

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

NO. 3999

27 October 2023

**HEREBY ISSUES A NOTICE REGARDING FINAL RADIO FREQUENCY SPECTRUM ASSIGNMENT PLAN 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, 2005 (Act No. 36 of 2005), 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 at which a provision of the RFSAP comes into effect, there is a conflict between this 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 shall prevail.

YOLISA KEDAMA
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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)**

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1 Glossary

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

“3GPP”	means the 3 rd Generation Partnership Project (3GPP), which consists of seven telecommunications standard development organisations;
“Act”	means the Electronic Communications Act, 2005 (Act No. 36 of 2005) as amended;
“CRASA”	means the Communications Regulators’ Association of Southern Africa (CRASA);
“DM RS”	means Demodulation Reference Signal;
“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);
“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-21”	means the National Radio Frequency Plan 2021 for South Africa;
“PCI”	means the Physical-Layer Cell Identities;
“PRACH”	means the Physical Random-Access Channel;

“PUCCH”	means the Physical Uplink Control Channel;
“RFSAP”	means this Radio Frequency Spectrum Assignment Plan;
“TCA”	means the Terrain Clearance Angle;
“TDD”	means the Time Division Duplex.

2 Purpose

- 2.1** A Radio Frequency Spectrum Assignment Plan provides information on the requirements attached to the use of a frequency band in line with the allocation and other information in the latest National Radio Frequency Plan. 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 study¹consultation concerning the 880-915/925-960 MHz band, is mandated by the Radio Frequency Migration Regulations, 2013 and Radio Frequency Migration Plan contained in the IMT Roadmap 2014² and IMT Roadmap 2019³, which concluded that the Authority proceeds with a 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 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; and
 - 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.

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

² Final (Draft) IMT Roadmap 2014, Government Gazette Vol. 593, 14 November 2014 No. 3821.

³ Final (Draft) IMT Roadmap 2019, Government Gazette Vol. 645, 29 March 2019 No. 42361 and the 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 (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 in the bands identified for IMT in the Radio Regulations; 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 range⁵



Figure 1: Frequency arrangements in the 880-960 MHz frequency range⁶

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-21 and an extract of the NRFP-21.
- 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)).

⁶ Ibid.

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 findings⁷ conducted for this band stated that the Authority should proceed with the RFSAP to achieve the following assignment plan for the band:

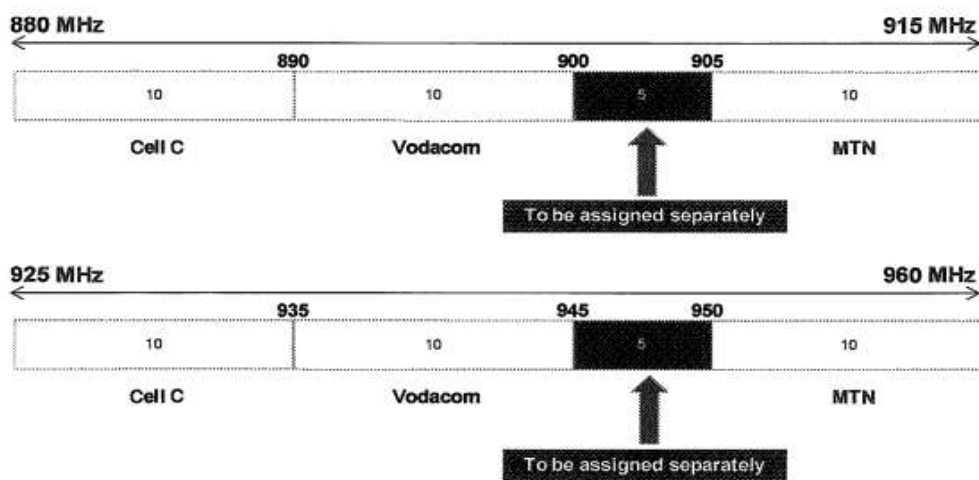


Figure 2: Required assignments for 900 MHz band.

6.2 The RFSAP 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) below.

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 HCM4A Agreement.

7.2 The ECC had noted the need for greater understanding of the concept and need for harmonisation in the signing of the HCM4A Agreement by SADC Member States if the implementation of the Agreement was to be effective. The ECC, therefore, agreed to convene a workshop on HCM4A

⁷Draft 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.

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, the subject of Cross Border Frequency Coordination using the HCM4A was discussed in detail, following similar efforts in Europe⁸. 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 HIPSSA⁹.
- 7.4** A harmonised calculation method (HCM4A¹⁰) 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 four (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 four (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];
- 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 the coordination of the spectrum resources in Sub-Saharan Africa in order to:¹¹

⁸https://www.itu.int/ITU-D/projects/ITU_EC_ACP/hipssa/docs/itu-j-f_le_bihan-presentation_general_du_projet-en.pdf

⁹https://www.itu.int/en/ITU-D/Projects/ITU-EC-ACP/HIPSSA/Documents/FINAL%20DOCUMENTS/FINAL%20DOCS%20ENGLISH/hcm4a_agreement.pdf.pdf

