Report 40 [2], CEPT Report 41 [3] and ECC Report 266 [6]. The 5G non-AAS system characteristics are detailed in ANNEX 1: of this Report.

NR system will be covered by the NR Harmonised Standards: EN 301 908 part 24 [23] (NR BS) and EN 301 908 part 25 [24] (NR UE).

The only relevant difference identified between non-AAS LTE and NR is the NR higher spectrum utilisation for CBW larger than 5 MHz. There is also some apparent difference in BS reference sensitivity levels between NR and LTE. However, Annex 1 explains in detail that:

- The difference in sensitivity between NR and LTE is justified mainly by the difference in the Fixed Reference Channel definition used (Noise BW). However, the receiver performance could be considered roughly the same since for the same modulated BW, NR and E-UTRA sensitivity requirements are comparable (0.2 dB better performance for NR compared to LTE);

- The BS Noise figure used for both NR and E-UTRA is 5 dB.

Since the in-band and out-of-band e.i.r.p. of the NR signal transmitted by the base station does not exceed the limits which apply to LTE carrier, the NR signal does not create more interference, to other services in the same band or to adjacent band services, than an LTE signal occupying the same bandwidth and transmitting at the same power.

The only relevant difference is the NR higher spectrum utilisation for CBW larger than 5 MHz. However for these CBWs, the NR last in-band resources block edge to the NR channel edge is larger than the last in-band resource block of LTE 1.4, 3 and 5 MHz channels and always higher than 300 kHz. Therefore, the impact of NR due to adjacent receiver blocking capabilities is expected not to be larger than LTE 1.4, 3 and 5 MHz channels.

Therefore, the results from CEPT Report 40, CEPT Report 41 and ECC Report 266 for LTE and LTE + Guard Band NB-IoT can be extended to NR non-AAS system and the same technical conditions as defined today for LTE non-AAS system in ECC Decision (06)13 [1] should apply to NR non AAS-system in 900/1800 MHz bands.

3.3.2 LTE AAS and 5G AAS systems

AAS functionality as defined in 3GPP for lower bands apply to the BS side only. The same UE conducted parameters/requirements defined by 3GPP apply whether the BS is AAS or non-AAS.

Therefore, the conclusions of CEPT Report 40 [2] and ECC Report 266 [6] regarding compatibility of LTE UE with other systems in the 1800 MHz band still apply to AAS (LTE/NR) 1800 MHz system's UE.

5G NR AAS BS parameters are specified in TS 38.104 [19] for single RAT NR operation and are also reflected in TS 37.105 [26] for MSR NR BS. The LTE-AAS (LTE evolutions AAS) BS parameters are specified in TS 37.105.

NR AAS system will be covered by the ETSI Harmonised European Standards: EN 301 908 part 24 [23] (NR BS) and EN 301 908 part 25 (NR UE) [24].

LTE AAS system will be covered by the NR Harmonised Standards EN 301 908 part 23 (NR BS) [1]. The UE part of LTE is covered by ETSI EN 301 908-13 [25] which is the same as for non-AAS system.

As can be seen from ANNEX 2: below (where both NR-AAS and LTE-AAS parameters are detailed), the AAS RF requirements are comparable for both 5G NR AAS BS and LTE evolutions AAS BS. Therefore, in the rest of this ECC Report, it is referred to as AAS (LTE/NR) systems.

TS 37.105 [26] provides the background for defining OTA AAS BS requirements. It states that for OTA AAS BS there are no conducted requirements. The radiated requirements have been derived in 3GPP based on the principle that they offer the same level of performance and protection as the hybrid AAS BS requirements.

Therefore, the radiated requirements use the same equivalence as hybrid AAS BS. The non-AAS BS RF requirements have therefore been further adapted to apply to OTA metrics in the far field.

For AAS NR BS, the main Tx/Rx limits are defined over the air (OTA). These are derived based on scaling of existing basic (conducted) limits defined in NR TS 38.104 with a value X, where X = 9 dB, unless stated differently in regional regulation. This approach is described in sections 4.3.3 and 9.7 of TS 38.104.

TS 38.104 states that for AAS BS the transceiver unit array must contain at least 8 transmitter units and at least 8 receiver units. Transmitter units and receiver units may be combined into transceiver units. The transmitter/receiver units have the ability to transmit/receive parallel independent modulated symbol streams.

3GPP uses for AAS the assumption of equivalence with a non-AAS system with the same number of TRX's (capped to 8 TRX). The scaling factor of 8 corresponding to 9 dB (9 dB=$10\log_{10}(8)$) comes originally from the maximum number of MIMO TRX achievable in the LTE RAN1 requirements and transmission modes. Hence, as non-AAS requirements are all defined per TRX then AAS is equivalent to 8 non AAS TRX. This is mainly the basis of the scaling for main OTA absolute power requirements.

Some "relative" requirements are direct references to the non-AAS BS RF specifications e.g. 3GPP TS 36.104 [22] and 3GPP TS 37.104 [27]. Some co-location requirements which have been developed from assumptions on BS-to-BS coupling do not have direct OTA equivalents.

For LTE AAS BS the scaling factor used is a function of the number of active transmitter units for the whole antenna panel and is capped at the value of 8. This approach is described in section 6.6.5 of TS 37.105 [26].

3.3.3 Suitability for NR Supplemental Uplink Mode of Operation

NR systems in frequency bands 880–915 MHz and 1710–1785 MHz may operate in Supplemental uplink mode (SUL), i.e. NR Uplink operation without paired downlink NR spectrum (No paired transmissions from the BS to the UE in the same band). This corresponds respectively to 3GPP NR band n81 and NR band n80.

SUL operation in the 880-915 MHz and 1710-1785 MHz frequency bands is combined with NR downlink operation in other MFCN frequency bands than the 925-960 MHz and 1805-1880 MHz frequency bands. The NR UE technical characteristics for SUL mode of operation as specified in TS 38.101-1 are aligned with those of an NR FDD UE. In particular, the UE maximum output power (i.e. 23 dBm), the supported channel bandwidths and the unwanted emissions limits for SUL, 880–915 MHz and 1710–1785 MHz, are all the same as per the non-AAS MFCN UE in related FDD operation mode.

Therefore, sharing conditions between MFCN UL and adjacent services remains the same whether the SUL mode of operation or the FDD MFCN operation is used. Therefore the current harmonised framework for 900 MHz and 1800 MHz frequency bands is considered suitable for NR SUL mode of operation. This of course accounts for the fact that no AAS is considered at the NR UE side.

4 COEXISTENCE STUDIES

This section discusses the technical compatibility of NR technology and provides an overview of compatibility requirements in terms of:

- Compatibility with other in-band applications;
- Compatibility with other radio systems operating in adjacent bands.

4.1 IN-BAND COEXISTENCE

4.1.1 In-band coexistence for 5G non-AAS system in 900 MHz and 1800 MHz frequency bands

The coexistence between LTE and WiMAX/UMTS/GSM systems was analysed in CEPT Report 40 [2] based on an analogy with UMTS systems. This was completed by the analyses in ECC Report 266 regarding IoT systems compatibility with the systems above. Considering the case when LTE is used in combination with Guard band NB-IoT, the final conclusion was frequency separation of 200 kHz between the NB-IoT transmitted bandwidth and the edge of the LTE channel.

For the non AAS case 3GPP defined for NR BS and UE similar RF requirements as those defined for LTE non AAS.

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 is not using 1.4 or 3 MHz bandwidth.

LTE + Guard band NB-IoT operation could be compared to NR operation due to the higher spectrum utilisation for CBW >5 MHz.

Considering the fact that the same RF requirements (TX and RX) as for LTE were reused generally for NR and the fact that the frequency spacing between the NR transmitted BW and the edge of the NR channel is always >200 kHz, the results of CEPT Report 40 and ECC Report 266 [6] on the compatibility of LTE and LTE + Guard Band IoT systems with other systems in the same band (namely GSM, UMTS, LTE, WiMAX and IoT systems) can be extended to NR and the same technical regulatory conditions applicable to LTE should apply to ensure coexistence between NR non-AAS system and other systems in the same band.

4.1.2 In-band coexistence for 5G AAS system in 1800 MHz frequency bands

4.1.2.1 Co-existence between AAS (LTE/NR) system and GSM/UMTS

The coexistence between LTE-non-AAS and GSM systems was analysed in CEPT Report 40 [2] based on an analogy with UMTS systems.

Similar methodology is followed here for AAS (LTE/NR) systems based on an analogy between AAS (LTE/NR) and LTE-non-AAS and taking into account the assumption of equivalence based on 8 TRX considered in 3GPP to derive the main absolute OTA RF requirements (AAS BS) based on conducted RF requirements (non-AAS BS).

Downlink ACIR from AAS (LTE/NR) to GSM/UMTS DL

AAS (LTE/NR) ACLR/200 kHz at 300 kHz frequency separation from the channel edge are calculated from the BS spectrum mask, assuming the principle of equivalence with a non-AAS-BS with 8 TRX used in 3GPP to derive both BS Transmit power and OBUE for AAS (LTE/NR) BS.

The calculation of GSM ACS values at different frequency offsets is described in Annex 3 of CEPT Report 40. These ACS values are considered to be applicable here for coexistence with LTE/NR system.

Then ACIR was calculated in CEPT Report 40 [2] with the formula below:

ACIR = 1/{1/ BS ACLR + 1/GSM MS ACS }

This formula is reused here:

ACIR = 1/{1/AAS BS ACLR + 1/GSM MS ACS }

The ACLR of the AAS (LTE/NR) BS is calculated based on the AAS(LTE/NR) OTA TX power (A2.2) and the AAS(LTE/NR) OTA OOBE (A2.4).

As detailed in 4.1.2.2, 3GPP conducted simulations in TR 37.840 [1] and TR 37.842 [29], that show that Cell average and 5% CDF throughput loss caused by aggressor AAS Legacy victim are consistent with that caused by legacy LTE-non-AAS BS to Legacy BS with the same ACLR.

It is further explained in 3.3.2 and detailed in ANNEX 2: of this Report, for AAS NR BS, the main OTA absolute TX/RX limits including OTA TX power and OTA OOBE are defined over the air (OTA). These are derived based on scaling of existing basic (conducted limits for non-AAS BS with 1 TRX) limits defined in NR TS 38.104 [19] with a value X, where X = 9 dB, unless stated differently in regional regulation. This approach is described in section 4.3.3 and 9.7 of TS 38.104. Since the same scaling factor of 9dB applied to both the AAS (LTE/NR) BS Transmit power and to its OBUE the ACLR/(200 kHz) at 300 kHz can be considered as equivalent to the ACLR for LTE-non-AAS BS and is equal to 50dB (43dBm+9dB-(-7dB (OOBE integrated over 200 kHz)+9dB)) (see also CEPT Report 40, section 7.1.1).

Table 3: AAS (LTE/NR) BS ACLR/(200 kHz) at 300 kHz frequency separation from channel edge

	BS ACLR (dB/(200 kHz))	GSM MS ACS (dB)	ACIR (dB)
AAS (LTE/NR) (5 MHz)	50	68.7	49.9
AAS (LTE/NR) (10 MHz)	50	78.7	50.0
AAS (LTE/NR) (15 MHz)	50	78.7	50.0
AAS (LTE/NR) (20 MHz)	50	78.7	50.0

It can be seen from the table above that the ACIR from AAS (LTE/NR) BS to GSM DL is dominated by AAS (LTE/NR) BS ACLR, the contribution from GSM ACS to ACIR is negligible.

Similar analyses are provided here for UMTS.

Table 4: BS ACLR/3.84 MHz at 2.5 MHz frequency separation from channel edge

	BS ACLR (dB/(3.84 MHz))	UMTS UE ACS (dB/(3.84 MHz))	ACIR (dB/(3.84 MHz))
LTE (5 MHz)	48.6	33	32.9
LTE (10 MHz)	48.6	33	32.9
LTE (15 MHz)	48.6	33	32.9
LTE (20 MHz)	48.6	33	32.9

The ACLR of AAS (LTE/NR) BS has been calculated from the OTA related spectrum mask, GSM/UMTS ACS.

The derived ACIR from AAS (LTE/NR) to GSM and UMTS DL are similar to those calculated for LTE-Non-AAS. Therefore, it is assumed that the conclusions from CEPT Report 40 t apply regarding the necessary frequency separation between LTE and GSM/UMTS.

Uplink ACIR from AAS (LTE/NR) UE to GSM/UMTS

The UE ACLR/200 kHz at 300 kHz frequency offset from the channel edge for AAS (LTE/NR) system is the same as for LTE-non-AAS system. Indeed, the AAS feature is only applicable to the BS. Therefore, the same conclusions from CEPT Report 40 [2] apply for compatibility between AAS (LTE/NR) Uplink and GSM/UMTS.

Interference from GSM to AAS (LTE/NR)

The coexistence between LTE-non-AAS and GSM systems was analysed in CEPT Report 40 [2] based on an analogy with UMTS systems. However, the UMTS and GSM co-existence study results given in 3GPP Report TR 25.816 [30] and ECC Report 82 [9] show that the dominant factor of interference from GSM to UMTS is the UMTS BS and UE receiver blocking performance.

Comparison between AAS(LTE/NR) system and LTE systems narrowband blocking for BS and UE :

As could be seen from Annex 2 the OTA narrowband blocking of AAS LTE BS is defined as:

Table 5: OTA narrowband blocking of AAS LTE BS

	Wanted signal mean power [dBm] (Note 1)	Interfering signal mean power [dBm]	Type of interfering signal
Wide Area BS	EISREFSENS + 6 dB	-49 – ΔOTAREFSENS	See table 10.5.4.2-2 of TS38.104 [19]
	EISminSENS + 6 dB	-49 – ΔminSENS	
Medium Range BS	EISREFSENS + 6 dB	-44 – ΔOTAREFSENS	See table 10.5.4.2-2 of TS38.104 [19]
	EISminSENS + 6 dB	-44 – ΔminSENS	
Local Area BS	EISREFSENS + 6 dB	-41 – ΔOTAREFSENS	See table 10.5.4.2-2 of TS 38.104 [19]
	EISminSENS + 6 dB	-41 – ΔminSENS	
Note 1: EISREFSENS and EISminSENS depend on the RAT, the BS class and on the channel bandwidth, see subclauses 10.3 and 10.2 of TS 38.104 [19].			

TS37.105 [26] provides the following definitions for these Δ:

- ΔminSENS = PREFSENS – EISminSENS
- ΔOTAREFSENS = PREFSENS - EISREFSENS

As it can be seen, the interference signal mean power is tested over 2 points. One that is shifted by ΔOTAREFSENS and the second shifted by ΔminSENS compared to LTE non AAS Interfering signal mean power.

The relative wanted signal mean power defined for LTE AAS BS is respectively a function of EISREFSENS and EISminSENS and is also shifted by the same ΔOTAREFSENS and ΔminSENS compared to LTE non AAS relative wanted signal mean power.

Therefore, provided the following comparison between Narrowband blocking definition for LTE-AAS and LTE non-AAS BS:

- The testing wanted and interfering signals power for LTE-AAS BS narrowband blocking are shifted by the same Δ compared to LTE-non-AAS case (relative value is the same);
- the same desensitisation value (6 dB) is used for AAS and non-AAS;
- generally comparable Interfering RB centre frequency offset to the lower/upper Base Station RF Bandwidth edge and types of interfering signals are used for AAS and non-AAS.

It can be concluded that the rejections (ACS relative) of the AAS LTE BS receiver at 300 kHz frequency offset derived from narrowband blocking is the same as for LTE-non-AAS BS.

Regarding NR AAS BS as explained in detail in Annex 2, there are some apparent differences in the absolute value for the Reference sensitivity level defined for NR AAS BS in TS 38.104 [19] compared to LTE in TS37.104 [27] for CBW >15 MHz. However, the AAS NR BS receiver performance could be considered to be essentially the same as for AAS LTE since for the same modulated BW, AAS NR and AAS LTE sensitivity requirements are comparable (0.2dB better performance for NR compared to LTE). The difference is only due to:

- Different Fixed Reference Channels defined for NR and for LTE in particular the noise bandwidth of the FRC changes as explained below;
- Small differences in the required SNR for demodulation – this is a minor effect 0.2dB better NR performance compared to LTE for same FRC BW.

The AAS (LTE/NR) and LTE non-AAS BS receiver rejections derived from the narrowband blocking characteristics defined in 3GPP technical specifications were compared above. Based on this the AAS LTE and AAS NR receiver rejection could be considered as equivalent for the same modulated bandwidth at a 300 kHz frequency offset from the LTE/NR channel edge.

The narrowband blocking levels and related receiver rejection for the UE in AAS (LTE/NR) system is comparable to LTE UE.

Therefore, based on the above UE and BS narrowband blocking analyses, it can be concluded that, similar to LTE-non-AAS, a recommended frequency separation of 300 kHz between GSM carrier frequency and AAS (NR/LTE) channel edge can be proposed, or alternatively 200 kHz separation between GSM and AAS (LTE/NR) channel edges.

Interference from GSM to AAS (LTE/NR)

3GPP TR 37.840 does not contain any results on interference from UMTS to AAS (LTE/NR). However, UMTS is not a worse interferer than LTE-non-AAS itself, so the results of interference between LTE-non-AAS and AAS (LTE/NR), in the section below, are sufficient to show that UMTS will not cause excessive interference to AAS (LTE/NR).

