

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

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**HEREBY ISSUES A NOTICE REGARDING THE FINAL RADIO FREQUENCY
ASSIGNMENT PLAN FOR THE IMT1500 FREQUENCY BAND 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 **Final Radio Frequency Spectrum Assignment Plan for the frequency band 1427 MHz to 1518 MHz for public consultation** in terms of Regulation 3 of the Radio Frequency Spectrum Regulations, 2015, read with Regulation 5 of the Radio Frequency Migration Regulations, 2013, and the International Mobile Telecommunications (IMT) Roadmap 2014 and 2019.

**DR CHARLES LEWIS
ACTING CHAIRPERSON**



Radio Frequency Spectrum Assignment Plan

Rules for Services operating in the Frequency Band
1427 MHz to 1518 MHz
(IMT1500)

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1 Glossary

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

“3GPP”	means the 3 rd Generation Partnership Project (3GPP), which consists of six telecommunications standard development organisations
“5G NR”	means 5G New Radio (NR) - the global standard for a unified, more capable 5G wireless air interface
“Act”	means the Electronic Communications Act, 2005 (Act No. 36 of 2005) as amended
“CRASA ECC”	means the Communications Regulators’ Association of Southern Africa (CRASA) Electronic Communications Committee (ECC)
“DM RS”	means Demodulation Reference Signal
“ECC/REC (11)04”	means ECC Recommendation (11)04 – Cross-border Coordination for Mobile/Fixed Communications Networks (MFCN) in the frequency band 790-862 MHz, Edition 3 February 2017. Amended 18 November 2022.
“ECC/REC (15)01”	means ECC Recommendation (15)01 – (15)01 – 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. Amended 10 June 2022.
“ECC”	means Electronic Communications Committee (ECC) within the European Conference of Postal and Telecommunications Administrations (CEPT)
“FDD”	means Frequency Division Duplex
“HCM”	means Harmonised Calculation Method
“HIPSSA”	means Sub-Saharan Africa Assessment Report on Harmonization of ICT Policies in Sub-Saharan Africa
“ICNIRP”	means International Commission on Non-Ionizing Radiation Protection (ICNIRP)
“IMT”	means International Mobile Telecommunications
“IMT1500”	means IMT in the band 1427 MHz to 1518 MHz
“ITA”	means Invitation to Apply
“ITU”	means the International Telecommunication Union
“ITU-R”	means the International Telecommunication Union Radiocommunication Sector

“LTE”	means Long Term Evolution, which is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies
“NRFP”	means the National Radio Frequency Plan 2013 for South Africa
“PCI”	means Physical-Layer Cell Identities
“PFD”	means Power Flux Density
“PPDR”	means Public Protection and Disaster Relief as defined in ITU-R Report M.2033
“PRACH”	means Physical Random Access Channel
“PSTN”	means Public Switched Telephone Network
“PUCCH”	means Physical Uplink Control Channel
“RFSAP”	means Radio Frequency Spectrum Assignment Plan
“SDL”	Means Supplementary Down Link
“TCA”	means Terrain Clearance Angle
“TDD”	means Time Division Duplex
“WRC-12”	means the World Radiocommunication Conference 2012 held in Geneva
“WRC-15”	means the World Radiocommunication Conference 2015 held in Geneva
“WRC-19”	means the World Radiocommunication Conference 2019 held in Sharm el-Sheikh

2 Purpose

- 2.1** A Radio Frequency Spectrum Assignment Plan (RFSAP) for the band IMT1500 provides information on the requirements attached to using 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 the required migration of existing users of the band and the expected method of assignment.
- 2.2** The feasibility study concerning the 1452 MHz to 1492 MHz band¹ which was mandated by the Frequency Band Migration Regulation and Plan contained in the IMT Roadmap 2014², and the IMT Roadmap 2019³, both concluded that the Authority proceeds with an RFSAP for IMT in

¹ Implementation of the Radio Frequency Migration Plan and the International Mobile Telecommunications (IMT) Roadmap for public consultation, Government Gazette No. 45690, 24 December 2021.

² Final (Draft) IMT Roadmap 2014, Government Gazette Vol. 593 Pretoria, 14 November 2014 No. 38213

³ Final (Draft) IMT Roadmap 2019, Government Gazette Vol. 645, 29 March 2019 No. 42361

this band. The feasibility study concerning the 1429 MHz - 1452 MHz band⁴ was mandated by the Frequency Band Migration Regulation and Plan contained in the IMT Roadmap 2014⁵, as well as the IMT Roadmap 2019⁶.

- 2.3** Considering the duties of the Authority under the Electronic Communications Act (“ECA”) (Act No. 36 of 2005), the Authority proposed to also implement the Radio Frequency Assignment Plan for the frequency range from 1492 MHz to 1517 MHz - in addition to the 1429 MHz - 1452 MHz band above. Therefore, in effect, the Authority proposed to proceed with an RFSAP for IMT1500 for the entire frequency band 1427 MHz to 1517 MHz in the Consultation on the Draft Assignment Plan⁷.
- 2.4** The ITU states that International Mobile Telecommunications (IMT) systems are mobile systems that provide access to a wide range of telecommunication services, including advanced mobile services, supported by mobile and fixed networks, which are increasingly packet-based. Key features are:
- a high degree of commonality of functionality worldwide whilst retaining the flexibility to support a wide range of services and applications in a cost efficient manner;
 - compatibility of services within IMT and with fixed networks;
 - capability of interworking with other radio access systems;
 - high quality mobile services;
 - user equipment suitable for worldwide use;
 - user-friendly applications, services and equipment;
 - worldwide roaming capability; and
 - enhanced peak data rates to support advanced services and applications

