Radio Frequency Spectrum Assignment Plan

Rules for Services operating in the Frequency Band

1900 MHz to 1920 MHz

1 Glossary of Terms, Abbreviations, and Acronyms

1.1 In this Radio Frequency Spectrum Assignment Plan, terms used will have the same meaning as in the Electronic Communications Act 36 of 2005; unless the context indicates otherwise. The definitions and acronyms for additional terms are listed below:

“3GPP”	means the 3rd Generation Partnership Project (3GPP) which consists of six telecommunications standard development organisations
“AAS”	means Active Antenna System
“Act”	means the Electronic Communications Act, 2005 (Act No. 36 of 2005) as amended
“AGM”	means Annual General Meeting
“AU”	means African Union
“BEM”	means Block Edge Masks
“BS”	means Base Stations
“CRASA”	means Communications Regulators’ Association of Southern Africa
“CRASA ECC”	means the Communications Regulators’ Association of Southern Africa (CRASA) Electronic Communications Committee (ECC)
“DM RS”	means Demodulation Reference Signal
“ECC”	means the Electronic Communications Committee within the European Conference of Postal and Telecommunications Administrations (CEPT)
“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
“EIRP”	means Effective Isotropic Radiated Power
“ESN”	means Emergency Service Network
“FDD”	means the Frequency Division Duplex
“FRMCS”	means Future Railway Mobile Communication System
“HCM”	means the Harmonised Calculation Method
“HCM4A”	means the Harmonised Calculation Method for Africa
“HDA"	means High-Density Area
“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
“IMT-2020”	means International Mobile Telecommunications-2020
“IMT Advanced”	means International Mobile Telecommunications-Advanced
“ITA”	means the Invitation to Apply
“ITU”	means the International Telecommunication Union
“ITU-R”	means the International Telecommunication Union Radiocommunication Sector
“LPI”	means Low Power Indoor
“LoS”	means Line of Sight
“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

"Non-AAS"	means Non-Active Antenna System
"NR"	means New Radio
"NRFP"	means the National Radio Frequency Plan 2013 for South Africa
"PCI"	means the Physical-Layer Cell Identities
"PFD"	means Power Flux Density
"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
"PUSCH"	means the Physical Uplink Shared Channel
"RAS"	means Radio Astronomy Service
"RFSAP"	means the Radio Frequency Spectrum Assignment Plan
"RR"	means Radio Regulations
"SADC"	means Southern African Development Community
"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
"UE"	means User Equipment
"VLP"	means Very Low Power
"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
"WRC-23"	means the World Radiocommunication Conference 2023 held in Dubai

2 Purpose

2.1 An 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 1900 MHz to 1920 MHz for 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:[11]

- 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 IMT systems will conform to all applicable South African standards, international standards, and ITU (including 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 allocations of the IMT bands and the information in this RFSAP are subject to review.

3.5 Frequency bands identified for IMT include the bands 1900 MHz to 1920 MHz.

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

- IMT-2000;
- IMT-Advanced;
- IMT-2020;

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[11] See ITU-R Frequently Asked Questions on IMT, available at: https://www.itu.int/en/ITU-R/Documents/FAQ-IMT-2024.pdf#:~:text=Key%20features%20of%20IMT%2D2000%20and,in%20a%20cost%20efficient%20manner%3B

- IMT-2030.

3.7 Typical technical and operational characteristics 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 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: Frequency arrangements for implementation of the terrestrial component of IMT in the bands identified for IMT in the RR;
- Recommendation ITU-R M.2150-1 (02/2022): Detailed specifications of the terrestrial radio interfaces of IMT-2020; and
- Recommendation ITU-R M.2160-0 (11/2023): Framework and overall objectives of the future development of IMT for 2030 and beyond.

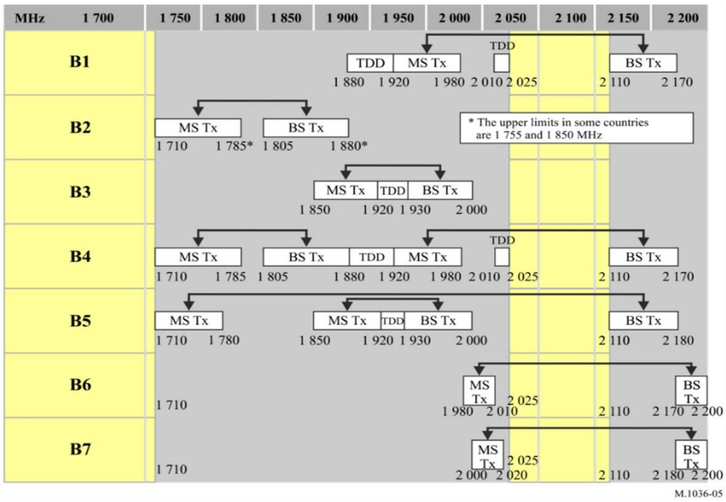
3.8 The ITU also provides guidelines for modelling and simulation, e.g.