Conclusion

Following the observations above, and considering:

- that OOBE requirements and narrowband blocking requirements of AAS (LTE/NR) were derived based on the principle of equivalence between AAS system with non-AAS system with the same number or TRX's (capped at 8);
- that based the above analyses of ACLR and blocking, the same technical conditions are understood to should apply for coexistence between AAS (LTE/NR) and UMTS/LTE systems;
- that for NR system the minimum CBW is 5 MHz and the minimum guard band between the last transmitted RB and the edge of the operating channel is always higher than 200 kHz.

As a consequence, there is a need for a frequency separation of 200 kHz or more between the NR/LTE AAS channel edge and the GSM carrier's channel edge. This requirement is already fulfilled by the NR AAS specification due the channel characteristics of NR (5 MHz or above channel bandwidth) and related minimum guard band as defined in 3GPP specifications.

Similarly to LTE non-AAS, there is also no need for frequency separation between NR/LTE AAS channel edge and the UMTS carrier's channel edge.

4.1.2.2 Co-existence between two AAS (LTE/NR) systems and between an AAS (LTE/NR) system and an LTE/NR-non-AAS systems at 1800 MHz

The co-existence between AAS (LTE/NR) system and LTE/NR-non-AAS (Legacy passive Antenna System) systems has been studied at 2 GHz. The simulations assumptions and results are reported in AAS study item TR 37.840 [1] and AAS work item TR 37.842 [29].

These simulations results are based on the assumption of a 10 MHz aggressor system, and 10 MHz victim system, 2 GHz frequency band was used in the simulations and macro cells (cell range 750 m) in an urban area with uncoordinated deployment.

To define ACLR value for AAS BS system simulations evaluated the downlink average and 5% CDF throughput loss of the victim system while coexisting with the adjacent system by varying ACLR value.

Simulation cases as shown in the table below were applied for evaluating in-band blocking and ACLR for AAS BS:

Table 6: Simulation cases for in-band blocking in TR 37.840 [1]

Case	Aggressor	Victim	Simulated link	Statistics
1-a	Legacy E-UTRA Macro system	AAS E-UTRA Macro system	Uplink	Interferer levels at victim BS
1-b	AAS E-UTRA Macro system	AAS E-UTRA Macro system	Uplink	Interferer levels at victim BS
1-c (Baseline)	Legacy E-UTRA Macro system	Legacy E-UTRA Macro system	Uplink	Interferer levels at victim BS

Table 7: Simulation cases for ACLR in TR 37.840 [1]

Case	Aggressor	Victim	Simulated link	Statistics
1-a	AAS E-UTRA Macro system	Legacy E-UTRA Macro system	Downlink	Throughput loss
1-b	AAS E-UTRA Macro system	AAS E-UTRA Macro system	Downlink	Throughput loss
1-c (Baseline)	Legacy E-UTRA Macro system	Legacy E-UTRA Macro system	Downlink	Throughput loss

Based on the above simulation in TR 37.840, 3GPP concluded that Cell average and 5% CDF throughput loss caused by aggressor AAS Legacy victim are consistent with that caused by legacy non-AAS BS to Legacy non-AAS BS with the same ACLR (per connector) assumption of 45 dB.

3GPP also concluded based on the preliminary simulations above for a single column AAS system that the blocking power level for each individual receiver channel of the AAS system was similar to the in-band blocking level for a legacy BS installed with an assumed typical reference passive antenna array.

On top of the above simulations, a downlink co-existence simulation campaign was performed by 3GPP in TR 37.842 [29] with the objective of establishing whether the radiated adjacent channel emissions pattern for an AAS BS aggressor system, which differs from a non-AAS BS aggressor system, impact co-existence

KPIs such as mean and 5th percentile throughput losses in the context of the co-existence simulation framework of 3GPP TR 25.942 [31].

Co-existence characteristics were studied in a macro scenario in which cell specific beamforming was performed. This scenario is directly comparable with the simulations performed when deriving the existing LTE-non-AAS ACLR and ACS requirements as outlined in 3GPP TR 36.942 [1].

Cell specific beamforming creates static patterns of interference that differ between AAS BS and non-AAS BS. Other types of beamforming, such as user specific beamforming create patterns which are time varying and are composed of intermodulation between multiple beams. Cell specific beamforming thus represents worst-case spatial interference behaviour, since its radiated pattern is not averaged across multiple beams or in time.

Besides, an uplink simulation was performed by 3GPP with the objective of establishing blocking levels that are likely to be encountered by an AAS BS victim system within the context of the 3GPP TR 36.942 framework. The blocking simulations were performed using the same system scenario as that used to derive the legacy LTE-non-AAS blocking requirements.

Table 8: Simulation cases for ACLR in TR 37.842 assuming Horizontal/vertical cell splitting

Case	Aggressor	Victim	Simulated link	Statistics	Target RF requirement
1a_1	AAS E-UTRA Macro system: Horizontal cell splitting;	Legacy E-UTRA Macro system: no cell splitting;	Downlink	Throughput loss	ACLR
1a_2	AAS E-UTRA Macro system: Vertical cell splitting;	Legacy E-UTRA Macro system: no cell splitting;	Downlink	Throughput loss	ACLR
1b_1	AAS E-UTRA Macro system: Horizontal cell splitting;	AAS E-UTRA Macro system: Horizontal cell splitting;	Downlink	Throughput loss	ACLR
1b_2	AAS E-UTRA Macro system: Vertical cell splitting;	AAS E-UTRA Macro system: Vertical cell splitting;	Downlink	Throughput loss	ACLR
1c(Baseline)	Legacy E-UTRA Macro system	Legacy E-UTRA Macro system	Downlink	Throughput loss	ACLR

Table 9: Simulation cases for In-band blocking in TR 37.842 [29] assuming Horizontal/vertical cell splitting

Case	Aggressor	Victim	Simulated link	Statistics	Target RF requirement
2a	Legacy E-UTRA Macro system	AAS E-UTRA Macro system: Horizontal cell splitting	Uplink	Interferer levels at victim BS	In-band blocking
2b (Baseline)	Legacy E-UTRA Macro system	Legacy E-UTRA Macro system	Uplink	Interferer levels at victim BS	In-band blocking

Table 10: Simulation cases for ACLR in TR 37.842 [29] assuming UE beamforming

Case	Aggressor	Victim	Simulated link	Statistics	Target RF requirement
3a	AAS E-UTRA Macro system: UE beamforming	AAS E-UTRA Macro system: UE beamforming	Downlink	Throughput loss	ACLR
3b	AAS E-UTRA Macro system: UE beamforming	Legacy E-UTRA Macro system	Downlink	Throughput loss	ACLR
3c	Legacy E-UTRA Macro system	AAS E-UTRA Macro system: UE beamforming	Downlink	Throughput loss	ACLR
3d (Baseline)	Legacy E-UTRA Macro system	Legacy E-UTRA Macro system	Downlink	Throughput loss	ACLR

Based on these simulations it was concluded that in all of the cell and user specific scenarios that were modelled, the spatial pattern of an AAS BS aggressor system did not increase the mean or 5th percentile throughput loss in the victim system beyond what is experienced with a passive system. Therefore, it is concluded that the existence of a different spatial distribution of adjacent channel interference that arises from an AAS BS compared to non-AAS BS does not necessitate any additional type of requirement.

Furthermore, the simulations indicated that the existing relative ACLR requirement of 45 dB can be applied per transceiver or across all transceivers for an AAS BS.

Therefore, for AAS (LTE/NR) BS in single RAT E-UTRA operation in TS 37.105 [26], the OTA ACLR limits were defined by 3GPP as ratio of the total wanted signal power at all TAB connectors to the total power at all connectors of adjacent channel power and correspond to 45 dBc which is the same as the requirement specified in 3GPP TS 36.104 [22] for LTE-non-AAS and TS 38.104 [19] for NR-non-AAS per antenna connector.

For AAS (LTE/NR) the ACLR absolute limits from LTE-non-AAS and NR-non-AAS were replaced by OTA values that are scaled with a factor of 9 dB (considering 8 TRX for AAS BS). Indeed the non-AAS requirement forms a basic limit, which is scaled up to an AAS BS requirement according to the number of active transceiver units, up to a maximum 8 for AAS BS. This is detailed below in ANNEX 2 of this Report.

Besides, it was concluded based on the above simulations that the minimum ACS requirements for the AAS BS are specified to correspond to the wanted signal power and adjacent channel signal power at the transceiver array boundary using the same: adjacent channel signal types, interfering signal power levels, wanted signal power levels, and test configuration for target throughputs as the non-AAS BS adjacent channel selectivity requirements in 3GPP.

Based on the above compatibility results from 3GPP there is no need for frequency separation between NR/LTE AAS system and NR/LTE non-AAS neighbouring network in 900/1800 MHz frequency bands. The same applies for NR/LTE 1800 MHz AAS coexistence with neighbouring LTE/NR 1800 MHz whether it is AAS or non AAS.

4.1.2.3 Co-existence between AAS (LTE/NR) systems and IoT systems

Generally speaking for In-band coexistence it is the systems relative ACLR performance which dominates interference to adjacent systems.

This can be seen if the unwanted emission mask (UEM) for LTE (ref: TS 37.104 [27], Table 6.6.4.1-1) is taken

Table 11: Unwanted emission mask (UEM) for LTE (ref: TS 37.104 [27], Table 6.6.4.1-1)

Frequency offset of measurement filter -3dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Minimum requirement (Note 1, 2)	Measurement bandwidth (Note 7)
0 MHz ≤ Δf < 0.2 MHz	0.015 MHz ≤ f_offset < 0.215 MHz	-14 dBm	30 kHz
0.2 MHz ≤ Δf < 1 MHz	0.215 MHz ≤ f_offset < 1.015 MHz	$-14dBm-15\cdot\left(\frac{f\_offset}{MHz}-0.215\right)dB$ (Note 4)	30 kHz
(Note 6)	1.015 MHz ≤ f_offset < 1.5 MHz	-26 dBm (Note 4)	30 kHz
1 MHz ≤ Δf ≤ min(Δfmax, 10 MHz)	1.5 MHz ≤ f_offset < min(f_offsetmax, 10.5 MHz)	-13 dBm (Note 4)	1 MHz
10 MHz ≤ Δf ≤ Δfmax	10.5 MHz ≤ f_offset < f_offsetmax	-15 dBm (Note 4, 8)	1 MHz

If this is normalised to 30 kHz the following is obtained:

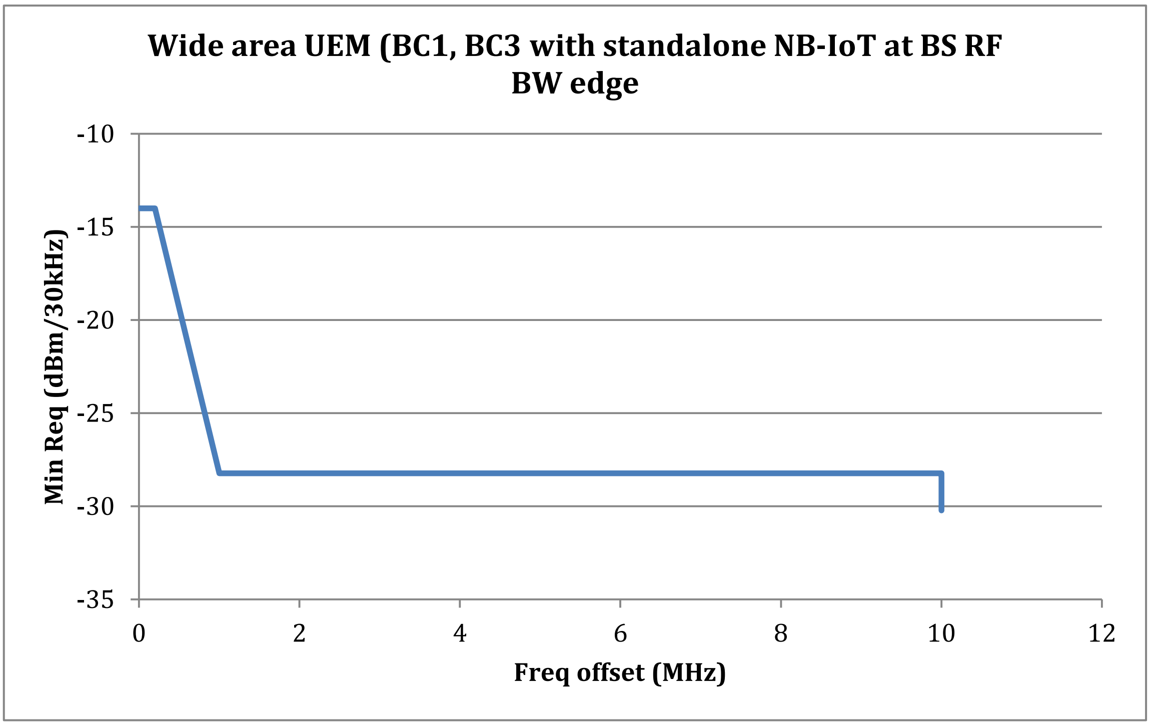

Figure 1: Wide area UEM

For a 10 MHz channel the average power in the adjacent channel is approximatively -26.5 dBm/(30 kHz) or -11.3 dBm/MHz in 1 MHz.

This is higher than the ACLR requirement of 45 dBc (or -13 dBm/MHz), and hence the ACLR dominates.

The purpose of the UEM mask is to ensure that the distribution of the adjacent channel power is appropriate across the adjacent channel.

An AAS BS with for example 43 dBm output power will therefore emit exactly the same adjacent channel emissions as a non-AAS system of the same output power. This is irrespective of the number of non-AAS transceivers as the dominant requirement is the relative requirement.

It has been shown in 3GPP compatibility studies that the effect on adjacent network throughput for an AAS system is the same as that for a non-AAS system with the same ACLR performance.

It is also important to note that for NR the minimum channel bandwidth is 5 MHz and that the guard band between NR transmission bandwidth and the operating channel edge is always higher than 200 MHz.

It can therefore be concluded that the NR/LTE AAS system will provide the same level of co-existence with NB-IoT, LTE MTC/eMTC and EC-GSM-IoT, as for an LTE non-AAS system. In particular:

For NB-IoT:

- Standalone mode: A frequency separation of 200 kHz or more between the standalone NB-IoT channel edge of one network and the NR/LTE AAS channel edge of the neighbouring network;
- In-band mode: No specific requirements for NR/LTE AAS system in addition to LTE non-AAS system[3] and the applicable harmonised standards;
- Guard band mode: A frequency separation of 200 kHz or more 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);

For LTE MTC/eMTC: No specific requirements for NR/LTE AAS system in addition to LTE non-AAS system and the applicable harmonised standards.

For EC-GSM-IoT: No specific requirements for NR/LTE AAS system in addition to GSM[4] and the applicable harmonised standards.

4.2 ADJACENT BAND COEXISTENCE

4.2.1 Adjacent band coexistence for 5G non-AAS system in 900 MHz and 1800 MHz frequency bands

The sections below address compatibility studies between NR systems and adjacent services/applications in particular in the 900 MHz frequency band, however the same justification and rational applies to compatibility for 1800 MHz frequency band with adjacent systems.

4.2.1.1 Interference of 5G non-AAS system into adjacent services in 900 MHz and 1800 MHz frequency bands

The coexistence between LTE and relevant adjacent services was analysed in CEPT Report 41 [3] based on an analogy with UMTS systems. The report covers the following systems.

900 MHz adjacent systems: GSM-R/E-GSM-R, PMR/PAMR, Aeronautical Radionavigation (DME/L-DACS), Aeronautical Mobile Service Communication systems and MIDS (Military NATO)

1800 MHz adjacent systems: DECT, MetSat/Fixed-Telemetry (Weather Satellite, Defence), radio microphones and Fixed Services.

[3] Frequency separation requirements on LTE as defined in ECC Report 266

[4] Frequency separation requirements on GSM as defined in ECC Report 266

This was completed by the analyses in ECC Report 266 [6] regarding IoT systems. Considering the case when LTE is used in combination with guard band NB-IoT, the final conclusion was a frequency separation of 200 kHz between the NB-IoT Transmitted bandwidth and the edge of the LTE channel.

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.

More particularly regarding 900 MHz, as shown in the figure below:

- MFCN band: UL occupies 880-915 MHz and DL occupies 925-960 MHz;
- GSM-R DL occupies 921-925 MHz.

Unlicensed SRDs occupy the 915-919.4 MHz band (see Decision (EU) 2018/1538 [62]).

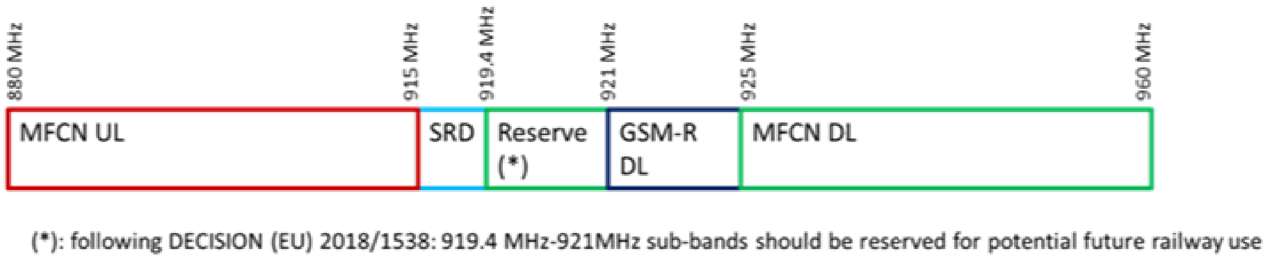

Figure 2: Frequency arrangement in 880-960 MHz

915-919.4 MHz is regulated as an unlicensed band and is used by multiple applications: RFID, SRDs 100 mW, SRDs 25 mW, ALD, etc. [33].