3 General

- 3.1** Technical characteristics of the equipment used in IMT1500 systems will conform to all applicable South African standards, international standards, International Telecommunications Union (ITU) and its Radio Regulations as agreed upon and adopted by South Africa.
- 3.2** All installations must comply with safety rules as specified in applicable standards.
- 3.3** The equipment used will be certified under South African law and regulations.
- 3.4** The proposed allocation of this frequency band and the information in this Second Draft Radio Frequency Spectrum Assignment Plan are subject to review.
- 3.5** Frequency bands identified for IMT include the band 1427 MHz to 1518 MHz.
- 3.6** The feasibility study conducted for the frequency range from 1452 MHz to 1492 MHz band⁸

⁴ Implementation of the Radio Frequency Migration Plan and the International Mobile Telecommunications (IMT) Roadmap for public consultation, Government Gazette No. 45690, 24 December 2021.

⁵ Final (Draft) IMT Roadmap 2014, Government Gazette Vol. 593 Pretoria, 14 November 2014 No. 38213

⁶ Final (Draft) IMT Roadmap 2019, Government Gazette Vol. 645, 29 March 2019 No. 42361

⁷ [2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf](https://www.icasa.org.za/uploads/files/2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf) (icasa.org.za) - <https://www.icasa.org.za/uploads/files/2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf>

⁸ Implementation of the Radio Frequency Migration Plan and the International Mobile Telecommunications (IMT) Roadmap for public consultation, Government Gazette No. 45690, 24 December 2021.

concluded that the band would be used for IMT-TDD. The feasibility study conducted for the frequency range from 1429 MHz - 1452 MHz band⁹ concluded that the band would be used for IMT-TDD or IMT-SDL. The subsequent consultation with stakeholders on the Draft 1452 MHz to 1492 MHz RFSAP saw little appetite for this spectrum in the short-term along with clear calls for the Authority to publish an RFSAP for the entire 1427 MHz to 1517 MHz band.

- 3.7 Through a RFSAP consultation¹⁰, the Authority *provisionally* agreed and proposed a RFSAP for the entire 1427 MHz to 1517 MHz band.
- 3.8 Considering international trends, the Authority proposed to maintain the same duplexing arrangement as was proposed for the 1452 MHz - 1492 MHz RFSAP, i.e., IMT-TDD, for the remainder of the band for consistent and efficient 'use of spectrum'. Therefore, the Authority proposed that IMT-TDD band plan would be used for the whole band, that is, 1427 MHz to 1517 MHz.
- 3.9 In the RFSAP consultation¹¹, the Authority noted that it was fully aware with its IMT-TDD proposal that Mobile/Fixed Communications Networks Supplemental Downlink (IMT MFCN SDL) is also feasible in the band. This was yet another key reason for this consultation on the entire band. For example, the consultation acknowledged that the frequency band 1429 MHz - 1452 MHz provides a total bandwidth of 23 MHz TDD or SDL. It noted that twenty-four (24) European countries have implemented ECC/DEC/ (13)03 and 14 implemented ECC/DEC/ (17)06 and both these Decisions look at using a part of the band for Supplemental Downlink (SDL).
- 3.10 The consultation noted existing international experience in using the band for IMT services, e.g. ECC/DEC/(17)06¹² on the harmonised use of the frequency bands 1427 - 1452 MHz and 1492 - 1518 MHz wherein Mobile/Fixed Communications Networks Supplemental Downlink (IMT MFCN SDL) has already been implemented¹³. The latter was a key reason for the Authority proposing to assign the entire 1427 MHz - 1517 MHz band for IMT, albeit IMT TDD.
- 3.11 The consultation noted that Footnote 5.341 in the National Frequency Plan for South Africa recognises the utilisation of band 1400 MHz - 1727 MHz for passive research for the search for intentional emissions of extra-terrestrial origin. Therefore, the Resolution 750 (Rev.WRC-19) applies¹⁴ - yet another reason to justify the RFSAP consultation. The consultation therefore sought the views of the Search for Extra-terrestrial Intelligence (SETI) community. None was received.
- 3.12 The consultation also noted that the Authority is aware that [in other jurisdictions] this band currently has satellite services in it as well as adjacent to it, plus passive radio astronomy (which means very low emission limits around 1427 MHz). The "neighbour" licensees closer to the upper 1517 MHz part of the band, for example, reduce the allowed EIRP down to 58 dBm/5 MHz for

⁹ Implementation of the Radio Frequency Migration Plan and the International Mobile Telecommunications (IMT) Roadmap for public consultation, Government Gazette No. 45690, 24 December 2021.

¹⁰ 2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf (icasa.org.za) - <https://www.icasa.org.za/uploads/files/2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf>

¹¹ *Ibid.*

¹² ECC/DEC/ (17)06, ECC Decision of 17 November 2017 on the harmonised use of the frequency bands 1427-1452 MHz and 1492-1518 MHz for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL), Approved 17 November 2017, Corrected 2 March 2018 (<https://docdb.cept.org/document/1016>)

¹³ <https://docdb.cept.org/implementation/1016>

¹⁴ RESOLUTION 750 (REV.WRC-19) Compatibility between the Earth exploration-satellite service (passive) and relevant active services, The World Radiocommunication Conference (Sharm el-Sheikh, 2019) (https://www.itu.int/dms_pub/itu-r/oth/0C/0A/R0C0A00000F00157PDFE.pdf)

as recommended per ECC/DEC/(17)06¹⁵. The consultation therefore sought the views of the Satellite Industry, which were received.

