INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

NO. 2784 **25 November 2022**

HEREBY ISSUES A NOTICE REGARDING DRAFT RADIO FREQUENCY ASSIGNMENT PLANS FOR THE FREQUENCY BAND 410 TO 430 MHZ IN TERMS OF REGULATION 3 OF THE RADIO FREQUENCY SPECTRUM REGULATIONS, 2015

1. The Independent Communications Authority of South Africa ("the Authority"), hereby publishes the **Draft Radio Frequency Spectrum Assignment Plan for the frequency band 410 MHz to 430 MHz for public consultation** in terms of regulation 3 of the Radio Frequency Spectrum Regulations 2015 and the Radio Frequency Migration Plan of 2013 and 2019.
2. The Radio Frequency Migration Regulations 2013 provide that upon completion of this Radio Frequency Spectrum Assignment Plan, the Authority will issue a notice to users to be migrated in terms of Regulation 6.
3. Interested persons are hereby invited to submit written representations of their views on the RFSAP, in both Microsoft Word and PDF format.
4. Submission must be made no later than 16h00 on Friday 13 January 2023.
5. Persons making representations are further invited to indicate whether they require an opportunity to make oral representations.
6. Written representations or enquiries may be directed by email to:

Attention:

Mr Manyaapelo Richard Makgotlho

e-mail: rmakgotlho@icasa.org.za

cc: jdikgale@icasa.org.za

7. All written representations submitted to the Authority pursuant to this notice will be made available for inspection by interested persons from 17January 2023 at the ICASA Library. Electronic copies of such representations are obtainable on request and documents will be obtainable on payment of a fee.

8. The draft plans and non-confidential representations will be uploaded to the ICASA website under this link: https://www.icasa.org.za/legislation-and-regulations/radio-frequency-spectrum-plans/draft-radio-frequency-spectrum-plans
9. In terms of section 4D of the ICASA Act, any person may request that any part of the pre-registration notice be treated as confidential. Confidential documents must be clearly marked as such and submitted together with the original written representation. Requests for Confidentiality must be submitted in line with the Guidelines for Confidentiality Request published in Government Gazette No 41839 (Notice No. 849) dated 17 August 2018.
10. Where an Applicant has requested confidentiality on sections of its written representations, the written representations must be accompanied by one (1) non-confidential copy with sections that are redacted. The non-confidential version of the written representations will be published for public comment if the request for confidentiality is granted. Requests for confidentiality will be considered within fourteen (14) working days of receiving the request. The Authority will communicate its decision to the respective Applicant.
11. In the event that the request for confidentiality is refused, the Applicant may choose to withdraw the information on which confidentiality is requested.

DR CHARLES LEWIS
ACTING CHAIRPERSON

Radio Frequency Spectrum Assignment Plan

Rules for Services operating in the Frequency Band
410 MHz to 430 MHz

Table of Contents

1 Glossary

In this Radio Frequency Spectrum Assignment Plan, terms used shall have the same meaning as in the Electronic Communications Act 2005 (no. 36 of 2005); unless the context indicates otherwise:

"3GPP"	means 3rd Generation Partnership Project
"5G"	means Fifth Generation (of mobile networks)
"Act"	means the Electronic Communications Act, 2005 (Act No. 36 of 2005) as amended
"Administration"	means any governmental department or service responsible for discharging the obligations undertaken in the Constitution of the International Telecommunication Union, in the Convention of the International Telecommunication Union and in the Administrative Regulations (CS 1002).
"APT"	means the Asia-Pacific Telecommunity
"BB-"	means Broadband (e.g., BB-PPDR)
"BS"	means Base Station
"BTX"	means Base Transceiver
"CEPT"	means the European Conference of Postal and Telecommunications Administrations
"CDMA"	means Code Division Multiple Access
"Days"	means working days unless otherwise specified
"dBc"	means decibels relative to carrier
"DF"	means Dual Frequency
"DM RS"	means Demodulation Reference Signal
"DSS"	means Dynamic Spectrum Sharing
"ECC"	means the Electronic Communications Committee (ECC) within the European Conference of Postal and Telecommunications Administrations (CEPT)
"ECC/DEC"	means ECC Decision
"ECC/REC"	means ECC Recommendation
"EIRP"	means Effective Isotropic Radiated Power
"ERP"	means Effective Radiated Power

"ETSI"	means the European Telecommunications Standards Institute
"FDD"	means Frequency Division Duplexing
"GSM"	means the Global System for Mobile Communications (GSM), the second generation (2G) of mobile networks
"HCM"	means Harmonised Calculation Method
"HIPSSA"	means the Sub-Saharan Africa Assessment Report on Harmonisation of ICT Policies in Sub-Saharan Africa
"ICNIRP"	means the International Commission on Non-Ionizing Radiation Protection (ICNIRP)
"IMT"	means the International Mobile Telecommunications
"IoT"	means the Internet of Things
"ITU"	means the International Telecommunication Union;
"ITU-R"	means the International Telecommunication Union Radiocommunication Sector
"LPWAN"	means Low Power Wide Area Network
"LRTC"	means the Least Restrictive Technical Conditions
"LTE"	means the Long-Term Evolution, which is a standard for wireless communication of high-speed data for mobile phones and data terminals
"M2M"	means Machine to Machine communications
"MTX"	means Mobile Transceiver
"NB-IoT"	means Narrow Band IoT
"NR"	means New Radio
"NRFP"	means the National Radio Frequency Plan 2021 for South Africa
"OOBE"	means Out Of Block Emissions
"PAMR"	means Public Access Mobile Radio
"PCI"	means Physical-Layer Cell Identities
"PN"	means Pseudo-Noise
"RFMP"	means the Radio Frequency Migration Plan
"RFSAP"	means the Radio Frequency Spectrum Assignment Plan
"PRACH"	means Physical Random Access Channel

"PMR"	means Private (Professional) Mobile Radio
"PN"	means Pseudo-Noise
"PPDR"	means Public Protection and Disaster Relief
"PUCCH"	means Physical Uplink Control Channel
"SF"	means Single Frequency
"TDD"	means Time Division Duplexing
"TEDS"	means TETRA Enhanced Data Service
"TETRA"	means a European standard for a trunked radio system, is a professional mobile radio and two-way transceiver specification; formerly known as Trans-European Trunked Radio
"UE"	means User Equipment (user terminal)
"WRC-12"	means the World Radio Conference held in Geneva in 2012
"WRC-15"	means the World Radio Conference held in Geneva in 2015
"WRC-19"	means the World Radio Conference held in Sharm el-Sheikh in 2019

2 Purpose

2.1 This Radio Frequency Spectrum Assignment Plan (RFSAP) provides information on the requirements attached to the use of a frequency band in line with the allocation and other information in the National Radio Frequency Plan (NRFP). This information includes technical characteristics of radio systems, frequency channelling, coordination, and details on required migration of existing users of the band and the expected method of assignment.

2.2 The Authority proposed in the RFMP 2013[1] and 2019 Radio Frequency Migration Plan[2] exclusive allocation for trunking services. However, in light of emerging trends in this band, the Authority proposed in the feasibility study concerning this band[3] to make this band available for other potential emerging applications such as broadband Public Protection and Disaster Relief (PPDR) and Internet of Things (IoT), in addition to digital public trunking. The Authority also proposed that all other services migrate out of the band.

2.3 This RFSAP states the requirements for the utilization of the frequency band between 410 MHz and 430 MHz for potential emerging applications such as broadband PPDR and IoT, in addition to digital public trunking services.

2.4 The Authority's decision is consistent with the ITU allocations for the 410 MHz to 430 MHz band. The 410 MHz to 420 MHz band is allocated to FIXED, MOBILE (except aeronautical mobile) and SPACE RESEARCH (space-to-space) services. The 420 MHz to 430 MHz band is allocated to FIXED and MOBILE (except aeronautical mobile) services on a primary basis within Region 1. In addition, footnote 5.268 in the National Frequency Plan for South Africa notes that the use of the frequency band 410 – 420 MHz by the space research service is limited to space-to-space communication links with an orbiting, manned space vehicle. In this frequency band, stations of the space research service (space-to-space) shall not claim protection from, nor constrain the use and development of, stations of the fixed and mobile services. **The Authority has concluded that this band will be made available for other potential emerging applications such as broadband PPDR (BB-PPDR) and IoT, in addition to digital public trunking**.

3 General

3.1 Technical characteristics of the equipment used in potential emerging applications such as broadband PPDR and IoT and digital public trunking systems shall conform to all applicable South African standards, international standards, International Telecommunication Union (ITU) and its radio regulations as agreed and adopted by South Africa.

3.2 All installations must comply with safety rules as specified in applicable standards.

3.3 The equipment used shall be certified under South African law and regulations.

3.4 The allocation of this frequency band and the information in this RFSAP are subject to review.

3.5 Use of this band will be for potential emerging applications such as broadband PPDR and IoT, in addition to digital public trunking services.

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[1] Frequency Migration regulation and Radio Frequency Migration Plan March 2013, Government Gazette No 36334, 3 April 2013

[2] Government Gazette No 42337, 29 March 2019. https://www.icasa.org.za/uploads/files/final-radio-frequency-migration-plan-2019.pdf

[3] Implementation of the Radio Frequency Migration Plan and the International Mobile Telecommunications (IMT) Roadmap for public consultation, Government Gazette No. 45690, 24 December 2021.

3.6 The 2021 Implementation document[4] discusses LTE and associated technologies in the context of PPDR and IoT. The LTE can be equally expanded on the next, fifth generation (5G) of the mobile networks, including New Radio (NR).

3.7 In line with the development of land mobile PMR/PAMR, the need for high-speed data and other additional services increases. Already now, there is an expressed requirement for services that cannot be delivered over traditional narrowband technology. In response, industry has already developed a number of systems, including for example TETRA TEDS using 25 kHz, 50 kHz, 100 kHz and 150 kHz bandwidth, systems using 200 kHz channel bandwidth based on GSM technology, M2M/IoT based on NB-IoT and LPWAN (Low Power Wide Area Network) technologies, CDMA-PAMR using 1.25 MHz channel bandwidth or LTE (Long-Term Evolution) based technologies using 200 kHz, 1.4 MHz, 3 MHz, and 5 MHz channel bandwidth.

3.8 As highlighted by "Implementation of the Radio Frequency Migration Plan and the International Mobile Telecommunications (IMT) Roadmap" 100, 3GPP has standardised two FDD band plans (see Figure 1) for the 410 – 430 MHz band [5], namely bands 87 for PMR in APT (410 – 415 MHz for uplink and 420 – 425 MHz for downlink) and 88 for PMR in EU (412 – 417 MHz for uplink and 422 – 427 MHz for downlink). In particular, the band 88 matches ITU Region 1, where South Africa belongs.

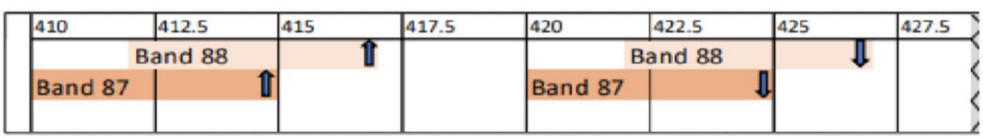

Figure 1: **Two 3GPP band plans (87 and 88) for 410 MHz to 430 MHz band [100].**

3.9 ECC/DEC/ (19)02[6] suggests the following options for the land mobile systems with channel bandwidth of 1.25 MHz, 1.4 MHz, 3 MHz, and 5 MHz:

3.9.1 410-415 MHz (uplink) / 420-425 MHz (downlink), similar to 3GPP's LTE band 87;

3.9.2 411-416 MHz (uplink) / 421-426 MHz (downlink); and

3.9.3 412-417 MHz (uplink) / 422-427 MHz (downlink), similar to 3GPP's LTE band 88.