Based on the addendum report [34] to CEPT Report 59, it is clearly stated that:

“Article 3 of Commission Implementing Decision (2006/771/EC [35] latest amended by 2013/752/EU [1]) on harmonisation of the radio spectrum for use by short-range devices requires that “Member States shall designate and make available, on a non-exclusive, non-interference and non-protected basis, the frequency bands for the categories of short-range devices, …”.

Article 2 of this Decision defines that “’non-interference and non-protected basis’ means that no harmful interference may be caused to any radio communications service and that no claim may be made for protection of these devices against harmful interference originating from radio communications services.”

In addition, it is highlighted in recital-3 of EC Decision 2006/771/EC that “… radiocommunications services, as defined in the International Telecommunications Union Radio Regulations, have priority over short-range devices and are not required to ensure protection of particular types of short-range devices against interference.”

Based on this principle, ECC Report 246 has not studied the interference from the 900 MHz cellular systems (GSM/UMTS/LTE) to SRDs (RFID, WAN NBN, etc.), but studied only the interference from SRDs (RFID, WAN NBN, etc.) to the cellular systems uplink. In the ECC Report 246 on the interference from SRDs to cellular system, LPWAN was not considered.

In the particular case of LTE/WiMAX DL and GSM-R DL coexistence at 925 MHz, according to CEPT Report 41 [3], the frequency separation between the nearest GSM-R channel centre frequency and LTE/WiMAX channel edge should be at least 300 kHz (200 kHz between channel edges).

In order to analyse the impact of NR on adjacent services, interference from NR out-of-band emissions and blocking impact of the victim receiver in adjacent bands should be considered.

Regarding the impact of out-of-band emissions of NR, as stated previously, the out-of-band emission of NR are generally similar to OOB emission of LTE thus there is no additional impact on adjacent services from NR system.

With respect to the blocking impact of the victim receiver, it was highlighted previously that the distance (offset) from the last NR RB edge and edge of the NR CBW >5 MHz is larger than the last in-band resource block of LTE 1.4, 3, 5 MHz channels (and is at least 242.5 kHz for the 5 MHz channel). Therefore, the impact of NR due to adjacent receiver blocking capabilities is not larger than LTE 1.4, 3, 5 MHz channels.

Based on the above analyses the results of CEPT Report 41 and ECC Report 266 on the compatibility of LTE and LTE + Guard Band IoT systems with adjacent systems in 1800/900 MHz bands can be extended to NR non-AAS systems and the same technical regulatory conditions applicable to LTE should apply to ensure compatibility with NR non-AAS.

4.2.1.2 Interference of adjacent services into 5G non-AAS system in 900 MHz and 1800 MHz frequency bands

The co-existence between LTE 900 and GSM-R at 925 MHz was described in CEPT Report 41 [3]. 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.

In ECC Report 246 [33], the interference from all SRDs (Wideband IoT 802.11ah, RFID, ALD, generic SRDs 25 mW) operation in 915-921 MHz to cellular system (GSM/UMTS/LTE) uplink below 915 MHz was studied with Monte-Carlo simulations. But NR system was not specified at that stage.

The simulation results show that the cellular system data service capacity/throughput loss caused by SRDs/IoT operations above 915 MHz depends on the SRD/IoT devices density and duty cycle. Under the assumption that SRDs operate at their regulatory duty cycle limits and high density as assumed, cellular system uplink capacity/throughput loss can be more than 20%.

Given that the receiver characteristics of NR are similar to those of LTE receivers (See Annex 1), it is expected that the behaviour of both receivers is the same and therefore the results of CEPT Report 41 for LTE should apply to NR non-AAS system and potential interference from adjacent systems to 900/1800 MHz NR would be similar to LTE.

4.2.2 Adjacent band coexistence for 5G AAS system in 1800 MHz frequency bands

In this section, generally similar methodology as the one used in CEPT Report 41 has been used to evaluate compatibility between LTE-non-AAS systems and adjacent systems.

4.2.2.1 Compatibility study between LTE/WiMAX 1800 and DECT

Figure 3: DECT frequency band is adjacent to 1800 DL

As shown in the figure above, the DECT frequency band 1880-1900 MHz is adjacent to the AAS (LTE/NR) 1800 downlink block 1805-1880 MHz band. The adjacent band compatibility study was intensively studied between DECT and LTE-non-AAS in CEPT Report 41 [3]. The adjacent band compatibility study between DECT and DCS1800 is described in ERC Report 31 [37], ERC Report 100 [1] and ECC Report 146 [8].

In order to evaluate the interference from the mobile system onto the DECT system, all previous studies assumed 5 MHz channel.

Similar methodology as the one used in CEPT Report 41 [3] for LTE/DECT compatibility will be followed here for AAS (LTE/NR).

The upper AAS (LTE/NR) carrier centred onto 1877.5 MHz and the lowest DECT channels are considered, since this configuration represents the worst case in terms of coexistence in line with the previous simulations.

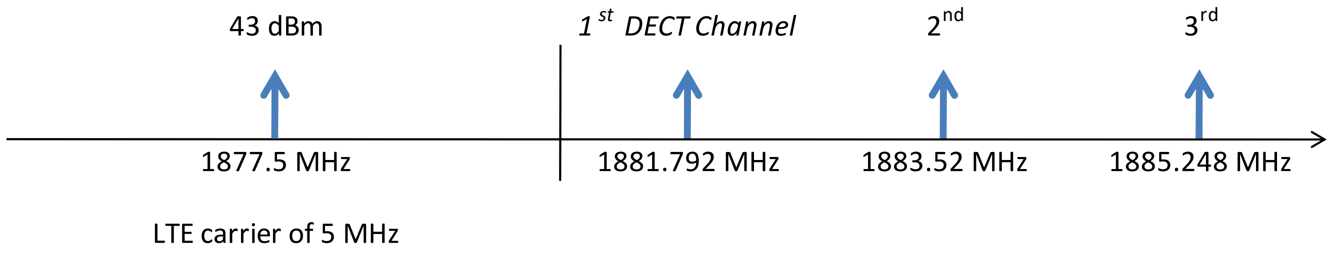

Figure 4: Channels under consideration

The interference is evaluated by calculating ACS and ACLR figures in a similar manner to the methodology used in CEPT Report 41 to analyse compatibility between LTE/WiMAX non AAS and DECT systems.

In the following, the evaluation of the DECT blocking response and the AAS (LTE/NR) 1800 unwanted emissions will be assessed through respectively the DECT ACS and AAS (LTE/NR) OTA ACLR figures.

<u>ACS figures for DECT derived from CEPT Report 41</u>

CEPT Report 41 [3] derived approximate DECT ACS figures for a 5 MHz LTE interferer at 1877.5 MHz. The DECT adjacent channel closest to the LTE block is at 1880.064 MHz. The first DECT adjacent channel within the LTE block is at 1878.236 MHz (see Figure 3). This adjacent channel was used to derive the ACS figures in the following table:

Table 12: DECT ACS figures related to an LTE interferer

DECT carrier	ACS figures (dB) related to 5 MHz LTE at 1877.5 MHz
F9	45
F8	51
F7 – F0	58

These figures same ACS figures can be reused and are valid for AAS (LTE/NR) 5 MHz channels.

ACLR figures for AAS (LTE/NR) derived from TS 37.105:

The ACLR figures for AAS (LTE/NR) related to a 1 MHz wide DECT receiver are shown in the following table. The AAS BS OTA TX power of 52 dBm was derived based on scaling of the LTE-non-AAS BS Transmit power of 43 dBm from CEPT Report 40 [2]scaled by a factor of 9 dB to account for the equivalence with a non-AAS system of 8TRX as explained in section 3.3.2 and section A2.2 of this Report based on 3GPP:

Table 13: AAS (LTE/NR) OTA ACLR related to a DECT 1 MHz receiver

DECT carrier	AAS (LTE/NR) OTA Out of band/block interference level	AAS (LTE/NR) OTA ACLR figures (dB) related to a 1 MHz DECT receiver and BS OTA/Radiated Tx power 52 dBm
F9 (1881.792 MHz)	-4 dBm/MHz	56
F8 (1883.52 MHz)	-4 dBm/MHz	56
F7 (1885.248 MHz)	-4 dBm/MHz	56
F6-F5	-4 dBm/MHz	56
F4 (1890.432 MHz)	-30 dBm/MHz	82
F3-F0	-30 dBm/MHz	82

For AAS (LTE/NR) BS 5 MHz option the ACLRs for F9-F5 is derived from TS37.105 [26], Table 9.7.5.2.3-1"Wide Area operating band unwanted emission mask (UEM) for BC2 for BS not supporting NR or BS supporting NR in band n3 or n8. For F4-F0 the unwanted emission limit in the spurious domain is defined in ERC Recommendation 74-01.

Comparing DECT ACS and AAS (LTE/NR) OTA ACLR figures

The table below compares DECT ACS and AAS (LTE/NR) OTA ACLR:

Table 14: Comparing ACLR and ACS

DECT carrier	DECT ACS (dB)	LTE non AAS ACLR (dB)	AAS (LTE/NR) OTA ACLR (dB)
F9	45	56	56
F8	51	56	56

DECT carrier	DECT ACS (dB)	LTE non AAS ACLR (dB)	AAS (LTE/NR) OTA ACLR (dB)
F7-F5	58	56	56
F4-F0	58	82	82

Conclusions for DECT:

AAS (LTE/NR) and LTE-non-AAS interferers effect is similar in the sense that blocking of DECT dominates except for three DECT carriers F7-F5.

In previous GSM studies in ERC Report 100 [1] and ECC Report 146 [8] this was not considered to be a problem as it has been assumed that DECT by its DCS provision is able to detect possible harmful interference on carriers close to the band edge and escape to a less interfered carrier. Similar conclusions were made for compatibility with LTE non-AAS in CEPT Report 41.

Therefore, the following relevant conclusions from previous studies (CEPT Report 41 [3], ERC Report 100 [1] and ECC Report 146 [8]) are considered applicable to AAS (LTE/NR) systems operating in 1800 MHz frequency band:

- No guard band is required between AAS/5G NR 1800 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 LTE/WiMAX1800 BS and UE is not a problem;
- When pico-cellular AAS/5G NR 1800 BS is deployed inside of the building in co-existence with DECT RFP and PP deployed in the same building indoor area, some potential interference is likely to exist from indoor pico-cellular BS to DECT if they are placed too close and they are operating in the adjacent channel at 1880 MHz;
- The following interference mitigation techniques could be used to address the potential interference from indoor pico-cellular BS to indoor DECT RFP and PP when they are operating at the adjacent frequency point of 1880 MHz (ECC Report 96):
  - Space separation between indoor pico-cell AAS/5G NR BS and DECT RFP or PP of 65 m or more;
  - Avoiding the adjacent frequencies of 1880 MHz for indoor pico-cellular AAS/5G NR 1800 BS and DECT or operate with reduced transmitting power if necessary.

In term of interference analysis, 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.

4.2.2.2 Compatibility consideration between AAS (LTE/NR) 1800 and MetSat

Meteorological satellite service (Space-to-earth) system characteristics are described in Recommendation ITU-R SA.1158 [39]. The main system parameters of the meteorological satellite system operating in the frequency range 1698-1710 MHz are summarised in Table 32 of CEPT Report 41 [3].

The MetSat operating frequency range of 1700-1710 MHz is adjacent to the AAS (LTE/NR) 1800 uplink frequency block at 1710-1785 MHz.

From the frequency arrangement between MetSat and AAS (LTE/NR) systems, the possible interference scenario is the interference from AAS (LTE/NR) system UE into MetSat Earth Station receivers.

CEPT Report 41 concluded that the interference from LTE/WiMAX1800 UE to MetSat Earth Stations operating in adjacent frequency band is unlikely to be a problem.

The potential interference from MetSat DL to LTE/WiMAX1800 UE was not covered in past studies and was left for future further study if it appears necessary.

<u>Conclusions</u>

AAS technology applies to BS side only and does not impact the UE characteristics. Besides the adjacent channel leakage power of 5G NR UE is in the same range as for legacy LTE UE.

The MetSat Earth stations have been adjacent to GSM 1800 and LTE 1800 MHz for many years, and have not experienced interference from GSM MS or LTE UE transmissions therefore the interference from AAS (LTE/NR) systems UE to MetSat Earth Stations operating in adjacent frequency band is unlikely to be a problem.

4.2.2.3 Compatibility consideration between AAS (LTE/NR) and Radio microphones

Radio microphone system characteristics are described in ERC Report 063 [40], ERC Recommendation 70-03 [41], ETSI Harmonised European Standard EN 300 422 [42] and CEPT Report 41 (Table 33) [3].

Interference analysis between GSM1800 and Radio Microphones operating in adjacent frequency bands was described in ERC Report 063. Interference analyses between LTE/WiMAX 1800 and Radio Microphones was described in CEPT Report 41.

Similar interference analysis methodology can be re-used for AAS (LTE/NR) 1800 and Radio Microphones compatibility. The conclusion of the interference analysis between LTE/WiMAX (non AAS) 1800 and Radio Microphones was that the 700 kHz guard band in ERC Report 63 and ERC Recommendation 70-03 for the protection of GSM1800 is sufficient for protecting LTE/WiMAX 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 and ERC Recommendation 70-03.

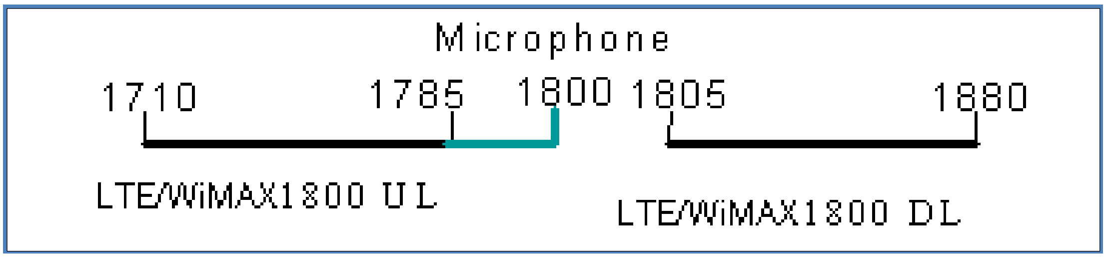

Figure 5: Radio Microphone frequency band is adjacent to AAS (LTE/NR) 1800 UL

For the compatibility between radio microphones and AAS (LTE/NR) 1800 system, there is a need to verify through analysis whether the recommended guard band of 700 kHz in ERC Report 063 [40] is sufficient for ensuring compatibility between AAS (LTE/NR) 1800 and radio microphones operating in the adjacent band.

AAS (LTE/NR) 1800 BS radiated (OTA) narrowband blocking is defined in Table 10.5.2.2-2 and Table 10.5.2.2-3 of 3GPP TS 38.104 [19] and is reflected in Annex 2 of this report.

For NR the narrowband blocking was defined to ensure that adjacent NR 1800 UE transmitting 1RB with maximum power of 23 dBm is able to co-exist with AAS (LTE/NR) when positioned with a much smaller frequency separation/guard band than 700 kHz. Therefore, by considering that radio microphones transmit at a maximum power of 13 dBm (smaller than the NR UE), the interference from radio microphones to AAS (LTE/NR) BS should not be a problem with a guard band of 700 kHz.

Conclusions for Radio Microphones

It can be considered that the proposed guard band of 700 kHz in ERC Report 063 [40] and ERC Recommendation 70-03 [41] 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 and ERC Recommendation 70-03.

4.2.2.4 Compatibility study between AAS (LTE/NR) 1800 and Fixed Services

Compatibility between UMTS and Fixed Services operating in co-frequency and adjacent bands was studied and reported in ERC Report 65 [43], ERC Report 64 [44] and ECC Report 96 [10] (based on the 2 previous ERC Reports). As described in these two reports, the critical interference scenarios are between UMTS BS and Fixed Service stations, the interference between UMTS UE and Fixed Services was not considered.

CEPT Report 41 [3] considers that the conclusions relating to Fixed Services compatibility with UMTS within the above mentioned reports are considered applicable to LTE/WiMAX 1800 MHz (non-AAS).

Similar to what has been concluded for UMTS, 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.

The Fixed Service frequency range is adjacent to AAS (LTE/NR) system UL at 1710 MHz and 1785 MHz. The potential interference, if any, will be between Fixed Service and AAS (LTE/NR) 1800 BS at 1805 MHz. A similar interference analysis method as the one used in the two ERC Reports 064 and 065, can be used by administrations planning deployment or coordination of AAS (LTE/NR) with existing fixed services to derive the separation/coordination distance as a function of frequency separations between AAS (LTE/NR) base station and Fixed Service station similarly to what has been described in ERC Report 64 [44] and ERC Report 65 [43].

ECC Report 173 “Fixed Service in Europe Current use and future trends post 2016” updated on 27 April 2018 [45] confirms the intention from several administrations to decrease the use of frequencies below 2 GHz, similarly to possible allocation to other services/applications.