¹⁰https://www.itu.int/en/ITU-D/Projects/ITU-EC-ACP/HIPSSA/Documents/FINAL_DOCUMENTS/FINAL_DOCS_ENGLISH/hcm4a_agreement.pdf.pdf

¹¹ 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>

- 7.6.1** 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)0212 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 dB μ V/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 dB μ V/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 dB μ V/m/5 MHz at the border (0 km) and 41 dB μ V/m/5 MHz¹³ at 6 km from the border line inside the neighbouring country for preferential PCI codes (discussed in Appendix 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 dB μ V/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 are the same as for the LTE-to-LTE coordination case. For unsynchronised TDD, the trigger field strength level is 24 dB μ V/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 $10 \times \log_{10}$ (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 ¹⁴)	Field strength level at 3 m height (LTE case)
5 MHz	55.0 dB μ V/m/5 MHz @0km	59.0 dB μ V/m/5 MHz @0km
	29.0 dB μ V/m/5 MHz @9km	41.0 dB μ V/m/5 MHz @6km
10 MHz	58.0 dB μ V/m/10 MHz @0km	62.0 dB μ V/m/10 MHz @0km
	32.0 dB μ V/m/10 MHz @9km	44.0 dB μ V/m/10 MHz @6km

¹² 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

¹³ The trigger value of value of 35 dB μ V/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 dB μ V/m/5 MHz at 6 km from the border line used in ECC/REC(11)04, as $20 \times \log_{10}(900 \text{ MHz} / 700 \text{ MHz}) + 20 \times \log_{10}(9 \text{ km} / 6 \text{ km}) \approx 6 \text{ dB} = 41 \text{ dB}\mu\text{V/m/5 MHz} - 35 \text{ dB}\mu\text{V/m/5 MHz}$.

¹⁴ As based on the original release of ECC/REC (11)04 (not the latest one).

15 MHz	59.8 dB μ V/m/15 MHz @0km	63.8 dB μ V/m/15 MHz @0km
	33.8 dB μ V/m/15 MHz @9km	45.8 dB μ V/m/15 MHz @6km
20 MHz	61.0 dB μ V/m/20 MHz @0km	65.0 dB μ V/m/20 MHz @0km
	35.0 dB μ V/m/20 MHz @9km	47.0 dB μ V/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)04¹⁵, 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 dB μ V/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 is 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 outlined 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 (introduce diffraction loss), site selection, and/or power control to facilitate the coordination of systems.

8 Assignment

This spectrum band will be assigned through inter-band migration of a licensee, from the frequency band 825 MHz to 830 MHz and 870 MHz to 875 MHz, to a new assignment in the frequency block 900 - 905 / 945 - 950 MHz, in terms of Regulation 9 of the Radio Frequency Spectrum Regulations, 2015, read with Regulation 6 of the Radio Frequency Migration Regulations, 2013.

9 Amendments

The original deadline for the in-band migration process for the assignments within the IMT900 band was set for 31st March 2020¹⁶ at the latest. This milestone was not achieved, and the target for the in-band Migration is now set forth to 31 March 2024. The Authority will amend the existing Radio

¹⁵ 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.

¹⁶ Government Gazette 38640 (Notice 275 of 2015), since repealed.

Frequency Spectrum Licences in terms of regulation 6 of the Radio Frequency Migration Regulations¹⁷ upon publication of this RFSAP.

10 Radio Frequency Migration

10.1 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 resolved that the in-band Migration shall be finalised by 31 March 2024.

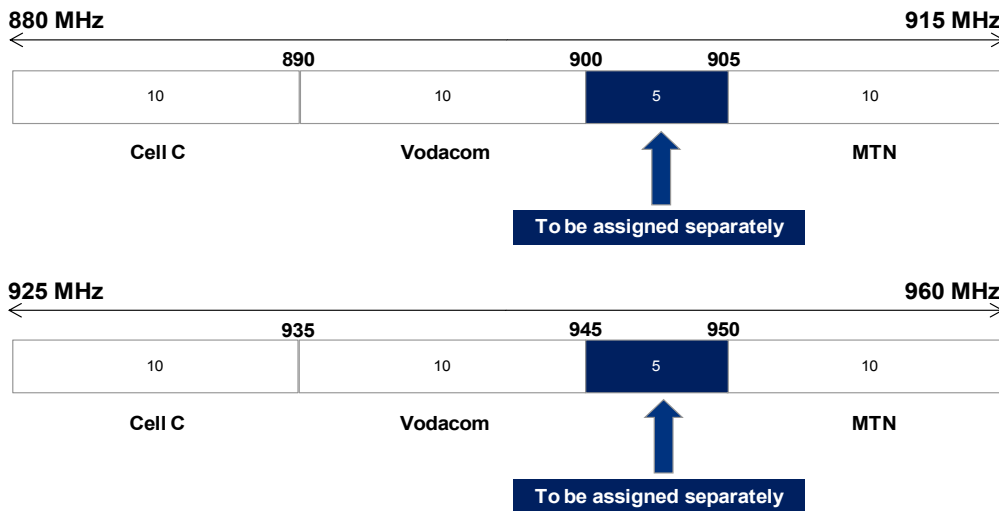


Figure 3: Assignments from 1st April 2023

11 Repeals

11.1 Notice regarding the Final Radio Frequency Spectrum Assignment Plan for the frequency band 880 MHz to 915 MHz and 925 MHz to 960 MHz (published in Government Gazette No. 47788), on 20 December 2022 is hereby repealed.

