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GENERAL NOTICES

NOTICE 270 OF 2015

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

PURSUANT TO SECTION 4 (1) OF THE ELECTRONIC COMMUNICATIONS ACT 2005, (ACT NO. 36 OF 2005)

HEREBY ISSUES A NOTICE REGARDING THE FINAL RADIO FREQUENCY SPECTRUM ASSIGNMENT PLAN FOR THE FREQUENCY BAND 450 TO 470 MHz.

1. The Independent Communications Authority of South Africa ("the Authority"), hereby publishes **Final Radio Frequency Spectrum Assignment Plan for the frequency band 450 to 470 MHz** terms of sections 2 (d), (e) and 4, read with sections 30, 31(4), and 33 of the Electronic Communications Act (Act No. 36 of 2005) and read with Regulation 3 of the Radio Frequency Spectrum Regulations 2011 and read with the IMT Roadmap 2014.

2. This Radio Frequency Spectrum Assignment Plan (RFSAP) supersedes any previous spectrum assignment arrangements for the same spectrum location. However, if it happens that on the date a provision of the RFSAP comes into effect, there is a conflict between the RFSAP and the latest versions of the National Radio Frequency Plan (NRFP) and Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan will prevail.

Dr SS MNCUBE
CHAIRPERSON

Final

Radio Frequency Spectrum Assignment Plan

Rules for Services operating in the Frequency Band 450 to 470 MHz (IMT450)

Table of Contents

1 Glossary

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

"3GPP"	means the 3rd Generation Partnership Project (3GPP) which consists of six telecommunications standard development organisations
"Act"	means the Electronic Communications Act, 2005 (Act No. 36 of 2005) as amended
"DM RS"	means Demodulation Reference Signal
"ECC/REC(11)04"	means ECC Recommendation (11)04
"ECC"	means Electronic Communications Committee within the European Conference of Postal and Telecommunications Administrations (CEPT)
"FDD"	means Frequency Division Duplex
"HCM"	means Harmonised Calculation Method
"ICNIRP"	Means International Commission on Non-Ionizing Radiation Protection (ICNIRP)
"IMT"	means International Mobile Telecommunications
"IMT450"	means IMT in the 450MHz band
"ITA"	means Invitation to Apply
"ITU"	means the International Telecommunication Union
"ITU-R"	means the International Telecommunication Union Radiocommunication Sector
"LTE"	means Long Term Evolution is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies
"NRFP"	means the National Radio Frequency Plan 2013 for South Africa
"PCI"	means Physical-Layer Cell Identities
"PPDR"	means Public Protection and Disaster Relief as defined in ITU-R Report M.2033.
"PRACH"	means Physical Random Access Channel
"PSTN"	means Public Switched Telephone Network
"PUCCH"	means Physical Uplink Control Channel

"RFSAP"	means Radio Frequency Spectrum Assignment Plan
"TCA"	means Terrain Clearance Angle
"TDD"	means Time Division Duplex
"WRC-12"	means World Radiocommunication Conference 2012 held in Geneva
"WRC-15"	means World Radiocommunication Conference planned to be held in 2015 in Geneva

2 Purpose

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

2.2 This Frequency Assignment Plan states the requirements for the utilisation of the frequency band between 450 MHz and 470 MHz for IMT450 in South Africa.

2.3 The ITU states that International Mobile Telecommunications (IMT) systems are mobile systems that provide access to a wide range of telecommunication services including advanced mobile services, supported by mobile and fixed networks, which are increasingly packet-based.

Key features are:

- a high degree of commonality of functionality worldwide whilst retaining the flexibility to support a wide range of services and applications in a cost efficient manner;
- compatibility of services within IMT and with fixed networks;
- capability of interworking with other radio access systems;
- high quality mobile services;
- user equipment suitable for worldwide use;
- user-friendly applications, services and equipment;
- worldwide roaming capability; and
- enhanced peak data rates to support advanced services and applications

3 General

3.1 Technical characteristics of equipment used in IMT450 systems must conform to all applicable South African standards, international standards, International

Telecommunications Union (ITU) and its radio regulations as agreed and adopted by South Africa.

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

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

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

3.5 Frequency bands assigned for IMT450 include bands 450 – 470MHz.

3.6 Likely use of this band will be for rural mobile broadband, PPDR or M2M communications nationwide.

3.7 The technologies which can provide IMT450 services include, but are not limited to:

- LTE;
- LTE Advanced;
- HSPA+; and
- WiMAX.

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

- Recommendation ITU-R M.2012-1 (02/2014): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT Advanced);
- Report ITU-R M.2110: Sharing studies between Radiocommunication services and IMT systems operating in the 450-470 MHz band;
- Recommendation ITU-R M.1645 Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000; and
- Recommendation ITU-R M.1036-4: Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations (RR).

4 Channelling Plan

4.1 The frequency band 450 – 470 MHz provides a total bandwidth of 2×5MHz FDD or 15MHz TDD for IMT450.

4.2 Channel arrangements.

4.3 The channel arrangements under consideration are based on the Recommendation ITU-R M.1036-4.

Frequency arrange-ments	Paired arrangements				Unpaired arrangements (e.g. for TDD) (MHz)
	Mobile station transmitter (MHz)	Centre gap (MHz)	Base station transmitter (MHz)	Duplex separation (MHz)	
D1	450.000-454.800	5.2	460.000-464.800	10	None
D2	451.325-455.725	5.6	461.325-465.725	10	None
D3	452.000-456.475	5.525	462.000-466.475	10	None
D4	452.500-457.475	5.025	462.500-467.475	10	None
D5	453.000-457.500	5.5	463.000-467.500	10	None
D6	455.250-459.975	5.275	465.250-469.975	10	None
D7	450.000-457.500	5.0	462.500-470.000	12.5	None
D8					450-470 TDD
D9	450.000-455.000	10.0	465.000-470.000	15	457.500-462.500 TDD
D10	451.000-458.000	3.0	461.000-468.000	10	None

Table 1: Channel arrangements for IMT450 (Source: ITU)

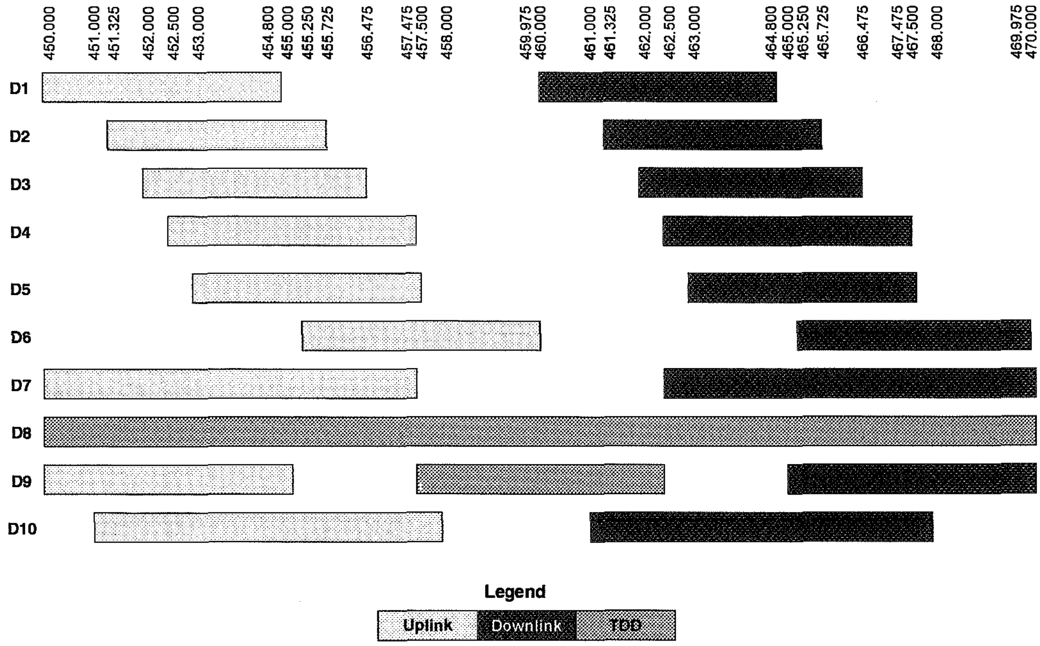

Figure 1: Channel arrangements for IMT450 *(Source ITU)*

For South Africa, the channel arrangements will be one of either D2, D3, D4 or D5. These options are applicable due to the need to maintain a guardband of 2.5 MHz to broadcast channel 21 and 1 MHz guardband to narrowband systems.

The channel arrangements as applicable to South Africa are depicted below, including the potential assignment to Transnet in cases of co-existence.

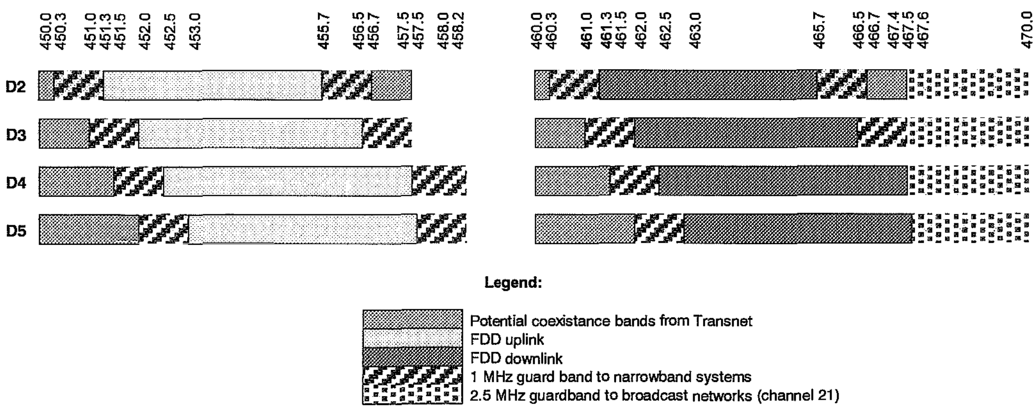

Figure 2: Channel options for South Africa

5 Requirements for usage of radio frequency spectrum

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

5.2 The use of the band is limited for IMT-services; narrowband services capable of coexistence with IMT may also be permitted. PPDR-supporting or M2M services might be implemented via IMT.

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

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

5.5 The allocation of spectrum and shared services within these bands are found in the National Radio Frequency Plan (NRFP) and an extract of NRFP is shown in Appendix A.

5.6 Maximum radiated power:

5.6.1 Base Station transmissions should not exceed 61dBm/5MHz EIRP;

5.6.2 Mobile Station transmissions should not exceed 23dBm EIRP;

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

5.6.4 Where appropriate, subscriber terminal stations should comply with the technical specification outlined under "3GPP TS 36.521-1" or the latest version.

5.7 ICNIRP compliance is encouraged, where applicable.

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

6 Implementation

6.1 This Radio Frequency Assignment Plan comes into effect on the 1st April 2018 except for the provisions in paragraph 6.2. which apply from the date of publication.

6.2 No new assignments in the band 450 – 470MHz will be approved unless they comply with this RFSAP.

7 Coordination Requirements

7.1 Use of these frequency bands will require coordination with the neighbouring countries within the coordination zones, of 6 kilometres in cases of LTE-to-LTE or 9 kilometres in cases of LTE-to-other technologies from the neighbouring country.

The coordination distances are continuously being reviewed and these may be updated from time to time.

7.2 The following field strength thresholds have to be assured based on (ECC/REC(11)04 for 790-862MHz. Operator-to-operator coordination may be necessary to avoid interference.

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 55dBµV/m/5MHz at a height of 3 m above ground at the borders between countries and does not exceed a value of 29dBµV/m/5MHz 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 both sides of the border, the field strength levels can be increased to 59 dBµV/m/5MHz and 41 dBµV/m/5MHz at 6 km.

If TDD is in operation across both sides of a border and is synchronised across the border then field strength levels as well.

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

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

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

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 15dBµV/m/5 MHz at 10% time, 50% of locations at 3 metres above ground level at the border line.

7.3 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.

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

7.5 In the event of any interference, the Authority will require affected parties to carry out coordination. In the event that the interference continues to be unresolved after 24 hours, the affected parties may refer the matter to the Authority for a resolution. The Authority will decide upon the necessary modifications and schedule of modifications to resolve the dispute. The Authority will be guided by the interference resolution process as shown in Appendix D.

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

8 Assignment

8.1 An Invitation to Apply will be published for new assignments in this band in line with regulations developed in terms of section 31(3) of the Act.

9 Amendment

9.1 All radio frequency spectrum licences are amended except for cases where their coexistence with IMT is proven.

9.1.1 Existing radio frequency spectrum licences for the use of the band will be amended as of 31st March 2018 for licensees operating in rural areas (except Transnet).

9.1.2 Existing radio frequency spectrum licences for the use of the band will be amended as of 31st March 2022 for all remaining licensees.

9.2 In cases of coexistence, i.e., where a radio frequency spectrum licensee is able to migrate within the 450-470 MHz band and coexist with IMT, the radio frequency spectrum licence will be modified accordingly.

10 Radio Frequency Migration

10.1 Potential destination bands.

The following graph describes the migration necessary to allocate the 450-470 MHz for IMT use:

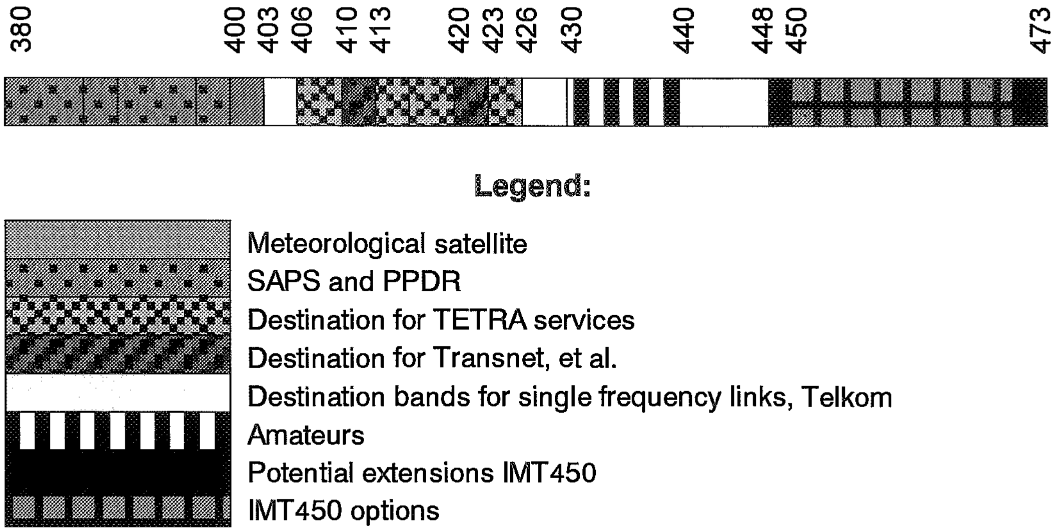

Figure 3: 450-470MHz potential destination spectrum

10.2 Migration Process:

- Migration starts in 2016 and is completed in 2022;
- Dual illumination stops in 2022;
- **SAPS** - free up 406-426 MHz and migrate to 380-400 MHz:
  - Additional 2×3 MHz are still free for potential PPDR licences, e.g., for emergencies, airports (SAA).
- **Transnet** - free up 450-470 MHz and potentially migrate to 406-426 MHz:
  - From 2016 Transnet can commence migration to 410-413//420-423MHz (2×3 MHz);
  - *Alternatively there are 2×4 MHz and 2×3 MHz for TETRA available in 406-426 MHz;*
  - Transnet may also migrate to GSM R.
- **Other licensees** - migrate from 450-470 MHz to:
  - 403-406 MHz (unpaired);
  - 426-430 MHz (unpaired);
  - 440-450 MHz (paired or unpaired), potentially for municipality networks; and
  - In cases of PPDR-use also to 387-390//397-400 MHz.
- **430-440 MHz** (amateurs) may be used in cases of congestion for a defined period e.g. two years.
- Many municipality networks are in the 440-450 MHz bands. Depending on future demand, a harmonisation might take place.

- In Figure 3, potential extensions to the IMT450-band are marked as well, in order to mitigate potential interference with the direct neighbour bands. These might be reserved in the case of extending 2×5 MHz to 2×10MHz, or to minimise interference.

10.3 Specific Procedure:

Existing licensees must migrate according to the specified process.

Appendix A National Radio Frequency Plan

ITU Region 1 allocation and footnotes	South African Allocation and footnotes	Typical Applications	Comments
450-455 MHz FIXED MOBILE 5.286AA 5.209 5.271 5.286, 5.286A 5.286B 5.286C 5.286D 5.286E	**400-455 MHz** FIXED MOBILE 5.286AA NF9 5.209 5.286 5.286A	Fixed links (450-453 MHz) Single Frequency Mobile (453-454 MHz) Paging (454-454.425MHz) Trunked Mobile BTX (454.425-460 MHz) IMT 450(450-470 MHz)	Paired with 460-463 MHz Government Services Paired with 464.425-470 MHz
455-456 MHz FIXED MOBILE 5.286AA 5.209 5.271 5.286A 5.286B 5.286C 5.286E	**455-456 MHz** FIXED MOBILE 5.286AA NF9 5.209 5.286A	Trunked Mobile BTX (454.425-460MHz) IMT 450(450-470 MHz) Government Services	Paired with 464.425-470 MHz
456-459 MHz FIXED MOBILE 5.286AA 5.271 5.287 5.288	**456-459 MHz** FIXED MOBILE 5.286AA NF9 5.287	Trunked Mobile BTX (454.425-460MHz) IMT 450(450-470 MHz) Government Services	Paired with 464.425-470 MHz
459-460 MHz FIXED MOBILE 5.286AA	**459-460 MHz** FIXED MOBILE 5.286AA NF9	Trunked Mobile BTX (454.425 - 460 MHz) IMT 450(450-470 MHz) Government Services	Paired with 464.425-470 MHz

5.209 5.271 5.286A 5.286B 5.286C 5.286E	5.209 5.271 5.286A		
460-470 MHz FIXED MOBILE 5.286AA	**460-470 MHz** FIXED MOBILE 5.286AA NF9	Fixed links (460-463 MHz) Single Frequency Mobile (463.025-463.975 MHz)	Paired with 450-453 MHz
		Low Power Mobile Radio(463.975 MHz, 464.125 MHz, 464.175 MHz, 464.325 MHz, 464.375 MHz)	Radio Frequency Spectrum Regulations Annex B GG No 34172, 31 March 2011)
		Single Frequency Mobile (464.375-464.425 MHz)	Paired with 454.425-460 MHz
		Trunked Mobile MTX (464-470 MHz)	
		IMT 450(450-470 MHz)	
		Security Systems (464.5375 MHz)	
		Non specific SRDs (464.5-464.5875 MHz)	Radio Frequency Spectrum Regulations (Annex B (GG. No 34172, 31 March 2011)
		Government Services	
Meteorological satellite (space to Earth) 5.287, 5.288, 5.289, 5.290	5.287, 5.289		

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 nature, 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 appropriate detailed terrain data is available, the propagation model for interference field strength prediction is the latest version of ITU-R Rec. P.452, For the relevant transmitting terminal, predictions of path loss would be made at x km steps along radials of y km at z degree intervals[1]. 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". This model is to be employed for 50% of locations, 10% time and using a receiver height of 3 m. For specific reception areas where terrain roughness adjustments for improved accuracy of field strength prediction are needed, administrations may use correction factors according to terrain irregularity and/or an averaged value of the TCA parameter in order to describe the roughness of the area on and around the coordination line.

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

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

Area calculations

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

For evaluation:

- only 10% of the number of geographical areas between the border line (including the border line) and the 6 km line itself inside the neighbouring country may be interfered with by higher field strength than the trigger field strength value given for the border line in section 7.2 at a height of 3m above ground.
- only 10% of the number of geographical areas between the 6km (including the 6km line) and 12km line inside the neighbouring country may be interfered with by a higher field strength than the trigger field strength value given for the 6km line in section 7.2 at a height of 3m 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 1km, free space propagation model needs to be applied. Furthermore, if there is no terrain obstacle within the 1st Fresnel zone, the free space propagation model should be applied.

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

For area type interference calculations, propagation models with path-specific terrain correction factors are recommended (e.g. Recommendation ITU–R P.1546 with the Terrain Clearance Angle correction factor TCA, HCM method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812).