4.2.3 Conclusions

This analysis is based mainly on CEPT Report 41 [3] which was developed for the introduction of LTE at 1800 MHz. The main conclusions from CEPT Report 041 for LTE-non-AAS 1800 system and ECC Report 96 [10] 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 DECT: No guard band is required between AAS/5G NR 1800 and DECT allocations and 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. 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 pico BS is installed in indoor environment close to DECT PP or RFP in which case different interference mitigation techniques could be used. In practice, DECT system has a DCA (Dynamic Channel Allocation) mechanism which allows it to avoid interference. GSM1800 deployment has demonstrated that no additional interference mitigation techniques with DECT are really needed in practice;
- For MetSat: Similar to LTE non-AAS, our analysis indicate that the potential interference between (LTE/NR) 1800 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;
- For Radio Microphones: The interference analysis leads to the conclusion that with the existing guard band of 700 kHz from the radio microphones frequency band the potential interference from radio microphones to AAS (LTE/NR) 1800 MHz BS should not be a problem, if the radio microphone maximum transmit 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 63 [40] and ERC Recommendation 70-03 [41];

- For Fixed services: 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 [44] and ERC Report 65 [43], can be used by administrations planning deployment or coordination of AAS (LTE/NR) with existing fixed services to derive the separation/coordination distance.

5 RECOMMENDED FRAMEWORK

5.1 BAND PLAN

Standardisation has defined the following operating modes in the 900 MHz and 1800 MHz frequency bands (see below table):

Table 15: NR operating bands in 900/1800 MHz

Uplink (UL) operating band BS receive/UE transmit FUL_low – FUL_high	Downlink (DL) operating band BS transmit/UE receive FDL_low – FDL_high	Duplex Mode
1710-1785 MHz	1805-1880 MHz	FDD
880-915 MHz	925-960 MHz	FDD
880-915 MHz	N/A	SUL
1710-1785 MHz	N/A	SUL
Note 1: NR systems in frequency bands 880-915 MHz and 1710-1785 MHz may operate in Supplemental uplink mode (SUL) (i.e. NR uplink operation without a paired downlink channel in the 925-960 MHz and 1805-1880 MHz frequency bands respectively). SUL operation in these bands will be combined with NR downlink operation in other MFCN frequency bands than the 925-960 MHz and 1805-1880 MHz frequency bands.		

For the update of ECC Decision (06)13 [1], the same consideration regarding 900/1800 MHz band plan used for LTE should be extended to NR systems (whether AAS or not). There is no need to revise the ECC decision with that regard. In addition, the SUL operating mode (see note 1 above) does not impact the current FDD band plan in 900-1800 MHz. Applicable technical conditions for 5G non-AAS system in 900 MHz and 1800 MHz frequency bands.

The compatibility results from CEPT Reports 40 [2] and 41 [3] and ECC Report 266 [6] for LTE in 900/1800 MHz bands can be extended to NR non-AAS system.

The same technical conditions defined in ECC Decision (06)13 [1] for LTE can be extended for 5G NR non-AAS system in 900/1800 MHz bands including SUL mode of operation.

To ensure coexistence with other systems operating in the 900/1800 MHz bands, the following requirements apply to 5G NR non-AAS system similarly for LTE (non AAS):

- Frequency separation of 200 kHz or more between the 5G NR channel edge and the GSM carrier's channel edge. This requirement is covered by the ETSI standards (see Table 16) due to the channel characteristics of 5G NR (5 MHz or above channel bandwidth). The same applies to coexistence between NR system and EC-GSM-IoT systems.
- No frequency separation is required between 5G NR channel edge and the UMTS carrier's channel edge.
- No frequency separation is required between 5G NR channel edge and the LTE carrier's channel edge. The same applies to coexistence with LTE MTC/eMTC system
- No frequency separation is required between 5G NR channel edges between two neighbouring 5G NR networks;
- A frequency separation of 200 kHz or more is needed between the standalone NB-IoT channel edge of one network and the NR channel edge of the neighbouring network. This requirement is already covered by the ETSI standard due the channel characteristics of 5G NR (5 MHz or above channel bandwidth).

ECC analysis confirms that the conclusions from CEPT Report 41 [3], CEPT Report 42 [4] and ECC Report 96 [10] for LTE-non-AAS 900/1800 MHz systems compatibility with adjacent systems are considered to be also applicable to NR non-AAS 900/1800 MHz systems. In consequence, reference to 5G ETSI harmonised standards (see Table 16) could be added to Annex 1 of the revised ECC Decision (06)13 [1].

5.2 APPLICABLE TECHNICAL CONDITIONS FOR AAS (LTE/5G) SYSTEM IN 1800 MHZ FREQUENCY BANDS

To ensure coexistence with other systems operating in the bands, the following requirements apply to AAS (LTE/NR) 1800 MHz system similarly for LTE non-AAS:

- Frequency separation of 200 kHz or more between the 5G NR channel edge and the GSM carrier's channel edge. 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 NR system and EC-GSM-IoT systems;
- No frequency separation is required between 5G NR channel edge and the UMTS carrier's channel edge;
- No frequency separation is required between 5G NR channel edge and the LTE carrier's channel edge. The same applies to coexistence with LTE MTC/eMTC system;
- No frequency separation is required between 5G NR channel edges between two neighbouring 5G NR networks;
- A frequency separation of 200 kHz or more is needed between the standalone NB-IoT channel edge of one network and the NR channel edge of the neighbouring network. This requirement is already covered by the ETSI standard due the channel characteristics of 5G NR (5 MHz or above channel bandwidth).

ECC analysis confirms that the conclusions from CEPT Report 41 [3], CEPT Report 42 [4] and ECC Report 96 [10] for LTE-non-AAS 1800 MHz systems compatibility with adjacent systems are considered to be also applicable to AAS (LTE/NR) 1800 MHz systems.

In consequence, reference to NR and AAS ETSI harmonised standard (see Table 16) could be added to Annex 1 of the ECC Decision (06)13 [1].

For AAS base stations in the 1800 MHz frequency band, the spurious domain for the base station starts 10 MHz from the band edge and the spurious emissions limits are defined in ERC Recommendation 74-01 (for the coexistence studies in ECC report 297 the value of -30 dBm/MHz was used). CEPT noted that AAS is relevant for BS only (In this report AAS is not considered for UE).

5.3 SUMMARY OF UPDATED FRAMEWORK FOR SUITABILITY TO 5G (900/1800 MHZ) AND AAS (1800 MHZ)

Based on the above, the following update to ECC Decision (06)13 Annex 1 is proposed. No changes are necessary to Annex 2 of the ECC Decision:

Table 16: Description of GSM, UMTS, LTE, NR and WiMAX

Technology	Terminology in ITU-R Recommendations (e.g. Recommendation ITU-R M.1457 [48]	Standards Development Organisations (SDO)	Terms used by SDO	Applicable ETSI standards	Other terms commonly used
GSM		3GPP ETSI	GSM GSM/EDGE	EN 301 502 [49] EN 301 511 [50] EN 301 908-18 [51]	GPRS, EDGE
UMTS	IMT-2000 CDMA Direct Spread	3GPP ETSI	UMTS UTRA	EN 301 908-1 [52] EN 301 908-2 [53] EN 301 908-3 [54] EN 301 908-11 [55] EN 301 908-18 [51]	IMT-2000/UMTS; W-CDMA; HSPA
LTE	IMT-2000 CDMA Direct Spread (E UTRAN)(1)	3GPP ETSI	LTE E-UTRA E-UTRA AAS	EN 301 908-1 [52] EN 301 908-13 [25] EN 301 908-14 [56] EN 301 908-15 [57] EN 301 908-18 [51] EN 301 908-23 [1]	IMT-Advanced/ LTE-Advanced
WiMAX	IMT-2000 OFDMA TDD WMAN(2)	IEEE	WiMAX	EN 301 908-1 [52] EN 301 908-21 [58] EN 301 908-22 [59]	
NR	IMT-2020(3)	3GPP ETSI	NR	EN 301 908-24 [23] EN 301 908-25 [24] EN 301 908-18 [51]	

(1) This radio interface now includes an option using OFDM modulation.
(2) This radio interface now supports FDD.
(3) This radio interface supports both FDD and SUL.

6 CONCLUSIONS

This Report assesses the suitability of the current ECC Decision (06)13 [1] regulatory framework for the possible future usage of:

- 900 MHz band for 5G non-AAS technology including SUL mode of operation. AAS technology support is currently not considered for the 900 MHz frequency band and therefore it is not considered in this Report;1800 MHz frequency band for 5G (AAS and non AAS) including SUL mode of operation;
- 1800 MHz frequency band for LTE-AAS.

ECC analysed and confirmed that the in-band compatibility conclusions from CEPT Report 40 [2] 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.

ECC also concluded that the adjacent bands compatibility conclusions from CEPT Report 41 [3] and CEPT Report 42 [4] applicable to LTE non-AAS systems in 900/1800 MHz frequency band are also applicable to both 5GNR non-AAS 900/1800 MHz systems and to LTE/5GNR AAS 1800 MHz systems.

This Report does not consider or propose a Block Edge Mask (BEM) approach to technical harmonisation for 900/1800 MHz frequency band. This first step in a two-part ECC process follows the current approach to reference the 5G NR standard in order to enable a timely update to the technical conditions. The second step, planned for completion in June 2020, will introduce a technology neutral block edge mask to replace the existing technology references.

Based on the above the following updated framework is recommended based on reference to relevant ETSI harmonised standard:

<u>Updated Band plan:</u>

According to the analyses performed in this Report, the same sharing conditions used for LTE could be extended to LTE AAS systems and to NR systems (whether AAS or not) including NR SUL mode of operation. There is a need to refer in the annex listing the relevant applicable ETSI harmonised standards to LTE AAS and to 5G including SUL mode of operation.

<u>Applicable technical conditions for 5G and AAS:</u>

The same technical conditions defined in ECC Decision (06)13 for LTE can be extended for 5G NR non-AAS system in 900/1800 MHz frequency bands including SUL mode of operation. The same applies for AAS (LTE/NR) in 1800 MHz frequency band.

To ensure coexistence with other systems operating 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. 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 NR system and EC-GSM-IoT systems;
- No frequency separation is required between 5G NR channel edge and the UMTS carrier's channel edge;
- No frequency separation is required between 5G NR channel edge and the LTE carrier's channel edge. The same applies to coexistence with LTE MTC/eMTC system;
- No frequency separation is required between 5G NR channel edges between two neighbouring 5G NR networks;

- A frequency separation of 200 kHz or more is needed between the standalone NB-IoT channel edge of one network and the NR channel edge of the neighbouring network. This requirement is already covered by the ETSI standard due the channel characteristics of 5G NR (5 MHz or above channel bandwidth[5]).

Based on the above, ECC decided that reference to NR (AAS and non-AAS) and to LTE-AAS ETSI harmonised standard could be added to Annex 1 of ECC Decision (06)13 as follows:

Table 17: Description of GSM, UMTS, LTE, NR and WiMAX

Technology	Terminology in ITU-R Recommendations (e.g. Recommendation ITU-R M.1457 [48])	Standards Development Organisations (SDO)	Terms used by SDO	Applicable ETSI standards	Other terms commonly used
GSM		3GPP ETSI	GSM GSM/EDGE	EN 301 502 [49] EN 301 511 [50] EN 301 908-18 [51]	GPRS, EDGE
UMTS	IMT-2000 CDMA Direct Spread	3GPP ETSI	UMTS UTRA	EN 301 908-1 [52] EN 301 908-2 [53] EN 301 908-3 [54] EN 301 908-11 [55] EN 301 908-18 [51]	IMT-2000/ UMTS; W-CDMA; HSPA
LTE	IMT-2000 CDMA Direct Spread (E UTRAN)(1)	3GPP ETSI	LTE E-UTRA E-UTRA AAS	EN 301 908-1 [52] EN 301 908-13 [25] EN 301 908-14 [56] EN 301 908-15 [57] EN 301 908-18 [51] EN 301 908-23 [1]	IMT-Advanced/ LTE-Advanced
WiMAX	IMT-2000 OFDMA TDD WMAN(2)	IEEE	WiMAX	EN 301 908-1 [52] EN 301 908-21 [58] EN 301 908-22 [59]	
NR	IMT-2020(3)	3GPP ETSI	NR 5GNR 5G New Radio	EN 301 908-24 [23] EN 301 908-25 [24] EN 301 908-18 [51]	

(1) This radio interface now includes an option using OFDM modulation.
(2) This radio interface now supports FDD.
(3) This radio interface supports both FDD and SUL.

[5] The available minimum guard band for each NR BS/UE CBW and sub-carrier spacing (SCS) is always larger than 200 kHz. This minimum guard band increases with the CBW and with SCS .

ANNEX 1: MAIN TECHNICAL PARAMETERS OF 5G NON-AAS SYSTEM FOR COEXISTENCE STUDIES IN 900 MHZ AND 1800 MHZ FREQUENCY BANDS

A1.1 BANDS DEFINITION

NR technology is standardised in 3GPP starting from NR release 15. The main transmitter and receiver technical characteristics for lower bands are described in TS 38.101-1 [18] for UE and TS 38.104 [19] for the BS. The NR non-AAS BS requirements are called conducted requirements and can be found in TS 38.104, under section 6 for the transmitter side and section 7 for the receiver side.

Table 18: NR operating bands in 900/1800 MHz

3GPP NR operating band	Uplink (UL) operating band BS receive/UE transmit FUL_low – FUL_high	Downlink (DL) operating band BS transmit/UE receive FDL_low – FDL_high	Duplex Mode
n3	1710-1785 MHz	1805-1880 MHz	FDD
n8	880-915 MHz	925-960 MHz	FDD
n81	880-915 MHz	N/A	SUL
n80	1710-1785 MHz	N/A	SUL

As can be seen from the table above, NR systems in frequency bands 880-915 MHz and 1710-1785 MHz may operate in Supplemental uplink mode (SUL), i.e. NR Uplink operation without paired downlink NR spectrum. SUL operation in the 880-915 MHz and 1710-1785 MHz frequency bands is combined with NR downlink operation in other MFCN frequency bands than the 925-960 MHz and 1805-1880 MHz frequency bands.

A1.2 CONDUCTED MAXIMUM OUTPUT POWER

For NR 900 MHz and 1800 MHz frequency bands UE, 3GPP define power class 3 which has 23 dBm maximum output power. This is the same requirement defined for LTE UE.

Regarding the NR BS, 3GPP defines 3 BS power classes for NR (Table 6.2.1-1 of TS38.104): Wide Area BS, Medium Range BS and Local Area BS with the same BS rated output power and BS Maximum output power limits as for the LTE.

Prated,c,AC is defined in 3GPP as the rated carrier output power per antenna connector.

Table 19: BS type 1-C rated output power limits for BS classes

BS class	Prated,c,AC
Wide Area BS	(Note)
Medium Range BS	≤ 38 dBm
Local Area BS	≤ 24 dBm
Note: There is no upper limit for the Prated,c,AC rated output power of the Wide Area Base Station	

A1.3 CHANNEL BANDWIDTH

The channel bandwidth requirement corresponds to The requirements in this specification apply to the combination of BS channel bandwidths, SCS and operating bands for NR is defined as follows:

Table 20: NR channel bandwidth and SCS per operating band

NR Band	SCS kHz	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz
n3 FDD band (1710–1785 / 1805–1880 MHz) and n80 SUL band (1710-1785 MHz)	15	Yes	Yes	Yes	Yes	Yes	Yes
	30		Yes	Yes	Yes	Yes	Yes
	60		Yes	Yes	Yes	Yes	Yes
n8 FDD band (880–915 / 925-960 MHz) n81 SUL band (880-915 MHz)	15	Yes	Yes	Yes	Yes		
	30		Yes	Yes	Yes		
	60						

For NR in band 1800 MHz (FDD band n3 and SUL band n80), in addition to the 5, 10, 15 and 20 MHz CBW that were defined as for LTE (case of SCS 15 kHz), 2 additional CBW were added: 25 MHz and 30 MHz. The NR TX requirements for these channel bandwidths are similar to the requirements defined in 3GPP for LTE intra-band contiguous carrier aggregation of respectively 5 MHz +20 MHz and 15 MHz+15 MHz carriers already deployed in the market.

Unlike LTE, CBW of 1.4 MHz and 3 MHz are not defined for NR.

A1.4 MAXIMUM TRANSMISSION BANDWIDTH CONFIGURATION AND CORRESPONDING MINIMUM GUARD BAND

The maximum transmission bandwidth configuration NRB for each UE channel bandwidth and subcarrier spacing is specified in the following Table (extract from Table 5.3.2-1 of TS 38.101-1), this corresponds to the BS Transmission bandwidth configuration (defined in Table 5.3.2-1 of TS 38.104):

Table 21: Maximum transmission bandwidth configuration NRB

SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz
	NRB	NRB	NRB	NRB	NRB	NRB
15	25	52	79	106	133	160
30	11	24	38	51	65	78
60	N/A	11	18	24	31	38

The minimum guardband for each BS/UE channel bandwidth and SCS is specified in the following table (extract from Table 5.3.3-1 of TS38.104 and Table 5.3.3-1 of TS36.101-1):

Table 22: Minimum guard band for each BS/UE channel bandwidth and SCS (kHz)

SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz
15	242.5	312.5	382.5	452.5	522.5	592.5
30	505	665	645	805	785	945
60	N/A	1010	990	1330	1310	1290
Note: The minimum guard bands have been calculated using the following equation: (CHBW x 1000 (kHz) - RB value x SCS x 12)/2 - SCS/2.						

