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INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

NO. 2886 **20 December 2022**

ICASA

HEREBY ISSUES A NOTICE REGARDING FINAL RADIO FREQUENCY ASSIGNMENT PLANS FOR THE IMT700 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 703 to 733 MHz and 758 to 788 MHz** in terms of regulation 3 of the Radio Frequency Spectrum Regulations, 2015 and the International Mobile Telecommunication Roadmap 2019.
2. This Radio Frequency Spectrum Assignment Plan ("RFSAP") supersedes any previous spectrum assignment arrangements for the same spectrum location. However, if it happens that on the date a provision of the RFSAP comes into effect, there is a conflict between the RFSAP and the latest versions of the National Radio Frequency Plan ("NRFP") and Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan will prevail.

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DR CHARLES LEWIS
ACTING CHAIRPERSON

ICASA

Radio Frequency Spectrum Assignment Plan

Rules for Services operating in the Frequency Band from 703 MHz to 733 MHz and 758 MHz to 788 MHz (IMT700)

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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 3rd Generation Partnership Project (3GPP), which consists of six telecommunications standard development organisations
“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 the Demodulation Reference Signal
“ECC/REC (15)01”	means the ECC Recommendation (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
“ECC”	means the Electronic Communications Committee (ECC) within the European Conference of Postal and Telecommunications Administrations (CEPT)
“FDD”	means the Frequency Division Duplex
“HCM”	means the Harmonised Calculation Method
HCM4A	means the Harmonised Calculation Method for Africa
“**HIPSSA**”	means Sub-Saharan Africa Assessment Report on Harmonisation of ICT Policies in Sub-Saharan Africa
“IMT”	means the International Mobile Telecommunications
“IMT700”	means the IMT in the 700 MHz band (703 MHz to 733 MHz and 758 MHz to 788 MHz)
“ICNIRP”	means the International Commission on Non-Ionizing Radiation Protection (ICNIRP)
“ITA”	means the Invitation to Apply
“ITU”	means the International Telecommunication Union
“ITU-R”	means the International Telecommunication Union Radiocommunication Sector

"LTE"	means the 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 2021 for South Africa
"PCI"	means the Physical-Layer Cell Identities
"PRACH"	means the Physical Random-Access Channel
"PSTN"	means the Public Switched Telephone Network
"PUCCH"	means the Physical Uplink Control Channel
"RFSAP"	means the Radio Frequency Spectrum Assignment Plan
"TCA"	means the Terrain Clearance Angle
"TDD"	means the 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 RFSAP provides information on the requirements attached to the use of a frequency band in line with the allocation and other information in the 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 This RFSAP states the requirements for the utilisation of the frequency band between 703 - 733 MHz paired with 758 - 788 MHz has been identified for mobile IMT.

2.3 The ITU states that 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 of the IMT systems 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 equipment used in IMT700 systems will conform to all applicable South African standards, international standards, including those of the 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 will be certified under South African law and regulations.

3.4 The IMT700 band ranges between 703 - 733 MHz paired with 758 - 788 MHz.

3.5 The IMT700 band will be used for mobile voice and data communications.

3.6 The requirements for the standard families which can provide IMT700 services include, but are not limited to:

- IMT-2000;
- IMT-Advanced; and
- IMT-2020.

3.7 Typical technical and operational characteristics of IMT systems as identified by the ITU are described in the following documents[1]:

- 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.2241-0 Compatibility studies in relation to Resolution 224 in the bands 698-806 MHz and 790-862 MHz (2011);
- Report ITU-R M.2074-0 (2006): Report on Radio Aspects for the terrestrial component of IMT-2000 and systems beyond IMT-2000;
- 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).

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;
- Recommendation ITU-R M.2090 (10/2015): Specific unwanted emission limit of IMT mobile stations operating in the frequency band 694-790 MHz to facilitate protection of existing services in Region 1 in the frequency band 470-694 MHz; 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 frequency band 703 - 733 MHz paired with 758 - 788 MHz provides a total bandwidth of:

- 2×30 MHz FDD for IMT700.

4.2 25 MHz of spectrum remains in the centre gap between the IMT 700 FDD uplink and downlink (i.e., 733 - 758 MHz), which is a different band (the IMT750 band).

4.3 Channel arrangements for the IMT700 band are according to the Region 1 recommendation by the ITU, as provided in Figure 1.

[1] These and other IMT documents are available at https://www.itu.int/rec/R-REC-M/en

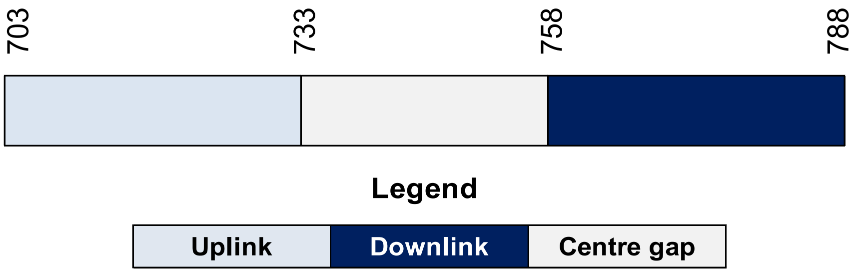

Figure 1: Channel arrangements for IMT700

5 Requirements for the usage of the 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 The use of the IMT700 band is limited to IMT services.

5.3 Only systems using digital technologies that promote spectral efficiency will be issued with an assignment. Capacity-enhancing digital techniques are being rapidly developed together with techniques that promote efficient spectrum use without reducing service quality. These techniques are encouraged.

5.4 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.

5.5 The allocation of spectrum and shared services within this band are found in the NRFP, and an extract of the NRFP is shown in Appendix A.

5.6 Maximum radiated power:

5.6.1 The conservative in-block base station power limit is 64 dBm/ (5 MHz) EIRP per antenna;

5.6.2 Mobile Station transmissions should not exceed 23 dBm EIRP;

5.6.3 On a case-to-case basis, higher EIRP may be permitted if acceptable technical justification is provided; and

5.6.4 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).

5.7 Total Radiated Power (TRP) limit for AAS base stations is to be used as the measure of the power limit in South Africa, in order to ensure quality of service in South Africa in line with global industry development.

5.8 The Authority has decided that TRP is not applicable to the frequency bands below 1 GHz.

5.9 ICNIRP Guideline compliance is required, where applicable.

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

6 Implementation

6.1 This RFSAP comes into effect upon publication of this Notice.

6.2 No new assignments in the band 703-733 MHz paired with 758-788 MHz will be approved unless they comply with the RFSAP.

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 the SADC Member States if the implementation of the Agreement is 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[2], 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 Harmonisation of ICT Policies in Sub-Saharan Africa[3] (HIPSSA)

7.4 A harmonised calculation method (HCM4A) brings these benefits:

7.4.1 Based on HCM Agreement used in Europe;

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;

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[2]https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwi81bOFz6P2AhUwQUEAHe1YDIgQFnoECAIQAQ&url=https%3A%2F%2Fextranet.crasa.org%2Fzip-agm.php%3Fid%3D332&usg=AOvVaw1bVAuEnE8a2iJnP20F_b_2

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

7.4.7 Transparent decisions through agreed assessment procedures;

7.4.8 Quick assessment of interference through data exchange.

7.5 HCM4A involves all 4 sub regions 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];

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[4]

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 HCM4A 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 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.

7.9 The following field strength thresholds have to be assured based on (ECC/REC (11)04 for 790 - 862 MHz, applied here to 703 - 790 MHz, and ECC/REC (15)015 for 694 - 790 MHz). Operator-to-operator coordination may be necessary to avoid interference.
As per ECC/REC(11)04, in general, stations of FDD systems 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 border line between countries and does not exceed a value of 29 dBμV/m/5 MHz at a height of 3 m above ground at a distance of 9 km inside the neighbouring country.

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[4] 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

[5] ECC Recommendation (15)01 "", Approved 13 February 2015, Amended 14 February 2020.

In the case that LTE is deployed on both sides of the border, the field strength levels can be increased to 59 dBμV/m/5 MHz at the border (0 km) and 41 dBμV/m/5 MHz at 6 km from the border line inside the neighbouring country for preferential PCI codes (discussed in Appendix C). For the use of non-preferential PCI codes and aligned centre frequencies, the trigger field strength level is 41 dBμV/m/5 MHz at the border.
As per ECC/REC (11)04, if TDD is in operation across both sides of a border and is synchronised across the border, then field strength levels are the same as for LTE-to-LTE coordination case. For unsynchronised TDD, the trigger field strength level is 24 dBμV/m/5 MHz at the border.

For field strength predictions, the calculations should be made according to Appendix B. In cases of other frequency block sizes $10*\log_{10}$ (frequency block size / 5 MHz) should be added to the field strength values, e.g.:

BW (MHz)	Field strength level at 3 m height for a given distance inside the neighbouring county (General case)	Field strength level at 3 m height for a given distance inside the neighbouring county (LTE case)
5 MHz	55.0 dBμV/m/5 MHz @0km	59.0 dBμV/m/5 MHz @0km
	29.0 dBμV/m/5 MHz @9km	41.0 dBμV/m/5 MHz @ 6 km
10 MHz	58.0 dBμV/m/10 MHz @0km	62.0 dBμV/m/10 MHz @0km
	32.0 dBμV/m/10 MHz @9km	44.0 dBμV/m/10 MHz @ 6 km
15 MHz	59.8 dBμV/m/15 MHz @0km	63.8 dBμV/m/15 MHz @0km
	33.8 dBμV/m/15 MHz @9km	45.8 dBμV/m/15 MHz @ 6 km
20 MHz	61.0 dBμV/m/20 MHz @0km	65.0 dBμV/m/20 MHz @0km
	35.0 dBμV/m/20 MHz @9km	47.0 dBμV/m/20 MHz @ 6 km

Table 1: Field Strength Adjustments

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.
As per ECC/REC (11)04[6], stations of IMT systems may be operated without coordination if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 15 dBμV/m/5 MHz at 10% time, 50% of locations at 3 metres above ground level at the border line.

7.10 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)04 and ECC/REC (15)01.

7.11 Specific information regarding coordination may be found in Appendix C based on an extract from ECC/REC (11)05 and ECC/REC (15)01.

7.12 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

[6] Also, per Report ITU-R M.2241 (11/2011): Compatibility studies in relation to Resolution 224 in the bands 698-806 MHz and 790-862 MHz.

upon the necessary modifications and the schedule of modifications to resolve the dispute. The Authority will be guided by the Frequency Coordination Process as shown in Appendix D.

7.13 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.

8 Assignment

8.1 This spectrum band will be assigned through an ITA in line with regulations developed in terms of Section 31(3) of the Act.

9 Transitional Arrangements

9.1 The Frequency Band 694 to 862 MHz is allocated on a primary basis to the Mobile Services and Identified for International Mobile Telecommunications through *Foot Note 9 (NF9*) in the National Radio Frequency Plan 2021. Accordingly, the frequency band has been prioritised for mobile services.

10 Amendment

10.1 Following on from the paragraph 9.1 above (i.e., Transitional Arrangements), all Broadcasting licences will be amended by the Authority in accordance with the Digital Migration Regulations[7]read with Radio Frequency Migration Regulations, 2013[8].

10.2 The Radio Frequency Spectrum Licences issued for the use of this band shall be amended in accordance with regulation 8 of the Radio Frequency Spectrum Regulations, 2015 as amended.

11 Repeals

11.1 The RFSAP for IMT700 published in Government Gazette Number 38640 (Notice 271 of 2015) is hereby repealed.

11.2 The RFSAP for IMT 700 published in Government Gazette Number 38640 (Notice 388 of 2015) is hereby repealed.

[7] Government Gazette Number 36000 (Notice 1070 of 2012)

[8] [8] Government Gazette Number 36334 (Notice 352 of 2013)

Appendix A National Radio Frequency Plan

Table 2 shows an extract from the National Radio Frequency Plan for South Africa.

ITU Region 1 allocations and footnote	South African allocations and footnotes	Typical Applications	Notes and Comments
694-790 MHz MOBILE except aeronautical mobile 5.312A 5.317A BROADCASTING 5.300 5.312	**694-790 MHz** MOBILE except aeronautical mobile 5.312A 5.317A NF9 NF9 5.312A 5.317A	IMT700 MTX (703 – 733 MHz) IMT750 (733 to 758 MHz) LTE LTE Advance	**Paired with BTX (758 – 788 MHz)** **International Mobile Telecommunication Roadmap (GG No. 42829 Notice 600 of 2019).** Radio Frequency Spectrum Assignment Plan (GG 38640 Notice 271 and 272 of 2015) as amended IMT in accordance with ITU-R Recommendation ITU-R M.2090 latest version and Resolution **760 (WRC-15**) applies **Recommendation ITU-R M.1036-6** Consideration of the future spectrum needs of Broadband Public Protection and Disaster Relief (PPDR) in the range 694-790 MHz as described in the most recent ITU-R M.2015, while taking into account studies called for by Resolution 646 (WRC15) for technical and operational measures. **Band IV/V analogue television is to be migrated to digital television and ensure harmonisation with SADC.** **WRC-07, WRC-12 and WRC-15 allocated this band to Mobile service except aeronautical mobile and identified it for IMT.** **Fixed links operating in this band will have to be migrated in order to accommodate IMT.**

<u>Table 2</u>: National Radio Frequency Plan for South Africa for 703 to 733 MHz and 758 to 788 MHz

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 approximations 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.452 [9]. For the relevant transmitting terminal, predictions of path loss would be made at *x* km steps along radials of *y* km at *z* degree intervals[10]. 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" [11]. 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.

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[9] 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).