- 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 arrangements for implementation of IMT in the 1 900 – 1 920 MHz frequency range are summarized in Figure 2 below, noting the implementation aspects in this RFSAP. Band plan 4 (“B4”) is applicable to South Africa.

Figure 2: Frequency arrangements for B1 to B7



Source: ITU M.1036-05

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 Band 4 (B4) spectrum on Figure 2 is limited to IMT services. The use of the range 1900-1910MHz for railway communications is mentioned in column 3 (typical applications).

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 these bands are found in the NRFP.

5.6 Maximum radiated power:

5.6.1 Maximum transmit power levels for base stations (“BS”) operating include:[12]

5.6.1.1 AAS base stations: The maximum power limit is specified as TRP of 60 dBm per cell (per 5 MHz block).

5.6.1.2 Non-AAS base stations: The maximum power limit for macro base stations is an in-block EIRP limit of 61 dBm per 5 MHz block.

5.6.2 UE: The ECC recommends that the in-block TRP for mobile UEs does not exceed 28 dBm;

[12] See, in this regard: ECC Decision (06)01; ECC Report 298; CEPT Report 67.

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

5.6.4 The Authority may specify BEM if necessary.

5.7 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 NR;

5.8 ICNIRP Guideline compliance is required, where applicable; and

5.9 The criteria and guidelines for interference mitigation are described in Appendices B and D.

6 Commencement

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

6.2 No new assignment for IMT in the band 1900 MHz – 1920 MHz will be approved unless it complies with this RFSAP.

7 Conflict

7.1 In the event of a conflict between this RFSAP and the applicable NRFP and/or Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan shall prevail.

8 Coordination Requirements

8.1 Cross Border Frequency Coordination will abide by the HCM4A Agreement. This follows the 3rd CRASA AGM that agreed that CRASA should implement the Cross Border Frequency Coordination HCM4A Agreement.

8.2 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.

8.3 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 HCM4A, to do so as soon as possible".

8.4 Therefore, coordination would follow the HCM4A as detailed in Sub-Saharan Africa Assessment Report on HIPSSA.[13]

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

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

8.5.1 Based on HCM Agreement used in Europe;

8.5.2 Optimise spectrum usage;

8.5.3 Prevent harmful interferences;

8.5.4 Confer an adequate protection for stations;

8.5.5 Define technical provisions and administrative procedures;

8.5.6 Quick assignment of preferential frequencies;

8.5.7 Transparent decisions through agreed assessment procedures;

8.5.8 Quick assessment of interference through data exchange.

8.6 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:

8.6.1 Central Africa [Burundi, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Sao Tome, and Principe];

8.6.2 East Africa [Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Mauritius, Rwanda, Seychelles, Somalia, Sudan, Tanzania, Uganda];

8.6.3 Southern Africa [Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Eswatini, Zambia, Zimbabwe];

8.6.4 West Africa [Benin, Burkina-Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Sierra Leone, Senegal, Togo].

8.7 HCM4A also comes with a software tool for Sub-Saharan Africa. This has the following features:[14]

8.7.1 Optimise spectrum usage by accurate interference field strength calculations;

8.7.2 Establish general parameters, improvement, and supplementation of technical provisions, individual restrictions;

8.7.3 Establish models for computer-aided interference range calculations; and

8.7.4 Harmonise parameters: objectively predictable towards transparent decisions.

8.8 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.

8.9 The below field strength thresholds have to be assured based on based on ECC/REC (08)02 in respect of the IMT1800 band, ECC/REC 01)01 for the IMT2100 band, and ECC/REC (23)01 for

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[14] See: https://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/Documents/Events/2017/May%20BKK/Presentations/HCM%20and%20HCM4A%20BKK%2020170504%20IB.pdf

the 1900-1910MHz band, applied over the range 1880-1920MHz range in South Africa. Operator-to-operator coordination may be necessary to avoid interference.