Please note that 'Guardband' does not refer to any potential guard band between bands of operation but to the spectrum on the side of an NR channel, where the emission masks rolls out in order to meet the out of block requirement.

From the tables above, it can be seen that for NR operating in 5 MHz CBW, the NR requirement in terms of maximum transmission Bandwidth configuration and related minimum guard band is defined for NR in identical manner as for LTE (for Subcarrier spacing of 15 kHz).

For CBW higher than 5 MHz, NR has higher spectrum utilisation compared to LTE. However for these larger CBWs, the related minimum guard band (distance between the NR last in-band resources block edge to the NR channel edge) is larger than LTE 1.4, 3 and 5 MHz channels and always higher than 300 kHz.

A1.5 CONDUCTED BS AND UE EMISSION MASK

3GPP defined for NR the following conducted/basic Category B requirements (Option 2) (in TS 38.104 Table 6.6.4.2.2.2-1) intended for Europe and that may be applied regionally for BS operating in bands n1 (2100 MHz), n3 (1800 MHz), n8 (900 MHz).

Table 23: Regional Wide Area BS operating band unwanted emission limits for Category B (specified at the antenna connector)

Frequency offset of measurement filter -3dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Basic limit (Note 1, 2)	Measurement bandwidth
0 MHz ≤ Δf < 0.2 MHz	0.015 MHz ≤ f_offset < 0.215 MHz	-14 dBm	30 kHz
0.2 MHz ≤ Δf < 1 MHz	0.215 MHz ≤ f_offset < 1.015 MHz	$-14dBm-15\cdot\left(\frac{f\_offset}{MHz}-0.215\right)dB$	30 kHz
(Note 4)	1.015 MHz ≤ f_offset < 1.5 MHz	-26 dBm	30 kHz
1 MHz ≤ Δf ≤ min(10 MHz, Δfmax)	1.5 MHz ≤ f_offset < min(10.5 MHz, f_offsetmax)	-13 dBm	1 MHz
10 MHz ≤ Δf ≤ Δfmax	10.5 MHz ≤ f_offset < f_offsetmax	-15 dBm (Note 3)	1 MHz

Note 1: For a 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 □f ≥ 10MHz from both adjacent sub blocks on each side of the sub-block gap, where the minimum requirement within sub-block gaps shall be -15 dBm/1MHz.

Note 2: For a multi-band connector with Inter RF Bandwidth gap < 20MHz 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 3: The requirement is not applicable when Δfmax < 10 MHz.

Note 4: This frequency range ensures that the range of values of f_offset is continuous.

The NR BS OOBE specified above for NR non AAS systems are the same as the LTE Category B option 2 requirements used in CEPT Reports 40, CEPT Report 41 and CEPT Report 42 for LTE compatibility analysis in frequency band 900 MHz and 1800 MHz.

A1.6 UE SPECTRUM EMISSION MASK

The NR general spectrum emission mask of the NR UE is provided in the table below:

Table 24: NR General spectrum emission mask

<table>
<tr><th colspan="8">Spectrum emission limit (dBm)/Channel bandwidth</th></tr>
<tr><td>ΔfOOB (MHz)</td><td>5 MHz</td><td>10 MHz</td><td>15 MHz</td><td>20 MHz</td><td>25 MHz</td><td>30 MHz</td><td>Measurement bandwidth</td></tr>
<tr><td>± 0-1</td><td>-15</td><td>-18</td><td>-20</td><td>-21</td><td>-22</td><td>-23</td><td>30 kHz</td></tr>
<tr><td>± 1-5</td><td>-10</td><td>-10</td><td>-10</td><td>-10</td><td>-10</td><td>-10</td><td rowspan="8">1 MHz</td></tr>
<tr><td>± 5-6</td><td>-13</td><td rowspan="2">-13</td><td rowspan="3">-13</td><td rowspan="4">-13</td><td rowspan="5">-13</td><td rowspan="6">-13</td></tr>
<tr><td>± 6-10</td><td>-25</td></tr>
<tr><td>± 10-15</td><td>-</td><td>-25</td></tr>
<tr><td>± 15-20</td><td>-</td><td>-</td><td>-25</td></tr>
<tr><td>± 20-25</td><td>-</td><td>-</td><td>-</td><td>-25</td></tr>
<tr><td>± 25-30</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-25</td></tr>
<tr><td>± 30-35</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-25</td></tr>
</table>

For the same CBW as that for LTE, i.e. 5 MHz, 10 MHz, 15 MHz and 20 MHz, the NR SEM requirement is the same as the SEM defined for LTE.

For NR CBW of 25 and 30 MHz (applicable to the 1800 MHz/band 3) the NR SEM requirement is the same as the SEM used for LTE intra-band contiguous carrier aggregation of respectively 5 MHz +20 MHz and 15 MHz+15 MHz carriers.

A1.7 CONDUCTED BS ADJACENT CHANNEL LEAKAGE RATIO (ACLR)

3GPP defined in TS38.104 section 6.6.3.2 for NR BS ACLR (relative) limit of 45 dB.

The ACLR for NR is defined with a square filter of bandwidth equal to the transmission bandwidth configuration of the transmitted signal (BWConfig) centred on the assigned channel frequency and a filter centred on the adjacent channel frequency according to the tables below.

For operation in paired and unpaired spectrum, the ACLR shall be higher than the value specified in the following table:

Table 25: Base station ACLR limit (Table 6.6.3.2-1 of TS38.104 [19])

Channel bandwidth of NR lowest/highest carrier transmitted BWChannel [MHz]	BS adjacent channel centre frequency offset below the lowest or above the highest carrier centre frequency transmitted	Assumed adjacent channel carrier (informative)	Filter on the adjacent channel frequency and corresponding filter bandwidth	ACLR limit
5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80,90, 100	BWChannel	NR of same BW (Note 2)	Square (BWConfig)	45 dB
	2 x BWChannel	NR of same BW (Note 2)	Square (BWConfig)	45 dB
	BWChannel /2 + 2.5 MHz	5 MHz E-UTRA	Square (4.5 MHz)	45 dB (Note 3)
	BWChannel /2 + 7.5 MHz	5 MHz E-UTRA	Square (4.5 MHz)	45 dB (Note 3)
Note 1: BWChannel and BWConfig are the BS channel bandwidth and transmission bandwidth configuration of the lowest/highest NR carrier transmitted on the assigned channel frequency. Note 2: With SCS that provides largest transmission bandwidth configuration (BWConfig). Note 3: The requirements are applicable when the band is also defined for E-UTRA or UTRA.				

This is the same value defined by 3GPP for LTE and considered for LTE compatibility analyses performed previously in CEPT e.g. CEPT Reports 40 and 41.

3GPP also defined absolute basic limits for ACLR corresponding to the following:

Table 26: Base station ACLR absolute limit (Table 6.6.3.2-2 of TS 38.104 [19])

BS category/BS class	ACLR absolute limit
Category A Wide Area BS	-13 dBm/MHz
Category B Wide Area BS	-15 dBm/MHz
Medium Range BS	-25 dBm/MHz
Local Area BS	-32 dBm/MHz

Either the “relative” ACLR limits or the absolute limit shall apply for each antenna connector, whichever is less stringent.

A1.8 UE NR_{ACLR}

NR adjacent channel leakage power ratio (NRACLR) is the ratio of the filtered mean power centred on the assigned NR channel frequency to the filtered mean power centred on an adjacent NR channel frequency at nominal channel spacing.

The assigned NR channel power and adjacent NR channel power are measured with rectangular filters with measurement bandwidths specified below.

If the measured adjacent channel power is greater than –50 dBm then the NRACLR shall be higher than the value specified in Table below:

Table 27: NR $_{ACLR}$ measurement bandwidth

NR channel bandwidth/NR$_{ACLR}$ measurement bandwidth						
	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz
NR$_{ACLR}$ measurement bandwidth	4.515	9.375	14.235	19.095	23.955	28.815

Table 28: NR$_{ACLR}$ requirement

	Power class 3
NR$_{ACLR}$	30 dB

For the same CBW as that for LTE, i.e. 5 MHz, 10 MHz, 15 MHz and 20 MHz, the ACLR requirement is similar to the one defined for LTE.

For NR CBW of 25 MHz and 30 MHz (applicable to the 1800 MHz: FDD band n3 and SUL band n80) the NR ACLR requirement is the same as the ACLR used for LTE intra-band contiguous carrier aggregation of respectively 5 MHz +20 MHz and 15 MHz+15 MHz carriers.

A1.9 UE UTRA $_{ACLR}$

UTRA adjacent channel leakage power ratio (UTRA$_{ACLR}$) is the ratio of the filtered mean power centred on the assigned NR channel frequency to the filtered mean power centred on an adjacent(s) UTRA channel frequency.

UTRAACLR is specified for the first adjacent UTRA channel (UTRA$_{ACLR1}$) which centre frequency is ± 2.5 MHz from NR channel edge and for the 2nd adjacent UTRA channel (UTRA$_{ACLR2}$) which centre frequency is ± 7.5 MHz from NR channel edge.

If the measured adjacent channel power is greater than –50 dBm then the UTRA$_{ACLR1}$ and UTRA$_{ACLR2}$ shall be higher than the value specified in the following Table:

Table 29: UTRA $_{ACLR}$ requirement

ACLR parameter	Power class 3 requirement
UTRA$_{ACLR1}$	33 dB
UTRA$_{ACLR2}$	36 dB

A1.10 CONDUCTED BS SPURIOUS EMISSIONS

3GPP defined the following limits applicable to category B NR Base stations in 900/1800 MHz.

This are identical to ones defined by 3GPP for LTE and considered for LTE compatibility analyses performed previously in CEPT e.g. CEPT Reports 40 and 41.

Table 30: NR BS Spurious emissions limits in FR1 (Lower bands), Category B (Table 6.6.5.2.1-2 from TS 38.104 [19])

Spurious frequency range	Basic limit	Measurement bandwidth	Notes
9 kHz – 150 kHz	-36 dBm	1 kHz	Note 1, Note 4
150 kHz – 30 MHz		10 kHz	Note 1, Note 4
30 MHz – 1 GHz		100 kHz	Note 1
1 GHz – 12.75 GHz	-30 dBm	1 MHz	Note 1, Note 2
12.75 GHz – 5th harmonic of the upper frequency edge of the operating band in GHz		1 MHz	Note 1, Note 2, Note 3
Note 1: Measurement bandwidths as in ITU-R SM.329 [1], s4.1. Note 2: Upper frequency as in ITU-R SM.329 [1]s2.5 table 1. Note 3: Applies only for operating bands for which the 5th harmonic of the upper frequency edge is reaching beyond 12.75 GHz. Note 4: This spurious frequency range applies only to BS type 1-C and BS type 1-H.			

In addition, 3GPP defined the following limits for the protection of the BS receiver of own or different BS: This requirement shall be applied for NR FDD operation in order to prevent the receivers of the BSs from being desensitised by emissions from a BS transmitter.

The power of any spurious emission shall not exceed the limits in the table below:

Table 31: NR BS Spurious emissions limits for protection of the BS receiver (Table 6.6.5.2.2-1 of TS 38.104 [19])

BS class	Frequency range	Basic limit	Measurement bandwidth	Note
Wide Area BS	FUL_low – FUL_high	-96 dBm	100 kHz	
Medium Range BS	FUL_low – FUL_high	-91 dBm	100 kHz	
Local Area BS	FUL_low – FUL_high	-88 dBm	100 kHz	

3GPP also defined the following optional Additional spurious emissions requirements. These may apply for the protection of specific equipment (UE, MS and/or BS) or equipment operating in specific systems (GSM, CDMA, UTRA, E-UTRA, etc.) as listed in the extract table below:

Table 32: BS Spurious emissions limits for BS for co-existence with systems operating in other frequency bands (Extract from Table 6.6.5.2.3-1 of TS 38.104 [19])

System type for NR to co-exist with	Frequency range for co-existence requirement	Basic limit	Measure-ment bandwidth	Note
GSM900	921-960 MHz	-57 dBm	100 kHz	This requirement does not apply to BS operating in band n8
	876-915 MHz	-61 dBm	100 kHz	For the frequency range 880-915 MHz, this requirement does not apply to BS operating in band n8, since it is already covered by the requirement in subclause 6.6.5.1.3.
DCS1800	1805-1880 MHz	-47 dBm	100 kHz	This requirement does not apply to BS operating in band n3.
	1710-1785 MHz	-61 dBm	100 kHz	This requirement does not apply to BS operating in band n3, since it is already covered by the requirement in subclause 6.6.5.1.3.
PCS1900	1930-1990 MHz	-47 dBm	100 kHz	This requirement does not apply to BS operating in band n2 or band n70.
	1850-1910 MHz	-61 dBm	100 kHz	This requirement does not apply to BS operating in band n2, since it is already covered by the requirement in subclause 6.6.5.1.3.
GSM850 or CDMA850	869-894 MHz	-57 dBm	100 kHz	This requirement does not apply to BS operating in band n5.
	824-849 MHz	-61 dBm	100 kHz	This requirement does not apply to BS operating in band n5, since it is already covered by the requirement in subclause 6.6.5.1.3.
UTRA FDD Band I or E-UTRA Band 1 or NR Band n1	2110-2170 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n1
	1920-1980 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n1, since it is already covered by the requirement in subclause 6.6.5.1.3.
UTRA FDD Band III or E-UTRA Band 3 or NR Band n3	1805-1880 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n3.
	1710-1785 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n3, since it is already covered by the requirement in subclause 6.6.5.1.3.
UTRA FDD Band VII or E-UTRA Band 7 or NR Band n7	2620-2690 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n7.
	2500-2570 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n7, since it is already covered by the requirement in subclause 6.6.5.1.3.
UTRA FDD Band VIII or E-UTRA Band 8 or NR Band n8	925-960 MHz	-52 dBm	1 MHz	This requirement does not apply to BS operating in band n8.
	880-915 MHz	-49 dBm	1 MHz	This requirement does not apply to BS operating in band n8, since it is already covered by the requirement in subclause 6.6.5.1.3.

The limits above are all identical to those defined by 3GPP for LTE and considered for LTE compatibility analyses performed previously in CEPT e.g. CEPT Reports 40 and 41.

A1.11 UE SPURIOUS EMISSIONS

Table 33: Boundary between NR out-of-band and general spurious domain (Table 6.5.3.1-1 of TS38.101-1 [18])

Channel bandwidth	OOB boundary FOOB (MHz)
BWChannel	BWChannel + 5

Table 34: Requirement for general spurious emissions limits (Table 6.5.3.1-2 of TS38.101-1 [18])

Frequency Range	Maximum Level	Measurement bandwidth	Note
9 kHz ≤ f < 150 kHz	-36 dBm	1 kHz	
150 kHz ≤ f < 30 MHz	-36 dBm	10 kHz	
30 MHz ≤ f < 1000 MHz	-36 dBm	100 kHz	
1 GHz ≤ f < 12.75 GHz	-30 dBm	1 MHz	
12.75 GHz ≤ f < 5th harmonic of the upper frequency edge of the UL operating band in GHz	-30 dBm	1 MHz	1
12.75 GHz < f < 26 GHz	-30 dBm	1 MHz	2
Note 1: Applies for Band that the upper frequency edge of the UL Band more than 2.69 GHz Note 2: Applies for Band that the upper frequency edge of the UL Band more than 5.2 GHz			

The table below specifies the requirements for NR bands for coexistence with protected bands.

Table 35: Requirements for spurious emissions for UE co-existence relevant to 900/1800 MHz (extract from Table 6.5.3.2-1 of TS 38.101-1 [18])

NR Band	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)
n3, n80	E-UTRA Band 1, 5, 7, 8, 20, 26, 27, 28, 31, 32, 33, 34, 38, 39, 40, 41, 43, 44, 45, 50, 51, 65, 67, 68, 69, 72, 73,74, 75, 76. NR Band n79	FDL_low	-	FDL_high	-50	1
	E-UTRA Band 3	FDL_low	-	FDL_high	-50	1
	E-UTRA Band 11, 18, 19, 21	FDL_low	-	FDL_high	-50	1
	E-UTRA Band 22, 42, NR Band n77, n78	FDL_low	-	FDL_high	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3
n8, n81	E-UTRA Band 1, 20, 28, 31, 32, 33, 34, 38, 39, 40, 45, 50, 51, 65, 67, 68, 69, 72, 73, 74, 75, 76	FDL_low	-	FDL_high	-50	1
	E-UTRA band 3, 7, 22, 41, 42, 43, NR Band n77, n78, n79	FDL_low	-	FDL_high	-50	1
	E-UTRA 8	FDL_low	-	FDL_high	-50	1
	E-UTRA Band 11, 21	FDL_low	-	FDL_high	-50	1
	Frequency range	1884.5	-	1915.7	-41	0.3

Note: To simplify the Table above, E-UTRA band numbers were listed for bands which are specified only for E-UTRA operation or both E-UTRA and NR operation. NR band numbers are listed for bands which are specified only for NR operation.

The NR UE spurious emissions limits above are generally aligned with those defined for LTE.

A1.12 UE IN-BAND BLOCKING

For NR bands with FDL_high < 2700 MHz and FUL_high < 2700 in-band blocking (IBB) is defined for an unwanted interfering signal falling into the UE receive band or into the first 15 MHz below or above the UE receive band.