3.9.4 Considering the mismatch to the 3GPP's for option 33.9.2, it is likely that only the other two options will receive industry support. For this reason, option 33.9.2 is not included in the proposed Channelling Plan shown in section 34.

3.10 Public Protection Disaster Relief (PPDR)

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4 https://www.gov.za/sites/default/files/gcis_document/202112/45690gen739.pdf

5 450 Alliance, https://450alliance.org/

6 ECC/DEC/ (19)02, ECC Decision of 8 March 2019 on Land mobile systems in the frequency ranges 68-87.5 MHz, 146-174 MHz, 406.1-410 MHz, 410-430 MHz, 440-450 MHz, and 450-470 MHz, 8 March 2019. (https://docdb.cept.org/document/9680)

3.10.1 Resolution 646 (Rev. WRC-15) [7] defines the purpose of a PPDR radio system. Such a system includes two different uses. The first one is for Public Protection (PP) which covers radiocommunications used by responsible agencies and organisations dealing with maintenance of law and order, protection of life and property, and emergency situations. The second one is for Disaster Relief (DR) which covers radiocommunications used by agencies and organisations dealing with a serious disruption of the functioning of society, posing a significant, widespread threat to human life, health, property or the environment, whether caused by accident, nature or human activity, and whether developing suddenly or as a result of complex, long-term processes (the precise definitions are also included and explained in ECC Report 102 [5]).

3.10.2 BB-PPDR services can be provided by means of three infrastructure models; through mobile broadband networks dedicated to providing service to BB-PPDR users to meet their specific requirements, through commercial mobile networks providing both PPDR and commercial service or through hybrid solutions with partly dedicated and partly commercial network infrastructure.

3.10.3 As per ECC/DEC/ (16)02 [8], the 400 MHz range does not provide enough available spectrum to provide a stand-alone solution for broadband PPDR as calculated in ECC Report 199 [9], even though it can offer national flexibility, e.g., in the context of additional spectrum beside the 700 MHz range. In addition, the 400 MHz range has the advantage of very good propagation characteristics, potentially reducing the number of base station sites needed to provide the necessary coverage (rural areas).

As per ECC/DEC/ (16)02[10], introduction of additional spectrum for BB-PPDR in parts of the 400 MHz range shall apply the Least Restrictive Technical Conditions (LRTC) for BB-PPDR (intended to ensure coexistence with other services), with channelling arrangements 1.4 MHz, 3 MHz, or 5 MHz within the following paired frequency ranges:

3.10.3.1 410.0-415.0 MHz (uplink) / 420.0-425.0 MHz (downlink);

3.10.3.2 411.0-416.0 MHz (uplink) / 421.0-426.0 MHz (downlink); or

3.10.3.3 412.0-417.0 MHz (uplink) / 422.0-427.0 MHz (downlink).

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[7] Resolution 646 (Rev. WRC-15): "Public Protection and Disaster Relief" recommends to use regionally harmonised bands for BB-PPDR radio systems to the maximum extent possible, taking into account the national and regional requirements and also having regard to any needed consultation and cooperation with other concerned countries/regions.

[8] ECC/DEC/ (16)02, ECC Decision of 17 June 2016 on harmonised technical conditions and frequency bands for the implementation of Broadband Public Protection and Disaster Relief (BB-PPDR) systems. Amended on 8 March 2019. (https://docdb.cept.org/document/941)

[9] ECC Report 199, User requirements and spectrum needs for future European broadband PPDR systems (Wide Area Networks), 30 May 2013. (https://docdb.cept.org/document/306)

[10] ECC/DEC/ (16)02, ECC Decision of 17 June 2016 on harmonised technical conditions and frequency bands for the implementation of Broadband Public Protection and Disaster Relief (BB-PPDR) systems. Amended on 8 March 2019. (https://docdb.cept.org/document/941)

3.11 The following documents may also be useful when considering the 410 – 430 MHz band:

3.11.1 ECC/DEC/ (19)02, ECC Decision of 8 March 2019 on Land mobile systems in the frequency ranges 68-87.5 MHz, 146-174 MHz, 406.1-410 MHz, 410-430 MHz, 440-450 MHz, and 450-470 MHz, 8 March 2019. (https://docdb.cept.org/document/9680)

3.11.2 ECC/DEC/ (16)02, ECC Decision of 17 June 2016 on harmonised technical conditions and frequency bands for the implementation of Broadband Public Protection and Disaster Relief (BB-PPDR) systems. Amended on 8 March 2019. (https://docdb.cept.org/document/941)

3.11.3 ECC Report 292, Current Use, Future Opportunities and Guidance to Administrations for the 400 MHz PMR/PAMR frequencies, 8 February 2019. (https://docdb.cept.org/document/9556)

3.11.4 T/R 25-08, Recommendation T/R of 30 May 2008 on Planning criteria and cross-border coordination of frequencies for land mobile systems in the range 29.7-470 MHz. Latest amended on 28 September 2018. (https://docdb.cept.org/document/909)

3.11.5 ECC Report 283, Compatibility and sharing studies related to the introduction of broadband and narrowband systems in the bands 410-430 MHz and 450-470 MHz, 14 September 2018. (https://docdb.cept.org/document/6033)

3.11.6 ECC Report 276, Thresholds for the coordination of CDMA and LTE broadband systems in the 400 MHz band, 27 April 2018. (https://docdb.cept.org/document/2014)

3.11.7 Decision (EU) 2017/1483, Commission Implementing Decision (EU) 2017/1483 of 8 August 2017 amending Decision 2006/771/EC on harmonisation of the radio spectrum for use by short-range devices and repealing Decision 2006/804/EC, 8 August 2017. (https://docdb.cept.org/document/1004)

3.11.8 ECC Report 218, Harmonised conditions and spectrum bands for the implementation of future European Broadband Public Protection and Disaster Relief (BB-PPDR) systems, 2 October 2015. (https://docdb.cept.org/document/325)

3.11.9 ECC Report 240, Compatibility studies regarding Broadband PPDR and other radio applications in 410-430 and 450-470 MHz and adjacent bands, 30 September 2015. (https://docdb.cept.org/document/346)

3.11.10 ECC Report 199, User requirements and spectrum needs for future European broadband PPDR systems (Wide Area Networks), 30 May 2013. (https://docdb.cept.org/document/306)

3.11.11 ECC Report 108, Border Code Coordination between CDMA-PAMR Systems, 16 October 2007. (https://docdb.cept.org/document/216)

3.11.12 ECC Report 099, TETRA Enhanced Data Services (TEDS): Impact on existing PMR/PAMR and Air Ground Air (AGA) systems in the 400 MHz band, 20 September 2007. (https://docdb.cept.org/document/207)

3.11.13 ECC Report 097, Cross Border Interference for Land Mobile Technologies, 20 February 2007. (https://docdb.cept.org/document/205)

3.11.14 ECC Report 102, Public protection and disaster relief spectrum requirements, 6 February 2007. (https://docdb.cept.org/document/210)

3.11.15 CEPT Report 011, Report from CEPT to the European Commission in response to the Mandate on: EFIS (ECO Frequency Information System), 27 September 2006. (https://docdb.cept.org/document/11)

3.11.16 ECC Report 039, The technical impact of introducing CDMA-PAMR on 12.5 / 25 kHz PMR/PAMR technologies in the 410-430 and 450-470 MHz bands, 23 February 2004. (https://docdb.cept.org/document/149)

3.11.17 ECC Report 042, Spectrum efficiency of CDMA-PAMR and other wideband systems for PMR/PAMR, 20 February 2004. (https://docdb.cept.org/document/152)

3.11.18 ECC Report 025, Strategies for the European use of frequency spectrum for PMR/PAMR applications, 12 June 2003. (https://docdb.cept.org/document/135)

3.11.19 ECC Report 022, The technical impact of introducing TAPS on 12.5 / 25 kHz PMR/PAMR technologies in the 380-400, 410-430 and 450-470 MHz bands, 22 May 2003. (https://docdb.cept.org/document/132)

3.11.20 ERC Report 104, Adjacent band compatibility of 400 MHz TETRA and analogue FM PMR - an analysis completed using a Monte Carlo based simulation tool, 1 June 2000. (https://docdb.cept.org/document/671)

4 Channelling Plan

4.1 The frequency band 410 MHz – 430 MHz provides a total bandwidth of 20 MHz.

4.2 Tables with current channel plans for the band 410 – 430 MHz are available in subsection 1.7 of Appendix G (i.e., on pages 171/293 – 178/293) in the Final Radio Frequency Migration Plan 2019 [11]. The tables cover the following applications:

1) **SAPS (193 x 12.5 kHz channels, SAPS):**

   BTX 417.5875 – 419.9875 MHz (in terms of the centres of the channels), paired with

   MTX 407.5875 – 409.9875 MHz

2) **DIGITAL TRUNKING (200 x 25 kHz channels, TETRA):**

   BTX 420 – 424.975 MHz, paired with

   MTX 410 – 414.975 MHz

3) **MOBILE DATA (61 X 12.5 kHz channels, WBS):**

   BTX 423 – 423.75 MHz, paired with

   MTX 413 – 413.75 MHz.

4.3 The channel arrangements for the band are based on Appendix A and shown in Figure 2 and Figure 3

[11] Final Radio Frequency Migration Plan 2019, Government Gazette No 42337, 29 March 2019 (https://www.icasa.org.za/uploads/files/final-radio-frequency-migration-plan-2019.pdf).

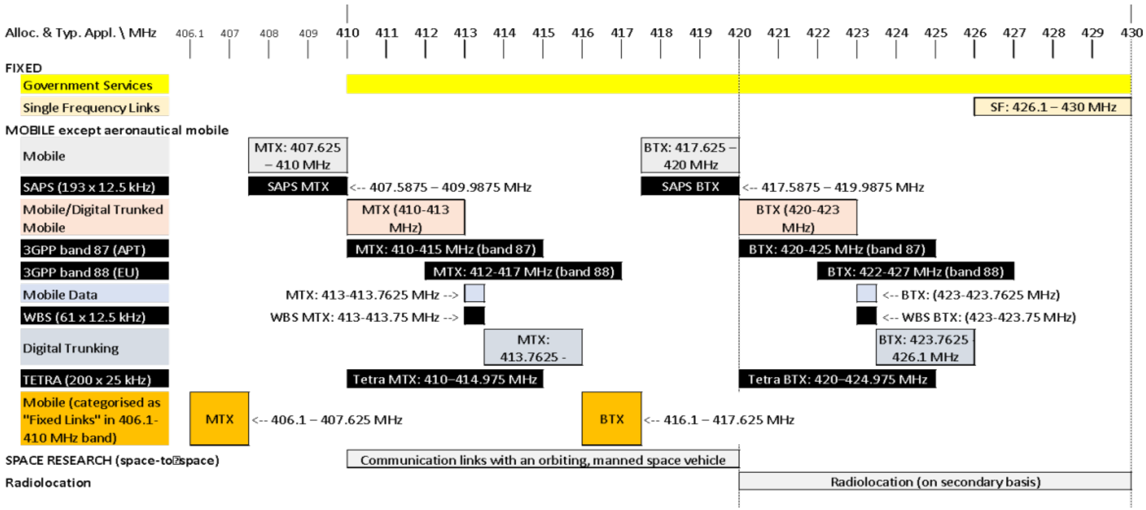

Figure 2: **Current Frequency arrangements in 410 MHz – 430 MHz band in South Africa (information from Appendix A is shown with black font, and information from the 2021 Implementation document[12] is shown with white font on black background). Except for SF Links, the other bands are paired.**

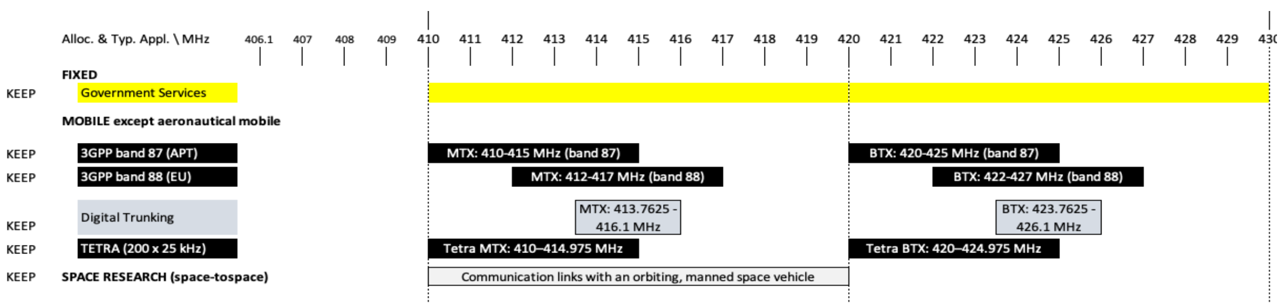

Figure 3: **Proposed Frequency arrangements in 410 MHz – 430 MHz band in South Africa**

4.4 Channelling for non-3GPP analogue and digital land mobile systems

4.4.1 Channelling for analogue and digital land mobile systems with channel spacing of up to 25 kHz, of 50 kHz, 100 kHz, or 150 kHz, abiding by T/R 25-08 [13].