As to correction factors for clutters 'open area' and 'quasi-open area', 20 dB and 15 dB should be used respectively. Recommendation ITU–R P.1406 should be used if a finer selection of clutter is required.

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

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE[2]

The following is extracted from ECC/REC(11)05 as an operational example and can be adapted for the SADC-countries

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

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

Administrations should agree on a repartition of these 504 PCI 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 PCI's is equivalent. Each country can use all PCI groups away from the border areas.

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

Four types of countries are defined in a way such that no country will use the same code set as any one of its neighbours. The following lists describe the distribution of European countries (*which needs to be adapted for SADC*):

Type country 1: BEL, CVA, CYP, CZE, DNK, E, FIN, GRC, IRL, ISL, LTU, MCO, SMR, SUI, SVN, UKR, AZE, SRB;

Type country 2: AND, BIH, BLR, BUL, D, EST, G, HNG, I, MDA, RUS (Exclave), GEO;

Type country 3: ALB, AUT, F, HOL, HRV, POL, POR, ROU, RUS, S, MLT;

Type country 4: LIE, LUX, LVA, MKD, MNE, NOR, SVK, TUR.

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:

(black)	Preferential PCI
	Non-preferential PCI

[2] ECC/REC(11)05

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

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

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

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

Notes

1) All PCIs are available in areas away from the border.
2) In certain specific cases (e.g. AUT/HRV), where the distance between two countries of the same type number is very small, it may be necessary to address the situation in bi/multilateral coordination agreements as necessary, and may include further subdivision of the allocated codes in certain areas.

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

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

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

1. Demodulation Reference Signal (DM RS) coordination

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

The case of partial channel overlap has not been studied but, due to DM RS occupying resource blocks of separate users, there is a risk of DM RS collisions between neighbouring networks when the subcarriers' positions coincide (the frequency offset between central carriers of neighbouring networks is 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 basic planning procedure only 30 DM RS sequence groups with favourable correlation characteristics are available: {0...29}. In this case each cell could be assigned one of the 30 DM RS sequence groups providing a cluster size of 30.
- It is possible to extend each DM RS sequence group to generate up to 12 time-shifted sequence groups by applying the cyclic shift parameter stated in 3GPP TS 36.211. For 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 a limited number of groups are 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 only recently during first trials of LTE and caused throughput loss as well as time alignment problems.

- Another approach for DM RS coordination is to implement dynamic DM RS sequence group allocation also called pseudo-random group hopping. In this method, nearby cells are grouped into clusters of up to 30 cells and within each cell cluster the same hopping pattern is used. At the border of two clusters, inter-cell interference is averaged since two different hopping patterns are used. There are 17 defined hopping patterns, numbered {0...16}, which leads to some minor inequality in the case of apportioning these patterns between neighbouring countries. Even in a trilateral case, each operator will have at least 5 hopping patterns available near the border which should be enough for planning purposes. It should be noted the pseudo-random group hopping option could be absent in the first generations of LTE equipment.

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

2. Physical Random Access Channel (PRACH) coordination

Another radio network parameter which 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 is usually the same for all cells, again because the PRACH-to-PRACH interference case is the more favourable one; and
- cell-specific root sequences are used to distinguish between PRACH requests addressed to different cells.

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

In early implementation, it is possible that a very limited number of frequency positions will be supported by LTE equipment which will not be enough to coordinate in the trilateral

case. In such cases, root-sequence repartition could be used. There are 838 root sequences in total, to be distributed between cells, numbered {0..837}. There are two numbering schemes for PRACH root sequences (physical and logical) and only logical root sequences numbering needs be used for coordination. Unfortunately, the process of root sequences planning doesn't involve direct mapping of root sequences between cells because the number of root sequences needed for one cell is dependent on the cell range. The table showing such interdependency is presented below:

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

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

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

Appendix D Interference Resolution Process

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 [deg];

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 [deg]

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.

NOTICE 271 OF 2015

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

PURSUANT TO SECTION 4 (1) OF THE ELECTRONIC COMMUNICATIONS ACT 2005, (ACT NO. 36 OF 2005)

HEREBY ISSUES A NOTICE REGARDING THE FINAL RADIO FREQUENCY SPECTRUM ASSIGNMENT PLAN FOR THE FREQUENCY BAND 703 TO 733 MHz AND 758 TO 788 MHz.

1. The Independent Communications Authority of South Africa ("the Authority"), hereby publishes **Final Radio Frequency Spectrum Assignment Plan for the frequency band 703 to 733 MHz and 758 to 788 MHz** in terms of sections 2 (d), (e) and 4, read with sections 30, 31(4), and 33 of the Electronic Communications Act (Act No. 36 of 2005) and read with Regulation 3 of the Radio Frequency Spectrum Regulations 2011 and read with the IMT Roadmap 2014.

2. This Radio Frequency Spectrum Assignment Plan (RFSAP) supersedes any previous spectrum assignment arrangements for the same spectrum location. However, if it happens that on the date a provision of the RFSAP comes into effect, there is a conflict between the RFSAP and the latest versions of the National Radio Frequency Plan (NRFP) and Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan will prevail.

Dr SS MNCUBE
CHAIRPERSON

Radio Frequency Spectrum Assignment Plan

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

Table of Contents

1 Glossary

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

"3GPP"	means the 3rd Generation Partnership Project (3GPP) which consists of six telecommunications standard development organisations
"Act"	means the Electronic Communications Act, 2005 (Act No. 36 of 2005) as amended
"DM RS"	means Demodulation Reference Signal
"ECC/REC(11)04"	means ECC Recommendation (11)04
"ECC"	means Electronic Communications Committee within the European Conference of Postal and Telecommunications Administrations (CEPT)
"FDD"	means Frequency Division Duplex
"HCM"	means Harmonised Calculation Method
"IMT"	means International Mobile Telecommunications
"IMT700"	means IMT in the 700MHz band
"ICNIRP"	Means International Commission on Non-Ionizing Radiation Protection (ICNIRP)
"ITA"	means Invitation to Apply
"ITU"	means the International Telecommunication Union
"ITU-R"	means the International Telecommunication Union Radiocommunication Sector
"LTE"	means Long Term Evolution is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies
"NRFP"	means the National Radio Frequency Plan 2013 for South Africa
"PCI"	means Physical-Layer Cell Identities
"PRACH"	means Physical Random Access Channel
"PSTN"	means Public Switched Telephone Network
"PUCCH"	means Physical Uplink Control Channel
"RFSAP"	means Radio Frequency Spectrum Assignment Plan

"TCA"	means Terrain Clearance Angle
"TDD"	means Time Division Duplex
"WRC-12"	means World Radiocommunication Conference 2012 held in Geneva
"WRC-15"	means World Radiocommunication Conference planned to be held in 2015 in Geneva

2 Purpose

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

2.2 This Frequency Assignment Plan states the requirements for the utilisation of the frequency band between 703-733 MHz paired with 758-788 MHz for IMT700.

2.3 The ITU states that International Mobile Telecommunications (IMT) systems are mobile systems that provide access to a wide range of telecommunication services including advanced mobile services, supported by mobile and fixed networks, which are increasingly packet-based.

Key features are:

- a high degree of commonality of functionality worldwide whilst retaining the flexibility to support a wide range of services and applications in a cost efficient manner;
- compatibility of services within IMT and with fixed networks;
- capability of interworking with other radio access systems;
- high quality mobile services;
- user equipment suitable for worldwide use;
- user-friendly applications, services and equipment;
- worldwide roaming capability; and
- enhanced peak data rates to support advanced services and applications.

3 General

3.1 Technical characteristics of equipment used in IMT700 systems must conform to all applicable South African standards, international standards, International Telecommunications Union (ITU) and its radio regulations as agreed and adopted by South Africa.

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

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

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

3.5 Frequency bands assigned for IMT700 include bands between 703-733 MHz paired with 758-788 MHz.

3.6 Likely use of this band will be for mobile voice and data communications.

3.7 The technologies which can provide IMT700 services include, but are not limited to:

- LTE;
- LTE Advanced;
- HSPA+; and
- WiMAX.

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

- Recommendation ITU-R M.2012-1 (02/2014): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT Advanced);
- Report ITU-R2241-0 Compatibility studies in relation to Resolution 224 in the bands 698-806 MHz and 790-862 MHz;
- Report ITU-R M.2074: Report on Radio Aspects for the terrestrial component of IMT-2000 and systems beyond IMT-2000;
- Recommendation ITU-R M.1645 Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000; and
- Recommendation ITU-R M.1036-4: Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations (RR).

4 Channelling Plan

4.1 The frequency band 703-733 MHz paired with 758-788 MHz provides a total bandwidth of:

- 2×30MHz FDD for IMT700.

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

4.2 Channel arrangements for the IMT700 band are according to the Region 1 recommendation by the ITU.

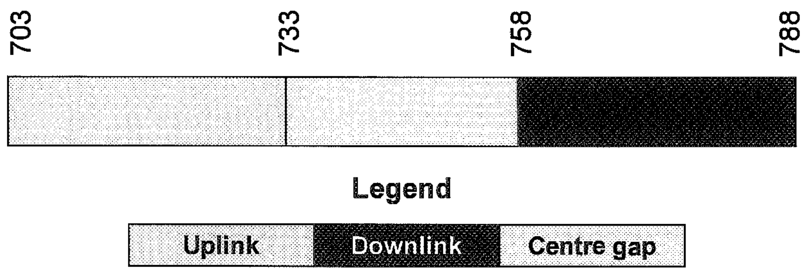

Figure 4: Channel arrangements for IMT700

5 Requirements for usage of radio frequency spectrum

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

5.2 The use of the band is limited for IMT-services.

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

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

5.5 The allocation of spectrum and shared services within these bands are found in the National Radio Frequency Plan (NRFP) and an extract of NRFP is shown in Appendix A.

5.6 Maximum radiated power:

5.6.1 Base Station transmissions should not exceed 61dBm/5MHz EIRP;

5.6.2 Mobile Station transmissions should not exceed 23dBm EIRP;

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

5.6.4 Where appropriate, subscriber terminal stations should comply with the technical specification outlined under "3GPP TS 36.521-1" or latest version;

5.7 ICNIRP compliance is encouraged, where applicable.

5.8 Criteria and guidelines for interference mitigation are described in **Error! Reference source not found.**.

6 Implementation

6.1 This Radio Frequency Assignment Plan comes into effect on 1st January 2016.

6.2 The process of assignment may commence prior to the date referred to in section 6.1.

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

7 Coordination Requirements

7.1 Use of these frequency bands will require coordination with the neighbouring countries within the coordination zones of 6 kilometres in cases of LTE-to-LTE or 9 kilometres in cases of LTE-to-other technologies from the neighbouring country. The coordination distance is continuously being reviewed and these may be updated from time to time.

7.2 The following field strength thresholds have to be assured based on (ECC/REC(11)04 for 790-862MHz also taken here for 703-790MHz). Operator-to-operator coordination may be necessary to avoid interference.

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 55dBμV/m/5MHz at a height of 3 m above ground at the border line between countries and does not exceed a value of 29dBμV/m/5MHz at a height of 3 m above ground at a distance of 9 km inside the neighbouring country.

In the case that LTE is deployed on both sides of the border, the field strength levels can be increased to 59 dBμV/m/5MHz and 41 dBμV/m/5MHz at 6 km.

If TDD is in operation across both sides of a border and is synchronised across the border then field strength levels as well.

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

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

BW (MHz)	Field strength level at 3 m height (general case)	Field strength level at 3 m height (LTE case)
	35.0 dBµV/m/20MHz @9km	47.0 dBµV/m/20MHz @6km

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

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 15dBµV/m/5 MHz at 10% time, 50% of locations at 3 metres above ground level at the border line.

7.3 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.

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

7.5 In the event of any interference, the Authority will require affected parties to carry out coordination. In the event that the interference continues to be unresolved after 24 hours, the affected parties may refer the matter to the Authority for a resolution. The Authority will decide upon the necessary modifications and the schedule of modifications to resolve the dispute. The Authority will be guided by the interference resolution process as shown in **Error! Reference source not found.**.

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

8 Assignment

8.1 An Invitation to Apply will be published for new assignments in this band in line with regulations developed in terms of section 31(3) of the Act.

9 Transitional Arrangements

9.1 The Authority resolved the following transitional arrangements for the right of use of spectrum in this frequency band:

9.1.1 That Broadcasting Spectrum Assignments in the band above 694 MHz, in the affected areas as stipulated in the Terrestrial Broadcasting Frequency Plan (Notice No. 298 of 2013 in Government Gazette No. 36321 and Notice No. 801 of 2014 in Government Gazette 38005 or the latest version), are to be used subject to meeting the conformance requirements in line with the GE06 Plan and are to be phased out during the performance period;

9.1.2 That broadcast transmissions and services ancillary to broadcasting in the band above 694 MHz are to be systematically switched off; and

9.2 That matters related to spectrum management geared at minimising and/or preventing harmful interference during the transitional arrangement period, are to be managed by the Authority which will develop a systematic implementation plan for the a seamless transition.

10 Radio Frequency Migration

10.1 Specific Procedure:

10.1.1 WRC 12 resolved to allocate the frequency band 694-790 MHz in Region 1 to the mobile except aeronautical mobile on a co-primary basis and to identify it for IMT and that the allocation is effective immediately after WRC-15;

10.1.2 Any Studio Transmission Links in this band must be migrated out to point to point fixed assignments;

10.1.3 Appropriate destination bands for STL's are:

- 2025 – 2110 MHz (paired with 2200 – 2285 MHz).

10.1.4 Self Help Stations must migrate out as per latest version of Terrestrial Broadcasting Frequency Plan.

Appendix A National Radio Frequency Plan

ITU Region 1 allocations and footnote	South African allocations and footnotes	Typical Applications	Comments
470-790MHz(694-790)	**470-790 MHz**		
BROADCASTING	BROADCASTING	Television Broadcasting (470 – 854 MHz)	Broadcasting Allotments in accordance with GE89 plan in the process of conversion to GE06. Broadcast assignments in accordance with the latest version of the Terrestrial Broadcasting Frequency Plan. The use of 'White Spaces' in this band is under consideration (subject to NINP basis to users under a primary allocation.)
	RADIO ASTRONOMY	Radio Astronomy (606-614 MHz)	
	MOBILE except aeronautical mobile NF9	IMT700 (694-790 MHz)	
5.149 5.291A 5.294 5.296 5.300 5.304 5.306 5.311A 5.312 5.312A	5.149 5.311A 5.312A		
790-862 MHz	**790-862 MHz**		
FIXED	FIXED	Fixed Links (856 – 864.1 MHz)	The fixed links will be migrated along with the broadcasting service in line with Radio Frequency Migration Plan.
MOBILE except aeronautical mobile 5.317A	MOBILE except aeronautical mobile 5.316B 5.317A NF9	IMT800 BTX (791 – 821 MHz)	Paired with 832 – 862 MHz
		Mobile Wireless Access (827.775 – 832.695 MHz)	Paired with Access (872.775 – 877.695 MHz)
		IMT800 MTX (832– 862 MHz)	Paired with 791 – 821 MHz
BROADCASTING	BROADCASTING	Television Broadcasting	Broadcasting Allotments

5.312 5.314 5.315 5.316 5.316A 5.319	5.316A	(470 – 854 MHz)	in accordance with GE89 plan in the process of conversion to GE06. Broadcast assignments in accordance with the latest version of the Terrestrial Broadcasting Frequency Plan.

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 nature, 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 appropriate detailed terrain data is available, the propagation model for interference field strength prediction is the latest version of ITU-R Rec. P.452, For the relevant transmitting terminal, predictions of path loss would be made at x km steps along radials of y km at z degree intervals[3]. 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". This model is to be employed for 50% of locations, 10% time and using a receiver height of 3 m. For specific reception areas where terrain roughness adjustments for improved accuracy of field strength prediction are needed, administrations may use correction factors according to terrain irregularity and/or an averaged value of the TCA parameter in order to describe the roughness of the area on and around the coordination line.

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

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

Area calculations

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

For evaluation:

- only 10% of the number of geographical areas between the border line (including the border line) and the 6 km line itself inside the neighbouring country may be interfered with by higher field strength than the trigger field strength value given for the border line in section 7.2 at a height of 3m above ground.
- only 10% of the number of geographical areas between the 6 km (including the 6 km line) and 12 km line inside the neighbouring country may be interfered with by a higher field strength than the trigger field strength value given for the 6 km line in section 7.2 at a height of 3m 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 1km, free space propagation model needs to be applied. Furthermore, if there is no terrain obstacle within the 1st Fresnel zone, the free space propagation model should be applied.

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

For area type interference calculations, propagation models with path-specific terrain correction factors are recommended (e.g. Recommendation ITU–R P.1546 with the Terrain Clearance Angle correction factor TCA, HCM method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812).

As to correction factors for clutters 'open area' and 'quasi-open area', 20 dB and 15 dB should be used respectively. Recommendation ITU–R P.1406 should be used if a finer selection of clutter is required.

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

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE[4]

The following is extracted from ECC/REC(11)05 as an operational example and can be adapted for the SADC-countries

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

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

Administrations should agree on a repartition of these 504 PCI 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 PCI's is equivalent. Each country can use all PCI groups away from the border areas.

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

Four types of countries are defined in a way such that no country will use the same code set as any one of its neighbours. The following lists describe the distribution of European countries (*which needs to be adapted for SADC*):

Type country 1: BEL, CVA, CYP, CZE, DNK, E, FIN, GRC, IRL, ISL, LTU, MCO, SMR, SUI, SVN, UKR, AZE, SRB;

Type country 2: AND, BIH, BLR, BUL, D, EST, G, HNG, I, MDA, RUS (Exclave), GEO;

Type country 3: ALB, AUT, F, HOL, HRV, POL, POR, ROU, RUS, S, MLT;

Type country 4: LIE, LUX, LVA, MKD, MNE, NOR, SVK, TUR.

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:

(shaded)	Preferential PCI
	Non-preferential PCI

[4] ECC/REC(11)05

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

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

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

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

Notes

1) All PCIs are available in areas away from the border.
2) In certain specific cases (e.g. AUT/HRV), where the distance between two countries of the same type number is very small, it may be necessary to address the situation in bi/multilateral coordination agreements as necessary, and may include further subdivision of the allocated codes in certain areas.

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

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

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

1. Demodulation Reference Signal (DM RS) coordination

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

The case of partial channel overlap has not been studied but, due to DM RS occupying resource blocks of separate users, there is a risk of DM RS collisions between neighbouring networks when the subcarriers' positions coincide (the frequency offset between central carriers of neighbouring networks is 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 basic planning procedure only 30 DM RS sequence groups with favourable correlation characteristics are available: {0...29}. In this case each cell could be assigned one of the 30 DM RS sequence groups providing a cluster size of 30.
- It is possible to extend each DM RS sequence group to generate up to 12 time-shifted sequence groups by applying the cyclic shift parameter stated in 3GPP TS 36.211. For 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 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 a limited number of groups are 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 only recently during first trials of LTE and caused throughput loss as well as time alignment problems.

- Another approach for DM RS coordination is to implement dynamic DM RS sequence group allocation also called pseudo-random group hopping. In this method, nearby cells are grouped into clusters of up to 30 cells and within each cell cluster the same hopping pattern is used. At the border of two clusters, inter-cell interference is averaged since two different hopping patterns are used. There are 17 defined hopping patterns, numbered {0...16}, which leads to some minor inequality in the case of apportioning these patterns between neighbouring countries. Even in a trilateral case, each operator will have at least 5 hopping patterns available near the border which should be enough for planning purposes. It should be noted the pseudo-random group hopping option could be absent in the first generations of LTE equipment.

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

2. Physical Random Access Channel (PRACH) coordination

Another radio network parameter which 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 is usually the same for all cells, again because the PRACH-to-PRACH interference case is the more favourable one; and
- cell-specific root sequences are used to distinguish between PRACH requests addressed to different cells.

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

In early implementation, it is possible that a very limited number of frequency positions will be supported by LTE equipment which will not be enough to coordinate in the trilateral

case. In such cases, root-sequence repartition could be used. There are 838 root sequences in total, to be distributed between cells, numbered {0..837}. There are two numbering schemes for PRACH root sequences (physical and logical) and only logical root sequences numbering needs be used for coordination. Unfortunately, the process of root sequences planning doesn't involve direct mapping of root sequences between cells because the number of root sequences needed for one cell is dependent on the cell range. The table showing such interdependency is presented below:

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

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

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

Appendix D Interference Resolution Process

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 [deg];

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 [deg]

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 mutual consent.