Table 36: In-band blocking parameters for NR bands with FDL_high < 2700 MHz and FUL_high < 2700 MHz (extract from Table 7.6.2-1 of TS38.101-1 [18])

RX parameter	Units	Channel bandwidth				
		5 MHz/10 MHz	15 MHz	20 MHz	25 MHz	30 MHz
Power in transmission bandwidth configuration	dBm	REFSENS + channel specific value below				
	dB	6	7	9	10	11
BWinterferer	MHz	5				
Floffset, case 1	MHz	7.5				
Floffset, case 2	MHz	12.5				

Table 37: In-band blocking for NR bands with FDL_high < 2700 MHz and FUL_high < 2700 MHz

NR band	Parameter	Unit	Case 1	Case 2	Case 3
n1, n2, n3, n5, n7, n8, n20, n28, n38, n41, n50, n51, n66, n70, n71, n74, n75, n76	Pinterferer	dBm	-56	-44	-15
	Finterferer (offset)	MHz	-CBW/2 – Floffset, case 1 and CBW/2 + Floffset, case 1	≤ -CBW/2 – Floffset, case 2 and ≥ CBW/2 + Floffset, case 2	
	Finterferer	MHz	Note 2	FDL_low – 15 to FDL_high + 15	

Note 1: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to $\left(\left\lceil |F_{\text{interferer}}| / SCS \right\rceil + 0.5\right) SCS$ MHz with SCS the sub-carrier spacing of the wanted signal in MHz. The interferer is an NR signal with an SCS equal to that of the wanted signal.

Note 2: For each carrier frequency, the requirement applies for two interferer carrier frequencies: a: -CBW/2 – Floffset, case 1; b: CBW/2 + Floffset, case 1

In-band blocking for NR UE is similar to LTE for Case 1 and 2. Case 3 requires further confirmation

A1.13 UE OUT-OF-BAND BLOCKING

For NR bands with FDL_high < 2700 MHz and FUL_high < 2700 MHz out-of-band band blocking is defined for an unwanted CW interfering signal falling outside a frequency range 15 MHz below or above the UE receive band.

Table 38: Out-of-band blocking parameters for NR bands with FDL_high < 2700 MHz and FUL_high < 2700 MHz (extract from Table 7.6.3-1 of TS38.101-1 [18])

RX parameter	Units	Channel bandwidth				
		5-10 MHz	15 MHz	20 MHz	25 MHz	30 MHz
Power in transmission bandwidth configuration	dBm	REFSENS + channel specific value below				
	dB	6	7	9	10	11
Note : The transmitter shall be set to 4dB below ….						

Table 39: Out of-band blocking for NR bands with FDL_high < 2700 MHz and FUL_high < 2700 MHz (extract from Table 7.6.3-2 of TS 38.101-1 [18])

NR band	Parameter	Unit	Range 1	Range 2	Range 3
n1, n2, n3, n5, n7, n8, n12, n20, n25, n28, n34, n38, n39, n40, n41, n51, n66, n70, n71, n75, n76	Pinterferer	dBm	-44	-30	-15 (Note)
	Finterferer (CW)	MHz	-60 < f – FDL_low < -15 or 15 < f – FDL_high < 60	-85 < f – FDL_low ≤ -60 or 60 ≤ f – FDL_high < 85	1 ≤ f ≤ FDL_low – 85 or FDL_high + 85 ≤ f ≤ 12750
Note: The power level of the interferer (PInterferer) for Range 3 shall be modified to -20 dBm for FInterferer > 6000 MHz.					

Out of band blocking for NR UE is similar to LTE.

A1.14 UE NARROWBAND BLOCKING

Narrowband blocking is measure of a receiver's ability to receive a NR signal at its assigned channel frequency in the presence of an unwanted narrowband CW interferer at a frequency, which is less than the nominal channel spacing.

The relative throughput shall be ≥ 95% of the maximum throughput of the reference measurement channels as specified in Annexes A.2.2, A.2.3 and A.3.2 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1) with parameters specified in Table 7.6.2-1. For operating bands with an unpaired DL part (as noted in Table 5.5-1), the requirements only apply for carriers assigned in the paired part.

The following table summarises the 3GPP NR requirement for some relevant lower bands including band 3 (1800 MHz) and 8 (900 MHz):

Table 40: Narrowband Blocking (extract from Table 7.6.4-1 of TS38.101-1 [18])

NR band	Parameter	Unit	Channel Bandwidth				
			5 MHz	10 MHz	15 MHz	20 MHz	25 MHz
n1, n3, n7, n8, n38	Pw	dBm	PREFSENS + channel-bandwidth specific value below				
			16	13	14	16	16
	Puw (CW)	dBm	-55	-55	-55	-55	-55
	Fuw (offset SCS= 15 kHz)	MHz	2.7075	5.2125	7.7025	10.2075	13.0275
	Fuw (offset SCS= 30 kHz)	MHz	NA	NA	NA	NA	

Note 1: The transmitter shall be set a 4 dB below PCMAX_L at the minimum uplink configuration specified in Table 7.3.1-2 with PCMAX_L as defined in subclause 6.2.5.

Note 2: Reference measurement channel is specified in Annex A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1.

Note 3: The PREFSENS power level is specified in Table 7.3.1-1 and Table 7.3.1-1a for two and four antenna ports, respectively.

Narrowband blocking for NR UE is similar to LTE.

A1.15 UE REFERENCE SENSITIVITY POWER LEVEL

UE Reference sensitivity for NR can be found in Section 7.3 of TS38.101-1. However, for NR more CBW's (for 1800MHz) and SCS are defined and some new configurations are considered compared to LTE e.g. Supplemental Uplink (SUL). NR reference Sensitivity level is comparable to LTE for the common CBWs and SCS with very minor differences fractions of dB (0.2 dB) which should not have major impact on compatibility studies in this Report.

A1.16 CONDUCTED BS REFERENCE SENSITIVITY LEVEL

For NR, the throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel as specified in Annex A of TS 38.104 with parameters specified as in the table below for Wide Area BS (Table 7.2.2-1 of TS 38.104):

Table 41: NR Wide Area BS reference sensitivity levels (defined per antenna connector)

BS channel bandwidth [MHz]	Sub-carrier spacing [kHz]	Reference measurement channel	Reference sensitivity power level, PREFSENS [dBm]
5, 10, 15	15	G-FR1-A1-1	-101.7
10, 15	30	G- FR1-A1-2	-101.8
10, 15	60	G- FR1-A1-3	-98.9
20, 25, 30, 40, 50	15	G- FR1-A1-4	-95.3
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	30	G- FR1-A1-5	-95.6
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	60	G- FR1-A1-6	-95.7
Note: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for each consecutive application of a single instance of the reference measurement channel mapped to disjoint frequency ranges with a width corresponding to the number of resource blocks of the reference measurement channel each, except for one instance that might overlap one other instance to cover the full BS channel bandwidth.			

The parameters for the reference measurement channels are specified the following table (table A.1-1 of TS38.104):

Table 42: NR FRC parameters for FR1 receiver sensitivity and in-channel selectivity

Reference channel	G-FR1-A1-1	G-FR1-A1-2	G-FR1-A1-3	G-FR1-A1-4	G-FR1-A1-5	G-FR1-A1-6	G-FR1-A1-7	G-FR1-A1-8	G-FR1-A1-9
Subcarrier spacing [kHz]	15	30	60	15	30	60	15	30	60
Allocated resource blocks	25	11	11	106	51	24	15	6	6
CP-OFDM Symbols per slot (Note 1)	12	12	12	12	12	12	12	12	12
Modulation	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
Code rate (Note 2)	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3
Payload size (bits)	2152	984	984	9224	4352	2088	1320	528	528
Transport block CRC (bits)	16	16	16	24	24	16	16	16	16
Code block CRC size (bits)	-	-	-	24	-	-	-	-	-
Number of code blocks - C	1	1	1	2	1	1	1	1	1
Coded block size (bits)	2168	1000	1000	4648	4376	2104	1336	544	544
Total number of bits per slot	7200	3168	3168	30528	14688	6912	4320	1728	1728
Total symbols per slot	3600	1584	1584	15264	7344	3456	2160	864	864

Note 1: UL-DMRS-config-type = 1 with UL-DMRS-max-len = 1, UL-DMRS-add-pos = 1 with l_0 = 2, l = 11 as per Table 6.4.1.1.3-3 of TS 38.211 [5].

Note 2: MCS index 4 and target coding rate = 308/1024 are adopted to calculate payload size for receiver sensitivity and in-channel selectivity

There are some apparent differences in the absolute value for the conducted Reference sensitivity defined for NR in TS38.104 [19] compared to LTE in TS 36.104. The difference is due only to

- Different Fixed Reference Channels defined for NR and for LTE in particular the noise bandwidth of the FRC changes as explained below.
- Small differences in the required SNR for demodulation – this is a minor effect 0.2dB better NR performance compared to LTE for same FRC BW

Table 43: E-UTRA Wide Area BS reference sensitivity levels

E-UTRA channel bandwidth [MHz]	Reference measurement channel	Reference sensitivity power level, PREFSENS [dBm]
1.4	FRC A1-1 in Annex A.1	-106.8
3	FRC A1-2 in Annex A.1	-103.0
3	FRC A1-6 in Annex A.1 for E-UTRA with NB-IoT in-band operation (Note 3)	-103.0 (Note 2)
5	FRC A1-3 in Annex A.1	-101.5
5	FRC A1-7 in Annex A.1 for E-UTRA with NB-IoT in-band operation	-101.5 (Note 2)
10	FRC A1-3 in Annex A.1 (Note 1)	-101.5
10	FRC A1-7 in Annex A.1 for E-UTRA with NB-IoT in-band operation (Note 4)	-101.5 (Note 2)
15	FRC A1-3 in Annex A.1 (Note 1)	-101.5
15	FRC A1-7 in Annex A.1 for E-UTRA with NB-IoT in-band operation (Note 4)	-101.5 (Note 2)
20	FRC A1-3 in Annex A.1 (Note 1)	-101.5
20	FRC A1-7 in Annex A.1 for E-UTRA with NB-IoT in-band operation (Note 4)	-101.5 (Note 2)

Note 1: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for each consecutive application of a single instance of FRC A1-3 mapped to disjoint frequency ranges with a width of 25 resource blocks each.

Note 2: The requirements apply to BS that supports E-UTRA with NB-IoT in-band operation.

Note 3: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for a single instance of FRC A1-6 mapped to the 12 E-UTRA resource blocks adjacent to the NB-IoT PRB.

Note 4: PREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for a single instance of FRC A1-7 mapped to the 24 E-UTRA resource blocks adjacent to the NB-IoT PRB, and for each consecutive application of a single instance of FRC A1-3 mapped to disjoint frequency ranges with a width of 25 resource blocks each.

The parameters for the LTE BS reference measurement channels are specified in Table A.1-1 of TS36.104:

Table 44: E-UTRA FRC parameters for reference sensitivity and in-channel selectivity

Reference channel	A1-1	A1-2	A1-3	A1-4	A1-5	A1-6	A1-7	A1-8	A1-9
Allocated resource blocks	6	15	25	3	9	12	24	101	102
DFT-OFDM Symbols per subframe	12	12	12	12	12	12	12	12	12
Modulation	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
Code rate	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3
Payload size (bits)	600	1544	2216	256	936	1224	2088	1032	1032
Transport block CRC (bits)	24	24	24	24	24	24	24	24	24
Code block CRC size (bits)	0	0	0	0	0	0	0	0	0
Number of code blocks - C	1	1	1	1	1	1	1	1	1
Coded block size including 12bits trellis termination (bits)	1884	4716	6732	852	2892	3756	6348	3180	3180

Reference channel	A1-1	A1-2	A1-3	A1-4	A1-5	A1-6	A1-7	A1-8	A1-9
Total number of bits per sub-frame	1728	4320	7200	864	2592	3456	6912	2880	2880
Total symbols per sub-frame	864	2160	3600	432	1296	1728	3456	1440	1440
Note 1: For reference channel A1-8, the allocated RB's are uniformly spaced over the channel bandwidth at RB index N, N+5, N+10, ..., N+45 where N = {0, 1, 2, 3, 4}. Note 2: For reference channel A1-9, the allocated RB's are uniformly spaced over the channel bandwidth at RB index N, N+10, N+20, ..., N+90 where N = {0, 1, 2, … 9}.									

Reference sensitivity level is calculated for both NR and LTE as follows:

$$P_{REFSENS} = 10 * \log_{10}(kT) + 10 * \log 10(B) + SNR + NF + IM$$

Where:

- kT is Boltzmann's constant and T is temperature in degrees Kelvin (-174 dBm at nominal temp);
- B is the noise/modulated BW of the signal which is – 4.5 MHz in the case of LTE FRC A1-3;
- SNR is the power to noise ratio required for demodulation of the signal –1dB for E-UTRA, (this is based on simulation of the demodulation of the FRC A1-3 measurement channel from RAN4);
- NF is the BS noise figure and is assumed to be - 5dB for both NR and LTE;
- IM is the implementation margin, 2dB is used for both NR and LTE.

It is important to note that for PREFSENS is based on the noise BW of the FRC not the Channel Bandwidth (CBW).

For E-UTRA 5,10,15,20 MHz channels BWs that all use E-UTRA FRC A1-3:

The noise modulated BW is:

$$BW_{signal} = N_{RB} * BW_{RB} = 25 * 180kHz = 4.5MHz$$

The reference E-UTRA sensitivity level is:

$$P_{REFSENS} = -174 + 10 * \log_{10}(4.5MHz) + -1 + 5 + 2 = -101.5dBm$$

For NR, the following table compares the Reference Sensitivity Level specified in TS 38.104 and the calculation based on the above formula:

Table 45: Comparison of Reference Sensitivity Level specified in TS 38.104 [19] and the calculation value

TS 38.104 Table 7.2.2-1: NR Wide Area BS reference sensitivity levels				Calculation by formula					
BS channel bandwidth [MHz]	Sub-carrier spacing [kHz]	Reference measurement channel	Reference sensitivity power level, PREFSENS	No RBs	Noise BW	NF	SNR	IM	PREFSENS
			[dBm]		MHz	dB	dB	dB	dBm
5, 10, 15	15	G-FR1-A1-1	-101.7	25	4.5	5	-1.2	2	-101.7
10, 15	30	G- FR1-A1-2	-101.8	11	3.96	5	-0.8	2	-101.8
10, 15	60	G- FR1-A1-3	-98.9	11	7.92	5	-0.9	2	-98.9
20, 25, 30, 40, 50	15	G- FR1-A1-4	-95.3	106	19.08	5	-1.1	2	-95.3
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	30	G- FR1-A1-5	-95.6	51	18.36	5	-1.2	2	-95.6
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	60	G- FR1-A1-6	-95.7	24	17.28	5	-1.1	2	-95.7

The following can be noted:

- The calculation gives the same result as the specified value;
- The BS RF NF is the same for all cases – and the same as E-UTRA i.e. 5dB;
- The SNR is based on the average result from simulations submitted to RAN4, details in TR 38.817-2 Annex B.3.

Based on the above it can be concluded that:

- The difference in sensitivity between NR and LTE is explained mainly by the difference in the Fixed Reference Channel definition used (Noise BW). the receiver performance could be considered to be essentially the same since for the same modulated BW, NR and E-UTRA sensitivity requirements are comparable (0.2dB better performance for NR compared to LTE);
- The BS Noise figure used for both NR and E-UTRA is 5dB.

A1.17 CONDUCTED BS BLOCKING

The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel.

The blocking requirements are applicable outside the Base Station RF Bandwidth or Radio Bandwidth. The interfering signal offset is defined relative to the Base Station RF Bandwidth edges or Radio Bandwidth edges. The blocking requirements apply in the in-band blocking frequency range, which is from 20 MHz below the lowest frequency of the uplink operating band up to 20 MHz above the highest frequency of the uplink operating band for BS type 1-C in an operating band less than 200 MHz wide or BS type 1-H in an operating band less than 100 MHz wide, or is from 60 MHz below the lowest frequency of the uplink operating band up to 60 MHz above the highest frequency of the uplink operating band for BS type 1-C in an operating band more than or equal to 200 MHz wide or BS type 1-H in an operating band more than or equal to 100 MHz wide, but excludes the downlink frequency range of the operating band.