¹⁷ Government Gazette 42337 (Notice 166 of 2019).

Appendix A: National Radio Frequency Plan, 2021

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

Table 3: National Radio Frequency Plan for South Africa for 880-960 MHz band¹⁸

¹⁸ 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 intervals¹⁹. 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”²⁰. 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.

¹⁹ Values for x , y , z , and path specific field strength levels are to be agreed between the administrations concerned.

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>).

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.1546²¹ with the terrain clearance angle correction factor TCA, HCM²² method with the terrain clearance angle correction factor or Recommendation ITU–R P.1812^{[23], [24]}).

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^[25] and/or ITU-R P.2108^[26] should be used if a finer selection of clutter is required.

²¹ 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>).

²² 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.

²³ 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>).

²⁴ 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>).

²⁵ 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>).

²⁶ 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/LTE²⁷

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 36.211²⁸ 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).

²⁷ ECC/REC (11)05.

²⁸ 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.

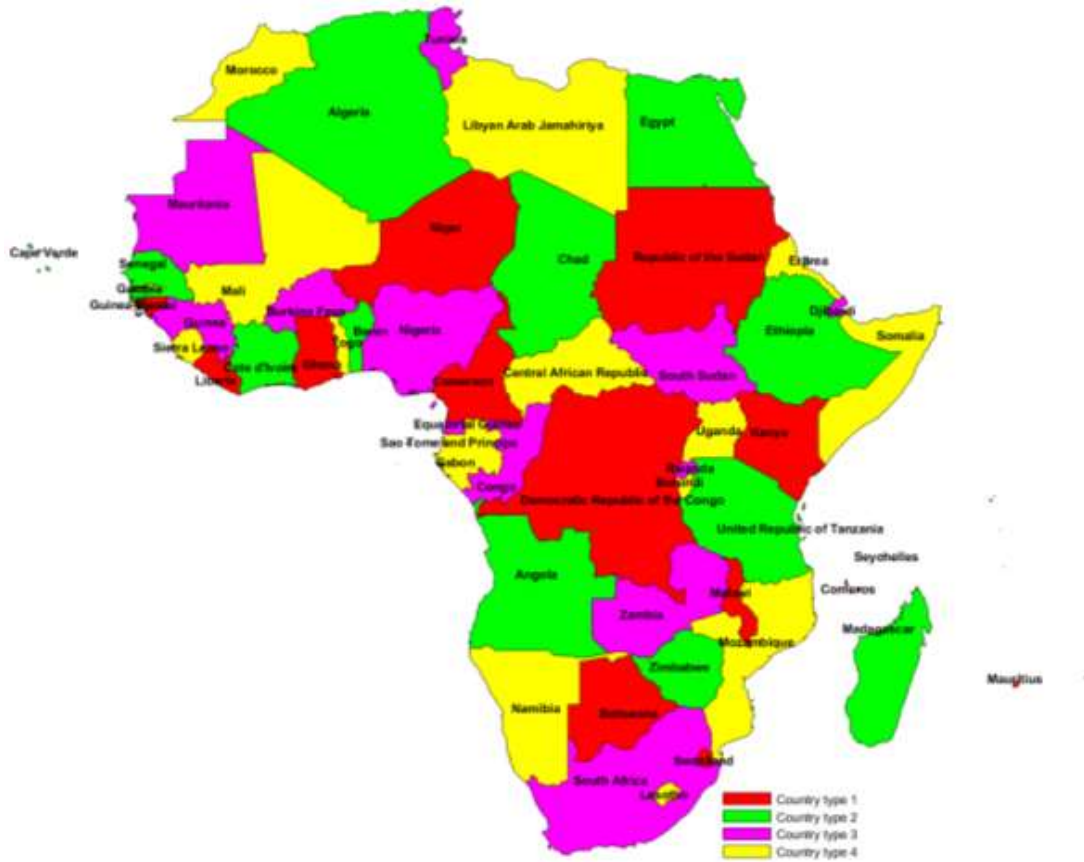


Figure 4: Country type map/PCI distribution map

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:

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

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

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

Table 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 MULTILATERAL 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 36.211²⁹ 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 $2\pi/3$, which provides cluster size 30 with only 10 DM RS sequence groups. The latter case corresponds well to the case of DM RS sequence group repartition between neighbouring countries when only a limited number of groups 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

²⁹ <https://portal.3gpp.org/ngppapp/DownloadTDoc.aspx?contributionUId=R1-1613067>.

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 $\{0\dots 16\}$, 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-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 $\{0\dots 837\}$. 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 repartition, 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)01³⁰ and ECC Report 296³¹. The text above is based on these.

³⁰ 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.

³¹ 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).³²

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 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.

³² 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