NOTICE 272 OF 2015

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

PURSUANT TO SECTION 4 (1) OF THE ELECTRONIC COMMUNICATIONS ACT 2005, (ACT NO. 36 OF 2005)

HEREBY ISSUES A NOTICE REGARDING THE FINAL RADIO FREQUENCY SPECTRUM ASSIGNMENT PLAN FOR THE FREQUENCY BAND 733 TO 758 MHz

1. The Independent Communications Authority of South Africa ("the Authority"), hereby publishes **Final Radio Frequency Spectrum Assignment Plan for the frequency band 733 to 758 MHz** in terms of sections 2 (d), (e) and 4, read with sections 30, 31(4), and 33 of the Electronic Communications Act (Act No. 36 of 2005) and read with Regulation 3 of the Radio Frequency Spectrum Regulations 2011 and read with the IMT Roadmap 2014.

2. This Radio Frequency Spectrum Assignment Plan (RFSAP) supersedes any previous spectrum assignment arrangements for the same spectrum location. However, if it happens that on the date a provision of the RFSAP comes into effect, there is a conflict between the RFSAP and the latest versions of the National Radio Frequency Plan (NRFP) and Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan will prevail.

Dr SS MNCUBE
CHAIRPERSON

ICASA

Radio Frequency Spectrum Assignment Plan

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

Table of Contents

1 Glossary

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

"3GPP"	means the 3rd Generation Partnership Project (3GPP) which consists of six telecommunications standard development organisations
"Act"	means the Electronic Communications Act, 2005 (Act No. 36 of 2005) as amended
"DM RS"	means Demodulation Reference Signal
"ECC/REC(11)04"	means ECC Recommendation (11)04
"ECC"	means Electronic Communications Committee within the European Conference of Postal and Telecommunications Administrations (CEPT)
"FDD"	means Frequency Division Duplex
"HCM"	means Harmonised Calculation Method
"IMT"	means International Mobile Telecommunications
"IMT750"	means IMT in the 750MHz band
"ICNIRP"	Means International Commission on Non-Ionizing Radiation Protection (ICNIRP)
"ITA"	means Invitation to Apply
"ITU"	means the International Telecommunication Union
"ITU-R"	means the International Telecommunication Union Radiocommunication Sector
"LTE"	means Long Term Evolution is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies
"NRFP"	means the National Radio Frequency Plan 2013 for South Africa
"PCI"	means Physical-Layer Cell Identities
"PRACH"	means Physical Random Access Channel
"PSTN"	means Public Switched Telephone Network
"PUCCH"	means Physical Uplink Control Channel
"RFSAP"	means Radio Frequency Spectrum Assignment Plan

"TCA"	means Terrain Clearance Angle
"TDD"	means Time Division Duplex
"WRC-12"	means World Radiocommunication Conference 2012 held in Geneva
"WRC-15"	means World Radiocommunication Conference planned to be held in 2015 in Geneva

2 Purpose

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

2.2 This Frequency Assignment Plan states the requirements for the utilisation of the frequency band between 733 MHz and 758 MHz for IMT750.

2.3 The ITU states that International Mobile Telecommunications (IMT) systems are mobile systems that provide access to a wide range of telecommunication services including advanced mobile services, supported by mobile and fixed networks, which are increasingly packet-based.

Key features are:

- a high degree of commonality of functionality worldwide whilst retaining the flexibility to support a wide range of services and applications in a cost efficient manner;
- compatibility of services within IMT and with fixed networks;
- capability of interworking with other radio access systems;
- high quality mobile services;
- user equipment suitable for worldwide use;
- user-friendly applications, services and equipment;
- worldwide roaming capability; and
- enhanced peak data rates to support advanced services and applications.

3 General

3.1 Technical characteristics of equipment used in IMT750 systems must conform to all applicable South African standards, international standards, International Telecommunications Union (ITU) and its radio regulations as agreed and adopted by South Africa.

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

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

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

3.5 Frequency bands assigned for IMT750 include bands between 733-758 MHz

3.6 Likely use of this band will be for mobile voice and data communications.

3.7 The technologies which can provide IMT750 services include, but are not limited to:

- LTE;
- LTE Advanced;
- HSPA+; and
- WiMAX.

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

- Recommendation ITU-R M.2012-1 (02/2014): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT Advanced);
- Report ITU-R2241-0 Compatibility studies in relation to Resolution 224 in the bands 698-806 MHz and 790-862 MHz;
- Report ITU-R M.2074: Report on Radio Aspects for the terrestrial component of IMT-2000 and systems beyond IMT-2000;
- Recommendation ITU-R M.1645 Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000; and
- Recommendation ITU-R M.1036-4: Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations (RR).

4 Channelling Plan

4.1 The frequency band 733 -758 MHz provides a total bandwidth of:

- 15MHz TDD for IMT750 and two 5 MHz guard bands.

4.2 The channel arrangements for the IMT750 band are according to the Region 1 recommendation by the ITU.

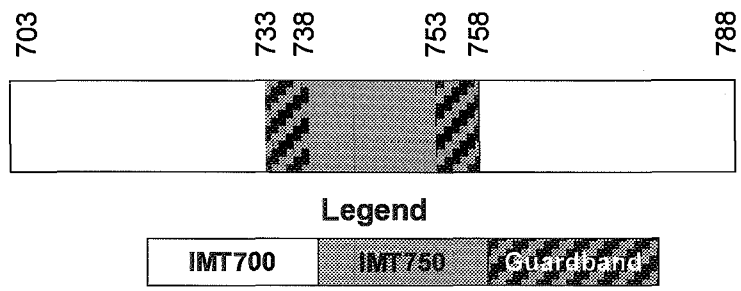

Figure 5: Channel arrangement for IMT750

5 Requirements for usage of radio frequency spectrum

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

5.2 The use of the band is limited for IMT-services.

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

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

5.5 The allocation of spectrum and shared services within these bands are found in the National Radio Frequency Plan (NRFP) and an extract of NRFP is shown in Appendix A.

5.6 Maximum radiated power:

5.6.1 Base Station transmissions should not exceed 61dBm/5MHz EIRP;

5.6.2 Mobile Station transmissions should not exceed 23dBm EIRP;

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

5.6.4 Where appropriate, the subscriber terminal station should comply with the technical specification outlined under "3GPP TS 36.521-1" or latest version.

5.7 ICNIRP compliance is encouraged, where applicable.

5.8 Criteria and guidelines for interference mitigation are described in **Error! Reference source not found.**.

6 Implementation

6.1 This Radio Frequency Assignment Plan comes into effect on 1st January 2016.

6.2 The process of assignment may commence prior to the date referred to in section 6.1.

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

7 Coordination Requirements

7.1 Use of these frequency bands will require coordination with the neighbouring countries within the coordination zones of 6 kilometres in cases of LTE-to-LTE or 9 kilometres in cases of LTE-to-other technologies from the neighbouring country. The coordination distance is continuously being reviewed and these may be updated from time to time.

7.2 The following field strength thresholds have to be assured based on (ECC/REC(11)04 for 790-862MHz. Operator-to-operator coordination may be necessary to avoid interference

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 55dBμV/m/5MHz at a height of 3 m above ground at the border line between countries and does not exceed a value of 29dBμV/m/5MHz 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 both sides of the border, the field strength levels can be increased to 59 dBμV/m/5MHz and 41 dBμV/m/5MHz at 6 km.

If TDD is in operation across both sides of a border and is synchronised across the border then field strength levels as well.

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

BW (MHz)	Field strength level at 3 m height (general case)	Field strength level at 3 m height (LTE case)
5 MHz	55.0 dBμV/m/5MHz @0km	59.0 dBμV/m/5MHz @0km
	29.0 dBμV/m/5MHz @9km	41.0 dBμV/m/5MHz @6km
10 MHz	58.0 dBμV/m/10MHz @0km	62.0 dBμV/m/10MHz @0km
	32.0 dBμV/m/10MHz @9km	44.0 dBμV/m/10MHz @6km
15 MHz	59.8 dBμV/m/15MHz @0km	63.8 dBμV/m/15MHz @0km

BW (MHz)	Field strength level at 3 m height (general case)	Field strength level at 3 m height (LTE case)
	33.8 dBμV/m/15MHz @9km	45.8 dBμV/m/15MHz @6km
20 MHz	61.0 dBμV/m/20MHz @0km	65.0 dBμV/m/20MHz @0km
	35.0 dBμV/m/20MHz @9km	47.0 dBμV/m/20MHz @6km

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

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 15dBμV/m/5 MHz at 10% time, 50% of locations at 3 metres above ground level at the border line.

7.3 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.

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

7.5 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 interference resolution process as shown in **Error! Reference source not found.**.

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

8 Assignment

8.1 An Invitation to Apply will be published for new assignments in this band in line with regulations developed in terms of section 31(3) of the Act.

9 Transitional Arrangements

9.1 The Authority resolved the following transitional arrangements for the right of use of spectrum in this frequency band:

9.1.1 That Broadcasting Spectrum Assignments in the band above 694 MHz, in the affected areas as stipulated in the Terrestrial Broadcasting Frequency Plan (Notice No. 298 of 2013 in Government Gazette No. 36321 and Notice No. 801 of 2014 in

Government Gazette 38005 or the latest version), are to be used subject to meeting the conformance requirements in line with the GE06 Plan and are to be phased out during the performance period;

9.1.2 That broadcast transmissions and services ancillary to broadcasting in the band above 694 MHz are to be systematically switched off;

9.2 That matters related to spectrum management geared at minimising and/or prevent harmful interference during the transitional arrangement period, are to be managed by the Authority which will develop a systematic implementation plan for a seamless transition

10 Radio Frequency Migration

10.1 Specific Procedure:

10.1.1 WRC 12 resolved to allocate the frequency band 694-790 MHz in Region 1 to the mobile except aeronautical mobile on a co-primary basis and to identify it for IMT and that the allocation is effective immediately after WRC-15;

10.1.2 Any Studio Transmission Links in this band must be migrated out to point-to-point fixed assignments;

10.1.3 Appropriate destination bands for STL's are:

- The 2025 – 2110 MHz (paired with 2200 – 2285 MHz).

10.1.4 Self Help Stations must be migrated out as per latest version of Terrestrial Broadcasting Frequency Plan.

Appendix A National Radio Frequency Plan

ITU Region 1 allocations and footnote	South African allocations and footnotes	Typical Applications	Comments
470-790MHz(694-790)	**470-790 MHz**		
BROADCASTING	BROADCASTING	Television Broadcasting (470 – 854 MHz)	Broadcasting Allotments in accordance with GE89 plan in the process of conversion to GE06. Broadcast assignments in accordance with the latest version of the Terrestrial Broadcasting Frequency Plan. The use of 'White Spaces' in this band is under consideration (subject to NINP basis to users under a primary allocation.)
	RADIO ASTRONOMY	Radio Astronomy (606-614 MHz)	
	MOBILE except aeronautical mobile NF9	IMT700 (694-790 MHz)	
5.149 5.291A 5.294 5.296 5.300 5.304 5.306 5.311A 5.312 5.312A	5.149 5.311A 5.312A		

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 nature, 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 appropriate detailed terrain data is available, the propagation model for interference field strength prediction is the latest version of ITU-R Rec. P.452, For the relevant transmitting terminal, predictions of path loss would be made at x km steps along radials of y km at z degree intervals[5]. 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". This model is to be employed for 50% of locations, 10% time and using a receiver height of 3 m. For specific reception areas where terrain roughness adjustments for improved accuracy of field strength prediction are needed, administrations may use correction factors according to terrain irregularity and/or an averaged value of the TCA parameter in order to describe the roughness of the area on and around the coordination line.

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

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

Area calculations

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

For evaluation:

- only 10% of the number of geographical areas between the border line (including the border line) and the 6 km line itself inside the neighbouring country may be interfered with by higher field strength than the trigger field strength value given for the border line in section 7.2 at a height of 3m above ground.
- only 10% of the number of geographical areas between the 6 km (including the 6 km line) and 12 km line inside the neighbouring country may be interfered with by a higher field strength than the trigger field strength value given for the 6 km line in section 7.2 at a height of 3m 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 1km, free space propagation model needs to be applied. Furthermore, if there is no terrain obstacle within the 1st Fresnel zone, the free space propagation model should be applied.

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

For area type interference calculations, propagation models with path-specific terrain correction factors are recommended (e.g. Recommendation ITU–R P.1546 with the Terrain Clearance Angle correction factor TCA, HCM method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812).

As to correction factors for clutters 'open area' and 'quasi-open area', 20 dB and 15 dB should be used respectively. Recommendation ITU–R P.1406 should be used if a finer selection of clutter is required.

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

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE[6]

The following is extracted from ECC/REC(11)05 as an operational example and can be adapted for the SADC-countries

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

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

Administrations should agree on a repartition of these 504 PCI 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 PCI's is equivalent. Each country can use all PCI groups away from the border areas.

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

Four types of countries are defined in a way such that no country will use the same code set as any one of its neighbours. The following lists describe the distribution of European countries (*which needs to be adapted for SADC*):

Type country 1: BEL, CVA, CYP, CZE, DNK, E, FIN, GRC, IRL, ISL, LTU, MCO, SMR, SUI, SVN, UKR, AZE, SRB;

Type country 2: AND, BIH, BLR, BUL, D, EST, G, HNG, I, MDA, RUS (Exclave), GEO;

Type country 3: ALB, AUT, F, HOL, HRV, POL, POR, ROU, RUS, S, MLT;

Type country 4: LIE, LUX, LVA, MKD, MNE, NOR, SVK, TUR.

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:

(black)	Preferential PCI
(white)	Non-preferential PCI

[6] ECC/REC(11)05

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

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

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

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

Notes

1) All PCIs are available in areas away from the border.
2) In certain specific cases (e.g. AUT/HRV), where the distance between two countries of the same type number is very small, it may be necessary to address the situation in bi/multilateral coordination agreements as necessary, and may include further subdivision of the allocated codes in certain areas.

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

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

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

1. Demodulation Reference Signal (DM RS) coordination

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

The case of partial channel overlap has not been studied but, due to DM RS occupying resource blocks of separate users, there is a risk of DM RS collisions between neighbouring networks when the subcarriers' positions coincide (the frequency offset between central carriers of neighbouring networks is 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 basic planning procedure only 30 DM RS sequence groups with favourable correlation characteristics are available: {0...29}. In this case each cell could be assigned one of the 30 DM RS sequence groups providing a cluster size of 30.
- It is possible to extend each DM RS sequence group to generate up to 12 time-shifted sequence groups by applying the cyclic shift parameter stated in 3GPP TS 36.211. For 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 a limited number of groups are 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 only recently during first trials of LTE and caused throughput loss as well as time alignment problems.

- Another approach for DM RS coordination is to implement dynamic DM RS sequence group allocation also called pseudo-random group hopping. In this method, nearby cells are grouped into clusters of up to 30 cells and within each cell cluster the same hopping pattern is used. At the border of two clusters, inter-cell interference is averaged since two different hopping patterns are used. There are 17 defined hopping patterns, numbered {0...16}, which leads to some minor inequality in the case of apportioning these patterns between neighbouring countries. Even in a trilateral case, each operator will have at least 5 hopping patterns available near the border which should be enough for planning purposes. It should be noted the pseudo-random group hopping option could be absent in the first generations of LTE equipment.

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

2. Physical Random Access Channel (PRACH) coordination

Another radio network parameter which 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 is usually the same for all cells, again because the PRACH-to-PRACH interference case is the more favourable one; and
- cell-specific root sequences are used to distinguish between PRACH requests addressed to different cells.

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

In early implementation, it is possible that a very limited number of frequency positions will be supported by LTE equipment which will not be enough to coordinate in the trilateral

case. In such cases, root-sequence repartition could be used. There are 838 root sequences in total, to be distributed between cells, numbered {0..837}. There are two numbering schemes for PRACH root sequences (physical and logical) and only logical root sequences numbering needs be used for coordination. Unfortunately, the process of root sequences planning doesn't involve direct mapping of root sequences between cells because the number of root sequences needed for one cell is dependent on the cell range. The table showing such interdependency is presented below:

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

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

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

Appendix D Interference Resolution Process

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 [deg];

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 [deg]

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 mutual consent.

NOTICE 273 OF 2015

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

PURSUANT TO SECTION 4 (1) OF THE ELECTRONIC COMMUNICATIONS ACT 2005, (ACT NO. 36 OF 2005)

HEREBY ISSUES A NOTICE REGARDING THE FINAL RADIO FREQUENCY SPECTRUM ASSIGNMENT PLAN FOR THE FREQUENCY BAND 791 TO 821 MHz AND 832 TO 862 MHz .

1. The Independent Communications Authority of South Africa ("the Authority"), hereby publishes **Final Radio Frequency Spectrum Assignment Plan for the frequency band 791 to 821 MHz and 832 to 862 MHz** in terms of sections 2 (d), (e) and 4, read with sections 30, 31(4), and 33 of the Electronic Communications Act (Act No. 36 of 2005) and read with Regulation 3 of the Radio Frequency Spectrum Regulations 2011 and read with the IMT Roadmap 2014.

2. This Radio Frequency Spectrum Assignment Plan (RFSAP) supersedes any previous spectrum assignment arrangements for the same spectrum location. However, if it happens that on the date a provision of the RFSAP comes into effect, there is a conflict between the RFSAP and the latest versions of the National Radio Frequency Plan (NRFP) and Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan will prevail.

Dr SS MNCUBE
CHAIRPERSON

Radio Frequency Spectrum Assignment Plan

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

(IMT800)

Table of Contents

1 Glossary

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

"3GPP"	means the 3rd Generation Partnership Project (3GPP) which consists of six telecommunications standard development organisations
"Act"	means the Electronic Communications Act, 2005 (Act No. 36 of 2005) as amended
"DM RS"	means Demodulation Reference Signal
"ECC/REC(11)04"	means ECC Recommendation (11)04
"ECC"	means Electronic Communications Committee within the European Conference of Postal and Telecommunications Administrations (CEPT)
"FDD"	means Frequency Division Duplex
"HCM"	means Harmonised Calculation Method
"IMT"	means International Mobile Telecommunications
"IMT800"	means IMT in the 800MHz band
"ICNIRP"	Means International Commission on Non-Ionizing Radiation Protection (ICNIRP)
"ITA"	means Invitation to Apply
"ITU"	means the International Telecommunication Union
"ITU-R"	means the International Telecommunication Union Radiocommunication Sector
"LTE"	means Long Term Evolution is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies
"NRFP"	means the National Radio Frequency Plan 2013 for South Africa
"PCI"	means Physical-Layer Cell Identities
"PPDR"	means Public Protection and Disaster Relief as defined in ITU-R Report M.2033.
"PRACH"	means Physical Random Access Channel
"PSTN"	means Public Switched Telephone Network
"PUCCH"	means Physical Uplink Control Channel

"RFSAP"	means Radio Frequency Spectrum Assignment Plan
"TCA"	means Terrain Clearance Angle
"TDD"	means Time Division Duplex
"WRC-12"	means World Radiocommunication Conference 2012 held in Geneva
"WRC-15"	means World Radiocommunication Conference planned to be held in 2015 in Geneva

2 Purpose

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

2.2 This Radio Frequency Spectrum Assignment Plan states the requirements for the utilisation of the frequency band between 791-821 MHz paired with 832-862 MHz for IMT800.

2.3 The ITU states that International Mobile Telecommunications (IMT) systems are mobile systems that provide access to a wide range of telecommunication services including advanced mobile services, supported by mobile and fixed networks, which are increasingly packet-based.

Key features are:

- a high degree of commonality of functionality worldwide whilst retaining the flexibility to support a wide range of services and applications in a cost efficient manner;
- compatibility of services within IMT and with fixed networks;
- capability of interworking with other radio access systems;
- high quality mobile services;
- user equipment suitable for worldwide use;
- user-friendly applications, services and equipment;
- worldwide roaming capability; and
- enhanced peak data rates to support advanced services and applications

3 General

3.1 Technical characteristics of equipment used in IMT800 systems must conform to all applicable South African standards, international standards, International

Telecommunications Union (ITU) and its radio regulations as agreed and adopted by South Africa

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

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

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

3.5 Frequency bands assigned for IMT800 include bands 791-821MHz paired with 832-862MHz.

3.6 Likely use of this band will be for mobile voice and data communications.

3.7 The technologies which can provide IMT800 services include, but are not limited to:

- LTE
- LTE Advanced;
- HSPA+; and
- WiMAX

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

- Recommendation ITU-R M.2012-1 (02/2014): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT Advanced);
- Report ITU-R2241-0 Compatibility studies in relation to Resolution 224 in the bands 698-806 MHz and 790-862 MHz;
- Report ITU-R M.2074: Report on Radio Aspects for the terrestrial component of IMT-2000 and systems beyond IMT-2000;
- Recommendation ITU-R M.1645 Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000; and
- Recommendation ITU-R M.1036-4: Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations (RR).