- 3.13** Responding to the Consultation on the Draft Assignment Plan for this band¹⁶, some stakeholders made a very evidenced-based case for *preferring* Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL), particularly LTE Band 32 (1452 - 1492 MHz) SDL, in this 1427 - 1517 MHz Band over IMT 5G-NR TDD/SDL (Bands 75/76). They cited both the much more plentiful devices ecosystem for Band 32 SDL as well as the many countries in Europe¹⁷ that have made decisions to deploy Band 32 SDL in this band.
- 3.14** The Satellite Community made equally evidenced representations of the risks of IMT base stations' [in the 1427 - 1517 MHz band] out-of-band interference into satellite terminals using 1518 - 1525 MHz. Some satellite players even argued for all IMT base station transmissions to stop at 1492 MHz to protect satellite terminals using 1518 - 1525 MHz.
- 3.15** The Authority has carefully considered both these sets of representations from IMT and Satellite Stakeholders, as well as other stakeholders.
- 3.16** The Authority has decided that the 1427 - 1517 MHz Band will be allocated both to Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL) and to IMT 5G-NR TDD/SDL. To address the out-of-band emission concerns of the Satellite community, the new licensees closer to the top of the band (i.e. closer to 1518MHz) would be required to reduce the allowed EIRP down to 58 dBm/5MHz (see Section 5.5). 1517 - 1518 MHz is also designated as a guard band between MSS and IMT. The Authority justifies its decisions made at the conclusion of two consultations in the accompanying Reasons Document published with this RFSAP.
- 3.17** The Authority notes that its decision above is consistent with the National Radio Frequency Plan 2021, published in Government Gazette 46088 (Notice 911 of 2022). The Plan allocates the frequency band to Mobile on a Primary Basis, and identifies for use by International Mobile Telecommunications (IMT) through National Footnote 9 (NF9).
- 3.18** The requirements for the family of standards which can provide IMT1500 services include, but are not limited to:
- IMT-2000;
 - IMT-Advanced; and
 - IMT-2020.
- 3.19** Typical technical and operational characteristics of IMT systems, as identified by the ITU, are described in the following documents¹⁸:
- Recommendation ITU-R M.2012-5 (02/2022): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT Advanced);
 - Report ITU-R M.2074-0 (2006): Report on Radio Aspects for the terrestrial component of IMT-2000 and systems beyond IMT-2000;

¹⁵ ECC/DEC/ (17)06, ECC Decision of 17 November 2017 on the harmonised use of the frequency bands 1427-1452 MHz and 1492-1518 MHz for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL), Approved 17 November 2017, Corrected 2 March 2018 (<https://docdb.cept.org/document/1016>)

¹⁶ [2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf](https://www.icasa.org.za/uploads/files/2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf) (icasa.org.za) - <https://www.icasa.org.za/uploads/files/2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf>

¹⁷ ECO Documentation (cept.org) - <https://docdb.cept.org/implementation/1016>

¹⁸ These and other IMT documents are available at <https://www.itu.int/rec/R-REC-M/en>

- Recommendation ITU-R M.1645 (06/2003): Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000;
- Recommendation ITU-R M.1036-6 (10/2019): Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations (RR); and
- Recommendation ITU-R M.2150-1 (02/2022): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2020 (IMT-2020).

A more comprehensive list of ITU IMT references may be found in ITU-R M.1036-6.

The ITU also provides guidelines for modelling and simulation, e.g.:

- Recommendation ITU-R M.2070-1 (02/2017): Generic unwanted emission characteristics of base stations using the terrestrial radio interfaces of IMT-Advanced;
- Recommendation ITU-R M.2071-1 (02/2017): Generic unwanted emission characteristics of mobile stations using the terrestrial radio interfaces of IMT-Advanced; and
- Recommendation ITU-R M.2101 (02/2017): Modelling and simulation of IMT networks and systems for use in sharing and compatibility studies.

4 Channelling Plan

4.1 The total bandwidth of the IMT1500 in the range of 1427 - 1518 MHz is 91 MHz. However, the usable bandwidth is 90 MHz.

4.2 The channel arrangements considered are based on the Recommendation ITU-R M.1036-6¹⁹.

Frequency arrangements	Paired arrangements (FDD)				Un-paired arrangements (TDD) (MHz)
	Mobile station transmitter (MHz)	Centre gap (MHz)	Base station transmitter (MHz)	Duplex separation (MHz)	
G1	External	–	1427 -1517	–	None
G2	1427 - 1470	5	1475 - 1518	48	None
G3					1427 - 1517

Table 1: Channel arrangements for IMT1500 (Source: ITU)

¹⁹ Recommendation M.1036-6 (10/2019): Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations.

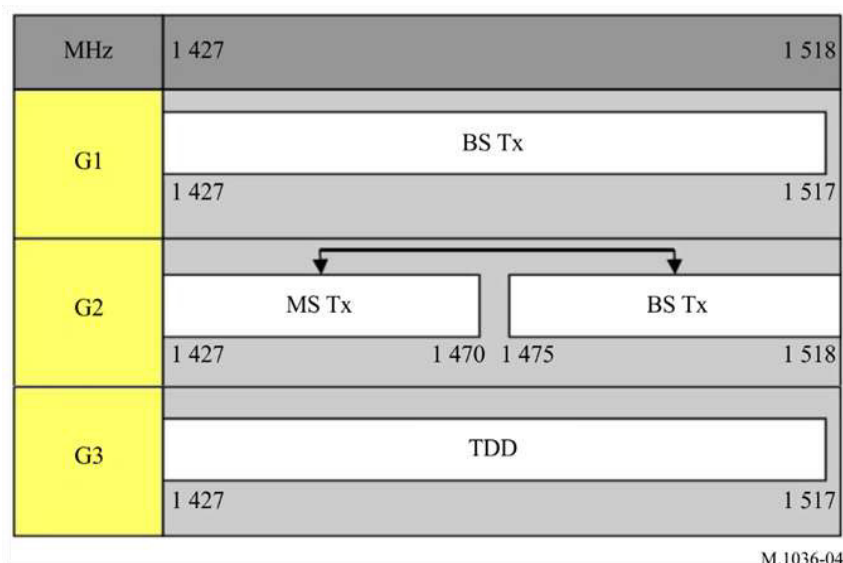


Figure 1: Channel arrangements for IMT1500 (Source ITU)