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

[11] 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).

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 by higher field strength than the trigger field strength value given for the border line in the main text above at a 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 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.1546 [12] with the Terrain Clearance Angle correction factor TCA, HCM[13] method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812 [14, 15]).

As to correction factors for clutters 'open area' and 'quasi-open area', 20 dB and 15 dB should be used, respectively. Recommendations ITU–R P.1406 [16] and/or ITU-R P.2108 [17] should be used if a finer selection of clutter is required.

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[12] 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).

[13] 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

[14] 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)

[15] 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)

[16] 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).

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

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.

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE[18]

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 36.211[19] 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;
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:

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[18] ECC/REC (11)05

[19] 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.

■	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:

Country 1	0..83	84..167	168..251	252..335	336..419	420..503
Border 1-2	■	■				■
Zone 1-2-3	■	■				
Border 1-3	■	■	■			
Zone 1-2-4	■					■
Border 1-4	■		■			■
Zone 1-3-4	■		■			

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

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

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

<u>Table 3</u>: Sharing of PCIs between Countries

<u>Notes</u>

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.

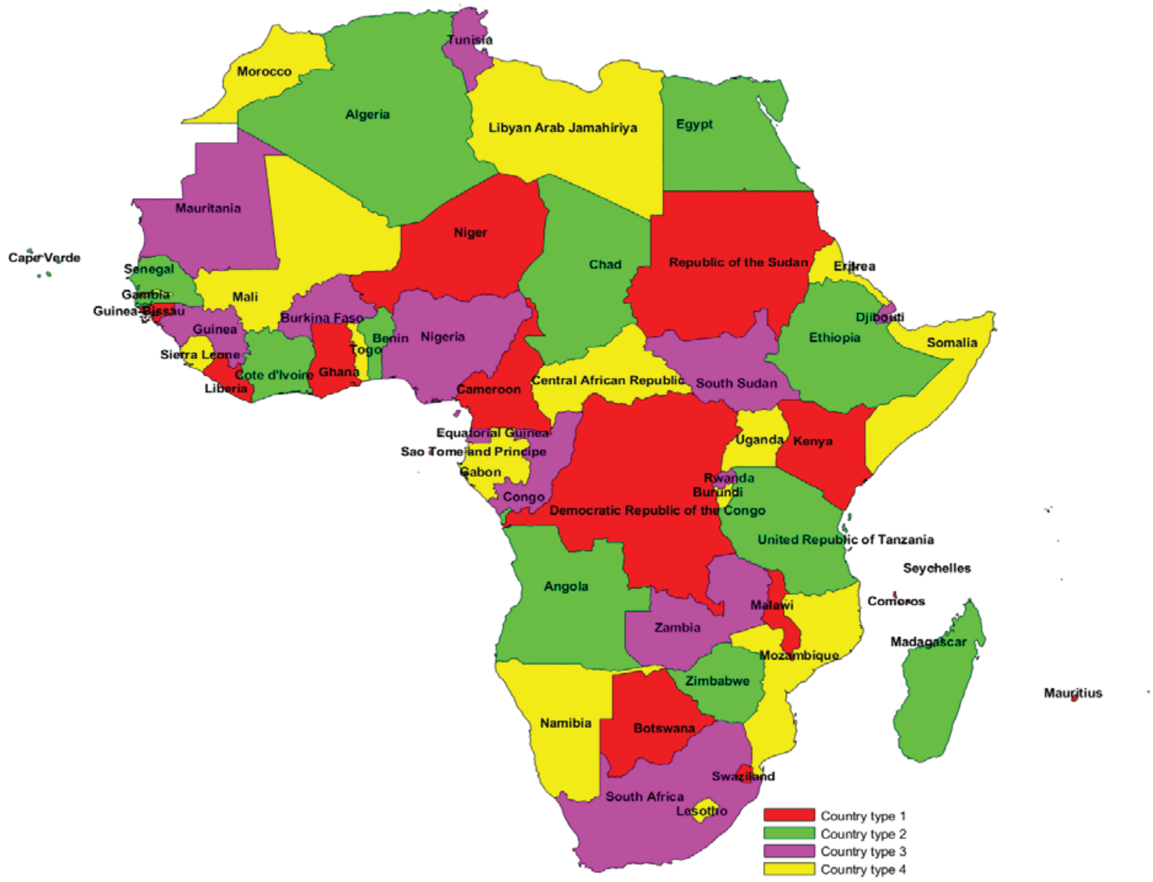

Figure 2: Country type map/PCI distribution map

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

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.

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.

1. Demodulation Reference Signal (DM RS) coordination

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.

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.

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.

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 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, since 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 4: 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 [20] and ECC Report 296 [21].

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[20] 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.

[21] 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 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 Harmonised Calculation Method for Africa (HCM4A) [22] [23]

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 thirty (30) days, it may send a reminder to the Administration affected. An Administration not having responded 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 periods mentioned above may be extended by mutual consent.

[22] Cross-Border Frequency Coordination: Harmonised 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

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

NO. 2887 **20 December 2022**

ICASA

HEREBY ISSUES A NOTICE REGARDING FINAL RADIO FREQUENCY ASSIGNMENT PLANS FOR THE IMT750 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 733 MHz to 758 MHz** in terms of regulation 3 of the Radio Frequency Spectrum Regulations 2015 and the International Mobile Telecommunication Roadmap 2019.
2. This Radio Frequency Spectrum Assignment Plan ("RFSAP") supersedes any previous spectrum assignment arrangements for the same spectrum location. However, if it happens that on the date a provision of the RFSAP comes into effect, there is a conflict between the RFSAP and the latest versions of the National Radio Frequency Plan ("NRFP") and Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan will prevail.

DR CHARLES LEWIS
ACTING CHAIRPERSON

Radio Frequency Spectrum Assignment Plan

Rules for Services operating in the Frequency Band from 733 MHz to 758 MHz (IMT750)

Table of Contents

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 3rd Generation Partnership Project (3GPP), which consists of six telecommunications standard development organisations
“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 (15)01”	means the ECC Recommendation (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
“ECC”	means the Electronic Communications Committee (ECC) within the European Conference of Postal and Telecommunications Administrations (CEPT)
“FDD”	means the Frequency Division Duplex
“HCM”	means the Harmonised Calculation Method
HCM4A	means the Harmonised Calculation Method for Africa
“**HIPSSA**”	Means the Sub-Saharan Africa Assessment Report on Harmonisation of ICT Policies in Sub-Saharan Africa
“IMT”	means the International Mobile Telecommunications
“IMT750”	Means the IMT in the 750 MHz band (733 MHz to 758 MHz)
“ICNIRP”	means the International Commission on Non-Ionizing Radiation Protection (ICNIRP)
“ITA”	means the Invitation to Apply
“ITU”	means the International Telecommunication Union
“ITU-R”	means the International Telecommunication Union Radiocommunication Sector

“LTE”	means the 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 2021 for South Africa
“PCI”	means the Physical-Layer Cell Identities
“PRACH”	means the Physical Random-Access Channel
“PSTN”	means the Public Switched Telephone Network
“PUCCH”	means the Physical Uplink Control Channel
“RFSAP”	means the Radio Frequency Spectrum Assignment Plan
“SDL”	means the Supplementary Downlink (SDL)
“TCA”	means Terrain Clearance Angle
“TDD”	means the 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) 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 This RFSAP states the requirements for the utilisation of the frequency band between 733 MHz and 758 MHz for IMT750.

2.3 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 of the IMT systems 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 equipment used in IMT750 systems will conform to all applicable South African standards, international standards, including those of the 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 will be certified under South African law and regulations.

3.4 The IMT750 band ranges between 733 MHz and 758 MHz

3.5 The IMT750 band shall be used as a Supplementary Downlink (SDL) band.

3.6 The requirements for the standards families which can provide IMT750 services include, but are not limited to:

- IMT-2000;
- IMT-Advanced; and
- IMT-2020.

3.7 Typical technical and operational characteristics of IMT systems as identified by the ITU are described in the following documents[1]:

- 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.2241-0 (2011): Compatibility studies in relation to Resolution 224 in the bands 698-806 MHz and 790-862 MHz;
- Report ITU-R M.2074-0 (2006): Report on Radio Aspects for the terrestrial component of IMT-2000 and systems beyond IMT-2000;
- 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).

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;
- Recommendation ITU-R M.2090 (10/2015): Specific unwanted emission limit of IMT mobile stations operating in the frequency band 694-790 MHz to facilitate protection of existing services in Region 1 in the frequency band 470-694 MHz; 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 frequency band 733 -758 MHz provides a total bandwidth of:

- 20 MHz Supplementary Downlink (SDL) for IMT750 with a 5 MHz guard band between the uplink and SDL downlink.

[1] These and other IMT documents are available at https://www.itu.int/rec/R-REC-M/en

4.2 This channel arrangement for the IMT750 band conforms to the Region 1 SDL IMT recommendation by the ITU, as shown in Figure 1.

Figure 1: Channel arrangement for IMT750 [2]

5 Requirements for the usage of the 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 The use of the IMT750 band is limited to IMT services.

5.3 Only systems using digital technologies that promote spectral efficiency will be issued with an assignment. Capacity-enhancing digital techniques are being rapidly developed together with techniques that promote efficient spectrum use without reducing service quality. These techniques are encouraged.

5.4 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.

5.5 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.

5.6 Maximum radiated power:

5.6.1 The European Commission published its final Decision (EU) 2016/687 on the harmonisation of the 694 - 790 MHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services and for flexible national use in the Union (the '700 MHz Commission Decision')[3] in April 2016. Given

[2] Award of the 700 MHz and 3.6-3.8 GHz spectrum bands, 13 March 2020, https://www.ofcom.org.uk/__data/assets/pdf_file/0020/192413/statement-award-700mhz-3.6-3.8ghz-spectrum.pdf

[3] "Commission Implementing Decision (EU) 2016/687 of 28 April 2016 on the harmonisation of the 694 -790 MHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications

that 738 - 758 MHz is a guard band within the 700 MHz band which is already subject to an award, the Authority would award 738 - 758 MHz band in line with the European Commission decision in the future;

5.6.2 . The Authority places an in-block base station power limit of 64 dBm/ (5 MHz).

5.6.3 The limits (i.e., 64 dBm/5 MHz), is in line with the 700 MHz Commission Decision, which does not set a mandatory in-block downlink power limit.

5.6.4 The Authority is of the view that this limit would provide adequate protection for adjacent DTT services.

5.6.5 Mobile Station transmissions should not exceed 23 dBm EIRP;

5.6.6 On a case-to-case basis, higher EIRP may be permitted if acceptable technical justification is provided; and

5.6.7 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).

5.7 Total Radiated Power (TRP) limit for AAS base stations is to be used as the measure of the power limit in South Africa, in order to ensure quality of service in South Africa in line with global industry development.

5.8 The Authority has decided that TRP is not applicable to the frequency bands below 1 GHz.

5.9 ICNIRP Guideline compliance is required, where applicable.

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

6 Implementation

6.1 The implementation of the 733-758 MHz range will be done as follows:

6.1.1 Use of the overall 20 MHz of the SDL B67, 738-758 MHz. This will allow the use of 2x30 MHz in B28 + 20 MHz in B67.

6.2 The Authority will licence this band in a future ITA consistent with paragraph 6.1 above.

6.3 This RFSAP comes into effect upon publication of this notice.

6.4 No new assignments in the band 733 – 758 MHz will be approved unless they comply with this RFSAP.

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.

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services and for flexible national use in the Union", https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2016.118.01.0004.01.ENG

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 the SADC Member States if the implementation of the Agreement is to be effective. The ECC, therefore, agreed to convene a workshop on HCM4A and requested the 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[4], 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 Harmonisation of ICT Policies in Sub-Saharan Africa5 (HIPSSA).

7.4 A harmonised calculation method (HCM4A) brings these benefits:

7.4.1 Based on HCM Agreement used in Europe;

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;

7.4.7 Transparent decisions through agreed assessment procedures;

7.4.8 Quick assessment of interference through data exchange.

7.5 HCM4A involves all 4 sub regions 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];

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[4] https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwi81bOFz6P2AhUwQUEAHe1YDIgQFnoECAIQAQ&url=https%3A%2F%2Fextranet.crasa.org%2Fzip-agm.php%3Fid%3D332&usg=AOvVaw1bVAuEnE8a2iJnP20F_b_2

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

7.5.3 Southern Africa [Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe];

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:

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 (11)04 for 790 - 862 MHz, applied here to 733 - 758 MHz, and ECC/REC (15)01[6] for 694 - 790 MHz). Operator-to-operator coordination may be necessary to avoid interference

As per ECC/REC(11)04, in general, stations of FDD systems 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 border line between countries and does not exceed a value of 29 dBµV/m/5 MHz at a height of 3 m above ground at a distance of 9 km inside the neighbouring country.

In the case that LTE is deployed on both sides of the border, the field strength levels can be increased to 59 dBµV/m/5 MHz at the border (0 km) and 41 dBµV/m/5 MHz at 6 km from the border line inside the neighbouring country for preferential PCI codes (discussed in Appendix C). For the use of non-preferential PCI codes and aligned centre frequencies, the trigger field strength level is 41 dBµV/m/5 MHz at the border.

As per ECC/REC(15)01, the 733 - 758 MHz band may also be used for Supplemental Downlink (SDL) systems, as a national option, and in the case of SDL vs. SDL scenario the same field strength levels should be used as for the above-mentioned FDD case, i.e. the trigger field strength levels are 59 dBµV/m/5 MHz at the border (0 km) and 41 dBµV/m/5 MHz at 6 km from the border line inside the neighbouring country.