8.10 In general stations of FDD systems may be used without coordination with a neighbouring country if the mean field strength produced of each carrier produced by the base station does not exceed the value of:

8.10.1 In respect of IMT1800:

8.10.1.1 If preferential codes are used: 65 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 47 dBµV/m/5 MHz at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.

8.10.1.2 If non-preferential codes are used with centre frequencies aligned: 47 dBµV/m/5MHz at a height of 3 m above ground at the borderline between neighbouring countries.

8.10.2 In respect of IMT2100:

8.10.2.1 If preferential codes are used: 65 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 37 dBµV/m/5 MHz at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.

8.10.2.2 Using non-preferential codes with centre frequencies aligned: 37 dBµV/m/5MHz at a height of 3 m above ground at and beyond the border line between countries.

8.10.2.3 Preferential use: For some cross-border situations, together with code coordination, it may be possible to agree on a frequency coordination based on preferential frequencies, while ensuring a fair treatment of different operators within a country. This could be implemented in the case when FDD mode in MFCN systems is used in following manner:

8.10.2.3.1 Preferential frequencies (or preferential frequency bands) shall be agreed between Administrations concerned.

8.10.2.3.2 Preferential frequencies may be used without coordination with a neighbouring country if the predicted mean field strength of each carrier produced by the base station does not exceed a value of 75 dBµV/m/5 MHz at a height of 3 m above ground at and beyond the border line between countries

8.10.2.3.3 Non-preferential frequencies may be used without coordination with a neighbouring country if the predicted mean field strength of each carrier produced by the base station does not exceed a value of 65 dBµV/m/5MHz at a height of 3 m above ground at the borderline between countries and 37 dBµV/m/5MHz at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.

8.10.2.3.4 Systems operating on non-preferential frequencies have to accept interference from services in the neighbouring country using preferential frequencies.

8.11 In general stations of TDD systems in the band 1900-1920MHz may be used without coordination with a neighbouring country:

8.11.1 Base stations of unsynchronised TDD networks (e.g. with non-compatible frame structures and/or without common phase clock reference) on both sides of the borderline do not exceed the limit of: 0 dBµV/m/(5 MHz) at a height of 3 m above ground at the borderline between countries.

8.11.2 Base stations of synchronised TDD networks on both sides of the borderline with synchronisation signal centre frequencies not aligned for all PCIs or with synchronisation signal[15] centre frequencies aligned and for preferential PCIs may be used without coordination with a neighbouring country if the field strength of each cell produced by the base station does not exceed the values of:

8.11.2.1 65 dBμV/m/(5 MHz) at a height of 3 m above ground at the borderline between countries;

8.11.2.2 47 dBμV/m/(5 MHz) at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.

8.11.3 Base stations of synchronised TDD networks on both sides of the borderline with synchronisation signal centre frequencies aligned and for non-preferential PCIs may be used without coordination with a neighbouring country if the field strength of each cell produced by the base station does not exceed the value of: 47 dBμV/m/(5 MHz) at a height of 3 m above ground at the borderline between countries.

8.12 For field strength predictions the calculations should be made according to Appendix A. In cases of other frequency block sizes 10*log10 (frequency block size / 5 MHz) should be added to the field strength values.

8.13 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.

8.14 Technical analysis may be conducted by the Authority before an assignment is issued according to Appendix A.

8.15 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 C.

8.16 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.

9 Assignment

9.1 The unassigned spectrum in this band will be assigned through a Section 5 process for FRMCS and ESN.

10 Amendments

[15] In this context, “synchronisation signals” refer to the Synchronisation Signal Block (SSB) for NR and Primary/Secondary Synchronisation Signal (PSS/SSS) for LTE as defined in relevant standards, and should not be confused with the general principle of synchronised/unsynchronised operation that is a different concept.

10.1 Applicable licences are hereby amended to conform with this RFSAP upon publication of this notice.

11 Radio Frequency Migration

11.1 Licensees in the band 1900-1920MHz are to migrate out of this band within 24 months.

12 Synchronisation

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

12.2 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.

13 Appendix A: Propagation Model

13.1 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.

A. Path specific model

13.2 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.[16] 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.[17] 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.

B. Site General model

13.3 If it is not desirable to utilise detailed terrain height data for propagation modelling in the border area, the basic model to be used to trigger coordination between administrations and to decide if

[16] 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).