- 4.3 The channel arrangement to be implemented in South Africa is G3, as shown in Figure 1 above – allocated to Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL) and to IMT 5G-NR TDD/SDL uses.

5 Requirements for usage of radio frequency spectrum

- 5.1 This chapter covers the minimum key characteristics considered necessary in order to make the best use of the available frequencies.
- 5.2 Historically, in Region 1, parts of this band – specifically 1452 MHz to 1492 MHz – has been allocated to T-DAB and S-DAB. However, there has been a trend for other services to replace DAB in this band, including in Africa. There is also a clear trend of IMT seeking an exclusive identification of the band.
- 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.
- 5.4 The allocation of spectrum and shared services within these bands are found in the National Radio Frequency Plan (NRFP) and an extract of the NRFP is shown in Appendix A.
- 5.5 Maximum radiated power:
- 5.5.1 Base Station transmissions should not exceed 61 dBm/5 MHz EIRP;
- 5.5.1.1 Base Station transmissions in 1512 - 1517 MHz should not exceed 58 dBm/5 MHz EIRP as recommended per ECC/DEC/(17)06²⁰ and special unwanted emissions limits may need to be satisfied;
- 5.5.1.2 1517 - 1518 MHz is designated as a guard band to provide 1 MHz further protection to MSS services;
- 5.5.2 Mobile Station transmissions should not exceed 23 dBm EIRP;

²⁰ ECC/DEC/ (17)06, ECC Decision of 17 November 2017 on the harmonised use of the frequency bands 1427-1452 MHz and 1492-1518 MHz for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL), Approved 17 November 2017, Corrected 2 March 2018 (<https://docdb.cept.org/document/1016>)

- 5.5.3 On a case-by-case basis, higher EIRP may be permitted if acceptable technical justification is provided;
- 5.5.4 On a case-by-case basis the Authority acknowledges that in unique scenarios, there may be a case for geographical separation of IMT and MSS systems, including PFD limits at seaports/waterways and at airports to ensure that IMT base stations keep adequate separation from ship earth stations and aircraft earth stations (ESIMs). If these scenarios are likely to arise in the future, the Authority will work with future licensees to mitigate such risks using geographical separation.
- 5.5.5 Where appropriate, subscriber terminal stations should comply with the technical specification outlined under the latest version of 3GPP specifications, e.g., TS 36.521-1 for LTE, 38.521-1 for 5G New Radio (NR);
- 5.6 ICNIRP Guideline compliance is required, where applicable; and
- 5.7 Criteria and guidelines for interference mitigation are described in Appendix D.

6 Implementation

- 6.1 The Authority has extended the frequency band to 1517 MHz in order for the implementation of G3 channel arrangement to cover the whole band, i.e., 1427 MHz to 1517 MHz band, in accordance with recommendation ITU-R M.1036-6.
- 6.2 No new assignments in the band 1427 MHz to 1517 MHz will be approved unless they comply with this RFSAP.
- 6.3 The Final RFSAP will come into force upon publication in the Government Gazette.

7 Coordination Requirements

- 7.1 Cross Border Frequency Coordination will abide by the Harmonised Calculation Method for Africa (HCM4A) Agreement. This follows the 3rd CRASA AGM that agreed that CRASA should implement the Cross Border Frequency Coordination Harmonised Calculation Method for Africa (HCM4A) Agreement.
- 7.2 The ECC had noted the need for greater understanding of the concept and need for harmonisation in the signing of the HCM4A Agreement by SADC Member States if the implementation of the Agreement was to be effective. The ECC, therefore, agreed to convene a workshop on HCM4A and requested CRASA Members to consider signing the agreement. These activities were part of the Frequency Planning Sub Committee (FPSC) Operations Plan 2015/16.
- 7.3 At the 5th CRASA AGM, Swakopmund, Namibia – 07-08 April 2016 [5], the subject of Cross Border Frequency Coordination using the Harmonised Calculation Method for Africa (HCM4A) was discussed in detail, following similar efforts in Europe. The Resolution CRASA/AGM/15.16/07 stipulates, “The AGM urged CRASA Members to prioritise the motivation to their administrations who are yet to indicate their interest to sign the Harmonised Calculation Method for Africa (HCM4A), to do so as soon as possible”.
 - 7.3.1 Therefore, coordination would follow the HCM4A as detailed in Sub-Saharan Africa Assessment Report on Harmonization of ICT Policies in Sub-Saharan Africa²¹ (HIPSSA)
- 7.4 A harmonised calculation method (HCM4A) brings these benefits
 - 7.4.1 Based on HCM Agreement used in Europe

²¹ https://www.itu.int/en/ITU-D/Projects/ITU-EC-ACP/HIPSSA/Documents/FINAL%20DOCUMENTS/FINAL%20DOCS%20ENGLISH/hcm4a_agreement.pdf.pdf