The channel centre frequencies (hereinafter called *centre frequencies*) use the following *preferred formula*. This preferred formula should be used whenever possible, but at least in new and re-farmed bands:

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[12] https://www.gov.za/sites/default/files/gcis_document/202112/45690gen739.pdf

[13] Recommendation T/R 25-08, Planning criteria and cross-border coordination of frequencies for land mobile systems in the range 29.7-470 MHz, Approved 15 January 1990. Amended 28 September 2018. (https://docdb.cept.org/document/909, https://docdb.cept.org/download/2544)

$$F_{CH} = \textit{Band Edge} - (\text{Channel Spacing}/2) + n \times \text{Channel Spacing}$$

Where:

F_{CH} = channel centre frequency
n = 1, 2, 3, … - channel number;

Band Edge is the lower edge of the allocated frequency band, i.e., 410 MHz.

For systems using a channel spacing of 200 kHz, the centre frequencies should be selected according to the preferred formula with an option to offset these centre frequencies by 100 kHz.

4.4.2 Duplex or two-frequency simplex channel separation, location of sub-bands and guard bands [14]:

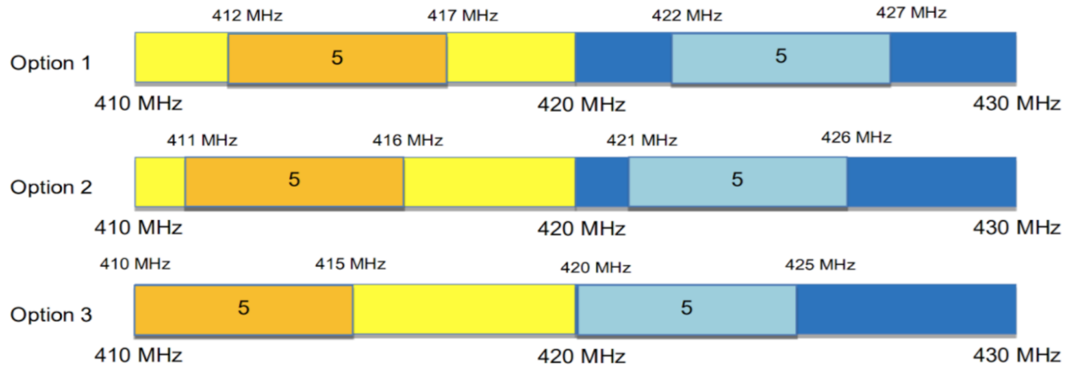
A sub-band can be simplex or duplex. The lower and upper parts of a duplex sub-band should be in the same allocated band.

The frequencies of emissions of base or repeater stations should be placed in the upper band and those of mobile stations in the lower band. The same positions of upper and lower bands should be selected for bordering/adjacent countries.

The channel centre frequency of a digital land mobile system using a channel spacing greater than 25 kHz may be selected in a way that the channel pertaining to the centre frequency with its nominal channel spacing falls entirely into a sub-band and does not overlap the guard band necessary around the edges of simplex sub-bands and the edges of the lower parts and upper parts of duplex sub-bands.

4.5 Non-exhaustive spectrum arrangement options for the band 410-430 MHz

ECC Report 292 [15], "based on the overall considerations," recommends three options for broadband technologies in the band, illustrated in Figure 4.



<u>Figure 4</u>: Non-exhaustive spectrum arrangement options for the band 410-430 MHz [112]

[14] ECC Recommendation T/R 25-08, Planning criteria and coordination of frequencies for land mobile systems in the range 29.7-470 MHz. http://spectrum.welter.fr/international/cept/erc-recommendations/erc-recommendation-25-08-public-land-mobile-29-MHz-470-MHz.pdf

[15] ECC Report 292, Current Use, Future Opportunities and Guidance to Administrations for the 400 MHz PMR/PAMR frequencies, 8 February 2019. (https://docdb.cept.org/document/9556)

4.6 Channelling for land mobile systems with channel bandwidths of 1.25 MHz, 1.4 MHz, 3 MHz, and 5 MHz

ECC/DEC/ (19)02[16], supported by ECC Report 283[17], advises on the technical requirements for land mobile systems with the channel bandwidth of 1.25 MHz, 1.4 MHz, 3 MHz, and 5 MHz (for 410-430 MHz)

4.6.1 1.4 MHz, 3 MHz and 5 MHz LTE FDD channelling arrangements could be implemented in the paired frequency arrangements in 410.0 - 415.0 MHz / 420.0 - 425.0 MHz, 411.0 - 416.0 MHz / 421.0 - 426.0 MHz, and 412.0 - 417.0 MHz / 422.0 - 427.0 MHz.

4.7 Technical conditions for land mobile systems based on NB-IoT and LPWAN technologies in the 410-430 MHz frequency range, based on ECC/DEC/ (19)02[18]:

The following technical conditions shall be applied as an essential component necessary to ensure coexistence between neighbouring networks. Operators may agree, on a bilateral or multilateral basis, different technical parameters providing that they continue to comply with the technical conditions applicable for the protection of other services, applications, or networks and with their cross-border obligations.

The technical requirements are derived from ECC Report 283[19].

4.7.1 LTE NB-IOT (STANDALONE)

ECC/DEC/ (19)02[20] advises on the channel bandwidth and frequency offset for NB-IoT standalone operation for a standalone NB-Io**T**, as summarised in Table 1 and Table 2.

NB-IoT	Standalone
Channel bandwidth (BW)	200 kHz
UE maximum EIRP	23 dBm

[16] ECC/DEC/ (19)02, ECC Decision of 8 March 2019 on Land mobile systems in the frequency ranges 68-87.5 MHz, 146-174 MHz, 406.1-410 MHz, 410-430 MHz, 440-450 MHz, and 450-470 MHz, 8 March 2019. (https://docdb.cept.org/document/9680)

[17] ECC Report 283, Compatibility and sharing studies related to the introduction of broadband and narrowband systems in the bands 410-430 MHz and 450-470 MHz, 14 September 2018. (https://docdb.cept.org/document/6033)

[18] *Ibid*.

[19] ECC Report 283, Compatibility and sharing studies related to the introduction of broadband and narrowband systems in the bands 410-430 MHz and 450-470 MHz, 14 September 2018. (https://docdb.cept.org/document/6033

[20] ECC/DEC/ (19)02, ECC Decision of 8 March 2019 on Land mobile systems in the frequency ranges 68-87.5 MHz, 146-174 MHz, 406.1-410 MHz, 410-430 MHz, 440-450 MHz, and 450-470 MHz, 8 March 2019. (https://docdb.cept.org/document/9680)

Table 1. Transmission parameters

Lowest or Highest Carrier	F_{offset}
Standalone NB-IoT	200 kHz

Table 2. Frequency offset for NB-IoT standalone operation

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4.7.2 LPWAN

ECC/DEC/ (19)02][21] advises on the baseline channel bandwidth of 125 kHz to 250 kHz.

4.8 BB-PPDR Channelling

4.8.1 Introduction

The 410-420 MHz / 420-430 MHz frequency range does not allow for enough available spectrum to provide for a stand-alone solution requiring 2 x 10 MHz for BB-PPDR as calculated in ECC Report 199 [107].

The range can offer national flexibility, e.g., in the context of additional spectrum beside the 700 MHz range. The 1.4 MHz, 3 MHz and 5 MHz LTE FDD channelling arrangements could be implemented in the paired frequency arrangements in 410.0-415.0 MHz / 420.0-425.0 MHz, 411.0-416.0 MHz / 421.0-426.0 MHz and 412.0-417.0 MHz / 422.0-427.0 MHz.

The least restrictive technical conditions (LRTC) set out in this document are derived from ECC Report 283 [22].

4.8.2 BB-PPDR channel bandwidths considered by ECC/DEC/ (16)02[23]: 1.4 MHz, 3 MHz, and 5 MHz.

5 Requirements for usage of radio frequency spectrum

5.1 This section covers the minimum key characteristics considered necessary to make the best use of the available frequencies.

5.2 The use of the band is limited to potential emerging applications such as broadband PPDR and IoT, in addition to digital public trunking services.

5.3 In some cases, a radio system conforming to the requirements of this RFSAP may require modifications if harmful interference is caused to other radio stations or systems.

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[21] *Ibid*

[22] ECC Report 283, Compatibility and sharing studies related to the introduction of broadband and narrowband systems in the bands 410-430 MHz and 450-470 MHz, 14 September 2018. (https://docdb.cept.org/document/6033)

[23] ECC/DEC/ (16)02, ECC Decision of 17 June 2016 on harmonised technical conditions and frequency bands for the implementation of Broadband Public Protection and Disaster Relief (BB-PPDR) systems. Amended on 8 March 2019. (https://docdb.cept.org/document/941)

5.4 The allocation of spectrum and shared services within these bands are found in the NRFP. An extract of the NRFP is shown in Appendix A.

5.5 The technical conditions listed in Sections 35.6 - 35.8 shall be applied as an essential component necessary to ensure coexistence between neighbouring networks. Operators may agree, on a bilateral or multilateral basis, different technical parameters providing that they continue to comply with the technical conditions applicable for the protection of other services, applications, or networks and with their cross-border obligations.