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

coordination is necessary, is ITU-R Rec. P.1546, "Method for point to area predictions for terrestrial services in the frequency range 30 to 4000 MHz".

13.4 This model is to be employed for 50% locations, 10% time and using a receiver height of 3m. 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.

13.5 Administrations and/or operators concerned may apply to the Authority to deviate from the aforementioned model.

C. Area calculations

13.6 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.

13.7 For evaluation:

13.7.1 Only 10% of the number of the geographical area 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:

13.7.2 Only 10% of the number of the geographical area 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;

13.8 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.

13.9 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.

13.10 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.

13.11 For area type interference calculations, propagation models with path specific terrain correction factors are recommended (e.g., the latest Recommendation ITU–R P.1546[18] with the Terrain

[18] 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).

Clearance Angle correction factor TCA, HCM[19] method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812[20]).

13.12 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[21] and/or ITU-R P.2108[22] should be used if a finer selection of clutter is required.

13.13 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.

14 Appendix B: Coordination for IMT-Systems

A. PREFERENTIAL PCI FOR IMT SYSTEMS

14.1 The following is extracted from the abovementioned ECC recommendations as an operational example and can be adapted for the SADC countries for IMT systems.

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

14.3 3GPP TS 36.211[23] defines 168 "unique physical-layer cell-identity groups" in §6.11, numbered 0...167, hereafter called "PCI groups" for IMT systems. Within each PCI group, there are three separate PCIs giving 504 PCIs in total.

14.4 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

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[19] 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

[20] 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).

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).

[21] 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).

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

[23] 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.

distance between “close to the border” and “away from the border” should be agreed between neighbouring countries.

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

14.6 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.

14.7 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:

14.7.1 Country type 1: Botswana, Cameroon, Comoros, Democratic Republic of the Congo, Ghana, Guinea- Bissau, Kenya, Liberia, Malawi, Mauritius, Niger, Republic of the Sudan, Eswatini;

14.7.2 Country type 2: Algeria, Angola, Benin, Cape Verde, Chad, Cote d'Ivoire, Egypt, Ethiopia, Madagascar, Senegal, United Republic of Tanzania, Zimbabwe;

14.7.3 Country type 3: Burkina Faso, Congo, Djibouti, Equatorial Guinea, Guinea, Mauritania, Nigeria, Rwanda, Sao Tome and Principe, Seychelles, South Africa, South Sudan, Tunisia, Zambia;

14.7.4 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).

14.8 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	

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

Table 2: Sharing of PCIs between countries

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

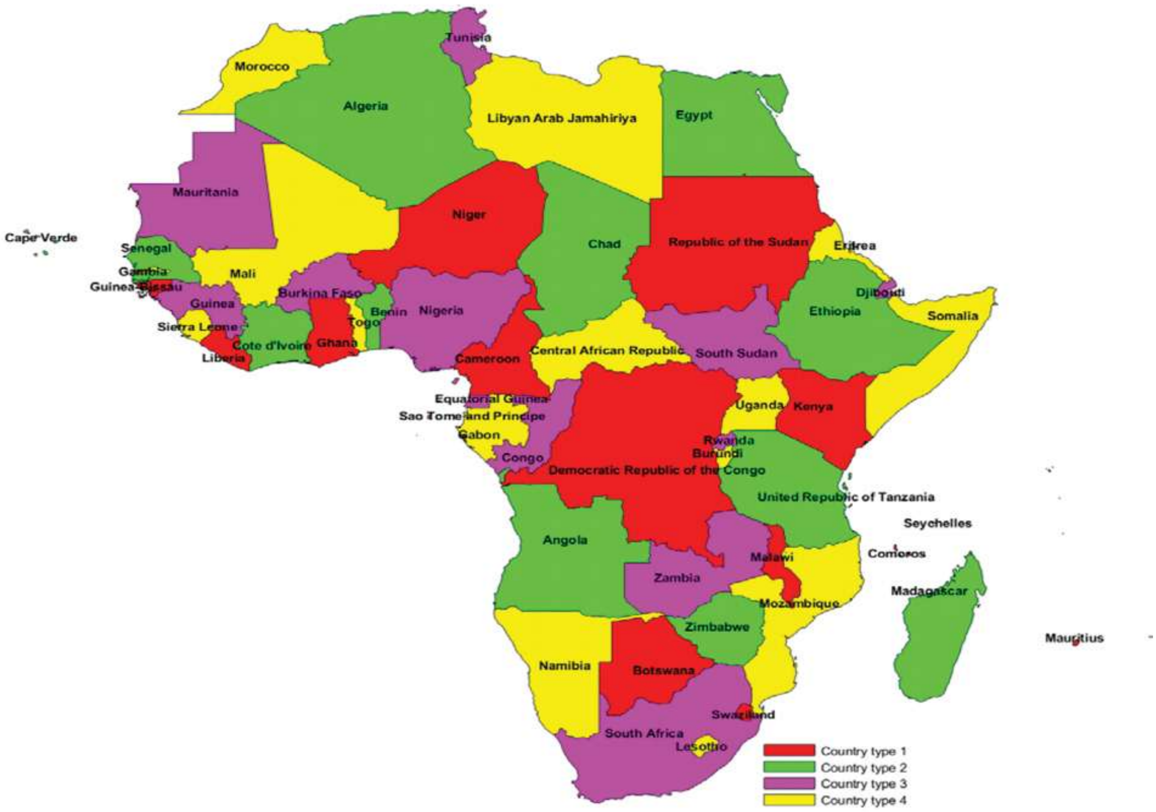
PCI	**Set A**	**Set B**	**Set C**	**Set D**	**Set E**	**Set F**
Country 4	0..83	84.. 167	168.. 251	252.. 335	336.. 419	420.. 503
Border 4-1						
Zone 4-1-2						
Border 4-2						
Zone 4-2-3						
Border 4-3						
Zone 4-3-1						