4 Channelling Plan

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

- 2×30MHz FDD for IMT800.

4.2 Channel arrangements.

4.3 The channel arrangements for the IMT800 band are based on the Region 1 recommendation by the ITU. Adjacent assignments are also shown in the channelling plan.

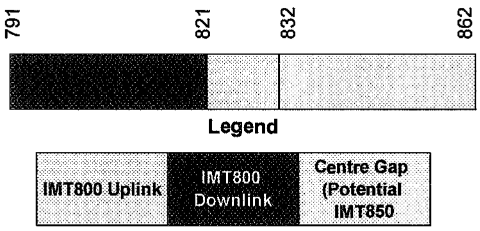


Figure 6: Channel arrangements for IMT800

5 Requirements for usage of radio frequency spectrum

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

5.2 The use of the band is limited for IMT-services.

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

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

5.5 The allocation of spectrum and shared services within these bands are found in the National Radio Frequency Plan (NRFP) and an extract of NRFP is shown in Appendix A.

5.6 Maximum radiated power:

5.6.1 Base Station transmissions should not exceed 61dBm/5MHz EIRP;

5.6.2 Mobile Station transmissions should not exceed 23dBm EIRP;

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

5.6.4 Where appropriate, the subscriber terminal station should comply with the technical specification outlined under "3GPP TS 36.521-1" or the latest version.

5.7 ICNIRP compliance is encouraged, where applicable.

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

6 Implementation

6.1 This Radio Frequency Assignment Plan comes into effect on 1st July 2015.

6.2 The process of assignment may commence prior to the date referred to in section 6.1.

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

7 Coordination Requirements

7.1 Use of these frequency bands will require coordination with the neighbouring countries within the coordination zones of 6 kilometres in cases of LTE-to-LTE or 9 kilometres in cases of LTE-to-other technologies from the neighbouring country. The coordination distance is continuously being reviewed and these may be updated from time to time.

7.2 The following field strength thresholds have to be assured based on (ECC/REC(11)04 for 790-862MHz. Operator-to-operator coordination may be necessary to avoid interference

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 55dBμV/m/5MHz at a height of 3 m above ground at the border line between countries and does not exceed a value of 29dBμV/m/5MHz 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 both sides of the border, the field strength levels can be increased to 59 dBμV/m/5MHz and 41 dBμV/m/5MHz at 6 km.

If TDD is in operation across both sides of a border and is synchronised across the border then field strength levels as well.

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

<table>
<tr><th>BW (MHz)</th><th>Field strength level at 3 m height (general case)</th><th>Field strength level at 3 m height (LTE case)</th></tr>
<tr><td rowspan="2">5 MHz</td><td>55.0 dBμV/m/5MHz @0km</td><td>59.0 dBμV/m/5MHz @0km</td></tr>
<tr><td>29.0 dBμV/m/5MHz @9km</td><td>41.0 dBμV/m/5MHz @6km</td></tr>
<tr><td rowspan="2">10 MHz</td><td>58.0 dBμV/m/10MHz @0km</td><td>62.0 dBμV/m/10MHz @0km</td></tr>
<tr><td>32.0 dBμV/m/10MHz @9km</td><td>44.0 dBμV/m/10MHz @6km</td></tr>
<tr><td rowspan="2">15 MHz</td><td>59.8 dBμV/m/15MHz @0km</td><td>63.8 dBμV/m/15MHz @0km</td></tr>
<tr><td>33.8 dBμV/m/15MHz @9km</td><td>45.8 dBμV/m/15MHz @6km</td></tr>
<tr><td rowspan="2">20 MHz</td><td>61.0 dBμV/m/20MHz @0km</td><td>65.0 dBμV/m/20MHz @0km</td></tr>
<tr><td>35.0 dBμV/m/20MHz @9km</td><td>47.0 dBμV/m/20MHz @6km</td></tr>
</table>

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

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

7.3 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.

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

7.5 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 interference resolution process as shown in Appendix D.

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

8 Assignment

8.1 An Invitation to Apply will be published for new assignments in this band in line with regulations developed in terms of section 31(3) of the Act.

9 Transitional Arrangements

9.1 The Authority resolved the following transitional arrangements for the right of use of spectrum in this frequency band:

9.2 That Broadcasting Spectrum Assignments in the affected areas as stipulated in the Terrestrial Broadcasting Frequency Plan (Notice No. 298 of 2013 in Government Gazette No. 36321 and Notice No. 801 of 2014 in Government Gazette 38005 or the latest version), are to be used subject to meeting the conformance requirements in line with the GE06 Plan and are to be phased out during the performance period – see Appendix E;

9.3 That broadcast transmissions and services ancillary to broadcasting in the band above 694 MHz are to be systematically switched off; and

9.4 That matters related to spectrum management geared at minimising and/or prevent harmful interference during the transitional arrangement period, are to be managed by the Authority which will develop a systematic implementation plan for the a seamless transition.

10 Radio Frequency Migration

10.1 Specific Procedure:

10.1.1 This band has been allocated to IMT (Terrestrial) for Region 1 countries at WRC-07 and is often termed Digital Dividend 1. Currently this band is occupied by UHF TV.

10.1.2 It is intended, as per the latest version of the Terrestrial Broadcasting Frequency Plan that:

- TV will migrate out of this band as per the Terrestrial Broadcasting Frequency Plan in line with the specified Analogue switch-off date;
- The small number of Studio Transmitter Links in this band must be migrated out and given point-to-point fixed assignments;
- Appropriate destination bands for STLs are:
    - The 2025 – 2110 MHz (paired with 2200 – 2285 MHz);
    - Self Help Stations must be migrated out as per latest version of Terrestrial Broadcasting Frequency Plan.

Appendix A National Radio Frequency Plan

ITU Region 1 allocations and footnote	South African allocations and footnotes	Typical Applications	Comments
790-862 MHz	**790-862 MHz**		
FIXED	FIXED	Fixed Links (856 – 864.1 MHz)	The fixed links will be migrated along with the broadcasting service in line with Radio Frequency Migration Plan.
MOBILE except aeronautical mobile 5.317A	MOBILE except aeronautical mobile 5.316B 5.317A NF9	IMT800 BTX (791 – 821 MHz)	Paired with 832 – 862 MHz
		Mobile Wireless Access (827.775 – 832.695 MHz)	Paired with Access (872.775 – 877.695 MHz)
		IMT800 MTX (832 – 862 MHz)	Paired with 791 – 821 MHz
BROADCASTING	BROADCASTING	Television Broadcasting (470 – 854 MHz)	Broadcasting Allotments in accordance with GE89 plan in the process of conversion to GE06. Broadcast assignments in accordance with the latest version of the Terrestrial Broadcasting Frequency Plan.
5.312 5.314 5.315 5.316 5.316A 5.319	5.316A		

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 nature, 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 appropriate detailed terrain data is available, the propagation model for interference field strength prediction is the latest version of ITU-R Rec. P.452, For the relevant transmitting terminal, predictions of path loss would be made at x km steps along radials of y km at z degree intervals[7]. The values for those receiver locations within the neighbouring country would be used to construct a histogram of path loss – and if more than 10% of predicted values exceed the threshold the station should be 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". This model is to be employed for 50% of locations, 10% time and using a receiver height of 3 m. For specific reception areas where terrain roughness adjustments for improved accuracy of field strength prediction are needed, administrations may use correction factors according to terrain irregularity and/or an averaged value of the TCA parameter in order to describe the roughness of the area on and around the coordination line.

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

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

Area calculations

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

For evaluation:

- only 10% of the number of geographical areas between the border line (including the border line) and the 6 km line itself inside the neighbouring country may be interfered with by higher field strength than the trigger field strength value given for the border line in section 7.2 at a height of 3m above ground.
- only 10% of the number of geographical areas between the 6 km (including the 6 km line) and 12 km line inside the neighbouring country may be interfered with by a higher field strength than the trigger field strength value given for the 6 km line in section 7.2 at a height of 3m 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 1km, free space propagation model needs to be applied. Furthermore, if there is no terrain obstacle within the 1st Fresnel zone, the free space propagation model should be applied.

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

For area type interference calculations, propagation models with path-specific terrain correction factors are recommended (e.g. Recommendation ITU–R P.1546 with the Terrain Clearance Angle correction factor TCA, HCM method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812).

As to correction factors for clutters 'open area' and 'quasi-open area', 20 dB and 15 dB should be used respectively. Recommendation ITU–R P.1406 should be used if a finer selection of clutter is required.

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

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE[8]

The following is extracted from ECC/REC(11)05 as an operational example and can be adapted for the SADC-countries

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

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

Administrations should agree on a repartition of these 504 PCI 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 PCI's is equivalent. Each country can use all PCI groups away from the border areas.

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

Four types of countries are defined in a way such that no country will use the same code set as any one of its neighbours. The following lists describe the distribution of European countries (*which needs to be adapted for SADC*):

Type country 1: BEL, CVA, CYP, CZE, DNK, E, FIN, GRC, IRL, ISL, LTU, MCO, SMR, SUI, SVN, UKR, AZE, SRB;

Type country 2: AND, BIH, BLR, BUL, D, EST, G, HNG, I, MDA, RUS (Exclave), GEO;

Type country 3: ALB, AUT, F, HOL, HRV, POL, POR, ROU, RUS, S, MLT;

Type country 4: LIE, LUX, LVA, MKD, MNE, NOR, SVK, TUR.

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:

(black)	Preferential PCI
	Non-preferential PCI

[8] ECC/REC(11)05

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

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

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

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

Notes

1) All PCIs are available in areas away from the border.
2) In certain specific cases (e.g. AUT/HRV), where the distance between two countries of the same type number is very small, it may be necessary to address the situation in bi/multilateral coordination agreements as necessary, and may include further subdivision of the allocated codes in certain areas.

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

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

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

1. Demodulation Reference Signal (DM RS) coordination

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

The case of partial channel overlap has not been studied but, due to DM RS occupying resource blocks of separate users, there is a risk of DM RS collisions between neighbouring networks when the subcarriers' positions coincide (the frequency offset between central carriers of neighbouring networks is 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 basic planning procedure only 30 DM RS sequence groups with favourable correlation characteristics are available: {0...29}. In this case each cell could be assigned one of the 30 DM RS sequence groups providing a cluster size of 30.
- It is possible to extend each DM RS sequence group to generate up to 12 time-shifted sequence groups by applying the cyclic shift parameter stated in 3GPP TS 36.211. For 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 a limited number of groups are 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 only recently during first trials of LTE and caused throughput loss as well as time alignment problems.

- Another approach for DM RS coordination is to implement dynamic DM RS sequence group allocation also called pseudo-random group hopping. In this method, nearby cells are grouped into clusters of up to 30 cells and within each cell cluster the same hopping pattern is used. At the border of two clusters, inter-cell interference is averaged since two different hopping patterns are used. There are 17 defined hopping patterns, numbered {0...16}, which leads to some minor inequality in the case of apportioning these patterns between neighbouring countries. Even in a trilateral case, each operator will have at least 5 hopping patterns available near the border which should be enough for planning purposes. It should be noted the pseudo-random group hopping option could be absent in the first generations of LTE equipment.

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

2. Physical Random Access Channel (PRACH) coordination

Another radio network parameter which 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 is usually the same for all cells, again because the PRACH-to-PRACH interference case is the more favourable one; and
- cell-specific root sequences are used to distinguish between PRACH requests addressed to different cells.

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

In early implementation, it is possible that a very limited number of frequency positions will be supported by LTE equipment which will not be enough to coordinate in the trilateral

case. In such cases, root-sequence repartition could be used. There are 838 root sequences in total, to be distributed between cells, numbered {0..837}. There are two numbering schemes for PRACH root sequences (physical and logical) and only logical root sequences numbering needs be used for coordination. Unfortunately, the process of root sequences planning doesn't involve direct mapping of root sequences between cells because the number of root sequences needed for one cell is dependent on the cell range. The table showing such interdependency is presented below:

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

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

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

Appendix D Interference Resolution Process

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 [deg];

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 [deg]

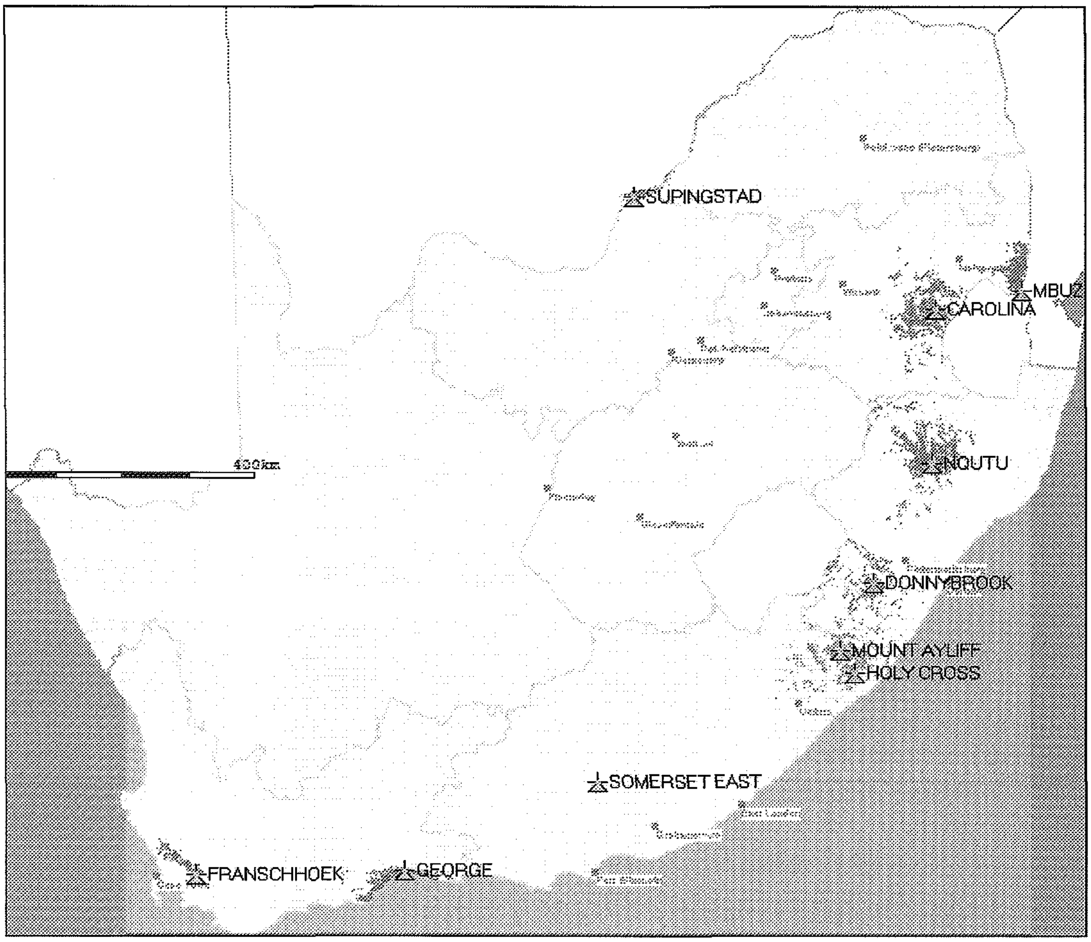
The Administration affected shall evaluate the request for coordination and shall within 30 days, notify the result of the evaluation to the Administration requesting coordination. If, in the course of the coordination procedure, the Administration affected requires additional information, it may request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

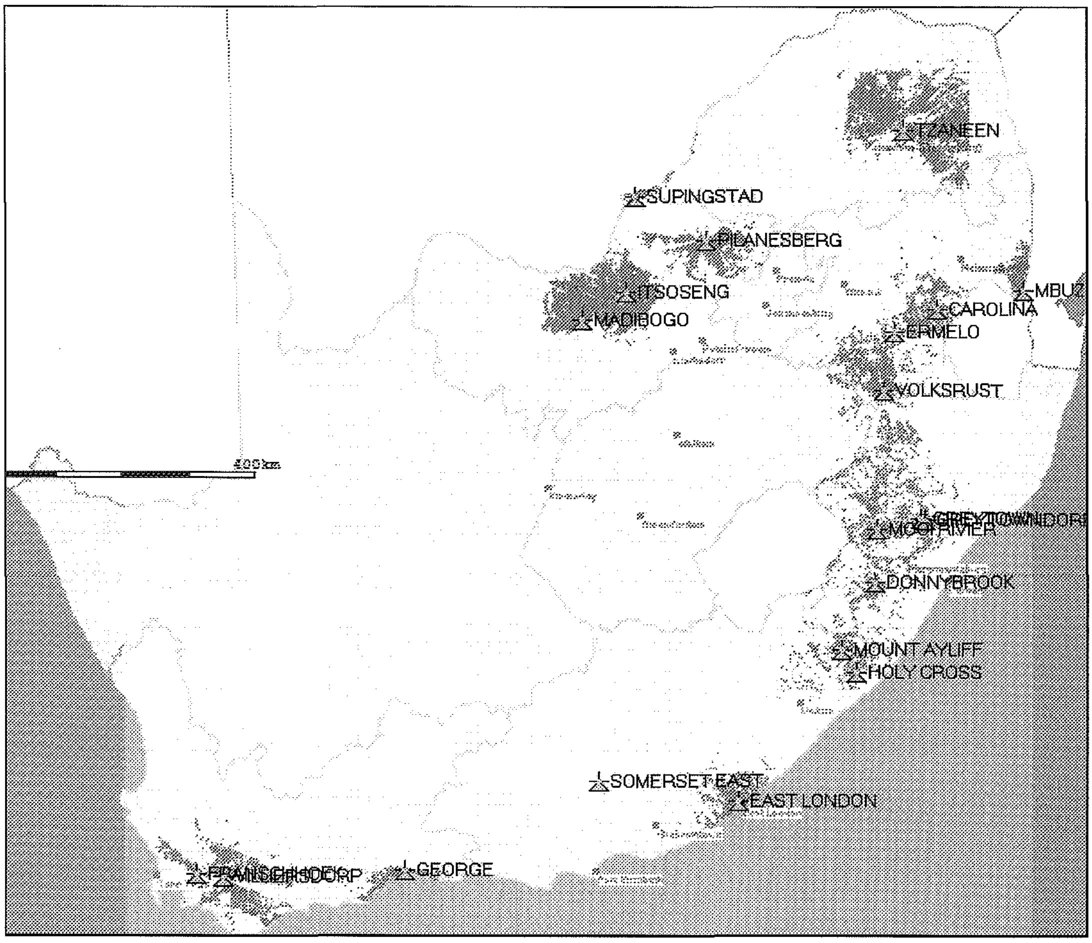
The periods mentioned above may be extended by mutual consent.