5.6 Non-3GPP Land mobile systems with channel bandwidths of 6.25 kHz, 12.5 kHz and 25 kHz, 50 kHz, 100 kHz, 150 kHz, and 200 kHz

5.7 The land mobile systems with channel bandwidths of 6.25 kHz, 12.5 kHz and 25 kHz, 50 kHz, 100 kHz, 150 kHz, and 200 kHz (the same requirements apply for channel bandwidth between 6.25 kHz and 200 kHz) should comply with requirements listed in ECC/DEC/ (19)02[24]

5.8 Transmitter Masks, Unwanted Emissions and Receiver Requirements for land mobile systems with channel bandwidth of 1.25 MHz, 1.4 MHz, 3 MHz, and 5 MHz

ECC/DEC/ (19)02[25], supported by ECC Report 283[26], advises on the technical requirements for land mobile systems with channel bandwidth of 1.25 MHz, 1.4 MHz, 3 MHz, and 5 MHz (for 410 – 430 MHz):

5.8.1 Transmitter Masks

A) Base station (BS) transmitter mask

Parameter		Value (dBm/cell)
Maximum in-block EIRP	56	

Table 4. BS in-block EIRP (dBm/cell, 1.4 MHz, 3 MHz, and 5 MHz channel width)

Channel width	Delta F_c (MHz) from centre frequency	Out-of-band emissions (transmitter output power)	Measurement bandwidth
1.4 MHz	0.7 to 2.1	-1 dBm -10/1.4 * (Delta F_c – 0.7) dB	100 kHz
	2.1 to 3.5	-11 dBm	100 kHz
	3.5 to 9.95	-16 dBm	100 kHz
3 MHz	1.5 to 4.5	-5 dBm -10/3* (Delta F_c – 1.5) dB	100 kHz

[24] ECC/DEC/ (19)02, ECC Decision of 8 March 2019 on Land mobile systems in the frequency ranges 68-87.5 MHz, 146-174 MHz, 406.1-410 MHz, 410-430 MHz, 440-450 MHz, and 450-470 MHz, 8 March 2019. (https://docdb.cept.org/document/9680)

[25] ECC/DEC/ (19)02, ECC Decision of 8 March 2019 on Land mobile systems in the frequency ranges 68-87.5 MHz, 146-174 MHz, 406.1-410 MHz, 410-430 MHz, 440-450 MHz, and 450-470 MHz, 8 March 2019. (https://docdb.cept.org/document/9680)

1.1.1 [26] ECC Report 283, Compatibility and sharing studies related to the introduction of broadband and narrowband systems in the bands 410-430 MHz and 450-470 MHz, 14 September 2018. (https://docdb.cept.org/document/6033)

Channel width	Delta F_c (MHz) from centre frequency	Out-of-band emissions (transmitter output power)	Measurement bandwidth
	4.5 to 7.5	-15 dBm	100 kHz
	7.5 to 9.995	-16 dBm	100 kHz
5 MHz	2.5 to 7.5	-7 dBm -7/5* (Delta F_c – 2.5) dB	100 kHz
	7.5 to 9.95	-14 dBm	100 kHz
Note 1: for the maximum mean out-of-block EIRP. the antenna gain and cable losses of the land mobile system have to be considered. Note 2: additional out-of-band emission reduction may be necessary for the protection of other land mobile systems in the adjacent bands (see ECC Report 283). For the protection of the uplink frequencies of land mobile systems within 410-420 MHz, a maximum mean out-of-block EIRP. of -43 dBm/100 kHz may be needed. Note 3: additional 40 dB of out-of-block emission reduction may be needed for the protection of radiolocation services)			

Table 5. BS frequency range of out-of-block emissions (OOBE) (1.4 MHz, 3 MHz, and 5 MHz channel width)

Frequency offset from centre frequency (MHz)	Channel width 1.25 MHz	Measurement bandwidth
±0.885-1.98	-17 dBm	30 kHz
±1.98-4	-22 dBm	30 kHz

Table 6. BS frequency range of out-of-block emissions (1.25 MHz channel width)

B) User Equipment (UE)

Parameter	Value
Channel bandwidth	1.25, 1.4, 3 or 5 MHz
Maximum mean in-block power	23 dBm (Note)
Note: administrations may use higher UE maximum mean in-block power up to 31 dBm for special deployment scenarios provided that protection of other services, networks and applications is not compromised. Vice-versa, the maximum mean in-block power of UE for the protection of other services may be limited on a cell-by-cell basis.	

Table 7. UE transmitter characteristics

Frequency offset from channel edge (MHz)	Channel width			Measurement bandwidth
	1.4 MHz	3 MHz	5 MHz	
± 0-1	-10 dBm	-13 dBm	-15 dBm	30 kHz
± 1-2.5	-10 dBm	-10 dBm	-10 dBm	1 MHz
± 2.5-2.8	-25 dBm	-10 dBm	-10 dBm	1 MHz
± 2.8-5		-10 dBm	-10 dBm	1 MHz
± 5-6		-25 dBm	-13 dBm	1 MHz
± 6-10			-25 dBm	1 MHz

Table 8. UE maximum unwanted emission levels (1.4 MHz, 3 MHz, and 5 MHz channel width)

Frequency offset from centre frequency (MHz)	Channel width 1.25 MHz	Measurement bandwidth
±0.885-1.98	-24 dBm	30 kHz
±1.98-4	-44 dBm	30 kHz

Table 9. UE maximum unwanted emission levels (1.25 MHz channel bandwidth)

5.8.2 Unwanted Emissions

5.8.2.1 Unwanted emissions in the spurious Domain

The unwanted emissions within the spurious domain during operation shall not exceed -36 dBm for frequencies up to 1 GHz and shall not exceed -30 dBm for frequencies above 1 GHz. In standby mode, the unwanted emissions shall not exceed -57 dBm for frequencies up to 1 GHz and shall not exceed -47 dBm for frequencies above 1 GHz.

5.8.2.2 Intermodulation Attenuation

This requirement applies only to transmitters to be used in base stations or repeaters.

Intermodulation attenuation is a measure of the capability of a transmitter to inhibit the generation of signals in its non-linear elements caused by the presence of the transmitter power and an interfering signal entering the transmitter via its antenna.

In general, the intermodulation attenuation ratio shall be at least 40 dB for any intermodulation component.

Note that national administrations may require a more stringent intermodulation attenuation requirement for base station equipment to be used in special service conditions, e.g., at sites where more than one transmitter will be in service, this is recommended to be at least 70 dB for any intermodulation component.

5.8.2.3 Adjacent channel transient power

Transient power is the power falling into adjacent spectrum due to switching the transmitter on and off. The transient power in the adjacent channels (e.g., caused by push-to-talk functionality) shall not exceed -60 dBc in the adjacent channels, or -50 dBc for equipment, without the need to be below -36 dBm.

5.8.3 Receiver requirements

The baseline performance for receiver blocking for 1.25 MHz systems is:

a) BS: -43 dBm at 900 kHz offset from the centre frequency;

b) UE: -44.5 dBm at 900 kHz offset from the centre frequency.

The baseline performance for receiver selectivity and blocking performance for 1.4 MHz, 3 MHz, and 5 MHz systems applicable for the 410-430 MHz is identical to those specification set out in ETSI TS 136 104 for the BS and ETSI TS 136 101 for UE for the 3GPP band 31 and 72.

5.9 NB-IoT and LPWAN: Technical conditions for land mobile systems based on NB-IoT and LPWAN technologies

Annex 4 of ECC/DEC/ (19)02[27], supported by ECC Report 283 [28], provides a description and technical conditions for land mobile systems based on NB-IoT and LPWAN technologies in the 410 - 430 MHz band, incl.:

5.9.1 LTE NB-IoT (Inband)

In an inband deployment, the NB-IoT technology will use some of the resources of an existing wideband carrier. This corresponds to a change of transmission mode on some subcarriers of a wideband carrier. This is very similar to what happens when a specific modulation is selected by the BS to serve a specific terminal.

Embedding an NB-IoT in an LTE carrier does not change the power or the spectrum emission mask, either on the BS (base station) or the UE (user equipment) side. In particular, it is not possible to go closer to block edge than a current LTE UE could go.

5.9.2 LTE NB-IoT (Guard band)

A guard band NB-IoT deployment corresponds to the case where a narrowband transmission is added on the side of an existing wideband carrier. This is made possible by the fact that wideband transmission technologies typically transmit a signal narrower than the channel bandwidth, i.e., they implement implicit guard bands within their transmission channel. The IoT can leverage these implicit guard bands as operating spectrum. The limits in the Tables in section 35.8.3 apply for operation of a NB-IoT carrier adjacent to the BS radio frequency bandwidth edge.

5.9.3 LTE NB-IoT (Standalone)

In a standalone deployment, the IoT carrier is deployed independently, in its own narrow band spectrum. This is exactly the same deployment mode as GSM.

ECC/DEC/ (19)02 advises on the UE maximum EIRP, out-of-band emissions and other parameters, provided below.

NB-IoT	Standalone
Channel bandwidth (BW)	200 kHz
UE maximum EIRP	23 dBm

Table 10. Transmission parameters for NB-IoT

[27] ECC/DEC/ (19)02, ECC Decision of 8 March 2019 on Land mobile systems in the frequency ranges 68-87.5 MHz, 146-174 MHz, 406.1-410 MHz, 410-430 MHz, 440-450 MHz, and 450-470 MHz, 8 March 2019. (https://docdb.cept.org/document/9680)

[28] ECC Report 283, Compatibility and sharing studies related to the introduction of broadband and narrowband systems in the bands 410-430 MHz and 450-470 MHz, 14 September 2018. (https://docdb.cept.org/document/6033)

Lowest or Highest Carrier	F_{offset}
Standalone NB-IoT	200 kHz

Table 11. Frequency offset for NB-IoT standalone operation

Frequency offset of measurement filter -3 dB point, Δf	Frequency offset of measurement filter centre frequency, f_{offset}	Minimum requirement (Notes 1 and 2) NB-IoT BS unwanted emission (transmitter output power)	Measurement bandwidth
0 MHz ≤ Δf < 0.05 MHz	0.015 MHz ≤ f_{offset} < 0.065 MHz	$Max(5dBm - 60 \cdot \left(\frac{f_{offset}}{MHz} - 0.015\right) dB + XdB, -14dBm)$	30 kHz
0.05 MHz ≤ Δf < 0.15 MHz	0.065 MHz ≤ f_{offset} < 0.165 MHz	$Max(2dBm - 160 \cdot \left(\frac{f_{offset}}{MHz} - 0.065\right) dB + XdB, -14dBm)$	30 kHz
0.15 MHz ≤ Δf < 0.2 MHz	0.165 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 1: In case the carrier adjacent to the radio frequency bandwidth edge is a NB-IoT carrier, the value of X = $P_{NB\text{-}IoT}$ carrier – 43, where $P_{NB\text{-}IoT}$ carrier is the power level of the NB-IoT carrier adjacent to the RF bandwidth edge. In other cases, X = 0. Note 2: For the maximum mean out-of-block EIRP. the antenna gain and cable losses of the land mobile system have to be considered. Additional out-of-band emission reduction may be necessary for the protection of other land mobile systems in the adjacent bands (see ECC Report 283).			

Table 12. Standalone NB-IoT BS out-of-band emissions (OOBE)

Band 31 and Band 72 have been specified in ETSI TS 136 104 and ETSI TS 136 101 also for use with NB-IoT carriers. The same technical baseline as well as receiver parameters can be assumed for operations inside the 410-430 MHz band.

ECC Report 283 assumed for the in-band BS emissions a maximum of 54 dBm/200 kHz EIRP.

5.9.4 LPWAN

ECC/DEC/ (19)02[29] advises on the UE and BS maximum EIRP, out-of-band emissions and other parameters, provided below.

[29] ECC/DEC/ (19)02, ECC Decision of 8 March 2019 on Land mobile systems in the frequency ranges 68-87.5 MHz, 146-174 MHz, 406.1-410 MHz, 410-430 MHz, 440-450 MHz, and 450-470 MHz, 8 March 2019. (https://docdb.cept.org/document/9680)

LPWAN parameters	Baseline value
Channel bandwidth	125 kHz to 250 kHz
BS maximum EIRP.	33.6 dBm
UE maximum EIRP.	23 dBm

Table 13. LPWAN system parameters

LPWAN BS frequency offset from centre frequency	BS unwanted emissions (EIRP)
at LPWAN channel edge	-55.4 dBm/1 kHz
at channel edge +/- 125 kHz	-65.4 dBm/1 kHz
at channel edge +/- 250 kHz	-62.4 dBm/100 kHz

Table 14. LPWAN BS unwanted emissions (EIRP)

LPWAN UE frequency offset from centre frequency	UE unwanted emissions (EIRP)
at LPWAN channel edge	-31 dBm/1 kHz
at channel edge +/- 125 kHz	-41 dBm/1 kHz
at channel edge +/- 250 kHz	-36 dBm/100 kHz

Table 15. LPWAN UE unwanted emissions (EIRP)

LPWAN Receiver parameter	Baseline
Receiver selectivity	The adjacent channel rejection at 200 kHz offset from centre frequency is -75 dBm, at 400 kHz is -62 dBm. If LTE is used in the adjacent spectrum, the BS receiver adjacent channel rejection is to be improved by 30 dB.
Receiver blocking	-55 dBm at 1 MHz offset from centre frequency -45 dBm at 2 MHz offset from centre frequency

Table 16. LPWAN Receiver considerations

Note: the precise parameters may depend on the spreading factor used in an LPWAN system.