- 7.4.2 Optimise spectrum usage;
 - 7.4.3 Prevent harmful interferences;
 - 7.4.4 Confer an adequate protection for stations;
 - 7.4.5 Define technical provisions and administrative procedures;
 - 7.4.6 Quick assignment of preferential frequencies; Transparent decisions through agreed assessment procedures; Quick assessment of interference through data exchange
- 7.5 HCM4A involves all 4 subregions of Africa. This means the HCM4A projects include performing a survey and a comparative analysis of existing administrative and technical procedures related to bilateral and multilateral cross-border frequency coordination agreements across the 4 geographical sub-regions as defined by the African Union (AU), namely,
- 7.5.1 **Central Africa:** (Burundi, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Sao Tome, and Principe);
 - 7.5.2 **East Africa:** (Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Mauritius, Rwanda, Seychelles, Somalia, Sudan, Tanzania, Uganda);
 - 7.5.3 **Southern Africa:** (Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe); and
 - 7.5.4 **West Africa:** (Benin, Burkina-Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Sierra Leone, Senegal, Togo).
- 7.6 HCM4A also comes with a software tool for Sub-Saharan Africa^{22, 23}
- 7.6.1 Optimise spectrum usage by accurate interference field strength calculations;
 - 7.6.2 Establish general parameters, improvement, and supplementation of technical provisions, individual restrictions;
 - 7.6.3 Establish models for computer-aided interference range calculations
 - 7.6.4 Harmonise parameters: objectively predictable towards transparent decisions
- 7.7 Use of these frequency bands will require coordination with the neighbouring countries within the coordination zones, of 6 kilometres in cases of LTE-to-LTE or 9 kilometres in cases of LTE-to-other technologies from the neighbouring country. The coordination distance is continuously being reviewed, and these may be updated from time to time.
- 7.8 The following field strength thresholds have to be assured based on ECC/REC (15)01²⁴. Operator-to-operator coordination may be necessary to avoid interference.

Non-advanced antenna systems (AAS) Supplementary Downlink (SDL) base stations of wideband systems on both sides of the border line with centre frequencies not aligned for all PCIs or with synchronisation signal²⁵ centre frequencies aligned and for preferential PCIs may be used

²² 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

²³ PowerPoint Presentation (itu.int) <https://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/Documents/Events/2017/May%20BKK/Presentations/HCM%20and%20HCM4A%20BKK%2020170504%20IB.pdf>

²⁴ 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. Approved 13 February 2015. Amended on 14 February 2020. Latest amended on 10 June 2022.

²⁵ Synchronisation signal means Synchronisation Signal Block (SSB) for 5G NR and Primary/Secondary Synchronisation Signal (PSS/SSS) for LTE.

without coordination with a neighbouring country if the mean field strength of each cell produced by base station does not exceed the values of 65 dB μ V/m/5 MHz at a height of 3 m above ground at the border line between countries, and 47 dB μ V/m/5 MHz at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.

Non-AAS SDL base stations of wideband systems on both sides of the border line with synchronisation signal centre frequencies aligned and for non-preferential PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by base station does not exceed the value of 47 dB μ V/m/5 MHz at a height of 3 m above ground at the border line between neighbouring countries.

The following table gives an overview of the trigger values of the field strength.

Case	Wideband system vs. Wideband system		
	Synchronisation signal centre frequencies Aligned		Synchronisation signal centre frequencies not aligned
	Preferential PCIs	Non-preferential PCIs	All PCIs
SDL case	65 dB μ V/m/5 MHz @ 0 km and 47 dB μ V/m/5 MHz @ 6 km	47 dB μ V/m/5 MHz @ 0 km	65 dB μ V/m/5 MHz @ 0 km and 47 dB μ V/m/5 MHz @ 6 km
@ stands for "at a distance inside the neighbouring country"			

Table 2: Wideband Systems Field strength Levels

ECC/REC (15)01 (paragraph A1.1) considers SDL band similar to FDD case as it says, "the 738 - 758 MHz band may be used for Mobile/Fixed Communication Networks (MFCN) SDL systems, as a national option, and in the case of MFCN SDL vs. MFCN SDL scenario the same field strength levels should be used as for FDD case". In the band 790 MHz to 862 MHz, as per Annexes 1 and 2 of ECC/REC (11)04, the trigger values for FDD and TDD are the same when under comparable conditions (except for unsynchronised TDD). The same may be concluded from ECC/REC (11)05. Based on these, the above-mentioned SDL values are deemed valid for the FDD/TDD uses in the IMT1500 band.

For field strength predictions, the calculations should be made according to Annex 2. In the case of channel bandwidth other than 5 MHz, a factor of $10 \times \log_{10} (\text{channel bandwidth} / 5 \text{ MHz})$, should be added to the field strength levels.

If neighbouring administrations wish to agree on frequency coordination based on preferential frequencies, whilst ensuring equitable treatment of different operators within a country, the Authority will add these into the mutual agreements.

- 7.9** Technical analysis may be conducted by the Authority before an assignment is issued according to Appendix B based on an extract from ECC/REC (11)05.
- 7.10** Specific information regarding coordination may be found in Appendix B, an extract from ECC/REC (11)05 and ECC/REC (15)01.
- 7.11** In the event of any interference, the Authority will require affected parties to carry out coordination. In the event that the interference continues to be unresolved after 24 hours, the affected parties may refer the matter to the Authority for a resolution. The Authority will decide upon the necessary modifications and schedule of modifications to resolve the dispute. The

Authority will be guided by the Frequency Coordination Process, as shown in Appendix D.