As per ECC/REC (11)04, if TDD is in operation across both sides of a border and is synchronised across the border then field strength levels are the same as for LTE-to-LTE coordination case. For unsynchronised TDD, the trigger field strength level is 24 dBµV/m/5 MHz at the border.

[6] ECC Recommendation (15)01 "", Approved 13 February 2015, Amended 14 February 2020.

For field strength predictions, the calculations should be made according to Appendix B. In cases of other frequency block sizes 10*log $_{10}$ (frequency block size / 5 MHz) should be added to the field strength values, e.g.:

BW (MHz)	Field strength level at 3 m height for a given distance inside the neighbouring county (General case)	Field strength level at 3 m height for a given distance inside the neighbouring county (LTE case)
5 MHz	55.0 dBμV/m/5 MHz @0km	59.0 dBμV/m/5 MHz @0km
	29.0 dBμV/m/5 MHz @9km	41.0 dBμV/m/5 MHz @ 6 km
10 MHz	58.0 dBμV/m/10 MHz @0km	62.0 dBμV/m/10 MHz @0km
	32.0 dBμV/m/10 MHz @9km	44.0 dBμV/m/10 MHz @ 6 km
15 MHz	59.8 dBμV/m/15 MHz @0km	63.8 dBμV/m/15 MHz @0km
	33.8 dBμV/m/15 MHz @9km	45.8 dBμV/m/15 MHz @ 6 km
20 MHz	61.0 dBμV/m/20 MHz @0km	65.0 dBμV/m/20 MHz @0km
	35.0 dBμV/m/20 MHz @9km	47.0 dBμV/m/20 MHz @ 6 km

Table 1: Field Strength Adjustments

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.

As per ECC/REC (11)04[7], stations of IMT systems may be operated without coordination if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 15 dBμV/m/5 MHz at 10% time, 50% of locations at 3 metres above ground level at the border line.

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)04 and ECC/REC (15)01.

7.10 Specific information regarding coordination may be found in Appendix C based on 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 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] Also, per Report ITU-R M.2241 (11/2011): Compatibility studies in relation to Resolution 224 in the bands 698-806 MHz and 790-862 MHz.

8 Assignment

8.1 New assignments in this spectrum band will be assigned through an Invitation to Apply in line with regulations developed in terms of Section 31(3) of the Act.

9 End of Transitional Arrangements

9.1 The Frequency Band 694 to 862 MHz is allocated on a primary basis, to the Mobile Services and Identified for International Mobile Telecommunications through Foot Note 9 (NF9) in the National Radio Frequency Plan 2021. Accordingly, the frequency band has been prioritised for mobile services.

10 Revocation

10.1 Following on from the previous Section 9.1 (i.e., End of Transitional Arrangements), all Broadcasting licences are revoked by the Authority as of 1st April 2023.

11 Repeals

11.1 Government Gazette Number 38640 (Notice 272 of 2015).

Appendix A National Radio Frequency Plan

Table 2 shows an extract from the National Radio Frequency Plan for South Africa.

ITU Region 1 allocations and footnotes	South African allocations and footnotes	Typical Applications	Notes and Comments
694-790 MHz MOBILE except aeronautical mobile 5.312A 5.317A BROADCASTING 5.300 5.312	**694-790 MHz** MOBILE except aeronautical mobile 5.312A 5.317A NF9 NF9 5.312A 5.317A	IMT700 MTX (703 – 733 MHz) IMT750 (733 to 758 MHz) LTE LTE Advance	Paired with BTX (758 – 788 MHz) International Mobile Telecommunication Roadmap (GG No. 42829 Notice 600 of 2019). Radio Frequency Spectrum Assignment Plan (GG 38640 Notice 271 and 272 of 2015) as amended IMT in accordance with ITU-R Recommendation ITU-R M.2090 latest version and Resolution **760 (WRC-15**) applies **Recommendation ITU-R M.1036-6** Consideration of the future spectrum needs of Broadband Public Protection and Disaster Relief (PPDR) in the range 694 - 790 MHz as described in the most recent ITU-R M.2015, while taking into account studies called for by Resolution 646 (WRC15) for technical and operational measures. **Band IV/V analogue television is to be migrated to digital television and ensure harmonisation with SADC.** **WRC-07, WRC-12 and WRC-15 allocated this band to Mobile service except aeronautical mobile and identified it for IMT.** **Fixed links operating in this band will have to be migrated in order to accommodate IMT.**

Table 2: National Radio Frequency Plan for South Africa for 733 MHz to 758 MHz band

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 approximations 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.452 [8]. For the relevant transmitting terminal, predictions of path loss would be made at *x* km steps along radials of *y* km at *z* degree intervals[9]. 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" [10]. 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 taken into consideration. For the relevant base

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[8] 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)

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

[10] 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)

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 (also including the border line) and the 6 km line itself inside the neighbouring country may be interfered by higher field strength than the trigger field strength value given for the border line in the main text above at a height of 3 m above ground.
- only 10% of the number of geographical area pixels between the 6 km (including also the 6 km line) and 12 km line inside the neighbouring country may be interfered by 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.1546[11] with the Terrain Clearance Angle correction factor TCA, HCM[12] method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812[13, 14]).

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[11] P.1546 : Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 4 000 MHz (itu.int) https://www.itu.int/rec/R-REC-P.1546-6-201908-I/en

[12] 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

[13] 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)

[14] 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)

As to correction factors for clutters ‘open area’ and ‘quasi-open area’, 20 dB and 15 dB should be used, respectively. Recommendations ITU–R P.1406 [15] and/or ITU-R P.2108[16] 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.

[15] 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)

[16] 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/LTE[17]

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 36.211[18] 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;
Country type 4: Burundi, Central African Republic, Eritrea, Gabon, Gambia, Lesotho, Libyan Arab Jamahiriya, Mali, Morocco, Mozambique, Namibia, Sierra Leone, Somalia, Togo, Uganda.

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[17] ECC/REC (11)05

[18] 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.

(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:

Country 1	0..83	84..167	168..251	252..335	336..419	420..503
Border 1-2	■	■				■
Zone 1-2-3	■	■				
Border 1-3	■	■	■			
Zone 1-2-4	■					■
Border 1-4	■		■			■
Zone 1-3-4	■		■			

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

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

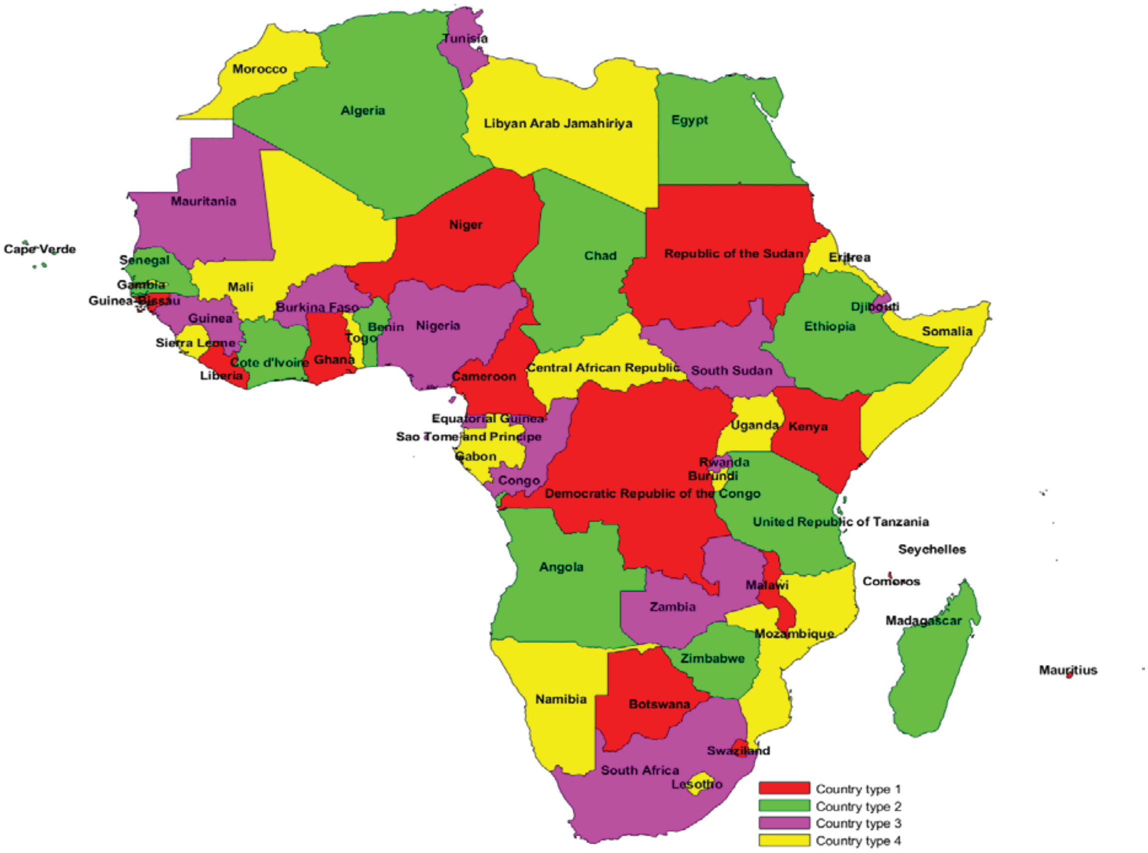
PCI	Set A	Set B	Set C	Set D	Set E	Set F
Country 4	0..83	84..167	168..251	252..335	336..419	420..503
Border 4-1		■		■	■	
Zone 4-1-2		■			■	
Border 4-2	■	■			■	
Zone 4-2-3	■	■				
Border 4-3	■	■		■		
Zone 4-3-1		■		■		

Table 3: 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.



<u>Figure 2:</u> Country type map/PCI distribution map

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

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.

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.

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 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.
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.

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.

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 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 4: 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 [19] and ECC Report 296 [20].

19 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.

20 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 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)[21].

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]; and
l) code group number used;
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.

[21] 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

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

NO. 2888 **20 December 2022**

HEREBY ISSUES A NOTICE REGARDING FINAL RADIO FREQUENCY ASSIGNMENT PLANS FOR THE IMT800 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 791 to 821 MHz and 832 to 862 MHz** in terms of regulation 3 of the Radio Frequency Spectrum Regulations 2015 and the International Mobile Telecommunication Roadmap 2019.
2. This Radio Frequency Spectrum Assignment Plan (“RFSAP”) supersedes any previous spectrum assignment arrangements for the same spectrum location. However, if it happens that on the date a provision of the RFSAP comes into effect, there is a conflict between the RFSAP and the latest versions of the National Radio Frequency Plan (“NRFP”) and Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan will prevail.

DR CHARLES LEWIS
ACTING CHAIRPERSON

Radio Frequency Spectrum Assignment Plan

Rules for Services operating in the Frequency Band from 791 MHz to 821 MHz and 832 MHz to 862 MHz (IMT800)

Table of Contents

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 3rd Generation Partnership Project (3GPP), which consists of six telecommunications standard development organisations
"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 the ECC Recommendation (11)04 - Cross-border Coordination for Mobile/Fixed Communications Networks (MFCN) in the frequency band 790-862 MHz, Edition 3 February 2017
"ECC"	means the Electronic Communications Committee (ECC) within the European Conference of Postal and Telecommunications Administrations (CEPT)
"FDD"	means the Frequency Division Duplex
"HCM"	means the Harmonised Calculation Method
"HCM4A"	means the Harmonised Calculation Method for Africa
"**HIPSSA**"	means the Sub-Saharan Africa Assessment Report on Harmonisation of ICT Policies in Sub-Saharan Africa
"IMT"	means the International Mobile Telecommunications
"IMT800"	means the IMT in the 800 MHz band (791 MHz to 821 MHz and 832 MHz to 862 MHz)
"ICNIRP"	Means the International Commission on Non-Ionizing Radiation Protection (ICNIRP)
"ITA"	means the Invitation to Apply
"ITU"	means the International Telecommunication Union
"ITU-R"	means the International Telecommunication Union Radiocommunication Sector
"LTE"	means the Long-Term Evolution 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 2021 for South Africa

"PCI"	means the Physical-Layer Cell Identities
"PPDR"	means the Public Protection and Disaster Relief as defined in ITU-R Report M.2033.
"PRACH"	means the Physical Random-Access Channel
"PSTN"	means the Public Switched Telephone Network
"PUCCH"	means the Physical Uplink Control Channel
"RFSAP"	means the Radio Frequency Spectrum Assignment Plan
"TCA"	means the Terrain Clearance Angle
"TDD"	means the 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) 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 This RFSAP states the requirements for the utilisation of the frequency band between 791 - 821 MHz paired with 832 - 862 MHz for IMT800.

2.3 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 of the IMT systems 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 equipment used in IMT800 systems will conform to all applicable South African standards, international standards, including those of the 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 will be certified under South African law and regulations.

3.4 The IMT800 band ranges between 791-821 MHz paired with 832-862 MHz.

3.5 The IMT800 band will be for mobile voice and data communications.

3.6 The requirements for the standard families which can provide IMT800 services include, but are not limited to:

- IMT-2000;
- IMT-Advanced; and
- IMT-2020.

3.7 Typical technical and operational characteristics of IMT systems as identified by the ITU are described in the following documents:

- 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.2241-0 (2011): Compatibility studies in relation to Resolution 224 in the bands 698 - 806 MHz and 790 - 862 MHz;
- Report ITU-R M.2074-0 (2006): Report on Radio Aspects for the terrestrial component of IMT-2000 and systems beyond IMT-2000;
- 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).

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 frequency band 791-821 MHz paired with 832-862 MHz provides a total bandwidth of:

- 2×30 MHz FDD for IMT800.