5.9.5 Common technical conditions on Unwanted Emissions for land mobile systems based on NB-IoT and LPWAN technologies

5.9.5.1 Unwanted emissions in the spurious Domain

The unwanted emissions within the spurious domain during operation shall not exceed -36 dBm for frequencies up to 1 GHz and shall not exceed -30 dBm for frequencies above 1 GHz. In standby mode, the unwanted emissions shall not exceed -57 dBm for frequencies up to 1 GHz and shall not exceed -47 dBm for frequencies above 1 GHz.

5.9.5.2 Intermodulation Attenuation

This requirement applies only to transmitters to be used in base stations or repeaters.

Intermodulation attenuation is a measure of the capability of a transmitter to inhibit the generation of signals in its non-linear elements caused by the presence of the transmitter power and an interfering signal entering the transmitter via its antenna.

In general, the intermodulation attenuation ratio shall be at least 40 dB for any intermodulation component.

Note that national administrations may require a more stringent intermodulation attenuation requirement for base station equipment to be used in special service conditions, e.g., at sites where more than one transmitter will be in service, this is recommended to be at least 70 dB for any intermodulation component.

5.9.5.3 Adjacent channel transient power

Transient power is the power falling into adjacent spectrum due to switching the transmitter on and off. The transient power in the adjacent channels shall not exceed -60 dBc in the adjacent channels, or -50 dBc for equipment, without the need to be below -36 dBm.

5.10 BB-PPDR

Least restrictive technical conditions (LRTC) for BB-PPDR in the paired frequency arrangement 410-420 MHZ / 420-430 MHZ, based on ECC/DEC/ (16)02[30], are shown in the tables in BB-PPDR user equipment and base station sections, respectively.

5.10.1 BB-PPDR User Equipment (UE)

Parameter	Value
Channel bandwidth	1.4, 3 or 5 MHz
Maximum mean in-block power	23 dBm (see Note)
Note: Administrations may use higher UE maximum mean in-block power up to 31 dBm for special deployment scenarios, provided that protection of other services, networks and applications is not compromised. Vice-versa, the maximum mean in-block power of PPDR-UE for the protection of other services may be limited on a cell-by-cell basis.	

Table 17. BB-PPDR UE transmitter characteristics

Frequency offset from channel edge (MHz)	Channel width			Measurement bandwidth
	1.4 MHz	3 MHz	5 MHz	
± 0-1	-10 dBm	-13 dBm	-15 dBm	30 kHz
± 1-2.5	-10 dBm	-10 dBm	-10 dBm	1 MHz
± 2.5-2.8	-25 dBm	-10 dBm	-10 dBm	1 MHz
± 2.8-5		-10 dBm	-10 dBm	1 MHz
± 5-6		-25 dBm	-13 dBm	1 MHz
± 6-10			-25 dBm	1 MHz

Table 18. BB-PPDR UE maximum unwanted emission levels

[30] ECC/DEC/ (16)02, ECC Decision of 17 June 2016 on harmonised technical conditions and frequency bands for the implementation of Broadband Public Protection and Disaster Relief (BB-PPDR) systems. Amended on 8 March 2019. (https://docdb.cept.org/document/941)

5.10.2 BB-PPDR Base Station (BS)

Channel width	Delta F_c (MHz) from centre frequency	Out-of-band emissions (transmitter output power)	Measurement bandwidth
1.4 MHz	0.7 to 2.1	-1 dBm -10/1.4 * (Delta F_c – 0.7) dB	100 kHz
	2.1 to 3.5	-11 dBm	100 kHz
	3.5 to 9.95	-16 dBm	100 kHz
3 MHz	1.5 to 4.5	-5 dBm -10/3* (Delta F_c – 1.5) dB	100 kHz
	4.5 to 7.5	-15 dBm	100 kHz
	7.5 to 9.995	-16 dBm	100 kHz
5 MHz	2.5 to 7.5	-7 dBm -7/5* (Delta F_c – 2.5) dB	100 kHz
	7.5 to 9.95	-14 dBm	100 kHz
Note 1: for the maximum mean out-of-block EIRP. the antenna gain and cable losses of the land mobile system have to be considered. Note 2: additional out-of-band emission reduction may be necessary for the protection of other land mobile systems in the adjacent bands (see ECC Report 283). For the protection of the uplink frequencies of land mobile systems within 410-420 MHz, a maximum mean out-of-block EIRP. of -43 dBm/100 kHz may be needed. Note 3: additional 40 dB of out-of-block emission reduction may be needed for the protection of radiolocation services.			

Table 19. PPDR BS unwanted emission levels

5.11 Space research

5.11.1 As per ITU Radio Regulations footnote 5.268, “Use of the frequency band 410 – 420 MHz by the space research service is limited to space-to-space communication links with an orbiting, manned space vehicle. The power flux-density at the surface of the Earth produced by emissions from transmitting stations of the space research service (space-to-space) in the frequency band 410 – 420 MHz shall not exceed −153 dB(W/m2) for $0° \leq \delta \leq 5°$, −153 + 0.077 (d − 5) dB(W/m2) for $5° \leq \delta \leq 70°$ and −148 dB(W/m2) for $70° \leq \delta \leq 90°$, where δ is the angle of arrival of the radio-frequency wave and the reference bandwidth is 4 kHz. In this frequency band, stations of the space research service (space-to-space) shall not claim protection from, nor constrain the use and development of, stations of the fixed and mobile services. No. 4.10 does not apply. (WRC-15)[31]”

5.12 On a case-by-case basis, higher EIRP may be permitted if acceptable technical justification is provided;

5.13 ICNIRP Guideline compliance is required, where applicable; and

5.14 Criteria and guidelines for interference mitigation are described in Appendix D.

[31] R15-WRC15-C-2015!!MSW-E (itu.int)

5.15 The mobile network operators are encouraged to share the spectrum, e.g., using the Dynamic Spectrum Sharing (DSS) technologies available in LTE and 5G/NR.

6 Implementation

6.1 This RFSAP shall be effective on the date of issue.

6.2 No new assignments in the band 410 MHz to 430 MHz will be approved unless they comply with this RFSAP.

7 Coordination Requirements

7.1 Coordination is performed by the Authority during the process of assignment.

7.2 As per section 11.4 of Annex 11 of "Implementation of the Radio Frequency Migration Plan and the International Mobile Telecommunications (IMT) Roadmap" [32], radiolocation systems in the frequency range 420 – 430 MHz which are deployed and protected, may require protection zones, if the frequency range 410 – 430 MHz is used by broadband land mobile systems.

7.3 Planning characteristics in border areas:

The location, the power, and the antenna heights of all stations in the network should be selected in such a way that their range is confined, as far as possible, to the zone to be covered by the intended service.

Excessive antenna heights and transmitter outputs should be avoided, by using several locations of reduced height wherever possible. In border areas, directional antennas should be used to minimise the interference potential.

The effective radiated power and the height of the antenna should be as low as possible in relation to the area to be served.

7.4 In the event of any interference, the affected parties may refer the matter to the Authority for a resolution.

7.5 In the event of any interference, the Authority will require affected parties to carry out coordination. If the interference continues to be unresolved after 24 hours, the affected parties may refer the matter to the Authority for a resolution.

7.6 The Authority will decide the necessary modifications and schedule of modifications to resolve the dispute.

7.7 The Authority will be guided by the interference resolution process as shown in Appendix B.

7.8 Assignment holders shall take full advantage of interference mitigation techniques such as antenna discrimination, tilt, polarisation, frequency discrimination, shielding/blocking (introduce diffraction loss), site selection, and/or power control to facilitate the coordination of systems.

7.9 Indicative coordination thresholds for analogue or digital land mobile systems, as per T/R 25-08[33]

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[32] Implementation of the Radio Frequency Migration Plan and the International Mobile Telecommunications (IMT) Roadmap for public consultation, Government Gazette No 45690, 24 December 2021.

[33] T/R 25-08, Recommendation T/R of 30 May 2008 on Planning criteria and cross-border coordination of frequencies for land mobile systems in the range 29.7 470 MHz. Latest amended on 28 September 2018. (https://docdb.cept.org/document/909)

7.9.1 The aim of coordination thresholds is to avoid harmful interference between stations located in neighbouring countries. To achieve this, indicative coordination thresholds are established which should not be exceeded without coordination between neighbouring countries.

7.9.2 Indicative coordination thresholds for land mobile systems (co-channel, 50% locations, 10% time [34], 10 m receiving antenna height, within a reference bandwidth of 25 kHz, at the border-line) is 20 dB(µV/m).

7.9.3 For systems using a channel spacing greater than 25 kHz, the following bandwidth conversion formula can be used provided that the spectral power distribution within this channel spacing is uniform within the channel.

$BC = 10 \times \log_{10}$ (channel spacing / 25 kHz), dB

The value **BC** resulting from the formula should be added to the indicative coordination threshold as listed above.

7.9.4 For all other spectral power distributions, indicative coordination threshold levels should be applied within every 25 kHz bandwidth within the channel spacing.

7.10 Field strength levels for cross-border coordination between FDD land mobile systems using preferential channels up to 25 kHz and systems using a channel greater than 1 MHz within the 410-430 MHz and 450-470 MHz frequency bands

T/R 25-08 [35] considers the coordination between preferential channels of land mobile systems up to 25 kHz on one side and land mobile systems with a channel greater than 1 MHz on the other side of the border, for operation within the 400 MHz frequency bands.

[34] In certain situations, the 1%-time curves should be used for digital systems, e.g., to better protect analogue systems.

[35] T/R 25-08, Recommendation T/R of 30 May 2008 on Planning criteria and cross-border coordination of frequencies for land mobile systems in the range 29.7 470 MHz. Latest amended on 28 September 2018. (https://docdb.cept.org/document/909)

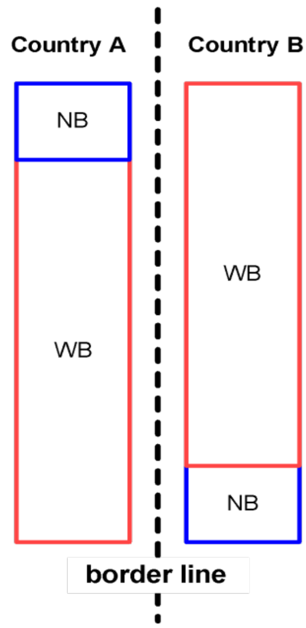

Figure 5: Overlapping narrower channel and wider channel land mobile systems across the border

The following should be considered:

- ECC Report 276 [36] provides a technical background for cross-border coordination of systems with a channel greater than 1 MHz in the 400 MHz band (410 – 430 MHz and 450 – 470 MHz) and proposes a method which can be applied in bilateral or multilateral agreements that allow for higher cross-border coordination thresholds for wideband systems in the 400 MHz band in situations where no or some overlap of narrowband and wideband allocations across the border occurs. In consequence, it means that land mobile systems up to 25 kHz keep their existing preferential rights and may extend them to all non-preferential channels in the overlapping range, if preferential rights of other administrations involved are not affected;
- The overlap is typically as small as a few hundred kilohertz. ECC Report 276 does not cover the case of full overlap between land mobile systems up to 25 kHz on one side and land mobile systems with a channel greater than 1 MHz on the other side of the border;
- In the situation where land mobile systems up to 25 kHz use preferential rights not to the full extent, i.e., they do not generate the maximum allowed field strength at a distance of 40 or 50 km in the territory of the neighbouring administration, solutions should be found between administrations or operators. One possible solution would be to increase the radiated power of the preferential system to the extent possible under preferential rights conditions. If not possible, a reduction of the radiated power of the system with a channel bandwidth > 1 MHz within the preferential frequency of the system with channel bandwidth up to 25 kHz may be considered;
- The two (2) most common preferential regimes for narrowband systems were considered, both defined as the field strength threshold of 20 dB μV/m at 10 m height in 25 kHz at a distance inside the neighbouring country: Preferential Regime a) at 40 km distance and Preferential