- 7.12** Assignment holders will 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.
- 7.13** ITU-R M.1036-6 indicates a possible need for addressing IMT – Mobile-satellite service (MSS) coexistence: “With respect to IMT in the frequency band 1492 - 1518 MHz and the MSS in the frequency band 1518 - 1525 MHz, ITU-R studies are being conducted in accordance with Resolution 223 (Rev.WRC-15) to provide possible technical measures to facilitate adjacent band compatibility. The implementation of the frequency arrangements and the text of this Note may need to be reviewed and revised taking into account the results of these studies, which are intended to be included in ITU-R Reports and ITU-R Recommendations, as appropriate. Based on the current results of these ongoing studies, one of a number of possible measures to facilitate adjacent band compatibility, is for administrations to consider additional frequency separation below 1 518 MHz at the upper part of G1, G2, or G3 (e.g. a total separation of different values up to 6 MHz). Moreover, when implementing these frequency arrangements, administrations are also encouraged to take into account the results of the compatibility studies, e.g. in order to address IMT-MSS coexistence in certain areas (around seaports and airports, etc.).” Report ITU-R RS.2336²⁶, Report ITU-R M.2324²⁷ and Recommendation ITU-R M.1459²⁸ as well as ECC/DEC/(17)06²⁹, ECC/DEC/(13)03³⁰, ECC Report 227³¹, ECC Report 269³², ECC Report 263³³, and ECC Report 299³⁴ may provide additional information (such as base station unwanted emissions, the minimum in-band blocking characteristic for land mobile earth stations receivers, and restrictions on base station power in 1512 - 1517 MHz not to exceed 58 dBm/5MHz EIRP).
- 7.14** Should ultrawide bandwidth (UWB) material sensing devices be introduced, CEPT Report 69³⁵ provides recommended maximum mean EIRP spectral density and maximum peak EIRP (defined in 50 MHz) values.

²⁶ ITU-R Report RS.2336-0 (11/2014): Consideration of the frequency bands 1 375-1 400 MHz and 1 427-1 452 MHz for the mobile service – Compatibility with systems of the Earth exploration-satellite service within the 1 400-1 427 MHz frequency band.

²⁷ ITU-R Report M.2324-0 (2014): Sharing studies between potential International Mobile Telecommunication systems and aeronautical mobile telemetry systems in the frequency band 1 429-1 535 MHz.

²⁸ Recommendation ITU-R M.1459-0 (05/2000): Protection criteria for telemetry systems in the aeronautical mobile service and mitigation techniques to facilitate sharing with geostationary broadcasting-satellite and mobile-satellite services in the frequency bands 1 452-1 525 MHz and 2 310-2 360 MHz.

²⁹ ECC/DEC/ (17)06 The harmonised use of the frequency bands 1427-1452 MHz and 1492-1518 MHz for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL). Approved 17 November 2017.

³⁰ ECC/DEC/(13)03 ECC Decision of 8 November 2013 on the harmonised use of the frequency band 1452-1492 MHz for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL). Latest amended on 2 March 2018.

³¹ ECC Report 227 Compatibility Studies for Mobile/Fixed Communication Networks (MFCN) Supplemental Downlink (SDL) operating in the 1452-1492 MHz band.

³² ECC Report 269 Least restrictive technical conditions for Mobile/Fixed Communications Networks in 1427-1518 MHz. Approved 17 November 2017.

³³ ECC Report 263 Adjacent band compatibility studies between IMT operating in the frequency band 1492-1518 MHz and the MSS operating in the frequency band 1518-1525 MHz. Approved 03 March 2017.

³⁴ ECC Report 299 Measures to address potential blocking of MES operating in bands adjacent to 1518 MHz (including 1525-155 at 9 MHz) at sea ports and airports.

³⁵ CEPT Report 069 Report from CEPT to the European Commission in response to the Mandate “Ultra-Wideband technology in view of a potential update of Commission Decision 2007/131/EC”, 26 October 2018.

8 Assignment

- 8.1** An Invitation to Apply will be published for new assignments in this band in line with regulations developed in terms of Section 31(3) of the Electronic Communications Act (“ECA”) (Act No. 36 of 2005).

9 Amendment

- 9.1** The feasibility study concerning the 1429 MHz - 1452 MHz band³⁶ stated the Authority’s plan to proceed with IMT (TDD or SDL) for the band following an RF migration plan for the band. The feasibility study conducted for the frequency range from 1452 MHz to 1492 MHz determined that this band should be assigned exclusively for IMT.
- 9.2** Considering the international trends, the Authority plans to assign the full band, i.e. from 1427 MHz to 1517 MHz, exclusively for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL) and IMT TDD/SDL. Existing radio frequency licensees in the band would need to have their licences amended to reflect new destination bands.
- 9.2.1** Therefore, existing radio frequency spectrum licences for the use of the band will be amended to a different destination band as necessary.

10 Radio Frequency Migration.

- 10.1** There are no known current assignments in this frequency band.

³⁶ Implementation of the Radio Frequency Migration Plan and the International Mobile Telecommunications (IMT) Roadmap for public consultation, Government Gazette No. 45690, 24 December 2021.

Appendix A National Radio Frequency Plan.

Table 3 shows an extract from the National Frequency Plan for South Africa. The Authority notes that the Digital Sound Broadcasting Regulations³⁷ were recently published, in 2021, and the 1427 MHz – 1518 MHz band is no longer included for Terrestrial Digital Audio Broadcasting.