4.2 The channel arrangements for the IMT800 band are based on the Region 1 recommendation by the ITU, as provided in Figure 1.

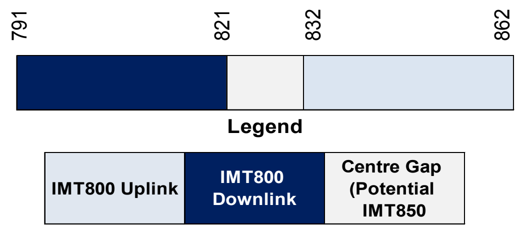


Figure 1: Channel arrangements for IMT800

5 Requirements for the usage of the 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 The use of the IMT800 band is limited to IMT services.

5.3 Only systems using digital technologies that promote spectral efficiency will be issued with an assignment. Capacity-enhancing digital techniques are being rapidly developed and such techniques that promote efficient spectrum use without reducing service quality. These techniques are encouraged.

5.4 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.

5.5 The allocation of spectrum and shared services within this band are found in the NRFP and an extract of the NRFP is shown in Appendix A.

5.6 Maximum radiated power:

5.6.1 The conservative in-block base station power limit is 64 dBm/5MHz EIRP;

5.6.2 Mobile Station transmissions should not exceed 23 dBm EIRP;

5.6.3 On a case-to-case basis, higher EIRP may be permitted if acceptable technical justification is provided; and

5.6.4 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).

5.7 ICNIRP Guideline compliance is required, where applicable.

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

6 Implementation

6.1 This RFSAP comes into effect upon publication.

6.2 No new assignments in the band 791-821 MHz paired with 832-862 MHz will be approved unless they comply with this RFSAP.

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 the 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 the 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[1] , 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 Harmonisation of ICT Policies in Sub-Saharan Africa[2] (HIPSSA)

7.4 A harmonised calculation method (HCM4A) brings these benefits:

7.4.1 Based on HCM Agreement used in Europe;

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;

7.4.7 Transparent decisions through agreed assessment procedures;

7.4.8 Quick assessment of interference through data exchange.

7.5 HCM4A involves all 4 sub regions 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];

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[1] https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwi81bOFz6P2AhUwQUEAHe1YDIgQFnoECAIQAQ&url=https%3A%2F%2Fextranet.crasa.org%2Fzip-agm.php%3Fid%3D332&usg=AOvVaw1bVAuEnE8a2iJnP20F_b_2

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

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[3]:

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 (11)04 for 790 - 862 MHz. Operator-to-operator coordination may be necessary to avoid interference.

FDD - In general, stations of FDD systems may be used without coordination with a neighbouring country if the mean field strength produced by the cell (all transmitters within the cell 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 countries and does not exceed a value of 29 dBμV/m/5 MHz at a height of 3 m above ground at a distance of 9 km inside the neighbouring country.

LTE FDD - In the case that LTE is deployed on both sides of the border, the field strength levels can be increased to 59 dBμV/m/5 MHz at the border (0 km) and 41 dBμV/m/5 MHz at 6 km from the border line inside the neighbouring country for preferential PCI codes (discussed in Appendix C) or if centre frequencies are not aligned. For the use of non-preferential PCI codes and aligned centre frequencies, the trigger field strength level is 41 dBμV/m/5 MHz at the border.

It is not usually considered necessary to define preferential frequencies. If administrations / operators wish to agree on cross-border coordination based on preferential frequencies, while ensuring a fair treatment of different operators, then they can do so based on agreements / operator arrangements
The following table gives an overview of the trigger values of the field strength at a height of 3 m above ground for IMT FDD systems ("@" stands for "at a distance inside the neighbouring country"):

Non-Preferential frequency usage		**Preferential frequency usage**
Centre frequencies aligned	**Centre frequencies not aligned**	Based on bi-or multilateral

[3] 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

Non-Preferential frequency usage			Preferential frequency usage
Using preferential PCI codes	Using non-preferential PCI codes	Using all PCI codes	agreements/ arrangements
59 dBµV/m/5 MHz @0 km and 41 dBµV/m/5 MHz @6 km	41 dBµV/m/5 MHz @0km	59 dBµV/m/5 MHz @0 km and 41 dBµV/m/5 MHz @6 km	

Table 1: Field Strength Trigger Values for FDD IMT

TDD - If TDD is in operation across both sides of a border and is synchronised across the border then field strength levels are the same as for the LTE-to-LTE coordination case. For unsynchronised TDD, the trigger field strength level is 24 dBµV/m/5 MHz at the border. The following table gives an overview of the trigger values of the field strength at a height of 3 m above ground between TDD systems ("@" stands for "at a distance inside the neighbouring country"):

Non-Preferential frequency usage					Preferential frequency usage
Centre frequencies aligned			Centre frequencies not aligned		Based on bi-or multilateral agreements
Synchronised TDD, or DL only		Unsynchronised TDD	Synchronised TDD, or DL only	Unsynchronised TDD	
Preferential PCI codes	Non-preferential PCI codes	All PCI codes	All PCI codes		
59 dBµV/m/5 MHz @0 km and 41 dBµV/m/5 MHz @6 km	41 dBµV/m/5 MHz @0 km	24 dBµV/m/5 MHz @0 km	59 dBµV/m/5 MHz @0 km and 41 dBµV/m/5 MHz @6 km	24 dBµV/m/5 MHz @0 km	

Table 2: Field Strength Trigger Values between TDD Systems

For field strength predictions, the calculations should be made according to Appendix B. In cases of other frequency block sizes 10*$\log_{10}$(frequency block size / 5 MHz) should be added to the field strength values, e.g.:

BW (MHz)	Field strength level at 3 m height for a given distance inside the neighbouring county (General case)	Field strength level at 3 m height for a given distance inside the neighbouring county (LTE case)
5 MHz	55.0 dBµV/m/5 MHz @0km	59.0 dBµV/m/5 MHz @0km
	29.0 dBµV/m/5 MHz @9km	41.0 dBµV/m/5 MHz @ 6 km
10 MHz	58.0 dBµV/m/10 MHz @0km	62.0 dBµV/m/10 MHz @0km
	32.0 dBµV/m/10 MHz @9km	44.0 dBµV/m/10 MHz @ 6 km
15 MHz	59.8 dBµV/m/15 MHz @0km	63.8 dBµV/m/15 MHz @0km

	33.8 dBμV/m/15 MHz @9km	45.8 dBμV/m/15 MHz @ 6 km
20 MHz	61.0 dBμV/m/20 MHz @0km	65.0 dBμV/m/20 MHz @0km
	35.0 dBμV/m/20 MHz @9km	47.0 dBμV/m/20 MHz @ 6 km

Table 3: Field Strength Adjustments

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 to the mutual agreements.
Stations of IMT systems may be operated without coordination if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 15 dBμV/m/5 MHz at 10% time, 50% of locations at 3 metres above ground level at the border line.

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)04.

7.10 Specific information regarding coordination may be found in Appendix C based on an extract from ECC/REC (11)05.

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 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.

8 Assignment

8.1 This spectrum band will be assigned through an Invitation to Apply in line with regulations developed in terms of Section 31(3) of the Act.

9 Transitional Arrangements

9.1 The Frequency Band 694 to 862 MHz is allocated on a Primary Basis, to the Mobile Services and Identified for International Mobile Telecommunications through Foot Note 9 (NF9) in the National Radio Frequency Plan 2021. Accordingly, the frequency band has been prioritised for mobile services

10 Amendment

10.1 Following on from the previous Section 9.1 (i.e., Transitional Arrangements), all Broadcasting licences will be amended by the Authority in accordance with the Digital Migration Regulations[4]read with Radio Frequency Migration Regulations 2013[5].

10.2 The Radio Frequency Spectrum Licences issued for the use of this band shall be amended in accordance with regulation 8 of the Radio Frequency Spectrum Regulations, 2015 as amended.

11 Repeals

11.1 RFSAP IMT800 published in Government Gazette Number 38640 (Notice 273 of 2015) is hereby repealed.

11.2 Government Gazette Number 38640 (Notice 390 of 2015) is hereby repealed.

[4] Government Gazette Number 36000 (Notice 1070 of 2012)

[5] [5] Government Gazette Number 36334 (Notice 352 of 2013)

Appendix A National Radio Frequency Plan

Table 4 shows an extract from the National Radio Frequency Plan for South Africa.

ITU Region 1 allocations and footnote	**South African allocations and footnotes**	**Typical Applications**	Notes and Comments
790-862 MHz **FIXED** **MOBILE except aeronautical mobile 5.316B 5.317A** BROADCASTING **5.312 5.319**	**790-862 MHz** **FIXED** **MOBILE except aeronautical mobile 5.316B 5.317A NF**9 5.312A 5317A	**Fixed Links (856 – 864.1 MHz)** **Wireless Access (827.775 – 832.695 MHz)** **IMT800 MTX (832 - 862 MHz)** **IMT850 MTX (825 – 830 MHz)**	**Paired with 868.1 – 876 MHz** **Paired with 827.775 - 832.695 MHz** **Paired with BTX (791 – 821 MHz)** **Paired with BTX (870 – 875 MHz)** **International Mobile Telecommunication Roadmap (GG No. 42829 Notice 600 of 2019).** Radio Frequency Spectrum Assignment Plan (GG 38640 Notice 271 and 272 of 2015) as amended IMT in accordance with ITU-R Recommendation ITU-R M.2090 latest version and Resolution **760 (WRC-15**) applies **Recommendation ITU-R M.1036-6** Consideration of the future spectrum needs of Broadband Public Protection and Disaster Relief (PPDR) in the range 694-790 MHz as described in the most recent ITU-R M.2015, while taking into account studies called for by Resolution 646 (WRC15) for technical and operational measures. **Band IV/V analogue television is to be migrated to digital television and ensure harmonisation with SADC.** **WRC-07, WRC-12 and WRC-15 allocated this band to Mobile service except aeronautical mobile and identified it for IMT.** **Fixed links operating in this band will have to be migrated in order to accommodate IMT.** **Radio Frequency Spectrum Assignment**

			Plan GG 42337 Notice 165 of 2019 Radio Frequency Spectrum Assignment Plan (GG 38640 Notice 273 of 2015) as amended **Radio Frequency Spectrum Assignment Plan GG 41082 Notice 648 of 2017**

Table 4: National Radio Frequency Plan for South Africa for 791 to 821 MHz and 832 to 862 MHz band

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 approximations 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.452 [6], For the relevant transmitting terminal, predictions of path loss would be made at *x* km steps along radials of *y* km at *z* degree intervals[7]. 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" [8]. This model is to be employed for 50% 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 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.

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[6] 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).

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

[8] 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).

For evaluation:

- Only 10% of the number of geographical area pixels between the border line (also including the border line) and the 6 km line itself inside the neighbouring country may be interfered by higher field strength than the trigger field strength value given for the border line in the main text above at a height of 3 m above ground.
- Only 10% of the number of geographical area pixels between the 6 km (including also the 6 km line) and 12 km line inside the neighbouring country may be interfered by 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 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.1546[9] with the Terrain Clearance Angle correction factor TCA, HCM[10] method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812[11, 12]).

As to correction factors for clutters 'open area' and 'quasi-open area,' 20 dB and 15 dB should be used, respectively. Recommendations ITU–R P.1406[13] and/or ITU-R P.2108[14] should be used if a finer selection of clutter is required.

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[9] P.1546 : Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 4 000 MHz (itu.int) https://www.itu.int/rec/R-REC-P.1546-6-201908-I/en

[10] 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

[11] 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)

[12] 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)

[13] 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)

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

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.

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE[15]

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 36.211[16] 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;
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).

[15] ECC/REC (11)05

[16] 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.

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:

Country 1	0..83	84..167	168..251	252..335	336..419	420..503
Border 1-2	■	■				■
Zone 1-2-3	■	■				
Border 1-3	■	■	■			
Zone 1-2-4	■					■
Border 1-4	■		■			■
Zone 1-3-4	■		■			

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

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

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

Table 5: 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.

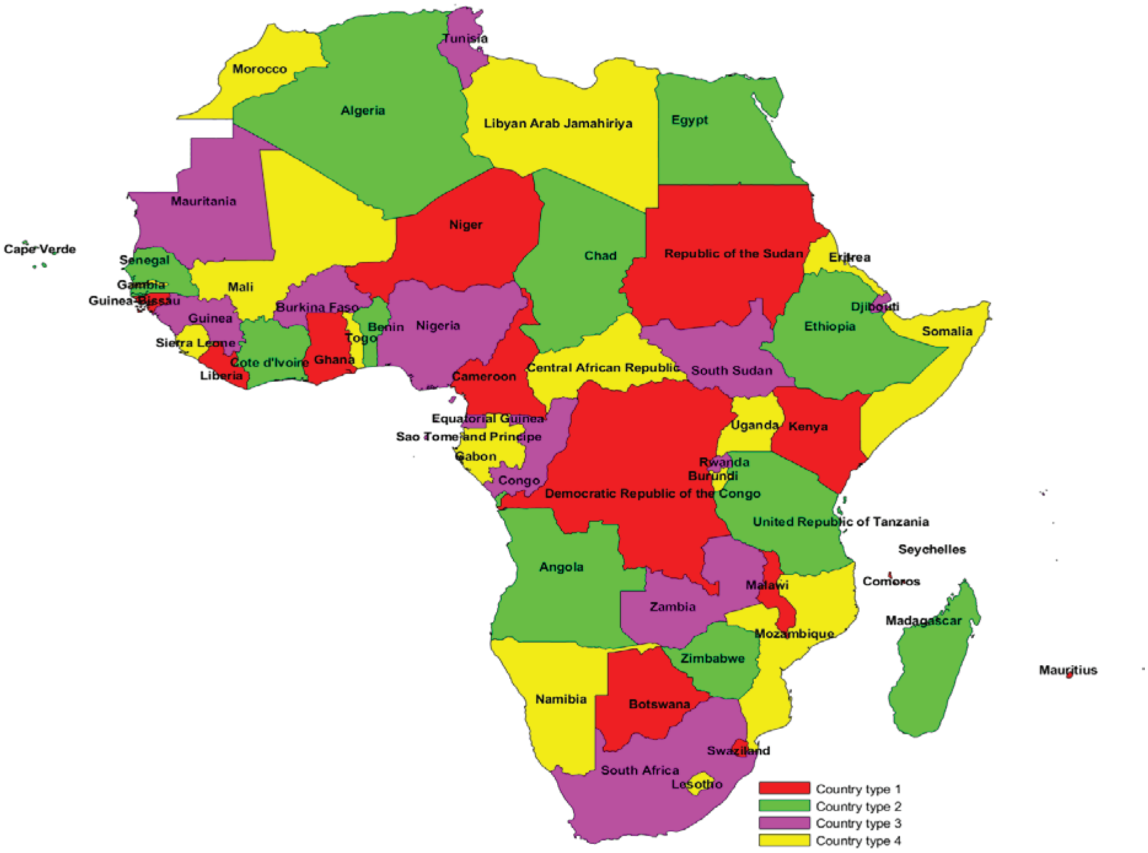

Figure 2: Country type map/PCI distribution map

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

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.