Appendix E DD 1 (790 – 862 MHz) - Affected Broadcast Networks

DDT1



DDT2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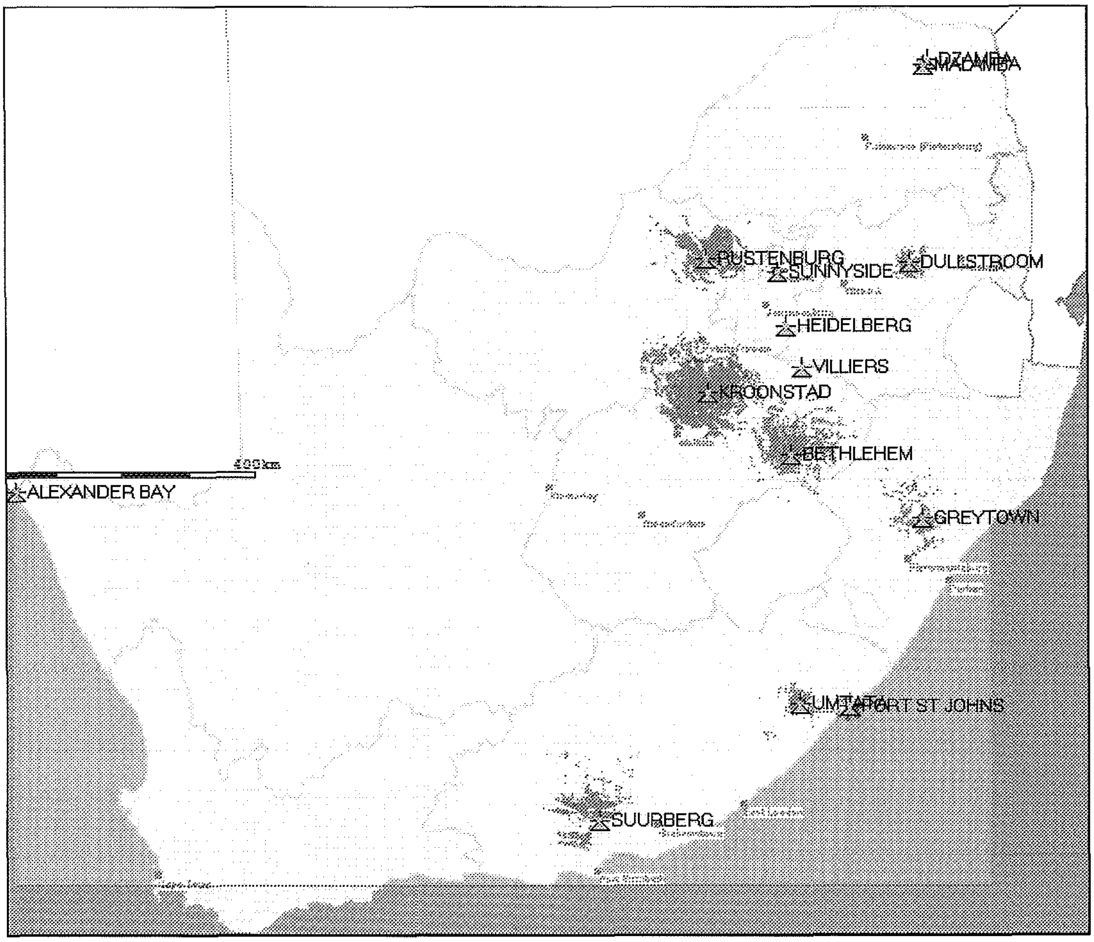
PILANESBERG
ITSOSENG
MADIBOGO
CAROLINA
ERMELO
VOLKSRUST
DONNYBROOK
MOUNT AYLIFF
HOLY CROSS
SOMERSET EAST
EAST LONDON
GEORGE
400km

SABC1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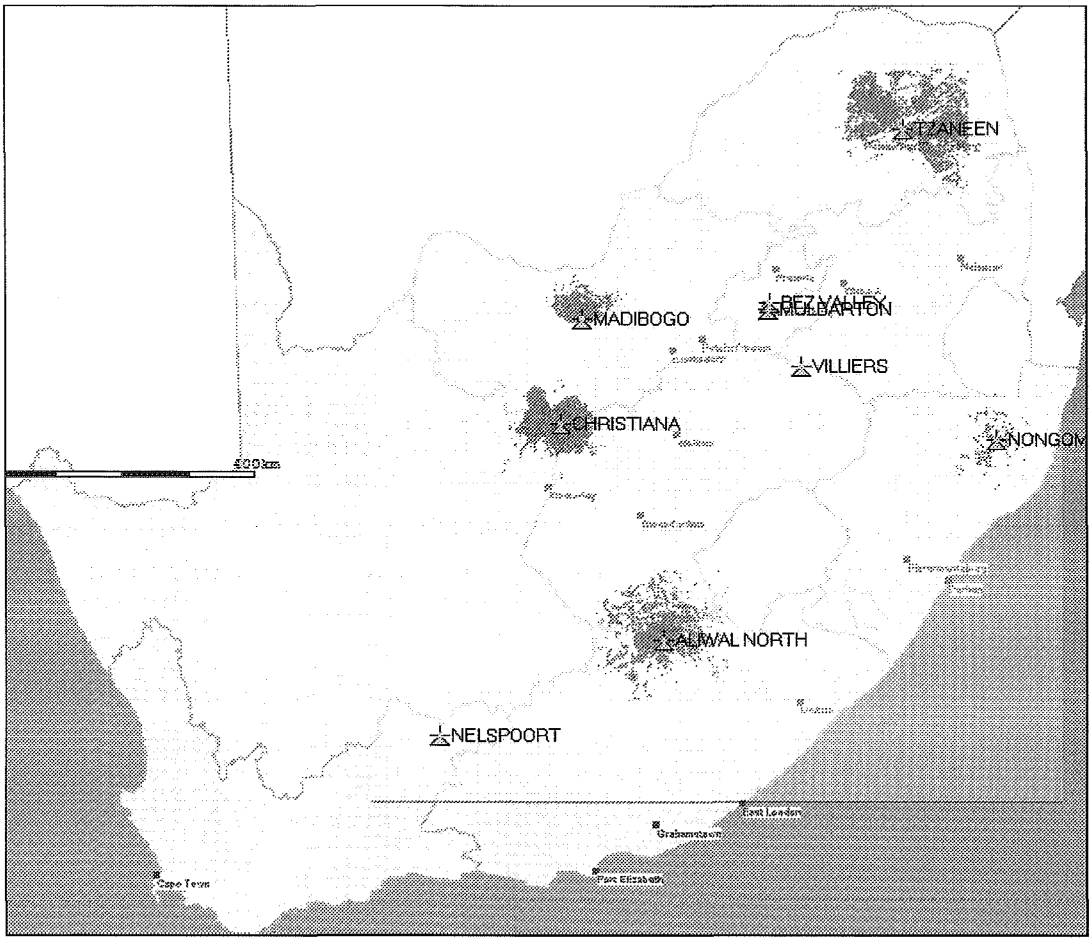
MALAMBA
RUSTENBURG
SUNNYSIDE
DULLSTROOM
HEIDELBERG
VILLIERS
KROONSTAD
BETHLEHEM
400km
ALEXANDER BAY
GREYTOWN
UMTATA
PORT ST JOHNS
SUURBERG

SABC2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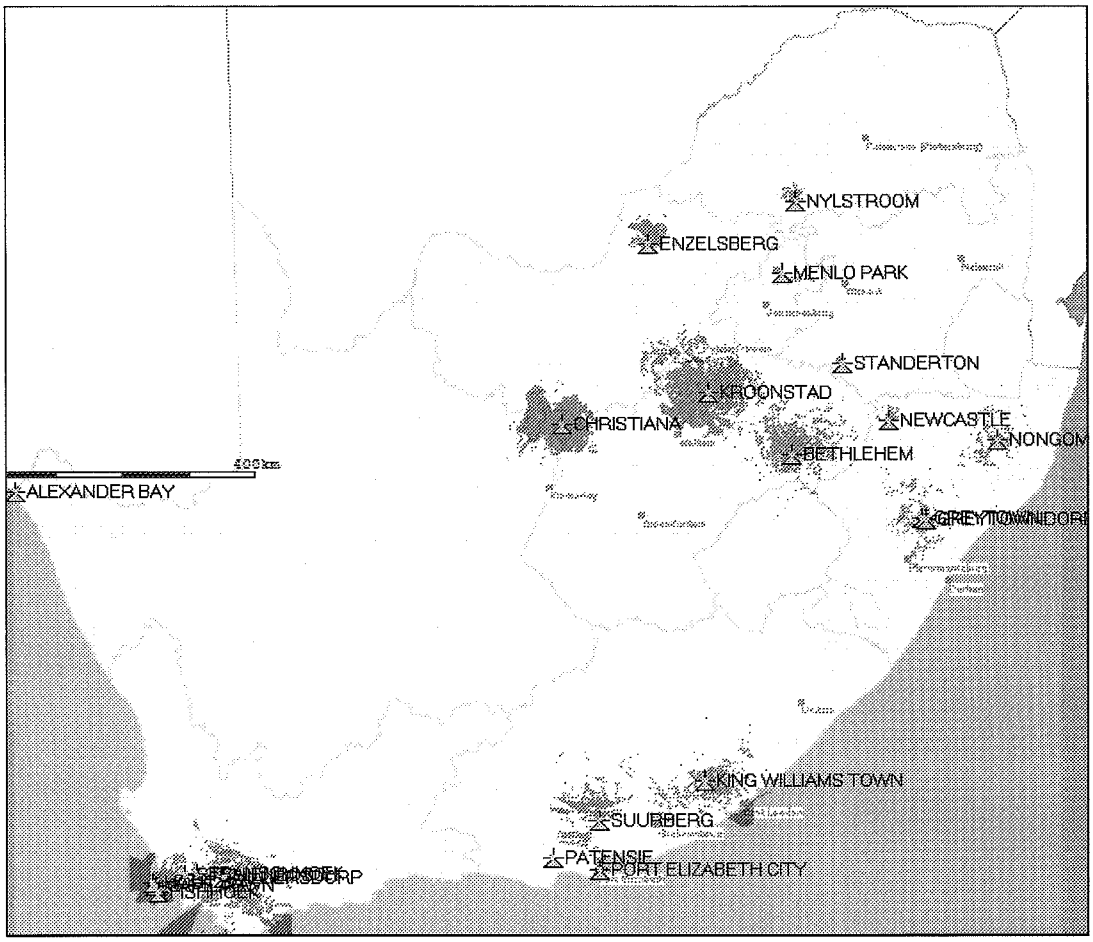
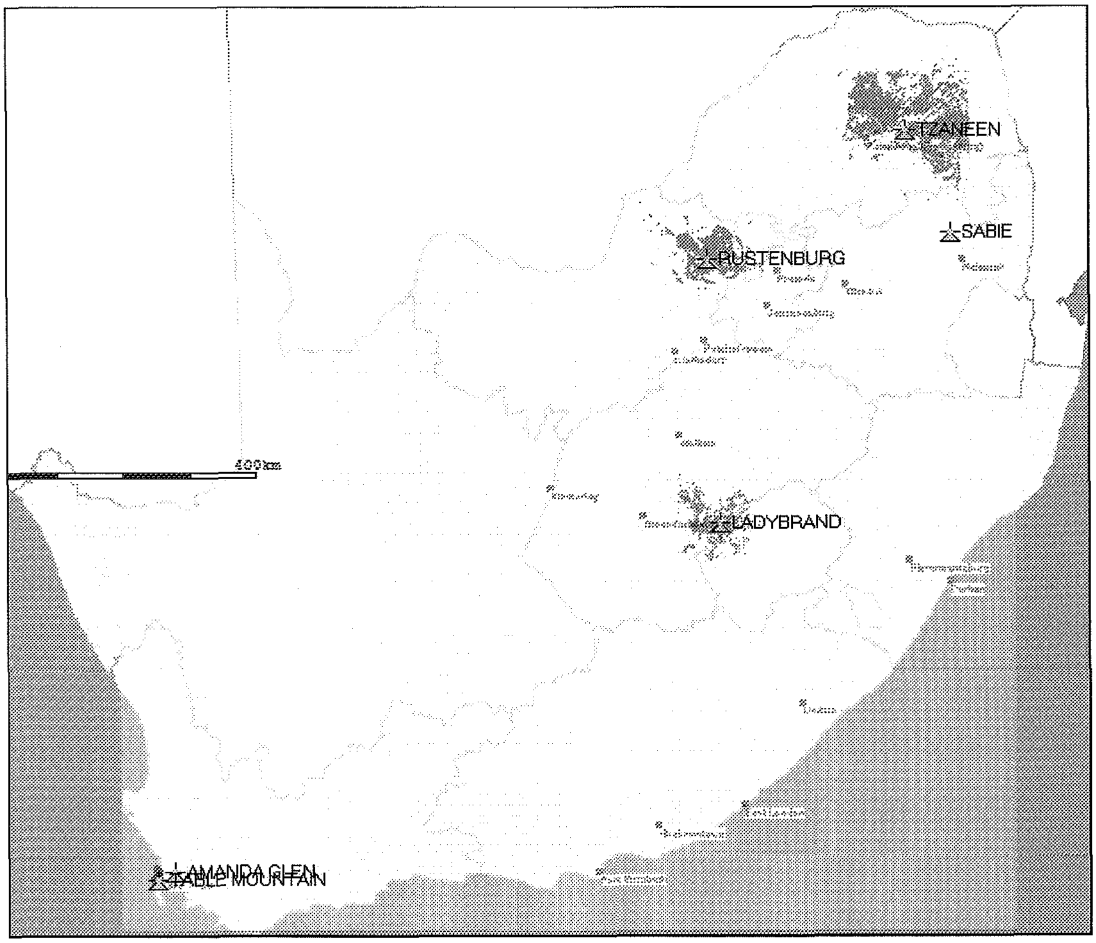
BEZ VALLEY
MULBARTON
MADIBOGO
VILLIERS
CHRISTIANA
NONGOMA
ALIWAL NORTH
NELSPOORT

SABC3

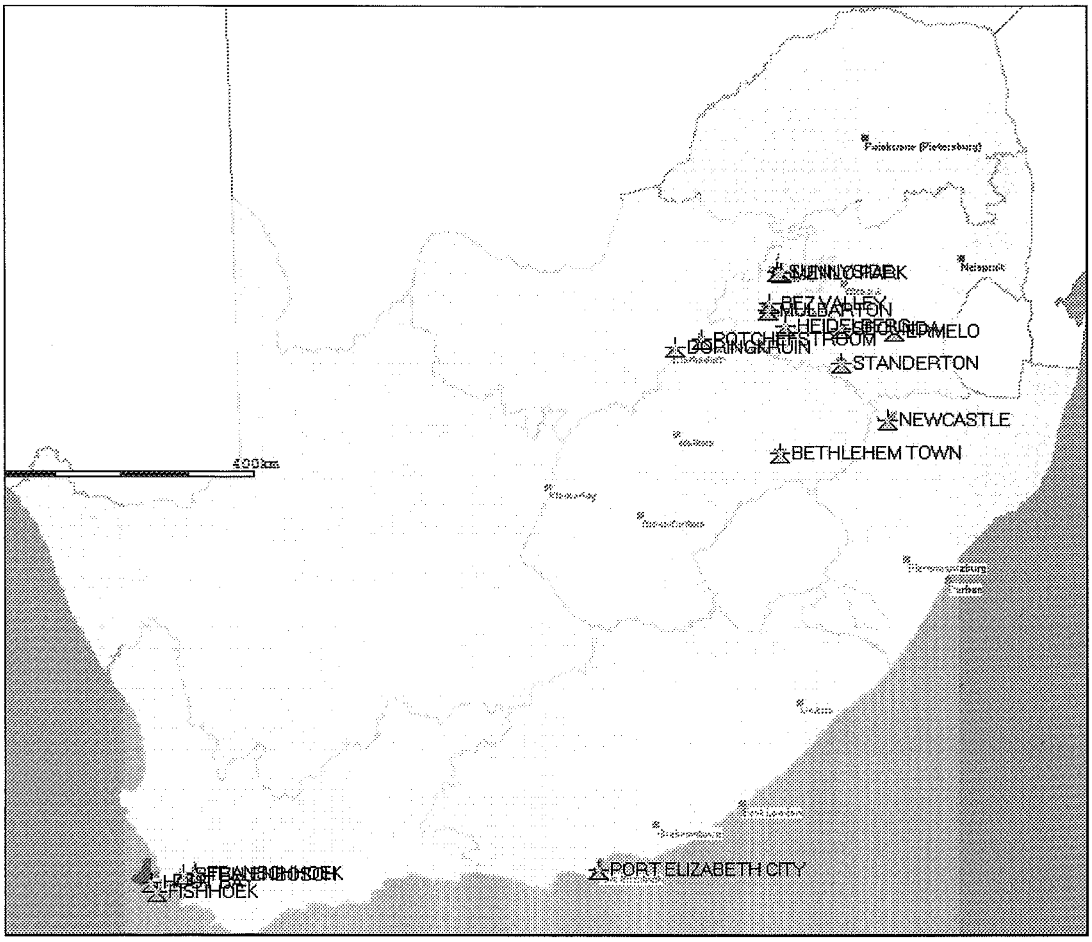

NYLSTROOM
ENZELSBERG
MENLO PARK
STANDERTON
KROONSTAD
CHRISTIANA
NEWCASTLE
BETHLEHEM
400km
ALEXANDER BAY
KING WILLIAMS TOWN
SUURBERG
PATENSIE
PORT ELIZABETH CITY

Etv


TZANEEN
SABIE
RUSTENBURG
LADYBRAND
AMANDA GLEN
TABLE MOUNTAIN
400km

Page 26

Mnet


STANDERTON
NEWCASTLE
BETHLEHEM TOWN
PORT ELIZABETH CITY
FISHHOEK

NOTICE 274 OF 2015

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

PURSUANT TO SECTION 4 (1) OF THE ELECTRONIC COMMUNICATIONS ACT 2005, (ACT NO. 36 OF 2005)

HEREBY ISSUES A NOTICE REGARDING THE FINAL RADIO FREQUENCY SPECTRUM ASSIGNMENT PLAN FOR THE FREQUENCY BAND 825 TO 830 MHz AND 870 TO 875 MHz

1. The Independent Communications Authority of South Africa ("the Authority"), published the draft **Radio Frequency Spectrum Assignment Plan for the frequency band 825 to 830 MHz and 870 to 875 MHz** in terms of sections 2 (d), (e) and 4, read with sections 30, 31(4), and 33 of the Electronic Communications Act (Act No. 36 of 2005) and read with Regulation 3 of the Radio Frequency Spectrum Regulations 2011 and read with the IMT Roadmap 2014.

2. The draft Radio Frequency Spectrum Assignment Plan in this location was published in Government Gazette number 38214 (Notice 1014 of 2014) on the 14th of November 2014.

3. Notice number 1014 of 2014 on the Draft Radio Frequency Spectrum Assignment Plan for the frequency band 825 to 830 MHz and 870 to 875 MHz is hereby deferred until further notice.

Dr SS MNCUBE
CHAIRPERSON

NOTICE 275 OF 2015

ICASA

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

PURSUANT TO SECTION 4 (1) OF THE ELECTRONIC COMMUNICATIONS ACT 2005, (ACT NO. 36 OF 2005)

HEREBY ISSUES A NOTICE REGARDING THE FINAL RADIO FREQUENCY SPECTRUM ASSIGNMENT PLAN FOR THE FREQUENCY BAND 880 TO 915 MHz AND 925 TO 960 MHz.

1. The Independent Communications Authority of South Africa ("the Authority"), hereby publishes **Final Radio Frequency Spectrum Assignment Plan for the frequency band 880 to 915 MHz and 925 to 960 MHz** in terms of sections 2 (d), (e) and 4, read with sections 30, 31(4), and 33 of the Electronic Communications Act (Act No. 36 of 2005) and read with Regulation 3 of the Radio Frequency Spectrum Regulations 2011 and read with the IMT Roadmap 2014.

2. This Radio Frequency Spectrum Assignment Plan (RFSAP) supersedes any previous spectrum assignment arrangements for the same spectrum location. However, if it happens that on the date a provision of the RFSAP comes into effect, there is a conflict between the RFSAP and the latest versions of the National Radio Frequency Plan (NRFP) and Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan will prevail.

Dr SS MNCUBE
CHAIRPERSON

ICASA

Radio Frequency Spectrum Assignment Plan

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

Table of Contents

1 Glossary

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

"3GPP"	means the 3rd Generation Partnership Project (3GPP) which consists of six telecommunications standard development organisations
"Act"	means the Electronic Communications Act, 2005 (Act No. 36 of 2005) as amended
"DM RS"	means Demodulation Reference Signal
"ECC/REC(11)04"	means ECC Recommendation (11)04
"ECC"	means Electronic Communications Committee within the European Conference of Postal and Telecommunications Administrations (CEPT)
"FDD"	means Frequency Division Duplex
"HCM"	means Harmonised Calculation Method
"ICNIRP"	Means International Commission on Non-Ionizing Radiation Protection (ICNIRP)
"IMT"	means International Mobile Telecommunications
"IMT900"	means IMT in the 900MHz band
"ITA"	means Invitation to Apply
"ITU"	means the International Telecommunication Union
"ITU-R"	means the International Telecommunication Union Radiocommunication Sector
"LTE"	means Long Term Evolution is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies
"NRFP"	means the National Radio Frequency Plan 2013 for South Africa
"PCI"	means Physical-Layer Cell Identities
"PPDR"	means Public Protection and Disaster Relief as defined in ITU-R Report M.2033.
"PRACH"	means Physical Random Access Channel
"PSTN"	means Public Switched Telephone Network
"PUCCH"	means Physical Uplink Control Channel

"RFSAP"	means Radio Frequency Spectrum Assignment Plan
"TCA"	means Terrain Clearance Angle
"TDD"	means Time Division Duplex
"WRC-12"	means World Radiocommunication Conference 2012 held in Geneva
"WRC-15"	means World Radiocommunication Conference planned to be held in 2015 in Geneva

2 Purpose

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

2.2 This Radio Frequency Spectrum Assignment Plan states the requirements for the utilisation of the frequency band between 880 and 915 MHz paired with 925 to 960 MHz for IMT900.