[36] ECC Report 276, Thresholds for the coordination of CDMA and LTE broadband systems in the 400 MHz band, 27 April 2018. (https://docdb.cept.org/document/2014)

Regime b) at 50 km distance. The proposed coordination thresholds for a partial overlap of land mobile systems up to 25 kHz on one side and land mobile systems with a channel greater than 1 MHz on the other side of the border are given in Table 20:

	Field strength at 10 m height	
	Regime a)	Regime b)
System up to 25 kHz using preferential frequency	20 dBµV/m/25 kHz @ 40 km beyond the borderline	20 dBµV/m/25 kHz @ 50 km beyond the borderline
System up to 25 kHz using NON-preferential frequency	20 dBµV/m/25 kHz @ 0 km (on the borderline)	20 dBµV/m/25 kHz @ 0 km (on the borderline)
System with a channel greater than 1 MHz	41 dBµV/m/25 kHz @ 0 km (on the borderline)	48 dBµV/m/25 kHz @ 0 km (on the borderline)
Note 1: Predictions for calculations: 50% location probability, 10%-time probability Note 2: If a channel bandwidth other than 25 kHz is used, then a bandwidth conversion factor of 10 x $\log_{10}$ (channel bandwidth/25 kHz) should be added to the field strength values. Note 3: For narrowband land mobile systems using preferential frequencies and bandwidth greater than 25 kHz (e.g., 50 kHz, 100 kHz, 150 kHz, or 200 kHz), indicative coordination threshold levels should be applied within every 25 kHz bandwidth within the channel spacing.		

Table 20: Trigger values for partial overlap between narrowband system and wideband systems at a height of 10 m above ground

Note: @ stands for "at a distance inside the neighbouring country."

For practical purposes, an antenna height correction factor of 10 dB from 10 m to 3 m height may be used. Other examples are the Okumura-Hatta model [37] that provides 15.6 dB, the ITU-R Recommendation P.1546 [38] that provides 10.3 dB or HCM that provides 9 dB.

7.11 Field strength levels for cross-border coordination between FDD land mobile systems with channels greater than 1 MHZ

T/R 25-08 [3] considers the coordination between land mobile systems with channel bandwidths greater than 1 MHz on both sides of the border, for operation within the 400 MHz ranges. ECC

[37] ERC Report 68 – Monte-Carlo Radio Simulation Methodology for the use in sharing and compatibility studies between different radio services or systems, February 2000, revised May 2001, and June 2002.

[38] ITU-R Recommendation P.1546: Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 3 000 MHz.

Report 276 [4] provides technical background information. The deployment mode considered is FDD in the frequency bands 410-420 MHz (duplex with 420-430 MHz) and 450-460 MHz (duplex with 460-470 MHz).

7.11.1 Field strength trigger values for LTE vs LTE and CDMA vs. CDMA systems

Case A

Base stations using the same technologies on both sides of the border line with centre frequencies not aligned, or using preferential PCIs or PN (Pseudo-Noise) codes given in Appendix C with centre frequencies aligned may be used without coordination between neighbouring countries if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 55 dBµV/m/5 MHz at a height of 3 m above ground at the border line between neighbouring countries and does not exceed a value of 37 dB□V/m/5 MHz at a height of 3 m above ground at a distance of 10 km inside the neighbouring country.

Case B

Base stations using the same technologies on both sides of the border line with centre frequencies aligned and using non-preferential PN codes or PCIs given in Appendix C may be used without coordination between neighbouring countries if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 37 dBµV/m/5 MHz at a height of 3 m above ground at the border line between neighbouring countries.

7.11.2 Field strength trigger values between LTE and CDMA

Case A

In the case of different technologies used on either side of the border line, with centre frequencies aligned or not aligned, base stations may be used without coordination with a neighbouring country if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 55 dBµV/m/5 MHz at a height of 3 m above ground at the borderline between neighbouring countries and does not exceed a value of 37 dBµV/m/5 MHz at a height of 3 m above ground at a distance of 10 km inside the neighbouring country.

7.11.3 Overview of the trigger values

For land mobile systems with channel bandwidth greater than 1 MHz, an overview of the trigger values of the field strength and the relevant paragraphs of this RFSAP is given in Table 21.

	Non-Preferential frequency usage		
	Centre frequencies aligned		Centre frequencies not aligned
	Preferential codes	Non-preferential codes	All codes

	Non-Preferential frequency usage		
LTE vs. LTE or CDMA vs. CDMA	55 dBµV/m/5 MHz @ 0 km and 37 dBµV/m/5 MHz@ 10 km Case A	37 dBµV/m/5 MHz @ 0km Case B	55 dBµV/m/5 MHz @ 0 km and 37 dBµV/m/5 MHz @ 10 km Case A
LTE vs. CDMA	55 dBµV/m/5 MHz @ 0 km and 37 dBµV/m/5 MHz @ 10 km Case A		
Note 1: Predictions for calculations: 50% location probability, 10% time probability Note 2: If a channel bandwidth other than 5 MHz is used, then a bandwidth conversion factor applies: 10 x $\log_{10}$ (channel bandwidth /5 MHz)			

Table 21: Field strength triggers for FDD LTE/CDMA systems at a height of 3 m above ground

Note: @ stands for "at a distance inside the neighbouring country."

7.11.4 Preferential frequencies for LTE/CDMA

Administrations may agree in bilateral or multilateral agreements/arrangements on preferential usage of frequencies, while ensuring fair treatment of different operators.

7.12 ECC Report 276 "Thresholds for the coordination of CDMA and LTE broadband systems in the 400 MHz band"[39] considers a possible improvement of the spectrum utilisation in border areas and proposes coordination levels for broadband technologies addressing the following two cases:

7.12.1 Mutual coordination of wideband systems using the same frequency band;

7.12.2 A Preferential Regime used for systems with channels up to 25 kHz bandwidth on the one side of the border and wideband systems on the other side of the border.

7.13 Compatibility between different systems (as per ECC Report 283 [40] , ECC Report 292 112, ECC Report 99 [41] , and ECC Report 97 [42])

[39] ECC Report 276, Thresholds for the coordination of CDMA and LTE broadband systems in the 400 MHz band, 27 April 2018. (https://docdb.cept.org/document/2014)

[40] ECC Report 283, Compatibility and sharing studies related to the introduction of broadband and narrowband systems in the bands 410-430 MHz and 450-470 MHz, 14 September 2018. (https://docdb.cept.org/document/6033)

[41] https://docdb.cept.org/download/432

[42] https://docdb.cept.org/download/428

7.13.1 Information is available on the following combinations of the systems

- LTE impact on PMR/PAMR systems with channel bandwidth up to 25 kHz (including paging and analogue PMR)
- LTE impact on narrowband fixed links
- LTE impact on radiolocation systems
- LTE impact on the radio astronomy service
- LTE impact on PMR links in audio-visual production
- LPWAN compatibility with TETRA
- LPWAN compatibility with the radiolocation service
- LPWAN compatibility with RAS (Radioastronomy)
- LPWAN compatibility with LTE
- LPWAN BS impact on LTE BS
- LTE BS impact on LPWAN BS
- LTE BS Impact on LPWAN End Device (ED)
- TEDS impact on PMR (Analogue FM, TETRA, TETRAPOL, CDMA-PAMR)
- PMR impact on TEDS
- Interference from and into Narrowband FM, TETRA, CDMA-PAMR, Flash OFDM

For example:

7.13.2 LPWAN and Radar: "For the co-channel cases in the 410-430 MHz frequency range, there is no possibility for compatibility between LPWAN system and airborne radar or LPWAN system and ground radar."

7.13.3 TETRA Base Station and LPWAN: "A guard band of 200 kHz is necessary between the TETRA base station (BS) and the LPWAN end device (ED). In the case of co-channel situation between TETRA and LPWAN systems, the minimum separation distance between base stations is more than 100 km."

7.13.4 LTE and Radioastronomy "Given the limited number of radio astronomy, it is expected a need of coordination for the deployment of LTE stations at distances lower that 250 km from a RAS station located in a neighbouring country".

8 Assignment

8.1 Standard Approach

8.1.1 The assignment of frequency will take place according to the Standard Application Procedures in the Radio Frequency Spectrum Regulations 2015[43].

9 Revocation

9.1 The Authority will revoke licences issued to all other services apart from digital public trunking services and other intended services listed in Section 3.5 above.

10 Radio Frequency Migration.

10.1 The Authority will migrate all other services apart from digital public trunking services out of the band.

[43] Radio Frequency Spectrum Regulations 2015, Government Gazette No. 38641, 30 March 2015. Available online at https://www.icasa.org.za/uploads/files/Radio-Frequency-Spectrum-Regulations-2015.pdf .

Appendix A National Radio Frequency Plan.

Table 22 shows an extract from the National Frequency Plan for South Africa.

ITU Region 1 allocations and footnotes	South African allocations and footnotes	Typical Applications	Notes and Comments
410-420 MHz FIXED MOBILE except aeronautical mobile SPACE RESEARCH (space-to-space) 5.268	410-420 MHz FIXED MOBILE except aeronautical mobile SPACE RESEARCH (space-to-space) 5.268	Government Services Mobile MTX (410 – 413 MHz) Mobile Data MTX (413-413.7625 MHz) Digital Trunking MTX (413.7625 – 416.1 MHz) Mobile BTX (416.1 – 417.625 MHz) PMR and/or PAMR PPDR Communication links with an orbiting, manned space vehicle	Paired with BTX (420 – 423 MHz) (Government Services) Paired with BTX (423-423.7625 MHz) Paired with 423.7625 – 426.1 MHz Paired with MTX (406.1 – 407.625 MHz) The use of this band for PPDR to be studied. Final Frequency Migration Plan 2019 (GG No. 42337 Notice 36 of 2019)
420-430 MHz FIXED MOBILE except aeronautical mobile Radiolocation	420-430 MHz FIXED MOBILE except aeronautical mobile Radiolocatio n	Single Frequency Links (426.1 – 430 MHz) Digital Trunked Mobile BTX (420 – 423 MHz) Mobile Data BTX (423 – 423.7625 MHz) Digital Trunking BTX (423.7625 – 426.1 MHz) PMR and/or PAMR PPDR	Frequencies will only be assigned for SF links where migration above 1 GHz would be impractical Paired with 410 - 413 MHz (Government use) Paired with MTX (413 – 413.7625 MHz) Paired with MTX (413.7626 – 416.1 MHz) The use of this band for PPDR to be studied. Final Frequency Migration Plan 2019 (GG No. 42337 Notice 36 of 2019)

5.269 5.270 5.271			

Table 22: National Radio Frequency Plan for South Africa for 410 - 430 MHz band[44]

[44] National Radio Frequency Plan 2021, (NRFP-21) 8.3 kHz – 3000 GHz, Independent Communications Authority of South Africa, Government Gazette No 46088, 25 March 2022 (https://www.icasa.org.za/uploads/files/National-Radio-Frequency-Plan-2021.pdf)

Appendix B Interference Resolution Process

Technical procedures related to bilateral and multilateral cross-border frequency coordination agreements for the 4 geographical sub-regions are defined by the African Union, which includes the Southern African sub-region of 10 countries. Cross-Border Frequency Coordination and interference resolution should follow the Harmonized Calculation Method for Africa (HCM4A) [45].