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.

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 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.
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.

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.

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 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 6: **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 [17] and ECC Report 296 [18].

[17] 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.

[18] 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 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 Harmonised Calculation Method for Africa (HCM4A)[19]

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;
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.

[19] Cross-Border Frequency Coordination: Harmonised 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

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

NO. 2889 **20 December 2022**

HEREBY ISSUES A NOTICE REGARDING FINAL RADIO FREQUENCY ASSIGNMENT PLANS FOR THE IMT900 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 880 MHz to 915 MHz and 925 MHz to 960 MHz** in terms of sections 2 (d) and (e), 30, 31(4) and 33 of the Electronic Communications Act (Act No. 36 of 2005), read with read with regulation 3 of the Radio Frequency Spectrum Regulations 2015 and the International Mobile Telecommunication Roadmap 2019.
2. This Radio Frequency Spectrum Assignment Plan ("RFSAP") supersedes any previous spectrum assignment arrangements for the same spectrum location. However, if it happens that on the date a provision of the RFSAP comes into effect, there is a conflict between the RFSAP and the latest versions of the National Radio Frequency Plan ("NRFP") and Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan will prevail.

DR CHARLES LEWIS
ACTING CHAIRPERSON

ICASA

Radio Frequency Spectrum Assignment Plan

Rules for Services operating in the Frequency Band
880 MHz to 915 MHz and
925 MHz to 960 MHz
(IMT900)

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 the 3rd Generation Partnership Project (3GPP), which consists of six telecommunications standard development organisations
"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 the ECC Recommendation (11)04 - Cross-border Coordination for Mobile/Fixed Communications Networks (MFCN) in the frequency band 790-862 MHz, Edition 3 February 2017
"ECC"	means the Electronic Communications Committee (ECC) within the European Conference of Postal and Telecommunications Administrations (CEPT)
"FDD"	means the Frequency Division Duplex
"HCM"	means the harmonised calculation method
"HCM4A"	means the Harmonised Calculation Method for Africa
"**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
"IMT900"	means the IMT in the 900 MHz band (880 MHz to 915 MHz and 925 MHz to 960 MHz)
"ITA"	means the Invitation to Apply
"ITU"	means the International Telecommunication Union
"ITU-R"	means the International Telecommunication Union Radiocommunication Sector
"LTE"	means the 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 2021 for South Africa
"PCI"	means the Physical-Layer Cell Identities

"PPDR"	means the Public Protection and Disaster Relief as defined in ITU-R Report M.2033.
"PRACH"	means the Physical Random-Access Channel
"PSTN"	means the public switched telephone network
"PUCCH"	means the Physical Uplink Control Channel
"RFSAP"	means the Radio Frequency Spectrum Assignment Plan
"TCA"	means the Terrain Clearance Angle
"TDD"	means the Time Division Duplex
"WRC-12"	means the World Radiocommunications 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) 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 feasibility study[1] consultation concerning the 880-915/925-960 MHz band, is mandated by the Frequency Band Migration Regulation and Plan contained in the IMT Roadmap 2014 and IMT Roadmap 2019[2, 3], which concluded that the Authority proceeds with an RFSAP for IMT in this band.

2.3 This RFSAP states the requirements for the utilization of the frequency band between 880 MHz and 915 MHz paired with 925 MHz to 960 MHz for IMT900.

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 of the IMT systems are:

- a high degree of commonality of functionality worldwide while 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
- enhanced peak data rates to support advanced services and applications

3 General

3.1 Technical characteristics of equipment used in IMT900 systems shall conform to all applicable South African standards, international standards, including those of the 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.

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[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 2019, Government Gazette Vol. 645, 29 March 2019 No. 42361

[3] Final IMT Roadmap 2019, Government Gazette Vol. 653, 8 November 2019 No. 42829

3.4 The allocation of this frequency band and the information in this Radio Frequency Spectrum Assignment Plan (RFSAP) are subject to review.

3.5 The IMT900 band ranges between 880 MHz to 915 MHz paired with 925 MHz to 960 MHz.

3.6 The IMT900 band will be used for IMT.

3.7 The requirements for the families of standards which can provide IMT800 services include, but are not limited to:

- IMT-2000;
- IMT-Advanced; and
- IMT-2020.

3.8 Typical technical and operational characteristics of IMT systems as identified by the ITU are described in the following documents[4:]

- 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 (2011): Report on Radio Aspects for the terrestrial component of IMT-2000 and systems beyond IMT-2000.
- 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).

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 frequency bands from 880 MHz to 915 MHz paired with 925 MHz to 960 MHz provide a total bandwidth of:

- 2×35 MHz FDD for IMT900

[4] These and other IMT documents are available at https://www.itu.int/rec/R-REC-M/en

4.2 The channel arrangements for the implementation of IMT in the IMT 900 band are summarised in Table 1 and Figure 1.

Frequency arrangements	Paired arrangements (FDD)				Un-paired arrangements (TDD) (MHz)
	Mobile station transmitter (MHz)	Centre gap (MHz)	Base station transmitter (MHz)	Duplex separation (MHz)	
A2	880-915	10	925-960	45	None

Table 1: Frequency arrangements in the 880-960 MHz frequency range[5]

Figure 1: Frequency arrangements in the 880-960 MHz frequency range

5 Requirements for the usage of the 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 The use of the IMT900 band is limited to IMT services.

5.3 Only systems using digital technologies that promote spectral efficiency will be issued with an assignment. Capacity enhancing digital techniques is being rapidly developed together with techniques that promote efficient spectrum use without reducing service quality. These techniques are encouraged.

5.4 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.

5.5 The allocation of spectrum and shared services within this band are found in the NRFP and an extract of the NRFP is shown in Appendix A.

5.6 Maximum radiated power:

5.6.1 The conservative in-block base station power limit is 61 dBm (5 MHz) EIRP per antenna;

5.6.2 Mobile Station transmissions should not exceed 23 dBm EIRP;

5.6.3 On a case to case basis, higher EIRP may be permitted if acceptable technical justification is provided; and

[5] ITU-R Recommendation M.1036-6, the latest version (currently, 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)).

5.6.4 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).

5.7 ICNIRP Guideline compliance is required, where applicable.

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

6 Implementation

6.1 The Feasibility study and findings[6] conducted for this band stated that the Authority's plan concluded the Authority should proceed with the RFSAP to achieve the following assignment plan for the band:

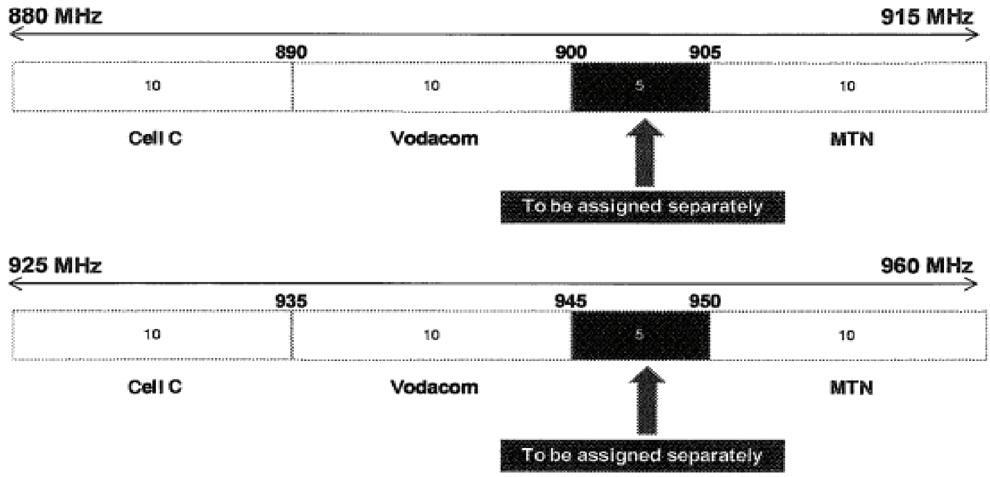

Figure 2: Required assignments for 900 MHz band

6.2 This new RFSAP which is illustrated with Figure 2 shall be effective on the 31st of March 2024.

6.3 Licensees are required to follow the in-band harmonization and optimization process detailed in Chapter 10 Radio frequency Migration of this RFSAP.

6.4 No new assignments for IMT900 in the 880 MHz and 915 MHz paired with 925 MHz to 960 MHz shall be approved unless they comply with this RFSAP.

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.

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

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[7] , 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 Harmonisation of ICT Policies in Sub-Saharan Africa[8] (HIPSSA)

7.4 A harmonised calculation method (HCM4A) brings these benefits

7.4.1 Based on HCM Agreement used in Europe, also under ITU Region 1;

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 sub regions of Africa. This means the HCM4A project includes 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 AU namely:

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[7] https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwi81bOFz6P2AhUwQUEAHe1YDIgQFnoECAIQAQ&url=https%3A%2F%2Fextranet.crasa.org%2Fzip-agm.php%3Fid%3D332&usg=AOvVaw1bVAuEnE8a2iJnP20F_b_2

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

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];

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] Optimise spectrum usage by accurate interference field strength calculations;

7.6 HCM4A also comes with a software tool for Sub-Saharan Africa[9].

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 shall require coordination with the neighbouring countries within the coordination zones of 6 kilometres in case of LTE-to-LTE or 9 kilometres in case of LTE-to-other technologies from the neighbouring country. The coordination distance is continuously being reviewed and may be updated from time to time.

7.8 The following field strength thresholds have to be assured based on ECC/REC (08)02[10] for 900 MHz band and ECC/REC (11)04 for 790 MHz - 862 MHz applied to the 900 MHz band. Operator-to-operator coordination may be necessary to avoid interference

7.9 In general stations of FDD systems 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 border line between countries and does not exceed a value of 29 dBµV/m/5 MHz at a height of 3 m above ground at a distance of 9 km inside the neighbouring country.

In the case that LTE is deployed on both sides of the border the field strength levels can be increased to 59 dBµV/m/5 MHz at the border (0 km) and 41 dBµV/m/5 MHz[11] at 6 km from the border line inside the neighbouring country for preferential PCI codes (discussed in Appendix

[9] 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

[10] ECC Recommendation (08)02 "Frequency planning and frequency coordination for GSM / UMTS / LTE / WiMAX Land Mobile systems operating within the 900 and 1800 MHz bands". Approved 21 February 2008. Amended 27 April 2012

[11] The trigger value of value of 35 dBµV/m/5 MHz at a height of 3 m above ground at a distance of 9 km inside the neighbouring country, in the frequency band 925 - 960 MHz, used in ECC/REC(08)02 may be shown to be mathematically equivalent to 41 dBµV/m/5 MHz at 6 km from the border line used in ECC/REC(11)04, as $20 \times \log_{10} (900\ \text{MHz} / 700\ \text{MHz}) + 20 \times \log_{10}(9\ \text{km} / 6\ \text{km}) \approx 6\ \text{dB} = 41\ \text{dB}\mu\text{V/m/5 MHz} - 35\ \text{dB}\mu\text{V/m/5 MHz}$.

C), also measured at a height of 3 m above ground. For the use of non-preferential PCI codes and aligned centre frequencies, the trigger field strength level is 41 dBµV/m/5 MHz at the border.

7.10 As per ECC/REC (11)04, if TDD is in operation across both sides of a border and is synchronised across the border then field strength levels as well.
For field strength predictions the calculations should be made according to Appendix B. In cases of other frequency block sizes 10*$\log_{10}$ (frequency block size / 5 MHz) should be added to the field strength values e.g.:

BW (MHz)	Field strength level at 3 m height (General case[12])	Field strength level at 3 m height (LTE case)
5 MHz	55.0 dBµV/m/5 MHz @0km	59.0 dBµV/m/5 MHz @0km
	29.0 dBµV/m/5 MHz @9km	41.0 dBµV/m/5 MHz @6km
10 MHz	58.0 dBµV/m/10 MHz @0km	62.0 dBµV/m/10 MHz @0km
	32.0 dBµV/m/10 MHz @9km	44.0 dBµV/m/10 MHz @6km
15 MHz	59.8 dBµV/m/15 MHz @0km	63.8 dBµV/m/15 MHz @0km
	33.8 dBµV/m/15 MHz @9km	45.8 dBµV/m/15 MHz @6km
20 MHz	61.0 dBµV/m/20 MHz @0km	65.0 dBµV/m/20 MHz @0km
	35.0 dBµV/m/20 MHz @9km	47.0 dBµV/m/20 MHz @6km

Table 2: Field Strength Adjustments

If neighbouring administrations wish to agree on frequency coordination based on preferential frequencies, while ensuring a fair treatment of different operators within a country the Authority will add these mutual agreements.
As per ECC/REC (11)04[13], stations of IMT systems may be operated without coordination if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 15 dBµV/m/5 MHz at 10% time, 50% of locations at 3 metres above ground level at the border line.