2.3 The ITU states that International Mobile Telecommunications (IMT) systems are mobile systems that provide access to a wide range of telecommunication services including advanced mobile services, supported by mobile and fixed networks, which are increasingly packet-based.

Key features:

- 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
- enhanced peak data rates to support advanced services and applications

3 General

3.1 Technical characteristics of equipment used in IMT900 systems must conform to all applicable South African standards, international standards, International

Telecommunications Union (ITU) and its radio regulations as agreed and adopted by South Africa.

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

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

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

3.5 Frequency bands assigned for IMT900 include bands 880 MHz to 915 MHz paired with 925 to 960 MHz.

3.6 Likely use of this band will be for IMT.

3.7 The technologies which can provide IMT800 services include, but are not limited to:

- UMTS;
- GSM;
- LTE;
- LTE Advanced;
- HSPA+; and
- WiMAX.

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

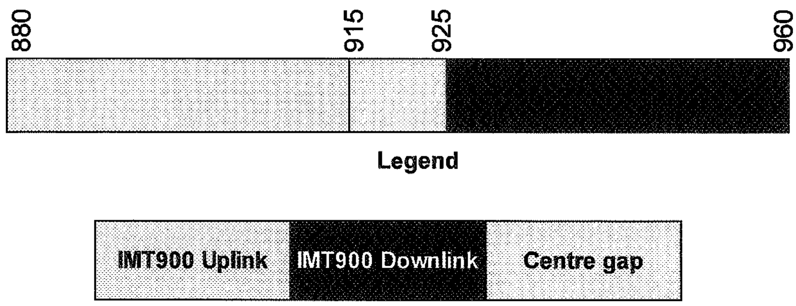
- Recommendation ITU-R M.2012-1 (02/2014): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT Advanced);
- Report ITU-R M.2074: Report on Radio Aspects for the terrestrial component of IMT-2000 and systems beyond IMT-2000;
- Recommendation ITU-R M.1645 Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000; and
- Recommendation ITU-R M.1036-4: Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations (RR).

4 Channelling Plan

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

- 2×35MHz FDD for IMT900.

4.2 Channel arrangements



5 Requirements for usage of radio frequency spectrum

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

5.2 The use of the band is limited for IMT-services.

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

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

5.5 The allocation of spectrum and shared services within these bands are found in the National Radio Frequency Plan (NRFP) and an extract of NRFP is shown in Appendix A.

5.6 Maximum radiated power:

5.6.1 Base Station transmissions should not exceed 61dBm/5MHz EIRP;

5.6.2 Mobile Station transmissions should not exceed 23dBm EIRP; and

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

5.6.4 Where appropriate, subscriber terminal station should comply with the technical specification outlined under "3GPP TS 36.521-1" or latest version.

5.7 ICNIRP compliance is encouraged, where applicable.

5.8 Criteria and guidelines for interference mitigation are described in **Error! Reference source not found.**.

6 Implementation

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

6.2 Licensees are required to follow the in-band harmonisation and optimisation process detailed in Chapter 10 (Radio Frequency Migration).

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

7 Coordination Requirements

7.1 Use of these frequency bands will require coordination with the neighbouring countries within the coordination zones of 6 kilometres in cases of LTE-to-LTE or 9 kilometres in cases of LTE-to-other technologies from the neighbouring country. The coordination distance is continuously being reviewed and these may be updated from time to time.

7.2 The following field strength thresholds have to be assured based on (ECC/REC(11)04 for 790-862MHz. Operator-to-operator coordination may be necessary to avoid interference

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 55dBμV/m/5MHz at a height of 3 m above ground at the border line between countries and does not exceed a value of 29dBμV/m/5MHz 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 both sides of the border the field strength levels can be increased to 59 dBμV/m/5MHz and 41 dBμV/m/5MHz at 6 km.

If TDD is in operation across both sides of a border and is synchronised across the border then field strength levels as well.

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

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

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

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 15dBμV/m/5 MHz at 10% time, 50% of locations at 3 metres above ground level at the border line.

7.3 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.

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

7.5 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 interference resolution process as shown in **Error! Reference source not found.**.

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

8 Assignment

8.1 When a new assignment is enabled for this band, an Invitation to Apply will be published for the assignments in this band in line with regulations developed in terms of section 31 (3) of the Act.

8.2 When an existing assignment is changed, the licence will be amended accordingly.

9 Amendment

9.1 Existing Radio Frequency Spectrum Licences will be amended as appropriate.

10 Radio Frequency Migration

10.1 Specific Procedure

10.1.1 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.

10.1.2 The following steps will 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 2011.
- The Authority has decided that the following assignments within the IMT900 band are to be achieved by 31st March 2020 at the latest.

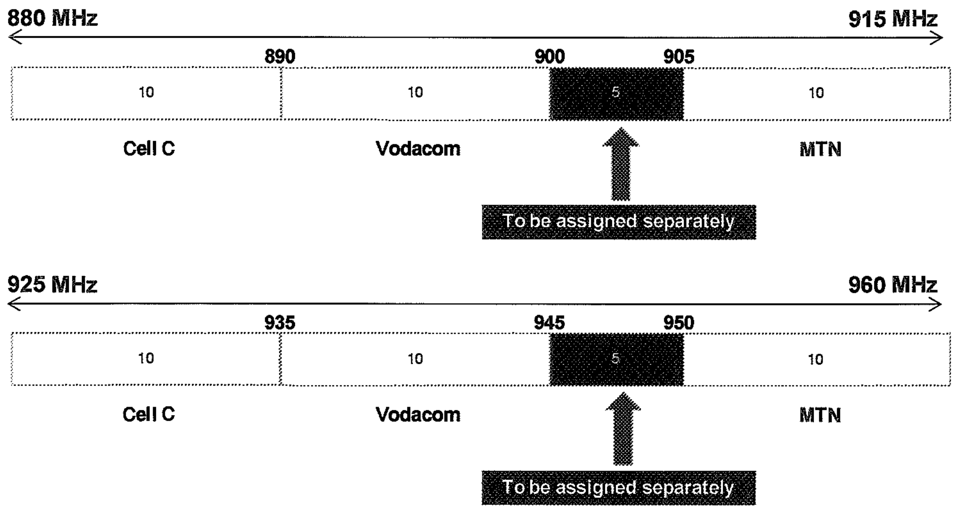


Figure 7: Assignments from 31st March 2020

- The 2x5 MHz block will be assigned in a separate process.

Appendix A National Radio Frequency Plan

ITU Region 1 allocations and footnote	South African allocations and footnotes	Typical applications	Comments
862-890 MHz	**862-890 MHz**		
FIXED	FIXED	Fixed links (856-864.1 MHz),	Paired with 868.1-876 MHz
MOBILE except aeronautical mobile 5.317A	MOBILE except aeronautical mobile 5.317A, NF9, NF10	Mobile Wireless Access (872.775-877.695 MHz)	Paired with 827.775-832.695 MHz
		GSM-R (MTX) 877.695-880 MHz) NF10,	Paired with 921-925 MHz
		IMT900 MTX (880-915 MHz),	Paired with 925-960 MHz
		Wireless Audio systems and Wireless microphones (863-865 MHz) CT2 cordless phones (864.1-868.1 MHz) CT2 FWA (864.1-868.1 MHz)	Radio Frequency Spectrum Regulations (Annexure B) (GG. No. 34172, 31 March 2011)
		RFID (865-868 MHz) Non-specific SRD and RFID (869.4-869.65 MHz)	Spectrum Re-allocation for (RFID) (GG. No. 31127, 5 June 2008)
		Non-specific SRDs (868 – 868.6 MHz, 868.7-869.2 MHz,869.4 - 869.65 MHz, 869.7-870 MHz) Alarms (868.6-868.7 MHz, 869.25-869.3 MHz, 869.65-869.7 MHz)	Radio Frequency Spectrum Regulations (Annex B) (GG. No. 34172, 31 March 2011)
BROADCASTING 5.322			
5.319 5.323			

890-942 MHz FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 Radiolocation 5.323	**890-942 MHz** MOBILE except aeronautical mobile 5.317A NF9 NF10 NF11	GSM-R (BTX) (921-925 MHz) IMT900 MTX (880-915 MHz), IMT900 BTX (925-960 MHz), RFID (including, passive tags and vehicle location (915.1-921MHz	Paired with 877.695-880 MHz Paired with 925-960 MHz Paired with 880-915 MHz Spectrum re-allocation for RFID (GG. No. 31127, 5 June 2008)
942-960 MHz FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 5.323	**942-960 MHz** MOBILE except aeronautical mobile 5.317A NF9	IMT900 BTX (925 – 960 MHz)	Paired with 880 – 915 MHz

Appendix B Propagation Model

The following methods are proposed for assessment of anticipated interference inside neighbouring countries based on established trigger values. Due to the complexity of radio-wave propagation nature, 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 appropriate detailed terrain data is available, the propagation model for interference field strength prediction is the latest version of ITU-R Rec. P.452, For the relevant transmitting terminal, predictions of path loss would be made at x km steps along radials of y km at z degree intervals[9]. The values for those receiver locations within the neighbouring country would be used to construct a histogram of path loss – and if more than 10% of predicted values exceed the threshold the station should be 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". This model is to be employed for 50% of locations, 10% time and using a receiver height of 3 m. For specific reception areas where terrain roughness adjustments for improved accuracy of field strength prediction are needed, administrations may use correction factors according to terrain irregularity and/or an averaged value of the TCA parameter in order to describe the roughness of the area on and around the coordination line.

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

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

Area calculations

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

For evaluation:

- only 10% of the number of geographical areas between the border line (including the border line) and the 6 km line itself inside the neighbouring country may be interfered with by higher field strength than the trigger field strength value given for the border line in section 7.2 at a height of 3m above ground.
- only 10% of the number of geographical areas between the 6 km (including the 6 km line) and 12 km line inside the neighbouring country may be interfered with by a higher field strength than the trigger field strength value given for the 6 km line in section 7.2 at a height of 3m 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 1km, free space propagation model needs to be applied. Furthermore, if there is no terrain obstacle within the 1st Fresnel zone, the free space propagation model should be applied.

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

For area type interference calculations, propagation models with path-specific terrain correction factors are recommended (e.g. Recommendation ITU–R P.1546 with the Terrain Clearance Angle correction factor TCA, HCM method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812).

As to correction factors for clutters 'open area' and 'quasi-open area', 20 dB and 15 dB should be used respectively. Recommendation ITU–R P.1406 should be used if a finer selection of clutter is required.

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

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE[10]

The following is extracted from ECC/REC(11)05 as an operational example and can be adapted for the SADC-countries

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

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

Administrations should agree on a repartition of these 504 PCI 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 PCI's is equivalent. Each country can use all PCI groups away from the border areas.

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

Four types of countries are defined in a way such that no country will use the same code set as any one of its neighbours. The following lists describe the distribution of European countries (*which needs to be adapted for SADC*):

Type country 1: BEL, CVA, CYP, CZE, DNK, E, FIN, GRC, IRL, ISL, LTU, MCO, SMR, SUI, SVN, UKR, AZE, SRB;

Type country 2: AND, BIH, BLR, BUL, D, EST, G, HNG, I, MDA, RUS (Exclave), GEO;

Type country 3: ALB, AUT, F, HOL, HRV, POL, POR, ROU, RUS, S, MLT;

Type country 4: LIE, LUX, LVA, MKD, MNE, NOR, SVK, TUR.

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:

(black)	Preferential PCI
	Non-preferential PCI

[10] ECC/REC(11)05

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

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

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

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

Notes

1) All PCIs are available in areas away from the border.
2) In certain specific cases (e.g. AUT/HRV), where the distance between two countries of the same type number is very small, it may be necessary to address the situation in bi/multilateral coordination agreements as necessary, and may include further subdivision of the allocated codes in certain areas.

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

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

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

1. Demodulation Reference Signal (DM RS) coordination

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

The case of partial channel overlap has not been studied but, due to DM RS occupying resource blocks of separate users, there is a risk of DM RS collisions between neighbouring networks when the subcarriers' positions coincide (the frequency offset between central carriers of neighbouring networks is 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 basic planning procedure only 30 DM RS sequence groups with favourable correlation characteristics are available: {0...29}. In this case each cell could be assigned one of the 30 DM RS sequence groups providing a cluster size of 30.
- It is possible to extend each DM RS sequence group to generate up to 12 time-shifted sequence groups by applying the cyclic shift parameter stated in 3GPP TS 36.211. For 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 a limited number of groups are 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 only recently during first trials of LTE and caused throughput loss as well as time alignment problems.

- Another approach for DM RS coordination is to implement dynamic DM RS sequence group allocation also called pseudo-random group hopping. In this method, nearby cells are grouped into clusters of up to 30 cells and within each cell cluster the same hopping pattern is used. At the border of two clusters, inter-cell interference is averaged since two different hopping patterns are used. There are 17 defined hopping patterns, numbered {0...16}, which leads to some minor inequality in the case of apportioning these patterns between neighbouring countries. Even in a trilateral case, each operator will have at least 5 hopping patterns available near the border which should be enough for planning purposes. It should be noted the pseudo-random group hopping option could be absent in the first generations of LTE equipment.

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

2. Physical Random Access Channel (PRACH) coordination

Another radio network parameter which 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 is usually the same for all cells, again because the PRACH-to-PRACH interference case is the more favourable one; and
- cell-specific root sequences are used to distinguish between PRACH requests addressed to different cells.

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

In early implementation, it is possible that a very limited number of frequency positions will be supported by LTE equipment which will not be enough to coordinate in the trilateral

case. In such cases, root-sequence repartition could be used. There are 838 root sequences in total, to be distributed between cells, numbered {0..837}. There are two numbering schemes for PRACH root sequences (physical and logical) and only logical root sequences numbering needs be used for coordination. Unfortunately, the process of root sequences planning doesn't involve direct mapping of root sequences between cells because the number of root sequences needed for one cell is dependent on the cell range. The table showing such interdependency is presented below:

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

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

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

Appendix D Interference Resolution Process

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 [deg];

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 [deg]

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 mutual consent.

NOTICE 276 OF 2015

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

PURSUANT TO SECTION 4 (1) OF THE ELECTRONIC COMMUNICATIONS ACT 2005, (ACT NO. 36 OF 2005)

HEREBY ISSUES A NOTICE REGARDING THE FINAL RADIO FREQUENCY SPECTRUM ASSIGNMENT PLAN FOR THE FREQUENCY BAND 2300 TO 2400 MHz .

1. The Independent Communications Authority of South Africa ("the Authority"), hereby publishes **Final Radio Frequency Spectrum Assignment Plan for the frequency band 2300 to 2400 MHz**in terms of sections 2 (d), (e) and 4, read with sections 30, 31(4), and 33 of the Electronic Communications Act (Act No. 36 of 2005) and read with Regulation 3 of the Radio Frequency Spectrum Regulations 2011 and read with the IMT Roadmap 2014.

2. This Radio Frequency Spectrum Assignment Plan (RFSAP) supersedes any previous spectrum assignment arrangements for the same spectrum location. However, if it happens that on the date a provision of the RFSAP comes into effect, there is a conflict between the RFSAP and the latest versions of the National Radio Frequency Plan (NRFP) and Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan will prevail.

Dr SS MNCUBE
CHAIRPERSON

Radio Frequency Spectrum Assignment Plan

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

Table of Contents

1 Glossary

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

"3GPP"	means the 3rd Generation Partnership Project (3GPP) which consists of six telecommunications standard development organisations
"Act"	means the Electronic Communications Act, 2005 (Act No. 36 of 2005) as amended
"DM RS"	means Demodulation Reference Signal
"ECC/REC(11)05"	means ECC Recommendation (11)05
"ECC"	means Electronic Communications Committee within the European Conference of Postal and Telecommunications Administrations (CEPT)
"FDD"	means Frequency Division Duplex
"HCM"	means Harmonised Calculation Method
"ICNIRP"	Means International Commission on Non-Ionizing Radiation Protection (ICNIRP)
"IMT"	means International Mobile Telecommunications
"IMT2300"	means IMT in the 2300MHz band
"ITA"	means Invitation to Apply
"ITU"	means the International Telecommunication Union
"ITU-R"	means the International Telecommunication Union Radiocommunication Sector
"LTE"	means Long Term Evolution is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies
"NRFP"	means the National Radio Frequency Plan 2013 for South Africa
"PCI"	means Physical-Layer Cell Identities
"PRACH"	means Physical Random Access Channel
"PSTN"	means Public Switched Telephone Network
"PUCCH"	means Physical Uplink Control Channel
"RFSAP"	means Radio Frequency Spectrum Assignment Plan

"TCA"	means Terrain Clearance Angle
"TDD"	means Time Division Duplex
"WRC-12"	means World Radiocommunication Conference 2012 held in Geneva
"WRC-15"	means World Radiocommunication Conference planned to be held in 2015 in Geneva

2 Purpose

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

2.2 This Radio Frequency Spectrum Assignment Plan states the requirements for the utilisation of the frequency band 2300 to 2400 MHz for IMT2300.

2.3 The ITU states that International Mobile Telecommunications (IMT) systems are mobile systems that provide access to a wide range of telecommunication services including advanced mobile services, supported by mobile and fixed networks, which are increasingly packet-based.

Key features:

- a high degree of commonality of functionality worldwide whilst retaining the flexibility to support a wide range of services and applications in a cost efficient manner;
- compatibility of services within IMT and with fixed networks;
- capability of interworking with other radio access systems;
- high quality mobile services;
- user equipment suitable for worldwide use;
- user-friendly applications, services and equipment;
- worldwide roaming capability; and
- enhanced peak data rates to support advanced services and applications.

3 General

3.1 Technical characteristics of equipment used in IMT2300 systems must conform to all applicable South African standards, international standards, International Telecommunications Union (ITU) and its radio regulations as agreed and adopted by South Africa

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

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

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

3.5 Frequency bands assigned for IMT2300 include bands 2300 to 2400 MHz.

3.6 Likely use of this band will be for IMT-TDD.

3.7 The technologies which can provide IMT2300 services include, but are not limited to:

- LTE;
- LTE Advanced;
- HSPA+; and
- WiMAX

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

- Recommendation ITU-R M.2012-1 (02/2014): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT Advanced);
- Report ITU-R M.2074: Report on Radio Aspects for the terrestrial component of IMT-2000 and systems beyond IMT-2000;
- Recommendation ITU-R M.1645 Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000; and
- Recommendation ITU-R M.1036-4: Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations (RR).

4 Channelling Plan

4.1 The frequency band 2300-2400MHz provides a total bandwidth of 100 MHz for the IMT service.

4.2 Channel arrangements: The ITU has proposed the following channel arrangement for the band:

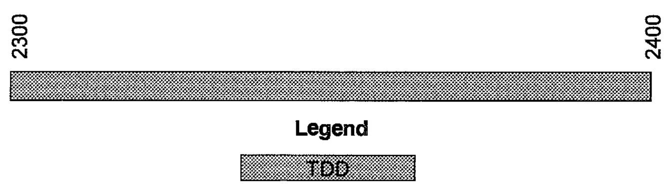


Figure 1: Channel arrangement for 2300-2400 MHz

5 Requirements for usage of radio frequency spectrum

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

5.2 The use of the band is limited to IMT services.

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

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

5.5 The allocation of spectrum and shared services within these bands are found in the National Radio Frequency Plan (NRFP) and an extract of NRFP is shown in Appendix A.

5.6 Maximum radiated power

5.6.1 Base Station transmissions should not exceed 61dBm/5MHz EIRP.

5.6.2 Mobile Station transmissions should not exceed 23dBm EIRP.

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

5.6.4 Where appropriate, subscriber terminal station should comply with the technical specification outlined under "3GPP TS 36.521-1" or latest version.