14.10 Note:

14.10.1 All PCIs are available in areas away from the border.

14.10.2 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 3: Country type map/PCI distribution map



15 Appendix C: Guidance on the consideration of IMT system radio parameters for use in bilateral and multilateral agreements

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

15.2 The parameters described in this section are usually optimised during IMT system 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 IMT system 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.

A. DM RS coordination

15.3 DM RS are transmitted in the uplink and used for channel estimation.

15.4 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.

15.5 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.

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

15.6.1 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.

15.6.2 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.

15.6.3 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.

15.6.4 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 or planning purposes. It should be noted the pseudo-random group hopping option could be absent in the first generations of IMT system equipment.

15.7 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.

B. PRACH coordination

15.8 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.

15.9 PRACH resources are allocated by specifying the PRACH Resource Blocks time positions within the uplink frame, their frequency position within the IMT system channel bandwidth and by apportioning cell- specific root sequences. During radio network planning, these parameters are usually used in the following way:

15.9.1 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;

15.9.2 Frequency positions within the IMT system channel bandwidth are usually the same for all cells, again because PRACH-to-PRACH interference case is a more favourable one.

15.9.3 Cell-specific root sequences are used to distinguish between PRACH requests addressed to different cells.

15.10 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 IMT systems to use only 6 Resource Blocks or 1.08 MHz of the IMT system 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.

15.11 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.

15.12 In an early implementation, it is possible that a very limited number of frequency positions could be supported by IMT system 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.

15.13 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.

15.14 The table showing such interdependency is presented below:

Table 3: PRACH – Range Interdependency

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

PRACH Configuration	Number of root seq. per cell	Cell Range (km)
13	13	22.7
14	22	38.7
15	32	58.7
0	64	118.8

15.15 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.

15.16 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.

15.17 Additional guidance for cross-border coordination of synchronised and unsynchronised IMT TDD systems may be found in ECC/REC/ (15)01[24] and ECC Report 296[25].

16 Appendix D: Frequency coordination process

16.1 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 HCM4A.[26]

16.2 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:

16.2.1 carrier frequency [MHz];

16.2.2 name of transmitter station;

16.2.3 country of location of transmitter station;

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

[25] 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.

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

16.2.4 geographical coordinates [latitude, longitude];

16.2.5 effective antenna height [m];

16.2.6 antenna polarisation;

16.2.7 antenna azimuth [degrees];

16.2.8 antenna gain [dBi];

16.2.9 effective radiated power [dBW];

16.2.10 expected coverage zone or radius [km];

16.2.11 date of entry into service [month, year].

16.2.12 code group number used; and

16.2.13 antenna tilt [degrees].

16.3 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.

16.4 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.

16.5 The periods mentioned above may be extended by common consent.