7.11 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.

7.12 Specific information regarding coordination may be found in Appendix C based on an extract from ECC/REC (11)05.

7.13 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 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.

7.14 Assignment holders shall take full advantage of interference mitigation techniques such as antenna discrimination, tilt, polarization, frequency discrimination, shielding / blocking

[12] As based on the original release of ECC/REC (11)04 (not the latest one).

[13] Also, per Report ITU-R M.2241 (11/2011): Compatibility studies in relation to Resolution 224 in the bands 698-806 MHz and 790-862 MHz.

(introduce diffraction loss), site selection, and/or power control to facilitate the coordination of systems.

8 Assignment

8.1 This spectrum band will be assigned through an Invitation to Apply that will be published for a new assignment in the frequency block 900 - 905 / 945 - 950 MHz in line with regulations developed in line with Section 31(3) of the Act.

9 Amendments

The deadline for the in-band migration process for the assignments within the IMT900 band was set for 31st March 2020[14] at the latest. The Authority will amend the existing Radio Frequency Spectrum Licences in terms of regulation 6 of the Radio Frequency Migration Regulations[15] upon publication of this RFSAP.

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[14] Government Gazette 38640 (Notice 275 of 2015)

[15] Government Gazette 42337 (Notice 166 of 2019)

11 Radio Frequency Migration

11.1 Specific Procedure: Frequency migration in the case of this IMT900 band consists of the optimisation and harmonisation of existing assignments involving the potential in-band migration of one or more licensees, as shown in Figure 3.

The following steps shall be followed:

- In the short term, the operators must coordinate on the reduction of guard bands. Disputes will be resolved as per Section 33(2) of the Act and read with Regulation 13 of the Radio Frequency Spectrum Regulations 2015.
- The Authority had decided that the following assignments within the IMT900 band was set to be achieved by 31st March 2020[16] at the latest.
- The Authority resolved that the in-band Migration shall be finalised by 31 March 2024.

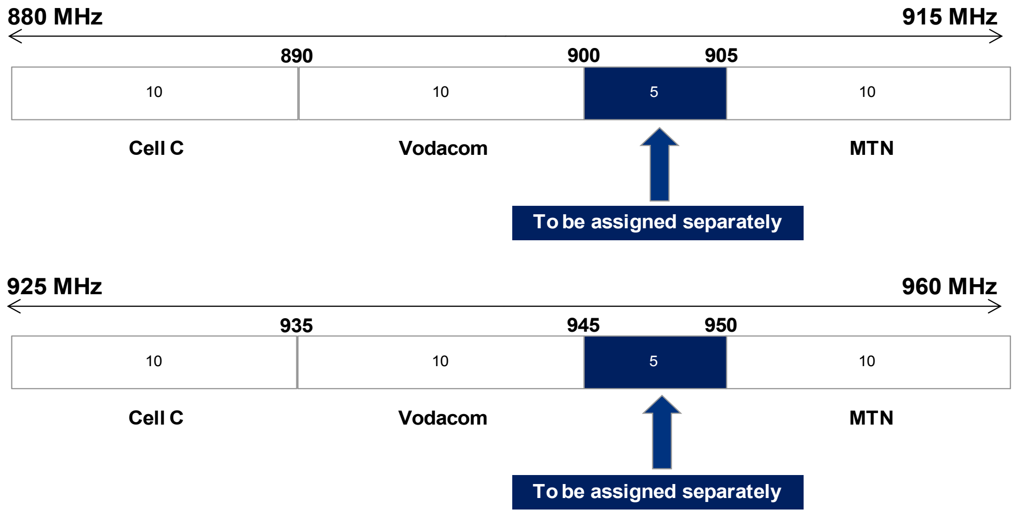

Figure 3: Assignments from 1st April 2023

12 Repeals

12.1 RFSAP IMT900 published in Government Gazette 38640 (Notice 275 of 2015) is hereby repealed.

12.2 Government Gazette Number 38640 (Notice 391 of 2015) is hereby repealed.

[16] Government Gazette 38640 (Notice 275 of 2015)

Appendix A National Radio Frequency Plan

Table 3 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
862-890 MHz FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 5.319 5.323	**862-890 MHz** FIXED MOBILE except aeronautical mobile 5.317A NF10	Fixed Links (856 – 864.1 MHz) Wireless Access (872.775 - 877.695 MHz) GSM-R MTX (877.695 – 880 MHz) NF10 IMT900 MTX (880-915 MHz) IMT850 BTX (870-875 MHz) Wireless Audio systems and Wireless microphones (863 – 865 MHz) CT2 cordless phones (864.1 – 868.1 MHz) FWA (864.1 – 868.1 MHz) RFID (865 – 868 MHz) Non-specific SRD and RFID (869.4 – 869.65 MHz) Non-Specific SRDs (868 – 868.6 MHz, 868.7 – 869.2 MHz, 869.4 – 869.65 MHz, 869.7 – 870.0 MHz) Alarms (868.6 – 868.7 MHz, 869.25 – 869.3 MHz, 869.65 – 869.7 MHz	Paired with 868.1 – 876 MHz Paired with 827.775 – 832.695 MHz Paired with 921 – 925 MHz Paired with BTX (925 – 960 MHz) Paired with MTX (825-830 MHz) Radio Frequency Spectrum Regulations as amended (Annex B) (GG. No. 38641, 30 March 2015). Recommendation ITU-R M.1036-6 Radio Frequency Spectrum Assignment Plan GG 42337 Notice 165 of 2019 Radio Frequency Spectrum Assignment Plan (GG 38640 Notice 275 of 2015) as amended International Mobile Telecommunication Roadmap GG No. 42829 Notice 600 of 2019).
890-942 MHz FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 Radiolocation 5.323	**890-942 MHz** FIXED MOBILE except aeronautical mobile 5.317A NF9 NF10 NF11 Radiolocation	IMT900 MTX (880 – 915 MHz) GSM-R (BTX) (921 - 925 MHz) RFID (including, passive tags and vehicle location (915.1 – 921 MHz)	Paired with BTX (925 – 960 MHz Paired with MTX (877.695 – 880 MHz) Radio Frequency Spectrum Assignment Plan (GG 38640 Notice 275 of 2015) as amended International Mobile Telecommunication Roadmap GG No. 42829 Notice 600 of 2019). Final Frequency Migration Plan 2019 (GG No. 42337 Notice 36 of 2019)
942-960 MHz FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 5.323	**942-960 MHz** FIXED MOBILE except aeronautical mobile 5.317A NF9	IMT900 BTX (925 – 960 MHz)	Paired with MTX (880 – 915 MHz) Recommendation ITU-R M.1036-6

Table 3: National Radio Frequency Plan for South Africa for 880-960 MHz band[17]

[17] National Radio Frequency Plan 2021, (NRFP-21) 8.3 kHz – 3000 GHz, Independent Communications Authority of South Africa

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.452, For the relevant transmitting terminal, predictions of path loss would be made at *x* km steps along radials of *y* km at *z* degree intervals[18]. 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 required to 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" [19]. This model is to be employed for 50% 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 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.

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

[19] 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)

For evaluation,

- Only 10 percent of the number of geographical area pixels between the border line (also including the border line) and the 6 km line itself inside the neighbouring country may be interfered by higher field strength than the trigger field strength value given for the border line in the main text above at a height of 3 m above ground.
- Only 10 percent of the number of geographical area pixels between the 6 km (including also the 6 km line itself) and 12 km line inside the neighbouring country may be interfered with by higher field strength than the trigger field strength value given for the 6 km line 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, also 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.1546[20] with the terrain clearance angle correction factor TCA, HCM[21] method with the terrain clearance angle correction factor or Recommendation ITU–R P.1812 [22], [23]).

As to correction factors for clutter in 'open area' and 'quasi-open area', 20 dB and 15 dB should be used, respectively. Recommendation ITU–R P.1406 [24] and/or ITU-R P.2108 [25] should be used if a finer selection of clutter is required.

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[20] 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)

[21] 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

[22] 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)

[23] 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)

[24] 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)

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

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.

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE[26]

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 36.211[27] 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, São Tomé and Príncipe, 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).

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[26] ECC/REC (11)05

[27] 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 4: **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:

Country 1	0..83	84..167	168..251	252..335	336..419	420..503
Border 1-2						
Zone 1-2-3						

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

	Set A	Set B	Set C	Set D	Set E	Set F
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
Border 2-3		■	■	■		
Zone 2-1-4			■	■		
Border 2-4			■	■		■
Zone 2-3-4			■	■		

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

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

Table 4: 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.

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

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.

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 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.

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 cyclic shift parameter stated in 3GPP TS 36.211[28] 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 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 is available for network planning. The drawback of DM RS sequence group cyclic shift is a loss of orthogonality 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 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 pattern 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 Blocks time positions within the uplink frame, their frequency position within the LTE channel bandwidth and by apportioning cell-

[28] https://portal.3gpp.org/ngppapp/DownloadTDoc.aspx?contributionUid=R1-1613067

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 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 only logical root sequence numbering needs be used for coordination. Unfortunately, the process of root sequence 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 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 [29] and ECC Report 296 [30]. The text above is based on these.

[29] 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.

[30] 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 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 Harmonised Calculation Method for Africa (HCM4A)[31]

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
m) antenna tilt [degrees]

The Administration affected shall evaluate the request for coordination and shall 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 shall 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.

[31] Cross-Border Frequency Coordination: Harmonised 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

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

NO. 2890 **20 December 2022**

HEREBY ISSUES A NOTICE REGARDING FINAL RADIO FREQUENCY ASSIGNMENT PLANS FOR THE IMT2300 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 2300 MHz to 2400 MHz** in terms of regulation 3 of the Radio Frequency Spectrum Regulations 2015 and the International Mobile Telecommunication Roadmap 2019.
2. This Radio Frequency Spectrum Assignment Plan ("RFSAP") supersedes any previous spectrum assignment arrangements for the same spectrum location. However, if it happens that on the date a provision of the RFSAP comes into effect, there is a conflict between the RFSAP and the latest versions of the National Radio Frequency Plan ("NRFP") and Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan will prevail.

DR CHARLES LEWIS
ACTING CHAIRPERSON

Radio Frequency Spectrum Assignment Plan

Rules for Services operating in the Frequency Band 2300 MHz to 2400 MHz (IMT2300)

Table of Contents

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 3rd Generation Partnership Project (3GPP), which consists of six telecommunications standard development organisations
"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)05"	means the ECC Recommendation (11)05 - Cross-border Coordination for Mobile/Fixed Communications Networks (MFCN) in the frequency band 2500-2690 MHz
"ECC/REC (14)04"	means the ECC Recommendation (14)04 - Cross-border coordination for mobile/fixed communications networks (MFCN) and between MFCN and other systems in the frequency band 2300-2400 MHz
"ECC"	means the Electronic Communications Committee within the European Conference of Postal and Telecommunications Administrations (CEPT)
"FDD"	means the Frequency Division Duplex
"HCM"	means the Harmonised Calculation Method
"HCM4A"	means the Harmonised Calculation Method for Africa
"**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
"IMT2300"	means the IMT in the 2300 MHz band (2300 MHz to 2400 MHz)
"ITA"	means the Invitation to Apply
"ITU"	means the International Telecommunication Union
"ITU-R"	means the International Telecommunication Union Radiocommunication Sector

"LTE"	means the 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 2021 for South Africa
"PCI"	means the Physical-Layer Cell Identities
"PRACH"	means the Physical Random-Access Channel
"PSTN"	means the Public Switched Telephone Network
"PUCCH"	means the Physical Uplink Control Channel
"RFSAP"	means the Radio Frequency Spectrum Assignment Plan
"TCA"	means the Terrain Clearance Angle
"TDD"	means the Time Division Duplex
"TRP"	means the total radiated power. The TRP is defined as the integral of the power transmitted in different directions over the entire radiation sphere.
"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) 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 feasibility study concerning the 2300 – 2400 MHz 3GPP band 40 is mandated by the Frequency Migration Plan, 2019 and in the IMT Roadmap 2014 and IMT Roadmap 2019[1] concluded that the Authority proceeds with an RFSAP for IMT in this band.

2.3 This RFSAP states the requirements for the utilisation of the frequency band 2300 MHz to 2400 MHz for IMT2300.

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 of the IMT systems 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 equipment used in IMT2300 systems will conform to all applicable South African standards, international standards, including those of the 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 will be certified under South African law and regulations.

3.4 The allocation of this frequency band and the information in this Radio Frequency Spectrum Assignment Plan (RFSAP) are subject to review.

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

3.5 The IMT2300 band ranges between 2300 MHz to 2400 MHz.

3.6 The IMT2300 band will be used for IMT-TDD.

3.7 The requirements for the family of standards which can provide IMT2300 services include, but are not limited to:

- IMT-2000;
- IMT-Advanced; and
- IMT-2020.