ITU Region 1 allocations and footnotes	South African allocations and footnotes	Typical Applications	Notes and Comments
1427 - 1429 MHz SPACE OPERATION (Earth-to-space) FIXED MOBILE except aeronautical mobile 5.341A 5.341B 5.341C	1427 - 429 MHz SPACE OPERATION (Earth-to-space) FIXED NF14 MOBILE except aeronautical mobile 5.341A	Fixed links (duplex) (1 427-1 452 MHz) IMT	Paired with 1375 – 1400 MHz In accordance with Recommendation ITU-R F.1242 ITU Res. 223 (Rev.WRC-15) Recommendation ITU-R M.1036-6 (International Mobile Telecommunications (IMT)) RFSAP's to be developed Resolution 528 (Rev. WRC-19) Resolution 739 (Rev. WRC-19).
5.338A 5.341	5.338A 5.341		
1429 - 1452 MHz FIXED MOBILE except aeronautical mobile 5.341A	1429 - 1452 MHz FIXED MOBILE except aeronautical mobile 5.341A	Fixed links (duplex) (1427 - 1452 MHz) IMT	Paired with 1375 – 1400 MHz) In accordance with Recommendation ITU-R F.1242 Recommendation ITU-R M.1036-6 (International Mobile Telecommunications (IMT)) RFSAP's to be developed Resolution 528 (Rev. WRC-19) Resolution 739 (Rev. WRC-19).

³⁷ [Electronic Communications Act: Regulations: Digital Sound Broadcasting Services \(www.gov.za\)](https://www.gov.za/documents/electronic-communications-act-regulations-digital-sound-broadcasting-services)

5.338A 5.341 5.342	5.338A 5.341		
1452 - 1492 MHz FIXED MOBILE except aeronautical mobile 5.346 BROADCASTING BROADCASTING- SATELLITE 5.208B 5.341 5.342 5.345	1452 - 1492 MHz FIXED NF14 MOBILE except aeronautical mobile 5.346 BROADCASTING BROADCASTING- SATELLITE 5.208B 5.341 5.345	IMT Terrestrial Digital Audio Broadcasting (T-DAB)	Resolution 528 (Rev. WRC-19) Resolution 739 (Rev. WRC-19).. Recommendation ITU-R M.1036-6 International Mobile Telecommunications (IMT)) Final Frequency Migration Plan 2019 (GG No.42337 Notice 36 of 2019) RFSAP to be Developed.
1492 - 1518 MHz FIXED MOBILE except aeronautical mobile 5.341A 5.341 5.342	1492 - 1518 MHz FIXED MOBILE except aeronautical mobile 5.341A 5.341	Fixed Links (1 492 – 1 517 MHz) Single Frequency Links (1 517 – 1 525 MHz) IMT	Paired with 1350 - 1375 MHz. In accordance with Recommendation ITU-R F.1242 ITU-R Res. 223 (Rev.WRC-15) Resolution 528 (Rev. WRC-19) and Resolution 739 (Rev. WRC-19) Recommendation ITU-R M.1036-6 International Mobile Telecommunications (IMT)) RFSAP's to be considered

Table 3: National Radio Frequency Plan South Africa for 1427-1518 MHz band³⁸

³⁸ National Radio Frequency Plan 2021, (NRFP-21) 8.3 kHz - 3000 GHz, Independent Communications Authority of South Africa, Government Gazette No 44803, 9 July 2021.

Appendix B Propagation Model

The following methods are proposed for assessment of anticipated interference inside neighbouring countries based on established trigger values. Due to the complexity of radio-wave propagation, different methods are proposed to be considered by administrations and are included here for guidance purposes only. It should be noted that the following methods provide theoretical predictions based on available terrain knowledge. It is practically impossible to recreate these methods with measurement procedures in the field. Therefore, only some approximation of measurements could be used to check compliance with those methods based on practical measurement procedures. The details of such approximation are not included in this recommendation and should be negotiated between countries based on their radio monitoring practices.

Path specific model

Where appropriately detailed terrain data is available, the propagation model for interference field strength prediction is the latest version of ITU-R Rec. P.452³⁹. For the relevant transmitting terminal, predictions of path loss would be made at x km steps along radials of y km at z degree intervals⁴⁰. The values for those receiver locations within the neighbouring country would be used to construct a histogram of path loss – and if more than 10% of predicted values exceed the threshold, the station should be coordinated.

Site general model

If it is not desirable to utilise detailed terrain height data for the propagation modelling in the border area, the basic model to be used to trigger coordination between administrations and to decide if coordination is necessary, is ITU-R Rec. P.1546, “Method for point to area predictions for terrestrial services in the frequency range 30 to 3000 MHz”⁴¹. This model is to be employed for 50% of locations, 10% time and using a receiver height of 3 m. For specific reception areas where terrain roughness adjustments for improved accuracy of field strength prediction are needed, administrations may use correction factors according to terrain irregularity and/or an averaged value of the TCA parameter in order to describe the roughness of the area on and around the coordination line.

Administrations and/or operators concerned may agree to deviate from the aforementioned model by mutual consent.

Area calculations

In the case where greater accuracy is required, administrations and operators may use the area calculation below. For calculations, all the pixels of a given geographical area to be agreed between the Administrations concerned in a neighbouring country are to be taken into consideration. For the relevant base station, predictions of path loss should be made for all the pixels of a given geographical area from a base station and at a receiver antenna height of 3 m above ground.

For evaluation:

- Only 10% of the number of geographical area pixels between the border line (including the border line) and the 6 km line itself inside the neighbouring country may be interfered with by higher field strength than the trigger field strength value given for the border line in the main text above at a

³⁹ Recommendation ITU-R P.452-17 (09/2021, with Editorial corrections on 28 October 2021) “Prediction procedure for the evaluation of interference between stations on the surface of the Earth at frequencies above about 0.1 GHz” (<https://www.itu.int/rec/R-REC-P.452/en>).