5.7 ICNIRP compliance is encouraged, where applicable.

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

6 Implementation

6.1 This Radio Frequency Assignment Plan comes into effect on the 1st April 2017.

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

7 Coordination Requirements

7.1 Use of these frequency bands will require coordination with the neighbouring countries within the coordination zones of 6 kilometres from the neighbouring country. The coordination distance is continuously being reviewed and these may be updated from time to time.

7.2 The following field strength thresholds have to be assured. Operator-to-operator coordination may be necessary to avoid interference.

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 65dBµV/m/5MHz at a height of 3 m above ground at the border line between countries and does not exceed a value of 37dBµV/m/5MHz at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.

In the case that LTE is deployed both sides of the border, the field strength level at 6 km can be increased to 49dBµV/m/5MHz.

If TDD is in operation across both sides of a border and is synchronised across the border then field strength levels as well.

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

BW (MHz)	Field strength at 3 m height (general case)	Field strength at 3 m height (LTE case)
5 MHz	65.0 dBµV/m/5MHz @0km	65.0 dBµV/m/5MHz @0km
	37.0 dBµV/m/5MHz @6km	49.0 dBµV/m/5MHz @6km
10 MHz	68.0 dBµV/m/10MHz @0km	68.0 dBµV/m/10MHz @0km
	40.0 dBµV/m/10MHz @6km	52.0 dBµV/m/10MHz @6km
15 MHz	69.8 dBµV/m/15MHz @0km	69.8 dBµV/m/15MHz @0km
	41.8 dBµV/m/15MHz @6km	53.8 dBµV/m/15MHz @6km
20 MHz	71.0 dBµV/m/20MHz @0km	71.0 dBµV/m/20MHz @0km
	43.0 dBµV/m/20MHz @6km	55.0 dBµV/m/20MHz @6km

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

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 21dBµV/m/5MHz at 10% time, 50% of locations at 3 metres above ground level at the border line.

7.3 Technical analysis may be conducted by the Authority before an assignment is issued according to Appendix B based on a extract from ECC/REC(11)05.

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

7.5 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 interference resolution process as shown in 0.

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

8 Assignment

8.1 The scope for new assignments in the IMT2300 band will be identified in a feasibility study to be carried out.

9 Amendments

9.1 Amendment of existing licences will be subject to the results of the feasibility study to be carried out on the use of the IMT2300 band in line with the Frequency Migration Plan 2013.

9.2 Radio frequency spectrum licences for purposes other than MOBILE (IMT).

10 Radio Frequency Migration

10.1 Specific Procedure:

10.1.1 IMT2300 TDD from 2360-2380 MHz (others) and 2380-2400 MHz is to be assigned and coordinated with the already assigned licences;

10.1.2 In cases of different TDD-configurations, a 5 MHz guard band has to be considered within the new assignment; and

10.1.3 The migration of Fixed and Outside broadcast links out of this band are subject to the outcome of a feasibility study to be carried out on the use of the 2300-2400 MHz band and such transitional arrangements as may be required will be determined accordingly.

Appendix A National Radio Frequency Plan

ITU Region 1 allocation and footnotes	South African Allocation and footnotes	Typical Applications	Comments
2300 -2450 MHz	**2300-2450MHz**		
FIXED	FIXED	FWA (PTP/PTMP)(2307-2387 MHz)	PAIRED with 2401-2481 MHz
		Outside Broadcast Links	28 MHz channels OB links. Frequency co-ordination with other systems operating in the band is mandatory on a case by case basis. Primary basis: 2377 MHz and 2471 MHz. Secondary basis: 2321 MHz, 2349 MHz, 2415 MHz and 2443 MHz.
		FWA(PTP/PTMP) (2401-2481 MHz	Paired with 2307-2387MHz
MOBILE 5.384A	MOBILE 5.384A NF9	IMT2300 TDD(2300-2400 MHz)	
		WLAN, FDDA and model ctrl. (2400 – 2483.5 MHz)	Radio Frequency Spectrum Regulations (Annex B)(GG. No. 34172, 31 March 2011)
		Non-specific SRDs and low power video surveillance (2400 -2483 MHz)	
		RFID (2400-2483.5 MHz)	Spectrum re-allocation to RFID(GG. No. 31127, 5 June 2008)
		ISM applications (2400-2500 MHz)	
Amateur	Amateur		
Radiolocation			
5.150 5.282 5.395	5.150 5.282		

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 nature, 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 appropriate detailed terrain data is available, the propagation model for interference field strength prediction is the latest version of ITU-R Rec. P.452, For the relevant transmitting terminal, predictions of path loss would be made at x km steps along radials of y km at z degree intervals[11]. The values for those receiver locations within the neighbouring country would be used to construct a histogram of path loss – and if more than 10% of predicted values exceed the threshold the station should be 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". This model is to be employed for 50% of locations, 10% time and using a receiver height of 3 m. For specific reception areas where terrain roughness adjustments for improved accuracy of field strength prediction are needed, administrations may use correction factors according to terrain irregularity and/or an averaged value of the TCA parameter in order to describe the roughness of the area on and around the coordination line.

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

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

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Area calculations

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

For evaluation:

- only 10% of the number of geographical areas between the border line (including the border line) and the 6 km line itself inside the neighbouring country may be interfered with by higher field strength than the trigger field strength value given for the border line in section 7.2 at a height of 3m above ground.
- only 10% of the number of geographical areas between the 6 km (including the 6 km line) and 12 km line inside the neighbouring country may be interfered with by a higher field strength than the trigger field strength value given for the 6 km line in section 7.2 at a height of 3m 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 1km, free space propagation model needs to be applied. Furthermore, if there is no terrain obstacle within the 1st Fresnel zone, the free space propagation model should be applied.

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

For area type interference calculations, propagation models with path-specific terrain correction factors are recommended (e.g. Recommendation ITU–R P.1546 with the Terrain Clearance Angle correction factor TCA, HCM method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812).

As to correction factors for clutters 'open area' and 'quasi-open area', 20 dB and 15 dB should be used respectively. Recommendation ITU–R P.1406 should be used if a finer selection of clutter is required.

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

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE[12]

The following is extracted from ECC/REC(11)05 as an operational example and can be adapted for the SADC-countries

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

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

Administrations should agree on a repartition of these 504 PCI 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 PCI's is equivalent. Each country can use all PCI groups away from the border areas.

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

Four types of countries are defined in a way such that no country will use the same code set as any one of its neighbours. The following lists describe the distribution of European countries (*which needs to be adapted for SADC*):

Type country 1: BEL, CVA, CYP, CZE, DNK, E, FIN, GRC, IRL, ISL, LTU, MCO, SMR, SUI, SVN, UKR, AZE, SRB;

Type country 2: AND, BIH, BLR, BUL, D, EST, G, HNG, I, MDA, RUS (Exclave), GEO;

Type country 3: ALB, AUT, F, HOL, HRV, POL, POR, ROU, RUS, S, MLT;

Type country 4: LIE, LUX, LVA, MKD, MNE, NOR, SVK, TUR.

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

[12] ECC/REC(11)05

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

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

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

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

Notes

1) All PCIs are available in areas away from the border.
2) In certain specific cases (e.g. AUT/HRV), where the distance between two countries of the same type number is very small, it may be necessary to address the situation in bi/multilateral coordination agreements as necessary, and may include further subdivision of the allocated codes in certain areas.

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

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

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

1. Demodulation Reference Signal (DM RS) coordination

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

The case of partial channel overlap has not been studied but, due to DM RS occupying resource blocks of separate users, there is a risk of DM RS collisions between neighbouring networks when the subcarriers' positions coincide (the frequency offset between central carriers of neighbouring networks is 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 basic planning procedure only 30 DM RS sequence groups with favourable correlation characteristics are available: {0...29}. In this case each cell could be assigned one of the 30 DM RS sequence groups providing a cluster size of 30.
- It is possible to extend each DM RS sequence group to generate up to 12 time-shifted sequence groups by applying the cyclic shift parameter stated in 3GPP TS 36.211. For 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 a limited number of groups are 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 only recently during first trials of LTE and caused throughput loss as well as time alignment problems.

- Another approach for DM RS coordination is to implement dynamic DM RS sequence group allocation also called pseudo-random group hopping. In this method, nearby cells are grouped into clusters of up to 30 cells and within each cell cluster the same hopping pattern is used. At the border of two clusters, inter-cell interference is averaged since two different hopping patterns are used. There are 17 defined hopping patterns, numbered {0...16}, which leads to some minor inequality in the case of apportioning these patterns between neighbouring countries. Even in a trilateral case, each operator will have at least 5 hopping patterns available near the border which should be enough for planning purposes. It should be noted the pseudo-random group hopping option could be absent in the first generations of LTE equipment.

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

2. Physical Random Access Channel (PRACH) coordination

Another radio network parameter which 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 is usually the same for all cells, again because the PRACH-to-PRACH interference case is the more favourable one; and
- cell-specific root sequences are used to distinguish between PRACH requests addressed to different cells.

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

In early implementation, it is possible that a very limited number of frequency positions will be supported by LTE equipment which will not be enough to coordinate in the trilateral

case. In such cases, root-sequence repartition could be used. There are 838 root sequences in total, to be distributed between cells, numbered {0..837}. There are two numbering schemes for PRACH root sequences (physical and logical) and only logical root sequences numbering needs be used for coordination. Unfortunately, the process of root sequences planning doesn't involve direct mapping of root sequences between cells because the number of root sequences needed for one cell is dependent on the cell range. The table showing such interdependency is presented below:

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

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

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

Appendix D Interference Resolution Process

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 [deg];

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 [deg]

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 mutual consent.

NOTICE 277 OF 2015

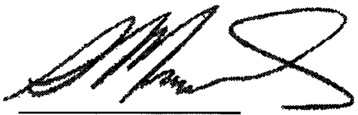
INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

PURSUANT TO SECTION 4 (1) OF THE ELECTRONIC COMMUNICATIONS ACT 2005, (ACT NO. 36 OF 2005)

HEREBY ISSUES A NOTICE REGARDING THE FINAL RADIO FREQUENCY SPECTRUM ASSIGNMENT PLAN FOR THE FREQUENCY BAND 2500 TO 2570 MHz AND 2620 TO 2690 MHz .

1. The Independent Communications Authority of South Africa ("the Authority"), hereby publishes **Final Radio Frequency Spectrum Assignment Plan for the frequency band 2500 to 2570 MHz and 2620 to 2690 MHz** in terms of sections 2 (d), (e) and 4, read with sections 30, 31(4), and 33 of the Electronic Communications Act (Act No. 36 of 2005) and read with Regulation 3 of the Radio Frequency Spectrum Regulations 2011 and read with the IMT Roadmap 2014.

2. This Radio Frequency Spectrum Assignment Plan (RFSAP) supersedes any previous spectrum assignment arrangements for the same spectrum location. However, if it happens that on the date a provision of the RFSAP comes into effect, there is a conflict between the RFSAP and the latest versions of the National Radio Frequency Plan (NRFP) and Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan will prevail.



Dr SS MNCUBE
CHAIRPERSON

Radio Frequency Spectrum Assignment Plan

Rules for Services operating in the Frequency Band 2500 to 2570 MHz and 2620 to 2690 MHz (IMT2600 FDD)

Table of Contents

1 Glossary

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

"3GPP"	means the 3rd Generation Partnership Project (3GPP) which consists of six telecommunications standard development organisations
"Act"	means the Electronic Communications Act, 2005 (Act No. 36 of 2005) as amended
"DM RS"	means Demodulation Reference Signal
"ECC/REC(11)04"	means ECC Recommendation (11)04
"ECC"	means Electronic Communications Committee within the European Conference of Postal and Telecommunications Administrations (CEPT)
"FDD"	means Frequency Division Duplex
"HCM"	means Harmonised Calculation Method
"ICNIRP"	Means International Commission on Non-Ionizing Radiation Protection (ICNIRP)
"IMT"	means International Mobile Telecommunications
"IMT2600"	means IMT in the 2600MHz band
"ITA"	means Invitation to Apply
"ITU"	means the International Telecommunication Union
"ITU-R"	means the International Telecommunication Union Radiocommunication Sector
"LTE"	means Long Term Evolution is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies
"NRFP"	means the National Radio Frequency Plan 2013 for South Africa
"PCI"	means Physical-Layer Cell Identities
"PRACH"	means Physical Random Access Channel
"PSTN"	means Public Switched Telephone Network
"PUCCH"	means Physical Uplink Control Channel
"RFSAP"	means Radio Frequency Spectrum Assignment Plan

"TCA"	means Terrain Clearance Angle
"TDD"	means Time Division Duplex
"WRC-12"	means World Radiocommunication Conference 2012 held in Geneva
"WRC-15"	means World Radiocommunication Conference planned to be held in 2015 in Geneva

2 Purpose

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

2.2 This Radio Frequency Spectrum Assignment Plan states the requirements for the utilisation of the frequency band 2500 to 2570 MHz and 2620 to 2690 MHz for IMT2600 FDD.

2.3 The centre gap (2570-2620 MHz band) is included with respect to migration only, this centre band will be the subject of a separate RFSAP by 31st March 2017.

2.4 The ITU states that International Mobile Telecommunications (IMT) systems are mobile systems that provide access to a wide range of telecommunication services including advanced mobile services, supported by mobile and fixed networks, which are increasingly packet-based.

Key features:

- 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 IMT2600 systems must conform to all applicable South African standards, international standards, International

Telecommunications Union (ITU) and its radio regulations as agreed and adopted by South Africa.

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

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

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

3.5 Frequency bands assigned for IMT2600 include bands 2500-2570 MHz and 2620-2690 MHz.

3.6 Likely use of this band will be for IMT-FDD and IMT-TDD.

3.7 The technologies which can provide IMT2600 services include, but are not limited to:

- LTE;
- LTE Advanced;
- HSPA+;
- WiMAX .

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

- Recommendation ITU-R M.2012-1 (02/2014): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT Advanced).
- Report ITU-R M.2146 Coexistence between IMT-2000 CDMA-DS and IMT-2000 OFDMA TDD WMAN in the 2 500-2 690 MHz band operating in adjacent bands in the same area.
- Report ITU-R 2113-1: Sharing studies in the 2 500-2 690 MHz band between IMT-2000 and fixed broadband wireless access systems including nomadic applications in the same geographical area.
- Report ITU-R M.2045-0: Mitigating techniques to address coexistence between IMT-2000 time division duplex and frequency division duplex radio interface technologies within the frequency range 2 500-2 690 MHz operating in adjacent bands and in the same geographical area.
- Report ITU-R M.2074: Report on Radio Aspects for the terrestrial component of IMT-2000 and systems beyond IMT-2000.
- Report ITU-R M.2041: Sharing and adjacent band compatibility in the 2.5 GHz band between the terrestrial and satellite components of IMT-2000.
- Recommendation ITU-R M.1645 Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000.

Recommendation ITU-R M.1036-4: Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations (RR

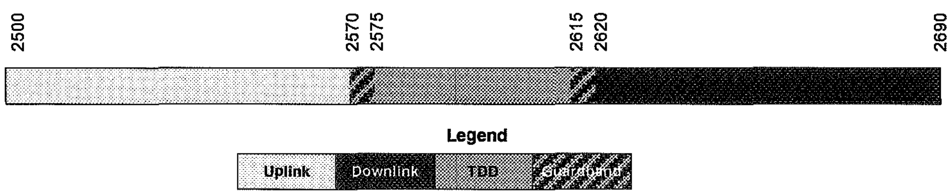
4 Channelling Plan

4.1 The frequency band 2500 to 2570 MHz and 2620 to 2690 MHz provides a total bandwidth of 2*70MHz FDD (and 50 MHz TDD in the 2570-2620 MHz band) for IMT 2600.

4.2 Channel arrangements: The ITU has proposed a list of channel arrangements shown below:

Frequency arrange-ments	Paired arrangements					Unpaired arrangements (e.g. for TDD) (MHz)
	Mobile station transmitter (MHz)	Centre gap (MHz)	Base station transmitter (MHz)	Duplex separation (MHz)	Centre gap usage	
C1	2 500-2 570	50	2 620-2 690	120	TDD	2 570-2 620 TDD
C2	2 500-2 570	50	2 620-2 690	120	FDD	2 570-2 620 FDD DL external
C3	Flexible FDD/TDD					

Option C1 has been selected for South Africa and is depicted in the figure below:



5 Requirements for usage of radio frequency spectrum

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

5.2 The use of the band is limited to IMT services.

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

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

5.5 The allocation of spectrum and shared services within these bands are found in the National Radio Frequency Plan (NRFP) and an extract of NRFP is shown in Appendix A.

5.6 Maximum radiated power:

5.6.1 Base Station transmissions should not exceed 61dBm/5MHz EIRP;

5.6.2 Mobile Station transmissions should not exceed 23dBm EIRP;

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

5.6.4 Where appropriate, subscriber terminal station should comply with the technical specification outlined under "3GPP TS 36.521-1" or latest version.

5.7 ICNIRP compliance is encouraged, where applicable.

5.8 Criteria and guidelines for interference mitigation are described in **Error! Reference source not found.**.

6 Implementation

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

6.2 No new assignments in the 2500 to 2570 MHz and 2620 to 2690 MHz FDD band will be approved unless they comply with this RFSAP or any subsequent RFSAP for the 2570-2620 MHz TDD Centre Gap.

7 Coordination Requirements

7.1 Use of these frequency bands will require coordination with the neighbouring countries within the coordination zones of 6 kilometres from the neighbouring country. The coordination distance is continuously being reviewed and these may be updated from time to time.

7.2 The following field strength thresholds have to be assured. Operator-to-operator coordination may be necessary to avoid interference.

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 65dBμV/m/5MHz at a height of 3 m above ground at the border line between countries and does not exceed a value of 37dBμV/m/5MHz at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.

In the case that LTE is deployed both sides of the border the field strength level at 6 km can be increased to 49dBμV/m/5MHz.

If TDD is in operation across both sides of a border and is synchronised across the border then field strength levels as well.

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

BW (MHz)	Field strength at 3 m height (general case)	Field strength at 3 m height (LTE case)
5 MHz	65.0 dBµV/m/5MHz @0km	65.0 dBµV/m/5MHz @0km
	37.0 dBµV/m/5MHz @6km	49.0 dBµV/m/5MHz @6km
10 MHz	68.0 dBµV/m/10MHz @0km	68.0 dBµV/m/10MHz @0km
	40.0 dBµV/m/10MHz @6km	52.0 dBµV/m/10MHz @6km
15 MHz	69.8 dBµV/m/15MHz @0km	69.8 dBµV/m/15MHz @0km
	41.8 dBµV/m/15MHz @6km	53.8 dBµV/m/15MHz @6km
20 MHz	71.0 dBµV/m/20MHz @0km	71.0 dBµV/m/20MHz @0km
	43.0 dBµV/m/20MHz @6km	55.0 dBµV/m/20MHz @6km

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

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 21dBµV/m/5MHz at 10% time, 50% of locations at 3 metres above ground level at the border line.

7.3 Technical analysis may be conducted by the Authority before an assignment is issued according to Appendix B taken from ECC/REC(11)05.

7.4 Specific information regarding coordination may be found in Appendix C taken from ECC/REC(11)05.

7.5 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 interference resolution process as shown in 0.

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

8 Assignment

8.1 The radio frequency spectrum licence of WBS in the 2550-2565 MHZ band will be amended for its re-assignment in the 2575-2590 MHz band.

8.2 An Invitation to Apply will be published for assignments in the 2500 to 2570 MHz and 2620 to 2690 MHz band in line with regulations developed in terms of section 31(3) of the Act.

8.3 New assignments in the 2570-2620 MHz band (IMT2600 TDD centre gap) will be made in a separate process.

9 Amendment

9.1 Existing radio frequency spectrum licences for the use of the band are to be amended as per the frequency migration timetable.