3.8 Typical technical and operational characteristics of IMT systems as identified by the ITU are described in the following documents [2]:

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;

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).

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 frequency band 2300 - 2400 MHz provides a total bandwidth of 100 MHz for IMT services.

4.2 Channel arrangements for the IMT2300 band have been proposed by the ITU as follows, as provided in Figure 1:

[2] These and other IMT documents are available at https://www.itu.int/rec/R-REC-M/en

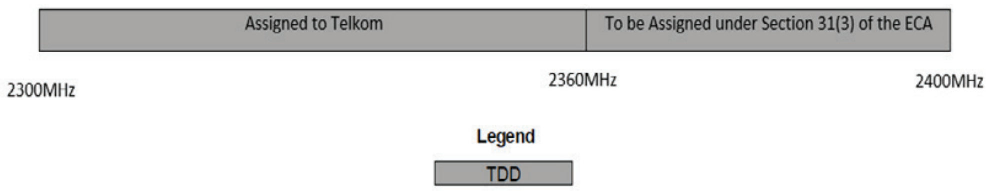

Figure 1: Channel arrangement for 2300-2400 MHz

5 Requirements for the usage of the 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 The use of the IMT2300 band is limited to IMT services.

5.3 Only systems using digital technologies that promote spectral efficiency will be issued with an assignment. Capacity-enhancing digital techniques are being rapidly developed together with techniques that promote efficient spectrum use without reducing service quality. These techniques are encouraged.

5.4 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.

5.5 The allocation of spectrum and shared services within this band are found in the NRFP, and an extract of the NRFP is shown in Appendix A.

5.6 Maximum radiated power:

5.6.1 The conservative in-block base station power limit is 68 dBm/ (5 MHz) EIRP.

5.6.2 The Authority acknowledges the feedback from the consultation that it should include a Total Radiated Power (TRP) limit for AAS base stations into the assignment plans. Stakeholders noted that this inclusion would bring South Africa in line with global industry development, and that if it is not done, the restrictive nature of the regulations will inevitably have a detrimental effect on the quality of service that can be expected from radio networks. TRP specifications are only allowed for and provided for mobile stations.

5.6.3 Mobile Station transmissions should not exceed 23 dBm EIRP.

5.6.4 Mobile Station transmissions should not exceed 25 dBm TRP.

5.6.5 On a case-to-case basis, higher EIRP may be permitted if acceptable technical justification is provided.

5.6.6 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).

5.6.7 ICNIRP Guideline compliance is required, where applicable.

6 Implementation

6.1 This RFSAP comes into effect on the 1st April 2023.

6.2 No new assignments in the band 2300 MHz – 2400 MHz will be approved unless they comply with this RFSAP.

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 the SADC Member States if the implementation of the Agreement is to be effective. The ECC, therefore, agreed to convene a workshop on HCM4A and requested the 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[3], 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 Harmonisation of ICT Policies in Sub-Saharan Africa[4] (HIPSSA5).

7.4 A harmonised calculation method (HCM4A) brings these benefits:

7.4.1 Based on HCM Agreement used in Europe;

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;

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[3] https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwi81bOFz6P2AhUwQUEAHe1YDIgQFnoECAIQAQ&url=https%3A%2F%2Fextranet.crasa.org%2Fzip-agm.php%3Fid%3D332&usg=AOvVaw1bVAuEnE8a2iJnP20F_b_2

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

7.4.6 Quick assignment of preferential frequencies;

7.4.7 Transparent decisions through agreed assessment procedures;

7.4.8 Quick assessment of interference through data exchange.

7.5 HCM4A involves all 4 sub regions 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];

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 [6]

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 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. Operator-to-operator coordination may be necessary to avoid interference.

7.9 TDD to TDD, based on ECC/REC (14)04
The 2300 - 2400 MHz band may be used for TDD systems without coordination if the mean field strength of each cell produced by the base station does not exceed a value of 30 dBµV/m/5 MHz at a height of 3 m above ground level at the border line between countries.

Synchronisation should be achieved including that of the field strength levels if TDD is in operation across both sides of a border.

When TDD systems are synchronised across the border, the 2300-2400 MHz band may be used without coordination with a neighbouring country if the mean field strength of each cell produced

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[6] 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

by the base station does not exceed a value of 65 dBµV/m/5MHz at a height of 3 m above ground level at the border line between countries and a value of 49 dBµV/m/5MHz at a height of 3 m above ground level at a distance of 6 km inside the neighbouring country.

When preferential and non-preferential spectrum blocks are defined in the 2300-2400 MHz band and are distributed between neighbouring countries, coordination is not required if the mean field strength of each cell produced by the base station does not exceed:

- for the preferential blocks, a value of 65 dBµV/m/5 MHz at a height of 3 m above ground level at the border line between two countries and a value of 49 dBµV/m/5 MHz at a height of 3 m above ground level at a distance of 6 km inside the neighbouring country;
- for non-preferential blocks, a value of 30 dBµV/m/5 MHz at a height of 3 m above ground level at the borderline between two countries.

The "mean field strength of each cell" refers up to a frequency block of 5 MHz.

For field strength predictions the calculations should be made according to Appendix B. In cases of other frequency block sizes 10 x $\log_{10}$ (frequency block size / 5 MHz) should be added to the field strength values.

If administrations wish to agree on frequency coordination based on preferential frequencies, while ensuring a fair treatment of different operators, they can do so based on mutual agreements.

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.

As per ECC/REC (11)05 of the 26th May 2011, the cross-border operation between TDD and TDD systems and between TDD and FDD systems, stations of IMT systems may be operated without coordination if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 21 dBµV/m/5 MHz at 10% time, 50% of locations at 3 metres above ground level at the border line.

ECC/REC (14)04 and ECC/REC (11)05 may offer guidance for additional scenarios (NB! the general FDD case is only included into the original ECC/REC (11)05 dated 26 May 2011, and not into the latest version published on 03 February 2017 [7]).

7.10 Technical analysis may be conducted by the Authority before an assignment is issued according to Appendix B based on an extract from ECC/REC (14)04.

7.11 Specific information regarding coordination may be found in Appendix B based on an extract from ECC/REC (14)04.

7.12 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 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.

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[7] https://docdb.cept.org/document/501

7.13 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.

8 Assignment

8.1 This spectrum band will be assigned through an Invitation to Apply in line with regulations developed with Section 31(3) of the Act.

9 Amendments

9.1 Following the feasibility study consultation[8], which determined that this band should be assigned exclusively for IMT, existing fixed service licensees will have their licences amended and be moved to a different destination band.

9.2 The migration of Fixed and Outside Broadcast links out of this band to the new destination band shall be completed by 31st March 2023.

10 Radio Frequency Migration

10.1 Specific Procedure.

10.1.1 All fixed services in the whole band should be cleared, save for the exception for FAR147 described below.

10.2 The band 2300 - 2400 MHz is currently used for testing purposes in flight area FAR147. Until this band is fully cleared, there is a geographic exclusion zone encompassing the proclaimed flight area FAR147, in which IMT transmissions are not permitted.

10.3 This frequency band should be cleared and exclusively assigned for IMT purposes, that is, current non-IMT users of the band should vacate the band by 31st March 2023, from which time the band is assigned exclusively for IMT services.

11 Synchronisation

11.1 In order to avoid interference between TDD networks operating in adjacent frequency carriers, the radio transmissions of adjacent TDD networks should be synchronized with the uplink and downlink frames aligned in time. Such synchronization of TDD networks is very important because it is the best way to avoid interference between networks and ensures efficient use of spectrum resources by avoiding inter-operator guard bands and

[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.

additional base station filtering. Otherwise, the uplink and downlink interference cannot be eliminated or avoided in terms of technical measures.

11.2 The Authority will align with the operators to define a unified national uplink and downlink frame as part of a future ITA for unassigned spectrum in this band (see Figure 1).

12 Repeals

12.1 The Radio Frequency Spectrum Assignment Plan for IMT2300 published in Government Gazette Number 38640 (Notice 276 of 2015) is hereby repealed.

12.2 The Radio Frequency Spectrum Assignment Plan Amendment, published in Government Gazette Number 38755 (Notice 392 of 2015)

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Appendix A National Radio Frequency Plan

Table 1 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
2 300 - 2 450 MHz FIXED MOBILE 5.384A Amateur Radiolocation 5.150 5.282 5.395	**2 300 - 2 450 MHz** FIXED MOBILE 5.384A NF9 Amateur Radiolocation Amateur-satellite 5.150 5.282 5.395	IMT2300 TDD (2300 – 2400 MHz) WLAN, FDDA and model ctrl. (2400 – 2483.5 MHz) Non-Specific SRDs and low power video surveillance (2400 – 2483.5 MHz) RFID (2 400 – 2 483.5 MHz) ISM applications (2400 – 2483.5 MHz) Amateur-satellite (2400 – 2450 MHz)	International Mobile Telecommunication Roadmap (GG No. 42829 Notice 600 of 2019) as amended. Common international SRD band; see ITU-R Rec. SM.1896 latest version (above 2400 MHz) Radio Frequency Spectrum Assignment Plan (GG N. 38640) as amended 30 March 2015. Radio Frequency Spectrum Regulations as amended (Annex B) (GG. No. 38641, 30 March 2015). Recommendation ITU-R M.1036 (International Mobile Telecommunications (IMT)) Radio Frequency Spectrum Assignment Plan to be amended to incorporate capabilities and requirements for IMT2020. Final Frequency Migration Plan 2019 (GG No. 42337 Notice 36 of 2019)

Table 1: National Radio Frequency Plan for South Africa for 2300 - 2450 MHz band [9]

[9] National Radio Frequency Plan 2021, (NRFP-21) 8.3 kHz – 3000 GHz, Independent Communications Authority of South Africa

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 approximations 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.452 [10]. For the relevant transmitting terminal, predictions of path loss would be made at *x* km steps along radials of *y* km at *z* degree intervals [11]. 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" [12]. This model is to be employed for 50% 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 taken into consideration. For the relevant base

[10] 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).

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

[12] 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).

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 (also including the border line) and the 6 km line itself inside the neighbouring country may be interfered by higher field strength than the trigger field strength value given for the border line in the main text above at a height of 3 m above ground.
- Only 10% of the number of geographical area pixels between the 6 km (including also the 6 km line) and 12 km line inside the neighbouring country may be interfered with by 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.1546[13] with the Terrain Clearance Angle correction factor TCA, HCM[14] method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812[15, 16]).

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[13] 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).

[14] 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

[15] 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)

[16] 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)

As to correction factors for clutters 'open area' and 'quasi-open area', 20 dB and 15 dB should be used, respectively. Recommendations ITU–R P.1406[17] and/or ITU-R P.2108[18] 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.

[17] 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)

[18] 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/LTE[19]

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 36.211[20] 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;
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).

[19] ECC/REC (11)05

[20] 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.

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:

Country 1	0..83	84..167	168..251	252..335	336..419	420..503
Border 1-2	■	■				■
Zone 1-2-3	■	■				
Border 1-3	■	■	■			
Zone 1-2-4	■					■
Border 1-4	■		■			■
Zone 1-3-4	■		■			

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

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

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

Table 2: 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.

<u>Figure 2:</u> Country type map/PCI distribution map

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

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.

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.

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 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.
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.

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.

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 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 3: 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 [21] and ECC Report 296 [22].

[21] 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.

[22] 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 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 Harmonised Calculation Method for Africa (HCM4A)[23]

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.

[23] Cross-Border Frequency Coordination: Harmonised 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

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

NO. 2891 **20 December 2022**

ICASA

HEREBY ISSUES A NOTICE REGARDING FINAL RADIO FREQUENCY ASSIGNMENT PLANS FOR THE IMT3300 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 3300 MHz to 3400 MHz** in terms regulation 3 of the Radio Frequency Spectrum Regulations 2015 and the International Mobile Telecommunication Roadmap 2019.
2. This Radio Frequency Spectrum Assignment Plan ("RFSAP") supersedes any previous spectrum assignment arrangements for the same spectrum location. However, if it happens that on the date a provision of the RFSAP comes into effect, there is a conflict between the RFSAP and the latest versions of the National Radio Frequency Plan ("NRFP") and Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan will prevail.

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DR CHARLES LEWIS
ACTING CHAIRPERSON

Radio Frequency Spectrum Assignment Plan

Rules for Services operating in the Frequency Band from 3300 MHz to 3400 MHz (IMT3300)

Table of Contents

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 3rd Generation Partnership Project (3GPP), which consists of six telecommunications standard development organisations
“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 the ECC Recommendation (11)04 - Cross-border Coordination for Mobile/Fixed Communications Networks (MFCN) in the frequency band 790-862 MHz, Edition 3 February 2017
“ECC/REC (15)01“	means the 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
“ECC”	means the Electronic Communications Committee (ECC) within the European Conference of Postal and Telecommunications Administrations (CEPT)
“FDD”	means the Frequency Division Duplex
“HCM”	means the Harmonised Calculation Method
“HCM4A	means the Harmonised Calculation Method for Africa
“**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
“IMT3300”	means the IMT in the 3300 MHz band (3300 MHz to 3400 MHz)
“ITA”	means the Invitation to Apply
“ITU”	means the International Telecommunication Union
“ITU-R”	means the International Telecommunication Union Radiocommunication Sector
“LTE”	means the 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 2021 for South Africa
"PCI"	means the Physical-Layer Cell Identities
"PRACH"	means the Physical Random-Access Channel
"PSTN"	means the Public Switched Telephone Network
"PUCCH"	means the Physical Uplink Control Channel
"RFSAP"	means the Radio Frequency Spectrum Assignment Plan
"TCA"	means the Terrain Clearance Angle
"TRP"	means the total radiated power. The TRP is defined as the integral of the power transmitted in different directions over the entire radiation sphere.
"TDD"	means the 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) 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 feasibility study concerning the 3300 MHz to 3400 MHz band is mandated by the Frequency Band Migration Regulation and Plan contained in the IMT Roadmap 2014, and IMT Roadmap 2019, which concluded that the Authority proceeds with an RFSAP for IMT in this band.