When requesting coordination, the relevant characteristics of the base station and the code or PCI group number should be forwarded to the Administration affected. All of the following characteristics should be included:

a) carrier frequency [MHz];
b) name of transmitter station;
c) country of location of transmitter station;
d) geographical coordinates [latitude, longitude];
e) effective antenna height [m];
f) antenna polarisation;
g) antenna azimuth [degrees];
h) antenna gain [dBi];
i) effective radiated power [dBW];
j) expected coverage zone or radius [km];
k) date of entry into service [month, year];
l) code group number used; and
m) antenna tilt [degrees]

The Administration affected will evaluate the request for coordination and will, within thirty (30) days, notify the Administration requesting coordination the result of the evaluation. If, in the course of the coordination procedure, the Administration affected requires additional information, it may request such information.

If no reply is received by the Administration requesting coordination within (30) days, it may send a reminder to the Administration affected. Where the Administration fails to respond within thirty (30) days following communication of the reminder will be deemed to have given its consent, and the code coordination may be put into use with the characteristics given in the request for coordination.

The above-mentioned periods are subject to extension by common consent.

[45] Cross-Border Frequency Coordination: Harmonized Calculation Method for Africa (HCM4A) https://www.itu.int/en/ITU-D/Projects/ITU-EC-ACP/HIPSSA/Documents/FINAL%20DOCUMENTS/FINAL%20DOCS%20ENGLISH/hcm4a_agreement.pdf.pdf

Appendix C Coordination for LTE- and CDMA- Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR LTE[46] AND CODES FOR CDMA

The following is extracted from ECC/REC (11)05 and T/R 25-08 as an operational example and can be adapted for the SADC countries for LTE. A respective extract from ECC/REC (15)01 may be considered for expanding the same onto NR.

1. PCI coordination for LTE

PCI coordination is only needed when channel centre frequencies are aligned independently of the channel bandwidth.

3GPP TS 36.211[47] defines 168 "unique physical-layer cell-identity groups" in §6.11, numbered 0...167, hereafter called "PCI groups" for LTE. Within each PCI group, there are three separate PCIs giving 504 PCIs in total.

Administrations should agree on a repartition of these 504 PCIs on an equitable basis when channel centre frequencies are aligned, as shown in the table below. It has to be noted that dividing the PCI groups or PCIs is equivalent. Each country should only use their own preferential PCIs close to the border and can use all PCIs away from the border. This transition distance between "close to the border" and "away from the border" should be agreed between neighbouring countries.

Administrations may wish to define different field strength levels (than those provided in the main text referring to this Appendix) for non-preferential PCIs.

As shown in the table below, the PCIs should be divided into 6 sub-sets containing each one sixth of the available PCIs. Each country is allocated three sets (half of the PCIs) in a bilateral case and two sets (one third of the PCIs) in a trilateral case.

Four types of countries are defined in a way such that no country will use the same code set as any one of its neighbours. The following lists describe a sample distribution for African countries:

Country type 1: Botswana, Cameroon, Comoros, Democratic Republic of the Congo, Ghana, Guinea-Bissau, Kenya, Liberia, Malawi, Mauritius, Niger, Republic of the Sudan, Swaziland;
Country type 2: Algeria, Angola, Benin, Cape Verde, Chad, Cote d'Ivoire, Egypt, Ethiopia, Madagascar, Senegal, United Republic of Tanzania, Zimbabwe;
Country type 3: Burkina Faso, Congo, Djibouti, Equatorial Guinea, Guinea, Mauritania, Nigeria, Rwanda, Sao Tome and Principe, Seychelles, South Africa, South Sudan, Tunisia, Zambia;

[46] ECC/REC (11)05

[47] 3GPP TS 36.211 "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation". (https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2425, also provided in ETSI TS 136 211). In comparison, 3GPP 38.211 (and ETSI TS 138 211) define NR Physical channels and modulation, in NR 2-step identification using PSS/SSS detection of the Physical Cell ID (same as LTE), the number of different cell IDs has been increased from 504 in LTE to 1008 for NR. Thus, for the deployment of LTE systems only the PCIs between 0 to 503 should be used and for NR systems PCIs between 0 to 1007 may be used.

Country type 4: Burundi, Central African Republic, Eritrea, Gabon, Gambia, Lesotho, Libyan Arab Jamahiriya, Mali, Morocco, Mozambique, Namibia, Sierra Leone, Somalia, Togo, Uganda.

(Note: A sample country type map can be found in the figure below).

For each type of country, the following tables and figure describe the sharing of the PCIs with its neighbouring countries, with the following conventions of writing:

■	Preferential PCI
	Non-preferential PCI

The 504 physical-layer cell-identities should be divided into the following 6 sub-sets when the carrier frequencies are aligned in border areas:

								PCI	Set A	Set B	Set C	Set D	Set E	Set F
Country 1	0..83	84..167	168..251	252..335	336..419	420..503		Country 2	0..83	84..167	168..251	252..335	336..419	420..503
Border 1-2	■	■				■		Border 2-1			■	■	■	
Zone 1-2-3	■	■						Zone 2-3-1			■	■		
Border 1-3	■	■	■					Border 2-3		■	■	■		
Zone 1-2-4	■					■		Zone 2-1-4			■	■		
Border 1-4	■		■			■		Border 2-4			■	■		■
Zone 1-3-4	■		■					Zone 2-3-4			■	■		
PCI	Set A	Set B	Set C	Set D	Set E	Set F		PCI	Set A	Set B	Set C	Set D	Set E	Set F
Country 3	0..83	84..167	168..251	252..335	336..419	420..503		Country 4	0..83	84..167	168..251	252..335	336..419	420..503

Border 3-2	■				■		Border 4-1		■		■	■	
Zone 3-1-2					■		Zone 4-1-2		■			■	
Border 3-1				■	■		Border 4-2	■	■			■	
Zone 3-1-4					■		Zone 4-2-3	■	■				
Border 3-4			■		■		Border 4-3	■	■		■		
Zone 3-2-4					■		Zone 4-3-1		■		■		

Table 23: Sharing of PCIs between Countries

Notes

1) All PCIs are available in areas away from the border.

2) In certain specific cases (e.g., if Angola and Botswana happened to have the same Country type/PCI code) where the distance between two countries of the same type number is very small (below a few tens of kilometres), it may be necessary to address the situation in bilateral /multilateral coordination agreements as necessary and may include further subdivision of the allocated codes in certain areas.

3) The country type map is given in section 3.

2. Code coordination for CDMA

For code coordination each base station shall use a unique time offset of the pilot pseudo-noise (PN) sequence to identify a Forward CDMA Channel. Time offsets may be reused within a CDMA cellular system. Distinct pilot channels shall be identified by an offset index (0 through 511 inclusive). This offset index specifies the offset time from the zero-offset pilot PN sequence in multiples of 64 chips. The same pilot PN sequence offset shall be used on all CDMA frequency assignments for a given base station. To distinct signals with PN sequence offsets all base stations should be time synchronised, but such synchronisation is mandatory requirement for CDMA2000 standard.

Administrations should agree on a repartition of these offset indexes on an equitable basis. Each country should only use its own codes close to the border.

In border areas, codes will be divided into 6 "index sets" containing each one sixth of the available offset indexes. Each country is allocated three index sets (half of the indexes) in a bilateral case, and two index sets (one third of the indexes) in a trilateral case.

Four types of countries are defined in such a way that no country will use the same index set as any one of its neighbours. The following lists describe a sample distribution for African countries:

Country type 1: Botswana, Cameroon, Comoros, Democratic Republic of the Congo, Ghana, Guinea-Bissau, Kenya, Liberia, Malawi, Mauritius, Niger, Republic of the Sudan, Swaziland;
Country type 2: Algeria, Angola, Benin, Cape Verde, Chad, Cote d'Ivoire, Egypt, Ethiopia, Madagascar, Senegal, United Republic of Tanzania, Zimbabwe;
Country type 3: Burkina Faso, Congo, Djibouti, Equatorial Guinea, Guinea, Mauritania, Nigeria, Rwanda, Sao Tome and Principe, Seychelles, South Africa, South Sudan, Tunisia, Zambia;
Country type 4: Burundi, Central African Republic, Eritrea, Gabon, Gambia, Lesotho, Libyan Arab Jamahiriya, Mali, Morocco, Mozambique, Namibia, Sierra Leone, Somalia, Togo, Uganda.

For each type of country, the following tables and figure describe the sharing of the indexes with its neighbouring countries, with the following conventions of writing:

	■	Preferential index
		non-preferential index

	Set A	Set B	Set C	Set D	Set E	Set F
Country 1	2..83	88..168	173..253	258..338	343..423	428..509
Border 1-2	■	■				■
Zone 1-2-3	■	■				
Border 1-3	■	■	■			
Zone 1-2-4	■					■
Border 1-4	■		■			■
Zone 1-3-4	■		■			

	Set A	Set B	Set C	Set D	Set E	Set F
Country 2	2..83	88..168	173..253	258..338	343..423	428..509
Border 2-1			■	■	■	
Zone 2-3-1			■	■		
Border 2-3		■	■	■		
Zone 2-1-4			■	■		
Border 2-4			■	■		■
Zone 2-3-4			■	■		

	Set A	Set B	Set C	Set D	Set E	Set F
Country 3	2..83	88..168	173..253	258..338	343..423	428..509
Border 3-2	■				■	■
Zone 3-1-2					■	■
Border 3-1				■	■	■

	Set A	Set B	Set C	Set D	Set E	Set F
Country 4	2..83	88..168	173..253	258..338	343..423	428..509
Border 4-1		■		■	■	
Zone 4-1-2		■			■	
Border 4-2	■	■			■	

Zone 3-1-4								Zone 4-2-3						
Border 3-4								Border 4-3						
Zone 3-2-4								Zone 4-3-1						

Table 24: Sharing of the indexes

Because of the time shifting mechanism for code generation, the situation can appear that propagation delay may lead to the synchronisation of two different base stations signals occurring in some parts of the service area. The average diameter of such correlation areas could be up to 245 meters (one chip duration multiplied on light speed). To prevent such situations in border areas it is recommended not to use some codes and to introduce 4 exclusion codes between neighbouring index sets what gives 78.125 km propagation path before a possible correlation area appears. This precludes any real synchronisation and will not affect network planning, causing a reduction of code space less than on 5% only in border areas.

Code sharing between two countries should be applied or used by base stations that exceed the relevant trigger level of only one neighbouring country. Code sharing between three countries should be applied or used by base stations that exceed the relevant trigger level of two neighbouring countries.

Notes

1) In certain specific cases (e.g., Angola / Botswana) where the distance between two countries of the same type number is very small (below few tens km), it may be necessary to address the situation in bilateral or multilateral coordination agreements as necessary and may include further subdivision of the allocated codes in certain areas.
2) The country type map is given in section 3.