⁴⁰ Values for x , y , z , and path specific field strength levels are to be agreed between the administrations concerned

⁴¹ ITU-R Recommendation P.1546-6 (08/2019): Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 3 000 MHz (<https://www.itu.int/rec/R-REC-P.1546/en>)

height of 3 m above ground.

- Only 10% of the number of geographical area pixels between the 6 km (including the 6 km line) and 12 km line inside the neighbouring country may be interfered with by a higher field strength than the trigger field strength value given for the 6 km line in the main text above at a height of 3 m above ground.

It is recommended that during area calculations, not only detailed terrain data but also clutter data be taken into account. Use of correction factors for clutter is crucial in particular where the border area is 'open' or 'quasi-open' from the point of view of clutter or where the interfering base station is just a few kilometres from a border line.

If the distance between a base station and a terrain point of a border line is closer than or equal to 1 km, the free space propagation model needs to be applied. Furthermore, if there is no terrain obstacle within the 1st Fresnel zone, the free space propagation model should be applied.

If clutter data is not available, it is proposed to extend the usage of the free space propagation model to a few kilometres, depending on the clutter situation in border areas.

For area type interference calculations, propagation models with path-specific terrain correction factors are recommended (e.g., the latest Recommendation ITU-R P.1546⁴² with the Terrain Clearance Angle correction factor TCA, HCM⁴³ method with the Terrain Clearance Angle correction factor or Recommendation ITU-R P.1812^{[44], [45]}).

As to correction factors for clutters 'open area' and 'quasi-open area', 20 dB and 15 dB should be used, respectively. Recommendation ITU-R P.1406⁴⁶ and/or ITU-R P.2108⁴⁷ should be used if a finer selection of clutter is required.

It must be noted that terrain irregularity factor Δh is not recommended to be used in area calculations. Administrations and/or operators concerned may agree to deviate from the aforementioned models by mutual consent.

⁴² ITU-R Recommendation P.1546-6 (08/2019): Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 3 000 MHz (<https://www.itu.int/rec/R-REC-P.1546/en>)

⁴³ HCM Agreement (Harmonised Calculation Method) between the administrations of Austria, Belgium, the Czech Republic, Germany, France, Hungary, the Netherlands, Croatia, Italy, Liechtenstein, Lithuania, Luxembourg, Poland, Romania, the Slovak Republic, Slovenia, and Switzerland on the Coordination of frequencies between 29.7 MHz and 43.5 GHz for the Fixed Service and the Land Mobile Service. The latest version of this agreement can be found from http://www.hcm-agreement.eu/http/englisch/verwaltung/index_europakarte.htm

⁴⁴ Recommendation P.1812-6 (09/2021) "A path-specific propagation prediction method for point-to-area terrestrial services in the frequency range 30 MHz to 6 000 MHz" (<https://www.itu.int/rec/R-REC-P.1812/en>).

⁴⁵ Annex 5: Determination of the interference field strength in the Land Mobile Service (<https://www.itu.int/en/ITU-D/Projects/ITU-EC-ACP/HIPSSA/Documents/REGIONAL%20documents/HCM4A-E-Annex05.pdf>)

⁴⁶ Recommendation P.1406-2 (07/2015) "Propagation effects relating to terrestrial land mobile and broadcasting services in the VHF and UHF bands" (<https://www.itu.int/rec/R-REC-P.1406/en>).

⁴⁷ Recommendation P.2108-1 (09/2021) "Prediction of clutter loss" (<https://www.itu.int/rec/R-REC-P.2108/en>).

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE⁴⁸

The following is extracted from ECC/REC (11)05 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.

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

3GPP TS 36.211⁴⁹ 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 each containing 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;

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).

⁴⁸ ECC/REC (11)05

⁴⁹ 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.



Figure 2: Country type map/PCI distribution map

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..8 3	84..16 7	168..2 51	252..3 35	336..4 19	420..5 03	
Country 2	0..8 3	84..16 7	168..2 51	252..3 35	336..4 19	420..5 03	
Border 1-2							
Border 2-1							

Table 4: Sharing of PCIs between Countries

- 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.

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 cases of high levels of uplink interference.

1. Demodulation Reference Signal (DM RS) coordination

Demodulation reference signals (DM RS) are transmitted in the uplink and used for channel estimation. There is a risk of inter cell interference between neighbouring cells even in cases 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.

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 a multiple of 300 kHz). Some minor benefits from DM RS coordination in these particular cases could be expected.

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 cyclical shift parameter stated in 3GPP TS 36.211. For example, each tri-sector site could be assigned one DM RS sequence group with each co-sited cell having its own cyclical shift of $2\pi/3$, which provides cluster size 30 with only 10 DM RS sequence groups. The latter case corresponds well to the case of DM RS sequence group repartition between neighbouring countries when only a limited number of groups are available for network planning. The drawback of DM RS sequence group cyclical shift is a loss of orthogonality of DM RS due to fading channels which has been found during first trials of LTE and has 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 of 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 used. There are 17 defined hopping patterns, numbered (0...16), which lead to some minor inequality in the 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.

2. 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 Block 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 the PRACH-to-PRACH interference case is the more favourable one; and
- 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 cases 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 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 5: PRACH – Range Interdependency

Thus, in the case of root sequence repartition, it will be the responsibility of radio network planners to assign the correct number of root sequences in order not to 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)01⁹ and ECC Report 296⁵⁰.

⁵⁰ 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.

Appendix D Frequency Coordination 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) ⁵¹.

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 30 days, notify the result of the evaluation to the Administration requesting coordination. 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. An Administration not having responded within 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 periods mentioned above may be extended by common consent.

⁵¹ 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