2.3 This RFSAP states the requirements for the utilisation of the frequency band between 3300 MHz - 3400 MHz for IMT3300.

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 of the IMT systems 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 equipment used in IMT3300 systems will conform to all applicable South African standards, international standards, including those of the 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 will be certified under South African law and regulations.

3.4 The allocation of this frequency band and the information in this Radio Frequency Spectrum Assignment Plan (RFSAP) are subject to review.

3.5 The IMT3300 band ranges between 3300 MHz to 3400 MHz.

3.6 The IMT 3300 band will be used for IMT TDD.

3.7 The requirements for technologies that can provide IMT3300 services include, but are not limited to:

- IMT-2000;
- IMT-Advanced; and
- IMT-2020.

3.8 Typical technical and operational characteristics of IMT systems as identified by the ITU are described in the following documents [1]:

- 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;
- 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).

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 frequency band 3300-3400 MHz provides a total bandwidth of 100 MHz TDD for IMT3300 service.

4.2 Channel arrangements for the IMT3300 band are according to the Region 1 recommendation by the ITU, as provided in Figure 1.

[1] These and other IMT documents are available at https://www.itu.int/rec/R-REC-M/en

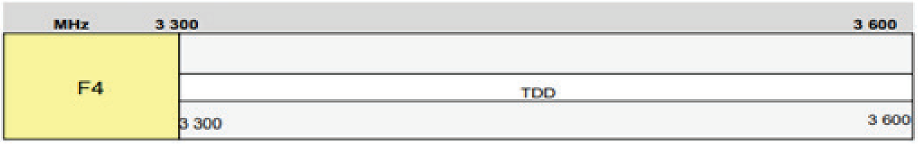

Figure 1: Frequency arrangements, 3300 MHz – 3600 MHz[2]

5 Requirements for the usage of the 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 The use of the IMT3300 band is limited to IMT services.

5.3 Only systems using digital technologies that promote spectral efficiency will be issued with an assignment. Capacity-enhancing digital techniques are being rapidly developed and such techniques that promote efficient spectrum use without reducing service quality. These techniques are encouraged.

5.4 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.

5.5 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.

5.6 Maximum radiated power:

5.6.1 The conservative in-block base station power limit is 68 dBm/ (5 MHz) EIRP.;

5.6.2 The Authority acknowledges the feedback from the consultation that it should include a Total Radiated Power (TRP) limit for AAS base stations into the assignment plans. Stakeholders noted that this inclusion would bring South Africa in line with global industry development, and that if it is not done, the restrictive nature of the regulations will inevitably have a detrimental effect on the quality of service that can be expected from radio networks. TRP specifications are only allowed for and provided for mobile stations;

5.6.3 Mobile Station transmissions should not exceed 23 dBm EIRP;

5.6.4 Mobile Station transmissions should not exceed 25 dBm TRP;

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

[2] Electronic Communications Act: Implementation of the Radio Frequency Migration Plan and of the International Mobile Telecommunications (IMT) Roadmap: Comments invited (www.gov.za) GG 45690, Annex 5

5.6.6 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);

5.6.7 ICNIRP Guideline compliance is required, where applicable; and

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

6 Implementation

6.1 The Feasibility Study[3] conducted for this band stated that the Authority's plan to proceed with the implementation of the RF migration plan for the 3300 MHz to 3400 MHz band proposed to proceed with an RFSAP for IMT in this band:

6.2 This Radio Frequency Assignment Plan comes into effect on the 1st of April 2023.

6.3 The process of assignment may commence prior to the date referred to in section 6.2.

6.4 No new assignments in the band 3300 MHz to 3400 MHz will be approved unless it complies with this RFSAP.

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 is 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[4] , 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".

[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

[4] https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwi81bOFz6P2AhUwQUEAHe1YDIgQFnoECAIQAQ&url=https%3A%2F%2Fextranet.crasa.org%2Fzip-agm.php%3Fid%3D332&usg=AOvVaw1bVAuEnE8a2iJnP20F_b_2

7.3.1 Therefore, coordination would follow the HCM4A as detailed in Sub-Saharan Africa Assessment Report on Harmonisation of ICT Policies in Sub-Saharan Africa[5] (HIPSSA)

7.4 A harmonised calculation method (HCM4A) brings these benefits

7.4.1 Based on HCM Agreement used in Europe

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 sub regions 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 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[6]

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.

7.7 Harmonise parameters: objectively predictable towards transparent decisions

7.8 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 and at the border itself. The coordination distance is continuously being reviewed and these may be updated from time to time.

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

[6] 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

7.9 The following field strength thresholds have to be assured based on ECC/REC (15)01 for the 3400 MHz to 3800 MHz band, here also applied for 3300 MHz to 3400 MHz band, based on the close proximity and similarity of these bands.

Operator-to-operator coordination may be necessary to avoid interference.

7.10 The below follows ECC/REC (15)01:

A) TDD, Synchronised case

Base stations of synchronised TDD systems on both sides of the border line with centre frequencies not aligned for all PCIs or with centre frequencies aligned and for preferential PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by the base station does not exceed the values of 67 dBµV/m/5 MHz at a height of 3 m above ground at the border line between countries and 49 dBµV/m/5 MHz at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.

Base stations of synchronised TDD systems on both sides of the border line with 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 the base station does not exceed the value of 49 dBµV/m/5 MHz at a height of 3 m above ground at the border line between countries.

The following table gives an overview of the trigger values of the field strength at a height of 3 m above ground between synchronised TDD systems:

SYNCHRONISED CASE		
Centre frequencies aligned		**Centre frequencies not aligned**
Preferential PCIs	**Non-preferential PCI**	**All PCIs**
67 dBµV/m/5 MHz @ 0 km, and 49 dBµV/m/5 MHz @ 6 km	49 dBµV/m/5 MHz @ 0 km	67 dBµV/m/5 MHz @ 0 km, and 49 dBµV/m/5 MHz @ 6 km
@ stands for "at a distance inside the neighbouring country".		
Note (1): It should be noted that for NR base station, in case of same PCIs use when centre frequencies are not aligned, the field strength levels for synchronised operation should be further studied. In fact, in NR, if the centre frequencies are not aligned it doesn't imply automatically that SSB blocks are not aligned. In case of LTE centre frequencies alignment is equivalent to synchronisation signals alignment.		
Note (2): However, in case of advanced antenna system (AAS) systems, these thresholds are not sufficient to deploy networks in border areas without further measures to be studied.		

Table 1: Field Strength Trigger Values between Synchronised TDD Systems

B) TDD, Unsynchronised case

1. Base stations of unsynchronised TDD systems on both sides of the border line for all PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by the base station does not exceed a value of 0 dBµV/m/5 MHz at a height of 3 m above ground level at the border line between countries.

If preferential and non-preferential frequency blocks are defined and are distributed between neighbouring countries, the following provisions apply:

2. Base stations of unsynchronised TDD systems on both sides of the border line with preferential frequency blocks and for preferential PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by the base station does not exceed the trigger values of:

- 45 dBμV/m/5 MHz at a height of 3 m above ground at the border line between countries, and
- 27 dBμV/m/5 MHz at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.

3. Base stations of unsynchronised TDD systems on both sides of the border line with preferential frequency blocks and for non-preferential PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by the base station does not exceed the trigger values of 27 dBμV/m/5 MHz at a height of 3 m above ground at the border line between countries.

4. Base stations of unsynchronised TDD systems on both sides of the border line with non-preferential frequency blocks and for all PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by the base station does not exceed the trigger values of 0 dBμV/m/5 MHz at a height of 3 m above ground level at the border line between countries.
The following table gives an overview of the trigger values of the field strength at a height of 3 m above ground for preferential frequency blocks of unsynchronised TDD systems:

UNSYNCHRONISED CASE		
PREFERENTIAL FREQUENCY BLOCKS		**NON-PREFERENTIAL FREQUENCY BLOCKS**
Preferential PCIs	**Non-preferential PCI**	**All PCIs**
45 dBμV/m/5 MHz @ 0 km and 27 dBμV/m/5 MHz @ 6 km	27 dBμV/m/5 MHz @ 0 km	0 dBμV/m/5 MHz @ 0 km
@ stands for "at a distance inside the neighbouring country"		

Table 2: Field Strength Trigger Values between Unsynchronised TDD Systems

For field strength predictions, the calculations should be made according to Appendix B. In the case of channel bandwidth other than 5 MHz, a factor of 10 x $\log_{10}$(channel bandwidth (MHz) [7] /5 MHz), should be added to the field strength levels.

For this band, due to the low field strength level in the unsynchronised case, in order to enable the field strength measurement, a conversion factor of 23 dB from 3 m to 10 m could be applied for a suburban environment.

[7] Not occupied bandwidth

GUIDANCE FOR OPERATORS FOR DEPLOYMENT IN BORDER AREAS

This section lists different techniques as a guidance for operators that can be used to reduce the interference across the border in case of both TDD and FDD systems. In the context of TDD systems, while these techniques decrease the interference, they may not be sufficient to enable unsynchronised operation of TDD networks across the border.

Antenna tilting and restricted beamforming: The downtilt of the base station antennas is adjusted such that there is suppression of all signals towards the horizon, thereby reducing the horizon component of interference to the base stations. In the case of advanced antenna system (AAS) antennas at the base stations, configured elevation-domain codeword subset restriction may also be used to decrease the interference to the base stations across the border.

Downlink power reduction: Another possible solution could be to reduce the downlink power on the base station sectors which are facing the border or located at sites near the border. One of the main advantages of this technique is that there is less interference radiated across the border. Moreover, since the difference between the uplink and downlink transmit powers is smaller, there is reduced UL/DL imbalance in a cell. The direct consequence of this technique is that the downlink to uplink interference becomes less problematic as there is a smaller area with vulnerable user equipment (UE). Also, smaller cells can be deployed closer to the border, providing a stronger uplink. Additionally, the performance degradation due to downlink power reduction can be compensated by link adaptation.

Minimum inter-cell interference scheduling: The selection of start Physical Resource Blocks (PRB) or Resource Block Group (RBG) in the scheduler can be enhanced to reduce the inter-cell interference. This can be accomplished through restricted or randomised distributed PRB scheduling in uplink or RBG scheduling in downlink.

TDD Downlink only scenario should be considered as FDD downlink scenario.

For field strength predictions, the calculations should be made according to Appendix B. In cases of other frequency block sizes $10*\log_{10}$ (frequency block size/5 MHz) should be added to the field strength values.
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.

7.11 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 and ECC/REC (15)01.

7.12 Specific information regarding coordination may be found in Appendix B based on an extract from ECC/REC (11)05 and ECC/REC (15)01.

7.13 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 the schedule of modifications to resolve the dispute. The Authority will be guided by the Frequency Coordination Process as shown in Appendix D.

7.14 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.

8 Assignment

8.1 This spectrum band will be assigned through an Invitation to Apply in line with regulations developed in terms of section 31(3) of the Act.

9 Amendments

9.1 Following the feasibility study consultation[8], which determined that this band should be assigned exclusively for IMT, existing licensees will have their licences amended (or revoked) and be moved to a different destination band.

10 Radio Frequency Migration

10.1 All existing transmissions from 3300 MHz - 3400 MHz band should be cleared.

[8] Government Gazette Number 45690 (Notice 739 **of 2021)**

Appendix A National Radio Frequency Plan

Table 3 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
3 300-3 400 MHz	**3 300-3 400 MHz**		
			See section 5 for coordination with radio astronomy
RADIOLOCATION	RADIOLOCATION	Radio astronomy (CH Molecules)	Recommendation ITU-R M.1036-6
			(International Mobile Telecommunications (IMT))
	MOBILE except aeronautical mobile	IMT Res. 223 (Rev.WRC-15)	Develop a RFSAP for the band
	5.149 5.429A 5.429B		
5.149 5.429 5.429A 5.429B 5.430			

Table 3: National Radio Frequency Plan for South Africa for 3300 MHz to 3400 MHz band[113]

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.452 [9]. For the relevant transmitting terminal, predictions of path loss would be made at *x* km steps along radials of *y* km at *z* degree intervals[10]. 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"[11] . 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.

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[9] 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).

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

[11] 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).

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 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.1546[12] with the Terrain Clearance Angle correction factor TCA, HCM [13] method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812 [14], [15]).

As to correction factors for clutters 'open area' and 'quasi-open area', 20 dB and 15 dB should be used, respectively. Recommendations ITU–R P.1406 [16] and/or ITU-R P.2108 [17] should be used if a finer selection of clutter is required.

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[12] 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)

[13] 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

[14] 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).

[15] 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)

[16] 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).

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

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.

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE[18]

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 36.211[19] 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).

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[18] ECC/REC (11)05

[19] 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:

Country 1	0..83	84..167	168..251	252..335	336..419	420..503
Border 1-2	■	■				■
Zone 1-2-3	■	■				

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

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

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

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

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

Table 4: 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.

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

This section is provided for guidance purposes, for use in bilateral 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.

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 2π/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 sequence 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 sequence 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 [20] and ECC Report 296 [21].

[20] 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.

[21] 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 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 Harmonised Calculation Method for Africa (HCM4A)-[22].

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 [dBs];
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 mutual consent.

[22] Cross-Border Frequency Coordination: Harmonised 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

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