3. Country type map (see below)

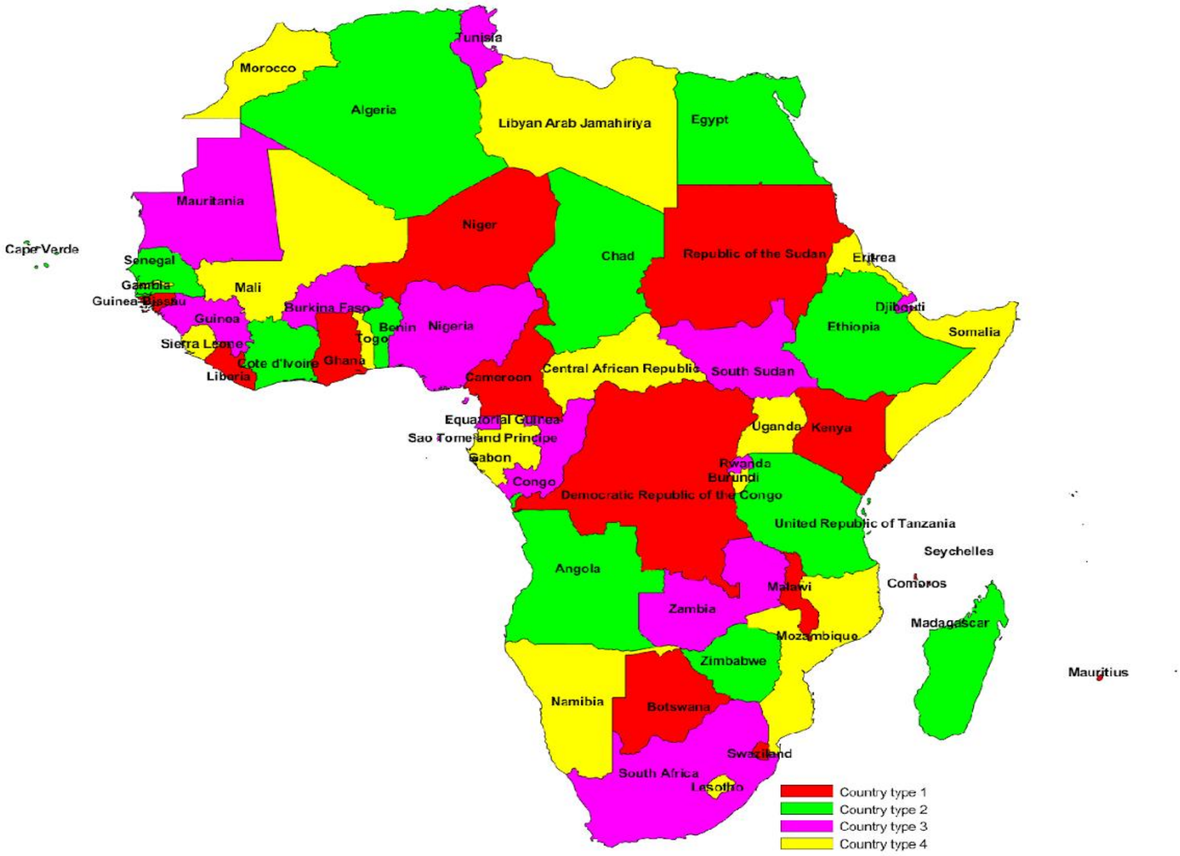

Figure 6: Country type map/PCI distribution map

4. GUIDANCE ON THE CONSIDERATION OF LTE RADIO PARAMETERS FOR USE IN BILATERAL AND MULTI LATERAL AGREEMENTS

4.1 This section is provided for guidance purposes for use in bi-lateral and multilateral discussions. For LTE, it may be beneficial to coordinate other radio parameters besides PCI in order to minimise deteriorating effects of uplink interference.

4.2 The parameters described in this section are usually optimised during LTE radio network planning of an operator's network. The idea of optimisation is to plan the parameters taking into account specific correlation properties of the uplink control signals, which enable more stable and predictable operation of the network. In the cross-border scenario the optimisation of parameters among neighbouring operators could provide better control of uplink interference. However, because of the difference between intra-network and inter-network interference and due to limited experience in the LTE cross-border deployment, it is difficult to assess the benefits of such optimisation. The following guidance provides the basis for operators to consider in border areas in case of high levels of uplink interference.

4.3 Demodulation Reference Signal (DM RS) coordination

4.3.1 Demodulation reference signals (DM RS) are transmitted in the uplink and used for channel estimation. There is a risk of intercell interference between neighbouring cells even in case of no frame synchronisation. That is why special measures for DM RS allocation between networks in neighbouring countries occupying the same channel may need to be applied.

4.3.2 The case of partial channel overlap has not been studied but due to DM RS occupying resource blocks of separate users, there is a risk of DM RS collisions between neighbouring networks when the subcarriers' positions coincide (the frequency offset between central carriers of neighbouring networks is multiple of 300 kHz). Some minor benefits from DM RS coordination in these particular cases could be expected.

4.3.3 There are a number of possible approaches to the coordination of DM RS:

- In the basic planning procedure, only 30 DM RS sequence groups with favourable correlation characteristics are available: {0…29}. In this case, each cell could be assigned one of the 30 DM RS sequence groups providing a cluster size of 30.
- It is possible to extend each DM RS sequence group to generate up to 12-time shifted sequence groups by applying the cyclic shift parameter stated in 3GPP TS 36.211 for LTE. For example, each tri-sector site could be assigned one DM RS sequence group with each co-sited cell having its own cyclic shift of 2π/3, which provides cluster size 30 only with 10 DM RS sequence groups. The latter case corresponds well to the case of DM RS sequence groups repartition between neighbouring countries when only limited number of groups is available for network planning. The drawback of DM RS sequence group cyclic shift is a loss of orthogonally of DM RS due to fading channels which has been found during first trials of LTE and caused throughput loss as well as time alignment problems.
- Another approach for DM RS coordination is to implement dynamic DM RS sequence group allocation, also called pseudo-random group hopping. In this method, nearby cells are grouped into clusters up to 30 cells, and within each cell cluster, the same hopping-pattern is used. At the border of two clusters, inter-cell interference is averaged since two different hopping patterns are utilised. There are 17 defined hopping patterns, numbered {0…16}, which leads to some minor unfairness in case of apportioning these patterns between neighbouring countries. Even in a trilateral case each operator will have at least 5 hopping patterns available near the border, which should be enough for planning purposes. It should be noted the pseudo-random group hopping option could be absent in the first generations of LTE equipment.

The decision of which of these methods to use in cross-border coordination should be agreed upon by the interested parties. Specific DM RS sequence groups or hopping patterns repartition is not provided in this text but could be deduced in a similar manner to the PCI repartition.

5. Physical Random Access Channel (PRACH) coordination

Another radio network parameter that is considered during radio network planning is PRACH configuration which is needed to distinguish random access requests addressed to different cells. PRACH resources are allocated by specifying the PRACH Resource Blocks time positions within the uplink frame, their frequency position within the LTE channel bandwidth and by apportioning cell-specific root sequences. During radio network planning, these parameters are usually used in the following way:

- time positions for PRACH resource allocations are usually used to create time collision of PRACH resources of co-sited/frame synchronised cells because PRACH-to-PRACH interference is usually less severe than PUSCH-to-PRACH interference;
- frequency positions within the LTE channel bandwidth are usually the same for all cells, again because PRACH-to-PRACH interference case is a more favourable one.
- cell-specific root sequences are used to distinguish between PRACH requests addressed to different cells.

For cross-border coordination, it is proposed to use frequency position offsets to exclude the possibility of so-called "ghost" PRACH requests caused by neighbouring networks. The PRACH is configured in LTE to use only 6 Resource Blocks or 1.08 MHz of the LTE channel bandwidth except in regions used by PUCCH. In case of overlapping or partially overlapping channel bandwidths of neighbouring networks, it is enough to establish non-overlapping PRACH frequency blocks to perform coordination. Because it is difficult to establish an implementation dependent procedure for such allocation, it will be the responsibility of operators to manage such frequency separation during coordination discussions.

In an early implementation, it is possible that a very limited number of frequency positions could be supported by LTE equipment which will not be enough to coordinate in the trilateral case. In such cases, root-sequence repartition could be used. There are 838 root sequences in total to be distributed between cells, numbered {0..837}. There are two numbering schemes for PRACH root sequences (physical and logical) and that only logical root sequences numbering needs to be used for coordination. Unfortunately, the process of root sequences planning doesn't involve direct mapping of root sequences between cells because the number of root sequences needed for one cell is dependent on the cell range. The table showing such interdependency is presented below:

PRACH Configuration	Number of root seq. per cell	Cell Range (km)
1	1	0.7
2	2	1
3	2	1.4
4	2	2
5	2	2.5
6	3	3.4
7	3	4.3
8	4	5.4
9	5	7.3
10	6	9.7
11	8	12.1
12	10	15.8
13	13	22.7
14	22	38.7
15	32	58.7
0	64	118.8

Table 25: PRACH – Range Interdependency

Thus, in the case of root sequence reparation, it will be the responsibility of radio network planners to assign the correct number of root sequences in order to not overlap with the root sequence ranges of other operators. It also should be noted that different root sequences have different cubic metrics and correlation properties, which affect PRACH coverage performance and planning of so-called high-speed cells. For simplicity of cross-border coordination, it is proposed to ignore these properties.

In summary, it should be stipulated that frequency separation of PRACH resources should be used as the main coordination method. PRACH root sequences repartition should be avoided and used only in exceptional cases. Specific PRACH root sequences repartition is not provided in this text but could be deduced in a similar manner to the PCI repartition.

Additional guidance for cross-border coordination of synchronised and unsynchronised LTE and 5G/NR TDD systems may be found in ECC/REC/ (15)01 [48] and ECC Report 296 [49].

Additional guidance on border code coordination between CDMA systems and additional information on coordination thresholds may be found in ECC Report 108 [50].

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[48] ECC Recommendation (15)01 “Cross-border coordination for Mobile/Fixed Communications Networks (MFCN) in the frequency bands: 694-790 MHz, 1427-1518 MHz, and 3400-3800 MHz”. Amended on 14 February 2020.

[49] ECC Report 296: “National synchronisation regulatory framework options in 3400-3800 MHz: a toolbox for coexistence of MFCNs in synchronised, unsynchronised, and semi-synchronised operation in 3400-3800 MHz”, March 2019.

[50] https://docdb.cept.org/download/457

Appendix D - Guidelines To Ensure Co-Existence Between Land Mobile, non-3GPP Land Mobile, NB-IoT, and LPWAN

This section is based on ECC/DEC/ (19)02.

The technical requirements set out in sections 3 and 5 alone may not guarantee interference-free adjacent spectrum use in all cases.

The impact of LTE-based systems in the 400 MHz frequency ranges on narrowband PMR, DTT above 470 MHz, on radars, on the radio astronomy, on the fixed service, on PMR links in audio-visual production, on paging and SRD systems is described in ECC Report 283[51]. In this Report, the interference probability calculations have been performed for downlink capacity/traffic limited systems; results may differ for uplink capacity/traffic limited systems, which may tolerate a noise rise in UE receivers up to a level of the DL/UL imbalance.

One interference effect to be considered is the potential impact of Intermodulation Distortion in PMR receivers caused by neighbouring broadband signals. This is dependent on frequency offset of the LTE carrier from the victim PMR receiver, the received power, and the intermodulation performance of the victim PMR receiver at that frequency offset. No conclusion on the intermodulation effect from broadband interferers into narrow band victims could be reached in ECC Report 283 and additional investigations will be conducted within ECC.

ECC Report 283 considers that compatibility between LTE systems in the 410-430 MHz band and the Radio astronomy service below 410 MHz is possible provided that minimum frequency separation and separation distances are implemented.

LPWAN:

ECC Report 283[52] considered a guard-band of 200 kHz between the TETRA base station (BS) and the LPWAN end device. This guard band is needed to minimise the interference from TETRA BS transmitter to LPWAN end device receiver.

ECC Report 283 considered the compatibility between a LPWAN system and airborne radars in the 410-430 MHz range is possible with a minimum guard band of 0.5 MHz from operating frequency edges.

ECC Report 283 considers the compatibility between LPWAN system in the band 410-430 MHz and the radio astronomy service below 410 MHz is possible under the condition of minimum frequency separation and separation distances are implemented.

LPWAN gateways (base stations) can operate with duty cycle limitations, if needed for compatibility reasons with adjacent services.

ECC Report 283 identified, based on measurements that compatibility with adjacent LTE is ensured with an improvement of the LPWAN receiver adjacent channel selectivity by 30 dB.

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[51] ECC Report 283, Compatibility and sharing studies related to the introduction of broadband and narrowband systems in the bands 410-430 MHz and 450-470 MHz, 14 September 2018. (https://docdb.cept.org/document/6033)

[52] *Ibid*.