Table 46: Base station general blocking requirement (TS 38.104 table 7.4.2.2-1)

NR channel bandwidth of the lowest/highest carrier received [MHz]	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering signal centre frequency offset to the band edge of the wanted carrier [MHz]	Type of interfering signal
5, 10, 15, 20	PREFSENS + 6 dB	Wide Area: -43 Medium Range: -38 Local Area: -35	7.5	5 MHz NR signal SCS: 15 kHz
25, 30, 40, 50, 60, 70, 80,90, 100	PREFSENS + 6 dB	Wide Area: -43 Medium Range: -38 Local Area: -35	30	20 MHz NR signal SCS: 15 kHz

Table 47: Base station narrowband blocking requirement

NR channel bandwidth of the lowest/highest carrier received [MHz]	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]
5, 10, 15, 20 (Note 1)	PREFSENS + 6 dB	Wide Area: -49 Medium Range: -44 Local Area: -41
25, 30, 40, 50, 60, 70, 80,90, 100 (Note 1)	PREFSENS + 6 dB	Wide Area: -49 Medium Range: -44 Local Area: -41
Note 1:The SCS for the lowest/highest carrier received is the lowest SCS supported by the BS for that bandwidth		

Table 48: Base Station narrowband blocking interferer frequency offsets

NR channel bandwidth of the lowest/highest carrier received [MHz]	Interfering signal centre frequency offset to the band edge of the wanted carrier [kHz]	Type of interfering signal
5	[342,5]+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz NR signal, 1 RB SCS: 15 kHz
10	[347.5]+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz NR signal, 1 RB SCS: 15 kHz
15	[352.5]+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz NR signal, 1 RB SCS: 15 kHz
20	[342.5]+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz NR signal, 1 RB SCS: 15 kHz
25	[557.5]+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	20 MHz NR signal, 1 RB SCS: 15 kHz
e	[562.5]+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	20MHz NR signal, 1 RB SCS: 15 kHz
40	[557.5]+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	20 MHz NR signal, 1 RB SCS: 15 kHz
50	[552.5]+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	20 MHz NR signal, 1 RB SCS: 15 kHz
60	[562.5]+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	20 MHz NR signal, 1 RB SCS: 15 kHz
70	[557.5]+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	20 MHz NR signal, 1 RB SCS: 15 kHz
80	[552.5]+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	20 MHz NR signal, 1 RB SCS: 15 kHz
90	[562.5]+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	20MHz NR signal, 1 RB SCS: 15 kHz
100	[557.5]+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	20 MHz NR signal, 1 RB SCS: 15 kHz

The out-of-band blocking characteristics is a measure of the receiver ability to receive a wanted signal at its assigned channel in the presence of an unwanted interferer out of the operating band, which is a CW signal for out-of-band blocking.

Table 49: Out-of-band blocking performance requirement for NR

Interfering Signal mean power [dBm]	Wanted Signal mean power [dBm]	Type of Interfering Signal
-15	PREFSENS +6 dB	CW carrier

The blocking performance requirements defined for NR BS are similar to those defined for LTE.

A1.18 UE ADJACENT CHANNEL SELECTIVITY

Adjacent channel selectivity (ACS) is a measure of a receiver's ability to receive an NR signal at its assigned channel frequency in the presence of an adjacent channel signal at a given frequency offset from the centre frequency of the assigned channel. ACS is the ratio of the receive filter attenuation on the assigned channel frequency to the receive filter attenuation on the adjacent channel(s).

The UE shall fulfil the minimum requirements specified in the table below for NR bands with FDL_high < 2700 MHz and FUL_high < 2700 MHz.

These limits are similar to LTE limits.

Table 50: ACS for NR bands with FDL_high < 2700 MHz and FUL_high < 2700 MHz

RX parameter	Units	Channel bandwidth				
		5-10 MHz	15 MHz	20 MHz	25 MHz	30 MHz
ACS	dB	33	30	27	26	25.5

A1.19 CONDUCTED BS ADJACENT CHANNEL SELECTIVITY

The ACS requirement is applicable outside the Base Station RF Bandwidth or Radio Bandwidth. The interfering signal offset is defined relative to the Base station RF Bandwidth edges or Radio Bandwidth edges.

Table 51: Base station ACS requirement

NR channel bandwidth of the lowest/highest carrier received [MHz]	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]
5, 10, 15, 20 (Note 1)	PREFSENS + 6 dB	Wide Area: -52 Medium Range: -47 Local Area: -44
[25, 30, 40, 50, 60, 70, 80, 90, 100] (Note 1)	PREFSENS + 6 dB	Wide Area: -52 Medium Range: -47 Local Area: -44
Note 1: The SCS for the lowest/highest carrier received is the lowest SCS supported by the BS for that bandwidth		

These limits are similar to LTE limits.

ANNEX 2: MAIN TECHNICAL PARAMETERS OF AAS (LTE/NR) SYSTEM FOR COEXISTENCE STUDIES IN 1800 MHZ FREQUENCY BAND

A2.1 AAS LTE AND AAS NR RADIATED (OTA) LIMITS

For lower bands AAS functionality is a feature that applied to the BS side only not to the UE. The NR and LTE UE requirements are defined in TS 38.101-1 and TS 36.101 respectively as conducted requirements they remain the same whether the BS is AAS or non-AAS.

LTE AAS BS requirements are defined in 3GPP TS 37.105 Section-9 for the BS transmitter side and Section-10 for the Receiver side. LTE AAS system will be covered by the NR Harmonised Standards EN 301 908 part 23 (NR BS). The UE part of LTE is covered by ETSI EN 301 908-13 which is the same as for non-AAS system.

NR AAS BS requirements are defined in 3GPP TS 38.104 Section-9 for the BS transmitter side and Section-10 for the receiver side for the receiver side, starting from NR release 15. NR AAS system will be covered by the NR Harmonised Standards: EN 301 908 part 24 (NR BS) and EN 301 908 part 25 (NR UE).

TS 37.105 provides the background for defining OTA AAS BS requirements. It states that for OTA AAS BS there are no conducted requirements. The radiated requirements have been derived in 3GPP based on the principle that they offer the same level of performance and protection as the hybrid AAS BS requirements. The radiated requirements therefore use the same equivalence as hybrid AAS BS to the non-AAS requirements assuming a scaling factor based on 8TRX compared to non-AAS BS.

Some "relative" requirements are direct references to the non-AAS BS RF specifications e.g. 3GPP TS 36.104 and 3GPP TS 37.104. Some co-location requirements which have been developed from assumptions on BS-to-BS coupling do not have direct OTA equivalents. The radiated co-location requirements use the same scenarios used to develop the non-AAS RF requirements.

Table 52: NR operating bands in 900/1800 MHz

NR operating band	Uplink (UL) operating band BS receive/UE transmit FUL_low – FUL_high	Downlink (DL) operating band BS transmit/UE receive FDL_low – FDL_high	Duplex Mode
n3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD
n8	880 MHz – 915 MHz	925 MHz – 960 MHz	FDD
n81	880 MHz – 915 MHz	N/A	SUL
n80	1710 MHz – 1785 MHz	N/A	SUL

A2.2 OTA BS OUTPUT POWER

3GPP defines the same 3 BS power classes for LTE OTA AAS BS and NR OTA AAS BS (Table 9.3.2.1-2 of TS37.105 [26]): Wide Area BS, Medium Range BS and Local Area BS.

Prated,c,TRP is defined in 3GPP as the rated carrier TRP output power.

Table 53: E-UTRA and NR OTA AAS Base Station rated output power limits for BS classes

OTA AAS BS class	PRated,c,TRP
Wide Area BS	(Note)
Medium Range BS	≤ 47 dBm
Local Area BS	≤ 33 dBm
Note: There is no upper limit for the PRated,c,TRP of the Wide Area Base Station.	

TR 37.843 (Release 15) [61] provides explanation in section 5.2.4 on how the AAS BS output power was derived from non-AAS BS specifications. These are important to apprehend some if the compatibility analyses in this Report.

The AAS BS output power limits in existing requirements are based on the values derived for the non-AAS BS specifications. These power levels are specified as the rated output power per carrier at the antenna connector, i.e. per non-AAS transceiver.

The equivalent output power limit for the OTA AAS BS specification is TRP. The AAS BS TRP is equivalent to the system output power (i.e. not the transceiver unit output power) by the following relationship:

$$P_{Rated,c,TRP} = P_{Rated,c,sys} – L_{TX}$$

The OTA AAS BS output power limit can therefore be defined as:

$$P_{Rated,c,TRP} \leq \text{Non-AAS Power limit} – L_{TX} + 10\log(N_{TXU})$$

Where NTXU is the minimum number of active transceiver units, for an OTA AAS BS has ≥8 TRXU's for E-UTRA or ≥4 TRXU's for UTRA. This number is fixed. As both LTX and NTXU have fixed values, the values in the power limit tables do not need to include variables and the adjusted fixed number can be used.

For example for medium range E-UTRA

$$P_{Rated,c,TRP} \leq 38 \text{ dBm} – 0 + 10LOG10(8) \leq 47 \text{ dBm}$$

A2.3 OTA BS CHANNEL BANDWIDTH AND MAXIMUM TRANSMISSION BANDWIDTH CONFIGURATION AND CORRESPONDING MINIMUM GUARD BAND

The channel bandwidth and Maximum transmission bandwidth configuration requirements in 3GPP are defined independently from whether the BS is AAS or non-AAS.

The same BW applies to LTE-AAS and LTE-non AAS BS.

The same BW and Maximum transmission bandwidth configuration applies to NR-AAS and NR-non-AAS BS.

Similar to the conclusion derived in ANNEX1 for NR-non-AAS, for CBW higher than 5 MHz, NR-AAS BS has higher spectrum utilisation compared to LTE BS. However, for these larger CBWs, the related minimum guard band (distance between the NR-AAS BS last in-band resources block edge to the NR channel edge) is larger than LTE 1.4, 3 and 5 MHz channels and always higher than 300 kHz. This is consistent with the coexistence conditions with GSM.

A2.4 OTA OPERATING BAND UNWANTED EMISSION

3GPP defines in TS 37.105 (section 9.7.5.2.3) [26] the same OTA Operating band unwanted emission requirements for NR-AAS and LTE-AAS BS in bands n3 (1800 MHz) and n8 (900 MHz).

Table 54: Wide Area operating band unwanted emission mask (UEM) for BC2 for BS not supporting NR or BS supporting NR in band n3 or n8

Frequency offset of measurement filter -3dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Minimum requirement (Note 2, 3)	Measurement bandwidth*
0 MHz ≤ Δf < 0.2 MHz (Note 1)	0.015 MHz ≤ f_offset < 0.215 MHz	-5 dBm	30 kHz
0.2 MHz ≤ Δf < 1 MHz	0.215 MHz ≤ f_offset < 1.015 MHz	$-5dBm - 15 \cdot \left(\frac{f\_offset}{MHz} - 0.215 \right) dB$	30 kHz
*	1.015 MHz ≤ f_offset < 1.5 MHz	-17 dBm	30 kHz
1 MHz ≤ Δf ≤ min(Δfmax, 10 MHz)	1.5 MHz ≤ f_offset < min(f_offsetmax, 10.5 MHz)	-4 dBm	1 MHz
10 MHz ≤ Δf ≤ Δfmax	10.5 MHz ≤ f_offset < f_offsetmax	-6 dBm*	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 9.7.5.2.3-2 apply for 0 MHz ≤ Δf < 0.15 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 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 □f ≥ 10 MHz from both adjacent sub-blocks on each side of the sub-block gap, where the minimum requirement within sub-block gaps shall be -6 dBm/MHz.

Note 3: For a MSR multi-band RIB with Inter RF Bandwidth gap < 2×ΔfOBUE operation 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, 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.

* For more information see TS 37.105 (section 9.7.5.2.3)

TR 37.843 (Release 15) provides explanation in section 5.6.1.2 on how the unwanted emissions for AAS BS were derived based on basic limits that are conducted requirements corresponding to non-AAS BS unwanted emissions and by applying a fixed scaling factor FSF that is based on minimum number of 8 transceiver units for E-UTRA.

The OTA AAS BS emissions limits for E-UTRA therefore are applied per cell and are based on the basic limits used in the Rel-13 AAS BS requirements multiplied by the FSF equal to 8 (or plus 9dB).

Besides, TR 37.843 provides some elements on how the existing EIRP regulations were interpreted to TRP e.g.:

- E-UTRA: OTA AAS BS emissions limits = EIRP – [17] dBi + 9 dB

A fixed assumption was made of the gain of a passive antenna system [17] dBi in order that an OTA TRP requirement can be provided for AAS BS

A2.5 OTA ADJACENT CHANNEL LEAKAGE POWER RATIO (ACLR)

3GPP defined in TS 37.105 section 9.7.3, OTA ACLR requirements (Relative and Absolute) for LTE AAS BS. These correspond to the same values defined in TS 38.104 for NR.

OTA Adjacent Channel Leakage power Ratio (ACLR) is defined as the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency. The measured power is TRP.

In these specifications, the (relative) OTA ACLR limits for AAS BS are the same as those specified in 3GPP TS 37.104 for LTE-non-AAS BS (which is the same as for NR-non-AAS) i.e. 45dB.

The ACLR absolute limits are defined as follows:

- For E-UTRA or NR Category A AAS BS of Wide Area BS class the OTA ACLR absolute limit of -4dBm/MHz shall apply;
- For E-UTRA or NR Category B AAS BS Wide Area BS class the OTA ACLR absolute limit of -6 dBm/MHz shall apply;
- For E-UTRA or NR AAS BS of Medium Range BS class the OTA ACLR absolute limit of -16 dBm/MHz shall apply;
- For E-UTRA or NR AAS BS of Local Area BS class the OTA ACLR absolute limit of -23dBm/MHz shall apply.

The OTA ACLR limit or the ACLR absolute limit of AAS BS, whichever is less stringent, shall apply outside the Base Station RF Bandwidth or Radio Bandwidth.

For 900/1800 MHz frequency bands in Europe the requirements for Category B BS applies.

Similar to the principle for operating band unwanted emissions definition, the ACLR absolute limits are defined based on the requirements from non-AAS-BS scaled by a fixed Scaling Factor FSF equal to 8 (or plus 9dB):

A2.6 OTA BS ADJACENT CHANNEL SELECTIVITY, GENERAL BLOCKING, AND NARROWBAND BLOCKING

3GPP defines in TS 37.105 section 10.5.4 OTA BS ACS and NB Blocking for single E-UTRA BS operation. The throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel.

The NR ACS, general blocking and NB-Blocking are defined in TS 38.104 in section 10.5.

Table 55: OTA Narrowband blocking requirement for E-UTRA BS

	Wanted signal mean power [dBm] (Note)	Interfering signal mean power [dBm]	Type of interfering signal
Wide Area BS	EISREFSENS + 6 dB	-49 – ΔOTAREFSENS	See table 10.5.4.2-2
	EISminSENS + 6 dB	-49 – ΔminSENS	
Medium Range BS	EISREFSENS + 6 dB	-44 – ΔOTAREFSENS	See table 10.5.4.2-2
	EISminSENS + 6 dB	-44 – ΔminSENS	
Local Area BS	EISREFSENS + 6 dB	-41 – ΔOTAREFSENS	See table 10.5.4.2-2
	EISminSENS + 6 dB	-41 – ΔminSENS	
Note: EISREFSENS and EISminSENS depend on the RAT, the BS class and on the channel bandwidth, see subclauses 10.3 and 10.2.			

Table 56: Interfering signal for OTA Narrowband blocking requirement for E-UTRA BS (Table 10.5.4.2-2 of TS37.105 [26])

E-UTRA channel BW of the lowest/highest carrier received [MHz]	Interfering RB centre frequency offset to the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap [kHz]	Type of interfering signal
1.4	±(252.5+m*180), m=0, 1, 2, 3, 4, 5	1.4 MHz E-UTRA signal, 1 RB (Note)
3	±(247.5+m*180), m=0, 1, 2, 3, 4, 7, 10, 13	3 MHz E-UTRA signal, 1 RB (Note)
5	±(342.5+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz E-UTRA signal, 1 RB (Note)
10	±(347.5+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz E-UTRA signal, 1 RB (Note)
15	±(352.5+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz E-UTRA signal, 1 RB (Note)
20	±(342.5+m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz E-UTRA signal, 1 RB (Note)
Note: Interfering signal consisting of one resource block is positioned at the stated offset, the channel bandwidth of the interfering signal is located adjacently to the lower/upper Base Station RF Bandwidth edge.		

Table 57: OTA Adjacent channel selectivity for E-UTRA Wide Area BS (Table 10.5.4.2-3 of TS 37.105 [26])

E-UTRA channel bandwidth of the lowest / highest carrier received [MHz]	Wanted signal mean power [dBm] (Note)	Interfering signal mean power [dBm]	Interfering signal centre frequency offset from the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap [MHz]	Type of interfering signal
1.4	EISminSENS + 11 dB	-52 – ΔminSENS	±0.7025	1.4°MHz E-UTRA signal
3	EISminSENS + 8 dB	-52 – ΔminSENS	±1.5075	3°MHz E-UTRA signal
5	EISminSENS + 6 dB	-52 – ΔminSENS	±2.5025	5 MHz E-UTRA signal
10	EISminSENS + 6 dB	-52 – ΔminSENS	±2.5075	5 MHz E-UTRA signal
15	EISminSENS + 6 dB	-52 – ΔminSENS	±2.5125	5 MHz E-UTRA signal
20	EISminSENS + 6 dB	-52 – ΔminSENS	±2.5025	5 MHz E-UTRA signal
Note: EISminSENS depends on the channel bandwidth as specified see subclause 10.2.				

Table 58: OTA ACS requirement for NR AAS BS type 1-O (Table 10.5.1.2-1o of TS38.104 [19])

BS channel bandwidth of the lowest/highest carrier received [MHz]	Wanted signal mean power [dBm] (Note 2)	Interfering signal mean power [dBm]
5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80,90, 100 (Note 1)	EISminSENS + 6 dB	Wide Area: -52 – ΔminSENS Medium Range: -47– ΔminSENS Local Area: -44– ΔminSENS
Note 1: The SCS for the lowest/highest carrier received is the lowest SCS supported by the BS for that bandwidth Note 2: EISminSENS depends on the BS channel bandwidth		

Table 59: OTA ACS interferer frequency offset for NR AAS BS type 1-O (Table 10.5.1.2-2 of TS38.104 [19])

BS channel bandwidth of the lowest/highest carrier received [MHz]	Interfering signal centre frequency offset from the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap [MHz]	Type of interfering signal
5	±2.5025	5 MHz DFT-s-OFDM NR signal SCS: 15 kHz, 25 RB
10	±2.5075	5 MHz DFT-s-OFDM NR signal SCS: 15 kHz, 25 RB
15	±2.5125	5 MHz DFT-s-OFDM NR signal SCS: 15 kHz, 25 RB
20	±2.5025	5 MHz DFT-s-OFDM NR signal SCS: 15 kHz, 25 RB
25	±9.535	20 MHz DFT-s-OFDM NR signal SCS: 15 kHz, 100 RB
30	±9.585	20 MHz DFT-s-OFDM NR signal SCS: 15 kHz, 100 RB
…		

Table 60: General OTA blocking requirement for NR AAS BS type 1-O (Table 10.5.2.2-1 of TS38.104 [19])

BS channel bandwidth of the lowest/highest carrier received [MHz]	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering signal centre frequency minimum offset from the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap [MHz]	Type of interfering signal
5, 10, 15, 20	EISREFSENS + 6 dB	Wide Area: -43 - ΔOTAREFSENS Medium Range: -38 - ΔOTAREFSENS Local Area: -35 - ΔOTAREFSENS	±7.5	5 MHz DFT-s-OFDM NR signal SCS: 15 kHz, 25 RB
	EISminSENS + 6 dB	Wide Area: -43 – ΔminSENS Medium Range: -38 – ΔminSENS Local Area: -35 –	±7.5	5 MHz DFT-s-OFDM NR signal SCS: 15 kHz, 25 RB

BS channel bandwidth of the lowest/highest carrier received [MHz]	Wanted signal mean power [dBm]	Interfering signal mean power [dBm]	Interfering signal centre frequency minimum offset from the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap [MHz]	Type of interfering signal
		ΔminSENS		
25 ,30, 40, 50, 60, 70, 80, 90, 100	EISREFSENS + 6 dB	Wide Area: -43 - ΔOTAREFSENS Medium Range: -38 - ΔOTAREFSENS Local Area: -35 - ΔOTAREFSENS	±30	20 MHz DFT-s-OFDM NR signal SCS: 15 kHz, 100 RB
	EISminSENS + 6 dB	Wide Area: -43 – ΔminSENS Medium Range: -38 – ΔminSENS Local Area: -35 – ΔminSENS	±30	20 MHz DFT-s-OFDM NR signal SCS: 15 kHz, 100 RB

Table 61: OTA narrowband blocking requirement for AAS NR BS type 1-O (Table 10.5.2.2-2 of TS38.104 [19])

BS channel bandwidth of the lowest/highest carrier received [MHz]	OTA Wanted signal mean power [dBm]	OTA Interfering signal mean power [dBm]
5, 10, 15, 20	EISREFSENS + 6 dB	Wide Area: -49 - ΔOTAREFSENS Medium Range: -44 - ΔOTAREFSENS Local Area: -41 - ΔOTAREFSENS
	EISminSENS + 6 dB	Wide Area: -49 – ΔminSENS Medium Range: -44 – ΔminSENS Local Area: -41 – ΔminSENS
25, 30, 40, 50, 60, 70, 80, 90, 100	EISREFSENS + 6 dB	Wide Area: -49 - ΔOTAREFSENS Medium Range: -44 - ΔOTAREFSENS Local Area: -41 - ΔOTAREFSENS
	EISminSENS + 6 dB	Wide Area: -49 – ΔminSENS Medium Range: -44 – ΔminSENS Local Area: -41 – ΔminSENS
Note: The SCS for the lowest/highest carrier received is the lowest SCS supported by the BS for that bandwidth		

Table 62: OTA narrowband blocking interferer frequency offsets for BS type 1-O (Table 10.5.2.2-3 from TS38.104 [19])

BS channel bandwidth of the lowest/highest carrier received [MHz]	Interfering RB centre frequency offset to the lower/upper Base Station RF Bandwidth edge or sub-block edge inside a sub-block gap [kHz]	Type of interfering signal
5	±([342.5] + m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz DFT-s-OFDM NR signal, 1 RB SCS: 15 kHz
10	±([347.5] + m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	
15	±([352.5] + m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	
20	±([342.5] + m*180), m=0, 1, 2, 3, 4, 9, 14, 19, 24	
25	±([557.5] + m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 104	20 MHz DFT-s-OFDM NR signal, 1 RB SCS: 15 kHz
30	±([562.5] + m*180), m=0, 1, 2, 3, 4, 29, 54, 79, 104	

The blocking performance requirements defined for AAS NR BS and those defined for AAS LTE BS are comparable.

OTA wanted signal mean power and OTA interfering signal mean power used in the above requirements' definition are shifted by Δ (ΔminSENS and ΔOTAREFSENS) compared to LTE-non-AAS requirements definition.

TS 37.105 provides the following definitions for the Δ:

- ΔminSENS = PREFSENS – EISminSENS
- ΔOTAREFSENS = PREFSENS -EISREFSENS

As it can be seen, the interference signal mean power is tested over 2 points: one that is scaled by ΔOTAREFSENS and the other by ΔminSENS compared to LTE non AAS Interfering signal mean power.

The relative wanted signal mean power defined for LTE AAS BS respectively is a function of EISREFSENS and EISminSENS and is also scaled by the same ΔOTAREFSENS and by ΔminSENS compared to LTE non AAS relative wanted signal mean power.

This means that the rejections of the AAS LTE BS receiver derived from narrowband blocking is the same as for LTE-non-AAS BS.

A2.7 OTA BS REFERENCE SENSITIVITY LEVEL

For AAS NR BS, the throughput shall be ≥ 95% of the maximum throughput of the reference measurement channel as specified in the corresponding table and Annex A of TS 38.104.

Table 63: NR AAS Wide Area BS OTA reference sensitivity levels (Table 10.3.2-1 of TS38.104 [19])

BS channel bandwidth [MHz]	Sub-carrier spacing [kHz]	Reference measurement channel	OTA Reference sensitivity level, EISREFSENS [dBm]
5, 10, 15	15	G- FR1-A1-1	-101.7 - ΔOTAREFSENS
10, 15	30	G- FR1-A1-2	-101.8 - ΔOTAREFSENS
10, 15	60	G- FR1-A1-3	-98.9 - ΔOTAREFSENS
20, 25, 30, 40, 50	15	G- FR1-A1-4	-95.3 - ΔOTAREFSENS
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	30	G- FR1-A1-5	-95.6 - ΔOTAREFSENS
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	60	G- FR1-A1-6	-95.7 - ΔOTAREFSENS
Note: EISREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for each consecutive application of a single instance of the reference measurement channel mapped to disjoint frequency ranges with a width corresponding to the number of resource blocks of the reference measurement channel each, except for one instance that might overlap one other instance to cover the full BS channel bandwidth.			

For OTA AAS LTE BS, the reference sensitivity level is defined in TS 37.105 in section 10.3.4 "Minimum requirement for single RAT E-UTRA operation" as follows:

Table 64: E-UTRA Wide area AAS BS OTA reference measurement channel (Table 10.3.4-1 from TS37.105)

E-UTRA channel bandwidth [MHz]	Reference measurement channel	EISREFSENS [dBm]
1.4	FRC A1-1 in 3GPP TS 36.104 [22], annex A.1	-106.8 - ΔOTAREFSENS
3	FRC A1-2 in 3GPP TS 36.104 [22], annex A.1	-103.0 - ΔOTAREFSENS
5	FRC A1-3 in 3GPP TS 36.104 [22], annex A.1	-101.5 - ΔOTAREFSENS
10	FRC A1-3 in 3GPP TS 36.104 [22], annex A.1 (Note)	-101.5 - ΔOTAREFSENS
15	FRC A1-1 in 3GPP TS 36.104 [22], annex A.1(Note)	-101.5 - ΔOTAREFSENS
20	FRC A1-2 in 3GPP TS 36.104 [22], annex A.1(Note)	-101.5 - ΔOTAREFSENS
Note: EISREFSENS is the power level of a single instance of the reference measurement channel. This requirement shall be met for each consecutive application of a single instance of FRC A1-3 mapped to disjoint frequency ranges with a width of 25 resource blocks each.		

As could be seen from the table above the OTA requirements of NR and LTE are defined in very similar way by applying a - ΔOTAREFSENS to the reference sensitivity levels defined respectively for NR-non-AAS and LTE-non-AAS BS.

Annex 1 has already analysed those apparent differences between LTE non-AAS and NR-Non AAS Reference sensitivity levels and concluded the following:

- The difference in sensitivity between NR and LTE is explained mainly by the difference in the Fixed Reference Channel definition used (Noise BW). <u>However, for the same modulated BW, NR and E-UTRA requirements are comparable (0.2 dB better performance for NR compared to LTE);</u>

- The BS Noise figure used for both NR-non-AAS and E-UTRA-non-AAS is 5 dB.

Based on the above it can be concluded that for the same modulated BW, AAS-NR and AAS-LTE receiver reference sensitivity requirement is comparable ((0.2 dB better performance for AAS-NR compared to AAS-LTE).

ANNEX 3: LIST OF REFERENCES

[1] 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 March 2018
[2] CEPT Report 40: "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)", November 2010
[3] CEPT Report 41: "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", November 2010
[4] CEPT Report 42: "Compatibility between UMTS and existing and planned aeronautical systems above 960 MHz", November 2010
[5] 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", March 2018
[6] 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", June 2017
[7] ECC Report 229: "Guidance for improving coexistence between GSM-R and MFCN in the 900 MHz band", May 2015
[8] 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", July 2010
[9] ECC Report 82: "Compatibility study for UMTS operating within the GSM 900 and GSM 1800 frequency bands", June 2006
[10] ECC Report 96: "Compatibility between UMTS 900/1800 and systems operating in adjacent bands", April 2007
[11] ERC Decision (94)01: "ERC Decision of 24th October 1994 on the frequency bands to be designated for the coordinated introduction of the GSM digital pan-European communications system"
[12] ERC Decision (97)02: "ERC Decision of 21 March 1997 on the extended frequency bands to be used for the GSM Digital Pan-European Communications System"
[13] EC Decision 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
[14] EC Decision 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
[15] ECC Recommendation (05)08: "Frequency planning and cross-border coordination between GSM Land Mobile Systems (GSM 900, GSM 1800 and GSM-R)"
[16] ECC Recommendation (08)02: "Frequency planning and frequency coordination for GSM / UMTS / LTE / WiMAX Land Mobile systems operating within the 900 and 1800 MHz bands", April 2012
[17] ERC Decision (95)03: "ERC Decision of 1 December 1995 on the frequency bands to be designated for the introduction of DCS 1800"
[18] 3GPP TS 38.101-1: "Technical Specification Group Radio Access Network; NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone" (Release 15)
[19] 3GPP TS 38.104: "Technical Specification Group Radio Access Network; NR; Base Station (BS) radio transmission and reception"; (Release 15)
[20] CEPT Report 67: "Report A from CEPT to the European Commission in response to the Mandate "to develop harmonised technical conditions for spectrum use in support of the introduction of next-generation (5G) terrestrial wireless systems in the Union" Review of the harmonised technical conditions applicable to the 3.4-3.8 GHz ('3.6 GHz') frequency band", July 2018
[21] 3GPP TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception"
[22] 3GPP TS 36.104: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception"
[23] ETSI EN 301 908-24: "IMT cellular networks; Harmonised Standard for access to radio spectrum Part 24: New Radio (NR) Base Stations (BS) NR BS", V15.1.1
[24] ETSI EN 301 908-25: "IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Radio Equipment Directive 2014/53/EU; Part 25: New Radio (NR) User Equipments (UE)"

[25] ETSI EN 301 908-23: “IMT cellular networks; Harmonised Standard for access to radio spectrum; Part 23: Active Antenna System (AAS) Base Station (BS); Conducted conformance testing AAS BS V13.1.1
[26] ETSI EN 301 908-13 V11.1.2: “IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 13: Evolved Universal Terrestrial Radio Access (E-UTRA) User Equipment (UE)”
[27] 3GPP TS 37.105: “Technical Specification Group Radio Access Network: "Active Antenna System (AAS) Base Station (BS) transmission and reception (Release 14)"
[28] 3GPP TS 37.104: “Technical Specification Group Radio Access Network: "E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) radio transmission and reception (Release 15)"
[29] 3GPP TR 37.840: “Study of Radio Frequency (RF) and Electromagnetic Compatibility (EMC) requirements for Active Antenna Array System (AAS) base station”
[30] 3GPP TR 37.842: “Evolved Universal Terrestrial Radio Access (E-UTRA) and Universal Terrestrial Radio Access (UTRA; Radio Frequency (RF) requirement background for Active Antenna System (AAS) Base Station (BS)”
[31] 3GPP TR 25.816: “UMTS 900 MHz Work Item technical report”
[32] 3GPP TR 25.942: “Radio Frequency (RF) system scenarios”
[33] 3GPP TR 36.942: “Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Frequency (RF) system scenarios”
[34] ECC Report 246: “Wideband and Higher DC Short Range Devices in 870-875.8 MHz and 915.2-920.8 MHz (companion to ECC Report 200)”
[35] Addendum to CEPT Report 59: “Addendum to the CEPT Report 59 in response to the EC Permanent Mandate on the ”Annual update of the technical annex of the Commission Decision on the technical harmonisation of radio spectrum for use by short range devices”, Possibilities for a harmonisation approach for the bands 870-876 MHz and 915-921 MHz also taking into account new opportunities in the band 862-868 MHz”
[36] EC Decision 2006/771/EC - Commission Decision on harmonisation of the radio spectrum for use by short-range devices
[37] EC Decision 2013/752/EU – Commission Implementing Decision amending Decision 2006/771/EC on harmonisation of the radio spectrum for use by short-range devices and repealing Decision 2005/928/EC
[38] ERC Report 031: “Compatibility between DECT and DCS 1800”, June 1994
[39] ERC Report 100: “Compatibility between certain radiocommunications systems operating in adjacent bands. Evaluation of DECT/GSM 1800 compatibility”, February 2000
[40] Recommendation ITU-R SA.1158-3: “Feasibility of frequency sharing in the 1 670-1 710 MHz band between the meteorological-satellite service (space-to-Earth) and the mobile-satellite service (Earth-to-space)”
[41] ERC Report 063: “Introduction of radio microphone applications in the frequency range 1785 - 1800 MHz”, May 1998
[42] ERC Recommendation 70-03: “Relating to the use of Short Range Devices (SRD) Annex 10 “Radio microphones and Assistive Listening Devices”, amended October 2018
[43] ETSI EN 300 422 V1.2.1: “Electromagnetic compatibility and Radio spectrum Matters (ERM); Technical characteristics and test methods for wireless microphones in the 25 MHz to 3 GHz frequency range;”
[44] ERC Report 065: “Adjacent band compatibility between UMTS and other services in the 2 GHz band”, November 1999
[45] ERC Report 064: “Frequency sharing between UMTS and existing fixed services”, May 1999
[46] ECC Report 173: “Fixed Service in Europe Current use and future trends post 2016”, April 2018
[47] ECC Decision (11)06: “Harmonised frequency arrangements and least restrictive technical conditions (LRTC) for mobile/fixed communications networks (MFCN) operating in the band 3400-3800 MHz”, amended October 2018
[48] ERC Recommendation 74-01: “Unwanted Emissions in the Spurious Domain, amended January 2011
[49] Recommendation ITU-R M.1457-13: “Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2000 (IMT-2000)”
[50] ETSI EN 301 502 V11.1.1: “Global System for Mobile communications (GSM); Harmonised EN for Base Station Equipment covering the essential requirements of article 3.2 of the R&TTE Directive”
[51] ETSI EN 301 511 V 12.5.1: “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”

[52] ETSI EN 301 908-18 V5.2.1: “IMT cellular networks; Harmonised EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 18: E-UTRA, UTRA and GSM/EDGE Multi-Standard Radio (MSR) Base Station (BS)”

[53] ETSI EN 301 908-1 V11.1.1: “IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 1: Introduction and common requirements”

[54] ETSI EN 301 908-2 V11.1.2: “IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 2: CDMA Direct Spread (UTRA FDD) User Equipment (UE)”

[55] ETSI EN 301 908-3 V11.1.3: “IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 3: CDMA Direct Spread (UTRA FDD) Base Stations (BS)”

[56] ETSI EN 301 908-11 V11.1.2: “IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 11: CDMA Direct Spread (UTRA FDD) Repeaters”

[57] ETSI EN 301 908-14 V11.1.2: “IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 14: Evolved Universal Terrestrial Radio Access (E-UTRA) Base Stations (BS)”

[58] ETSI EN 301 908-15 V11.1.2: “IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 15: Evolved Universal Terrestrial Radio Access (E-UTRA FDD) Repeaters”

[59] ETSI EN 301 908-21 V6.1.1: “IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 21: OFDMA TDD WMAN (Mobile WiMAX) FDD User Equipment (UE)”

[60] ETSI EN 301 908-22 V6.1.1: “IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 22: OFDMA TDD WMAN (Mobile WiMAX) FDD Base Stations (BS)”

[61] Recommendation ITU-R SM.329-12: “Unwanted emissions in the spurious domain”

[62] 3GPP TR 37.843 V15.2.0: “Radio Frequency (RF) requirement background for Active Antenna System (AAS) Base Station (BS) radiated requirements”

[63] Decision (EU) 2018/1538: “COMMISSION IMPLEMENTING DECISION (EU) 2018/1538 of 11 October 2018 on the harmonisation of radio spectrum for use by short-range devices within the 874-876 and 915-921 MHz frequency bands”