10 Radio Frequency Migration

10.1 Specific Procedure:

10.1.1 The licensee is required to vacate its existing assignment from 2550-2565 MHz within six months of publication of this RFSAP and migrate to 2575-2595 MHz with a 5 MHz guard band to the IMT2600 FDD spectrum (2570-2575MHz);

10.1.2 The remaining spectrum in the IMT2600 TDD Centre Gap band 2595-2615 MHz (excluding guard band to IMT 2600 FDD) is reserved for future assignment through an ITA[13];

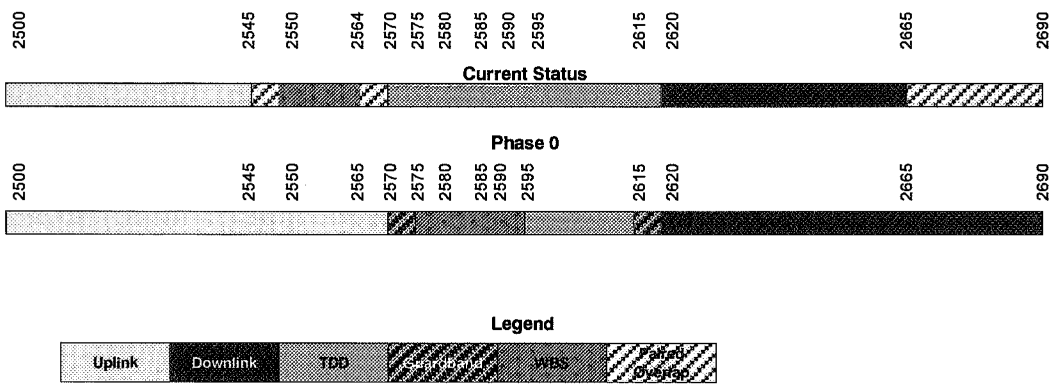


Figure 8: WBS migration

10.1.3 The 5 MHz guard band to IMT FDD in a protected mode is needed so as not to interfere with the paired FDD spectrum.

[13] An RFSAP will be developed for the 2570-2620 MHz band (IMT2600 Centre Gap) by 31st March 2017.

Appendix A National Radio Frequency Plan

ITU Region 1 allocation and footnotes	South African Allocation and footnotes	Typical Applications	Comments
2500-2520 MHz FIXED MOBILE except aeronautical mobile 5.384A 5.412	**2500-2520 MHz** MOBILE except aeronautical mobile 5.384A NF9	IMT2600 MTX (2500-2570 MHz)	PAIRED with 2620-2690MHz
2520-2655 MHz FIXED 5.410 MOBILE except aeronautical mobile 5.384A BROADCASTING SATELLITE 5.413 5.416 5.339 5.412 5.417C 5.417D 5.418B 5.418C	**2520-2655 MHz** MOBILE except aeronautical mobile 5.384A NF9 5.339	IMT2600 MTX (2500-2570 MHz) IMT2600 TDD (2570-2620 MHz) IMT2600 BTX (2620-2690 MHz)	PAIRED with 2620-2690MHz PAIRED with 2500-2570MHz
2655-2670 MHz FIXED 5.410 MOBILE except aeronautical mobile 5.384A BROADCASTING SATELLITE 5.20B 5.413 5.146 Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149 5.412	**2655-2670 MHz** MOBILE except aeronautical mobile 5.384A NF9 Radio Astronomy 5.149	IMT2600 BTX (2620-2690 MHz)	PAIRED with 2500-2570 MHz
2670-2690 MHz FIXED 5.410 MOBILE except aeronautical mobile	**2670-2690 MHz** MOBILE except aeronautical mobile	IMT2600 MTX (2620-2690 MHz)	PAIRED with 2500-2570 MHz

5.384A Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149 5.412	5.384A Radio Astronomy 5.149		

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 nature, 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 appropriate detailed terrain data is available, the propagation model for interference field strength prediction is the latest version of ITU-R Rec. P.452, For the relevant transmitting terminal, predictions of path loss would be made at x km steps along radials of y km at z degree intervals[14]. 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". This model is to be employed for 50% of locations, 10% time and using a receiver height of 3 m. For specific reception areas where terrain roughness adjustments for improved accuracy of field strength prediction are needed, administrations may use correction factors according to terrain irregularity and/or an averaged value of the TCA parameter in order to describe the roughness of the area on and around the coordination line.

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

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

Area calculations

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

For evaluation:

- only 10% of the number of geographical areas between the border line (including the border line) and the 6 km line itself inside the neighbouring country may be interfered with by higher field strength than the trigger field strength value given for the border line in section 7.2 at a height of 3m above ground.
- only 10% of the number of geographical areas between the 6 km (including the 6 km line) and 12 km line inside the neighbouring country may be interfered with by a higher field strength than the trigger field strength value given for the 6 km line in section 7.2 at a height of 3m 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 1km, free space propagation model needs to be applied. Furthermore, if there is no terrain obstacle within the 1st Fresnel zone, the free space propagation model should be applied.

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

For area type interference calculations, propagation models with path-specific terrain correction factors are recommended (e.g. Recommendation ITU–R P.1546 with the Terrain Clearance Angle correction factor TCA, HCM method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812).

As to correction factors for clutters 'open area' and 'quasi-open area', 20 dB and 15 dB should be used respectively. Recommendation ITU–R P.1406 should be used if a finer selection of clutter is required.

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

Appendix C Coordination for IMT-Systems

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

The following is extracted from ECC/REC(11)05 as an operational example and can be adapted for the SADC-countries

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

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

Administrations should agree on a repartition of these 504 PCI 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 PCI's is equivalent. Each country can use all PCI groups away from the border areas.

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

Four types of countries are defined in a way such that no country will use the same code set as any one of its neighbours. The following lists describe the distribution of European countries (*which needs to be adapted for SADC*):

Type country 1: BEL, CVA, CYP, CZE, DNK, E, FIN, GRC, IRL, ISL, LTU, MCO, SMR, SUI, SVN, UKR, AZE, SRB;

Type country 2: AND, BIH, BLR, BUL, D, EST, G, HNG, I, MDA, RUS (Exclave), GEO;

Type country 3: ALB, AUT, F, HOL, HRV, POL, POR, ROU, RUS, S, MLT;

Type country 4: LIE, LUX, LVA, MKD, MNE, NOR, SVK, TUR.

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:

(black)	Preferential PCI
(white)	Non-preferential PCI

[15] ECC/REC(11)05

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

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

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

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

Notes

1) All PCIs are available in areas away from the border.
2) In certain specific cases (e.g. AUT/HRV), where the distance between two countries of the same type number is very small, it may be necessary to address the situation in bi/multilateral coordination agreements as necessary, and may include further subdivision of the allocated codes in certain areas.

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

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

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

1. Demodulation Reference Signal (DM RS) coordination

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

The case of partial channel overlap has not been studied but, due to DM RS occupying resource blocks of separate users, there is a risk of DM RS collisions between neighbouring networks when the subcarriers' positions coincide (the frequency offset between central carriers of neighbouring networks is 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 basic planning procedure only 30 DM RS sequence groups with favourable correlation characteristics are available: {0...29}. In this case each cell could be assigned one of the 30 DM RS sequence groups providing a cluster size of 30.
- It is possible to extend each DM RS sequence group to generate up to 12 time-shifted sequence groups by applying the cyclic shift parameter stated in 3GPP TS 36.211. For 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 a limited number of groups are 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 only recently during first trials of LTE and caused throughput loss as well as time alignment problems.

- Another approach for DM RS coordination is to implement dynamic DM RS sequence group allocation also called pseudo-random group hopping. In this method, nearby cells are grouped into clusters of up to 30 cells and within each cell cluster the same hopping pattern is used. At the border of two clusters, inter-cell interference is averaged since two different hopping patterns are used. There are 17 defined hopping patterns, numbered {0...16}, which leads to some minor inequality in the case of apportioning these patterns between neighbouring countries. Even in a trilateral case, each operator will have at least 5 hopping patterns available near the border which should be enough for planning purposes. It should be noted the pseudo-random group hopping option could be absent in the first generations of LTE equipment.

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

2. Physical Random Access Channel (PRACH) coordination

Another radio network parameter which 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 is usually the same for all cells, again because the PRACH-to-PRACH interference case is the more favourable one; and
- cell-specific root sequences are used to distinguish between PRACH requests addressed to different cells.

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

In early implementation, it is possible that a very limited number of frequency positions will be supported by LTE equipment which will not be enough to coordinate in the trilateral

case. In such cases, root-sequence repartition could be used. There are 838 root sequences in total, to be distributed between cells, numbered {0..837}. There are two numbering schemes for PRACH root sequences (physical and logical) and only logical root sequences numbering needs be used for coordination. Unfortunately, the process of root sequences planning doesn't involve direct mapping of root sequences between cells because the number of root sequences needed for one cell is dependent on the cell range. The table showing such interdependency is presented below:

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

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

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

Appendix D Interference Resolution Process

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 [deg];

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 [deg]

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 mutual consent.

NOTICE 278 OF 2015

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

PURSUANT TO SECTION 4 (1) OF THE ELECTRONIC COMMUNICATIONS ACT 2005, (ACT NO. 36 OF 2005)

HEREBY ISSUES A NOTICE REGARDING THE FINAL RADIO FREQUENCY SPECTRUM ASSIGNMENT PLAN FOR THE FREQUENCY BAND 3400 TO 3600 MHz.

1. The Independent Communications Authority of South Africa ("the Authority"), hereby publishes **Final Radio Frequency Spectrum Assignment Plan for the frequency band 3400 to 3600 MHz** in terms of sections 2 (d), (e) and 4, read with sections 30, 31(4), and 33 of the Electronic Communications Act (Act No. 36 of 2005) and read with Regulation 3 of the Radio Frequency Spectrum Regulations 2011 and read with the IMT Roadmap 2014.

2. This Radio Frequency Spectrum Assignment Plan (RFSAP) supersedes any previous spectrum assignment arrangements for the same spectrum location. However, if it happens that on the date a provision of the RFSAP comes into effect, there is a conflict between the RFSAP and the latest versions of the National Radio Frequency Plan (NRFP) and Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan will prevail.

Dr SS MNCUBE
CHAIRPERSON

Radio Frequency Spectrum Assignment Plan

Rules for Services operating in the Frequency Band 3400 to 3600 MHz (IMT3500)

Table of Contents

1 Glossary

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

"3GPP"	means the 3rd Generation Partnership Project (3GPP) which consists of six telecommunications standard development organisations
"Act"	means the Electronic Communications Act, 2005 (Act No. 36 of 2005) as amended
"DM RS"	means Demodulation Reference Signal
"ECC/REC(11)04"	means ECC Recommendation (11)04
"ECC"	means Electronic Communications Committee within the European Conference of Postal and Telecommunications Administrations (CEPT)
"FDD"	means Frequency Division Duplex
"HCM"	means Harmonised Calculation Method
"ICNIRP"	Means International Commission on Non-Ionizing Radiation Protection (ICNIRP)
"IMT"	means International Mobile Telecommunications
"IMT3500"	means IMT in the 3500MHz band
"ITA"	means Invitation to Apply
"ITU"	means the International Telecommunication Union
"ITU-R"	means the International Telecommunication Union Radiocommunication Sector
"LTE"	means Long Term Evolution is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies
"NRFP"	means the National Radio Frequency Plan 2013 for South Africa
"PCI"	means Physical-Layer Cell Identities
"PPDR"	means Public Protection and Disaster Relief as defined in ITU-R Report M.2033.
"PRACH"	means Physical Random Access Channel
"PSTN"	means Public Switched Telephone Network
"PUCCH"	means Physical Uplink Control Channel

"RFSAP"	means Radio Frequency Spectrum Assignment Plan
"TCA"	means Terrain Clearance Angle
"TDD"	means Time Division Duplex
"WRC-12"	means World Radiocommunication Conference 2012 held in Geneva
"WRC-15"	means World Radiocommunication Conference planned to be held in 2015 in Geneva

2 Purpose

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

2.2 This Radio Frequency Spectrum Assignment Plan states the requirements for the utilisation of the frequency band 3400 to 3600 MHz for IMT3500.

2.3 The ITU states that International Mobile Telecommunications (IMT) systems are mobile systems that provide access to a wide range of telecommunication services including advanced mobile services, supported by mobile and fixed networks, which are increasingly packet-based.

Key features:

- 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 IMT3500 systems must conform to all applicable South African standards, international standards, International

Telecommunications Union (ITU) and its radio regulations as agreed and adopted by South Africa.

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

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

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

3.5 Frequency bands assigned for IMT3500 include bands 3400-3600MHz.

3.6 Likely use of this band will be for IMT.

3.7 IMT3500 is applicable for the provision of the system and service and the typical technical and operational characteristics identified as appropriate by the ITU are described in the following documents:

- Recommendation ITU-R M.2012-1 (02/2014): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT Advanced);
- Report ITU-R- M.2111: Sharing studies between IMT-Advanced and the radiolocation service in the 3 400-3 700 MHz bands;
- Report ITU-R M.2074: Report on Radio Aspects for the terrestrial component of IMT-2000 and systems beyond IMT-2000;
- Recommendation ITU-R M.1645 Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000; and
- Recommendation ITU-R M.1036-4: Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations (RR).

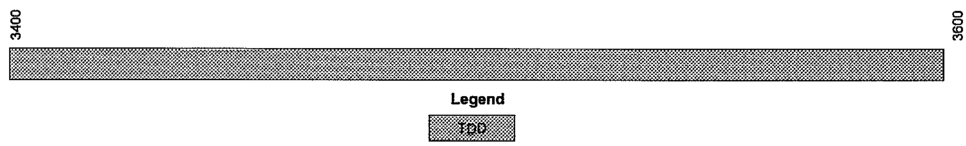
4 Channelling Plan

4.1 The frequency band 3400-3600MHz provides a total bandwidth of 200MHz TDD for IMT 3500.

4.2 Channel Arrangements: The ITU has proposed a list of channel arrangements shown below:

Frequency arrange-ments	Paired arrangements				Unpaired arrangements (e.g. for TDD) (MHz)
	Mobile station transmitter (MHz)	Centre gap (MHz)	Base station transmitter (MHz)	Duplex separation (MHz)	
F1					3 400-3 600
F2	3 410-3 490	20	3 510-3 590	100	None

Option F1 has been selected for South Africa and is depicted in the figure below:.



5 Requirements for usage of radio frequency spectrum

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

5.2 The use of the band is limited for IMT-services.

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

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

5.5 The allocation of spectrum and shared services within these bands are found in the National Radio Frequency Plan (NRFP) and an extract of NRFP is shown in Appendix A.

5.6 Maximum radiated power:

5.6.1 Base Station transmissions should not exceed 61dBm/5MHz EIRP.

5.6.2 Mobile Station transmissions should not exceed 23dBm EIRP.

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

5.6.4 Where appropriate, subscriber terminal station should comply with the technical specification outlined under "3GPP TS 36.521-1" or latest version.

5.7 ICNIRP compliance is encouraged, where applicable.

5.8 Criteria and guidelines for interference mitigation are described in **Error! Reference source not found.**.

6 Implementation

6.1 This Radio Frequency Assignment Plan comes into effect on the 1st April 2017.

6.2 No new assignment for IMT3500 in the band 3400 – 3600MHz will be approved unless they comply with this RFSAP.

6.3 The National Radio Frequency Plan will be amended to indicate a typical application for TDD.

7 Coordination Requirements

7.1 Use of these frequency bands will require coordination with the neighbouring countries within the coordination zones of 6 kilometres from the neighbouring country. The coordination distance is continuously being reviewed and these may be updated from time to time.

7.2 The following field strength thresholds have to be assured. Operator-to-operator coordination may be necessary to avoid interference.

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 65dBμV/m/5MHz at a height of 3 m above ground at the border line between countries and does not exceed a value of 37dBμV/m/5MHz at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.

In the case that LTE is deployed both sides of the border the field strength level at 6 km can be increased to 49dBμV/m/5MHz.

If TDD is in operation across both sides of a border and is synchronised across the border then field strength levels as well.

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

BW (MHz)	Field strength at 3 m height (general case)	Field strength at 3 m height (LTE case)
5 MHz	65.0 dBµV/m/5MHz @0km	65.0 dBµV/m/5MHz @0km
	37.0 dBµV/m/5MHz @6km	49.0 dBµV/m/5MHz @6km
10 MHz	68.0 dBµV/m/10MHz @0km	68.0 dBµV/m/10MHz @0km
	40.0 dBµV/m/10MHz @6km	52.0 dBµV/m/10MHz @6km
15 MHz	69.8 dBµV/m/15MHz @0km	69.8 dBµV/m/15MHz @0km
	41.8 dBµV/m/15MHz @6km	53.8 dBµV/m/15MHz @6km
20 MHz	71.0 dBµV/m/20MHz @0km	71.0 dBµV/m/20MHz @0km
	43.0 dBµV/m/20MHz @6km	55.0 dBµV/m/20MHz @6km

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

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 21dBµV/m/5MHz at 10% time, 50% of locations at 3 metres above ground level at the border line.

7.3 Technical analysis may be conducted by the Authority before an assignment is issued according to Appendix B based on an extraction from ECC/REC (11)05.

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

7.5 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 interference resolution process as shown in Appendix D.

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

8 Assignment

8.1 An Invitation to Apply will be published for the assignments in this band in line with regulations developed in terms of section 31(3) of the Act.

9 Amendment

9.1 Existing radio frequency spectrum licences for the use of the band will be amended as appropriate.

10 Radio Frequency Migration

10.1 Specific Procedure:

10.1.1 Existing licensees are to conform to the requirements of this RFSAP by the effective date.

Appendix A National Radio Frequency Plan

ITU Region 1 allocation and footnotes	South African Allocation and footnotes	Typical Applications	Comments
3400 – 3600MHz	**3400-3600MHz**		
FIXED	FIXED	FWA (3400-3600MHz)	
FIXED SATELLITE (space to Earth)			
Mobile 5.430A	MOBILE	IMT3500 (3410-3490MHz)	PAIRED with 3510-3590 MHz
	5.430A, NF9	IMT3500(3510-3590MHz)	PAIRED with 3410-3490MHz
Radiolocation			
5.431			

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 nature, 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 appropriate detailed terrain data is available, the propagation model for interference field strength prediction is the latest version of ITU-R Rec. P.452, For the relevant transmitting terminal, predictions of path loss would be made at x km steps along radials of y km at z degree intervals[16]. 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". This model is to be employed for 50% of locations, 10% time and using a receiver height of 3 m. For specific reception areas where terrain roughness adjustments for improved accuracy of field strength prediction are needed, administrations may use correction factors according to terrain irregularity and/or an averaged value of the TCA parameter in order to describe the roughness of the area on and around the coordination line.

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

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

Area calculations

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

For evaluation:

- only 10% of the number of geographical areas between the border line (including the border line) and the 6 km line itself inside the neighbouring country may be interfered with by higher field strength than the trigger field strength value given for the border line in section 7.2 at a height of 3m above ground.
- only 10% of the number of geographical areas between the 6 km (including the 6 km line) and 12 km line inside the neighbouring country may be interfered with by a higher field strength than the trigger field strength value given for the 6 km line in section 7.2 at a height of 3m 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 1km, free space propagation model needs to be applied. Furthermore, if there is no terrain obstacle within the 1st Fresnel zone, the free space propagation model should be applied.

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

For area type interference calculations, propagation models with path-specific terrain correction factors are recommended (e.g. Recommendation ITU–R P.1546 with the Terrain Clearance Angle correction factor TCA, HCM method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812).

As to correction factors for clutters 'open area' and 'quasi-open area', 20 dB and 15 dB should be used respectively. Recommendation ITU–R P.1406 should be used if a finer selection of clutter is required.

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

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE[17]

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

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

Administrations should agree on a repartition of these 504 PCI 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 PCI's is equivalent. Each country can use all PCI groups away from the border areas.

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

Four types of countries are defined in a way such that no country will use the same code set as any one of its neighbours. The following lists describe the distribution of European countries (*which needs to be adapted for SADC*):

Type country 1: BEL, CVA, CYP, CZE, DNK, E, FIN, GRC, IRL, ISL, LTU, MCO, SMR, SUI, SVN, UKR, AZE, SRB;

Type country 2: AND, BIH, BLR, BUL, D, EST, G, HNG, I, MDA, RUS (Exclave), GEO;

Type country 3: ALB, AUT, F, HOL, HRV, POL, POR, ROU, RUS, S, MLT;

Type country 4: LIE, LUX, LVA, MKD, MNE, NOR, SVK, TUR.

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

[17] ECC/REC(11)05

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

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

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

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

Notes

1) All PCIs are available in areas away from the border.
2) In certain specific cases (e.g. AUT/HRV), where the distance between two countries of the same type number is very small, it may be necessary to address the situation in bi/multilateral coordination agreements as necessary, and may include further subdivision of the allocated codes in certain areas.

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

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

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

1. Demodulation Reference Signal (DM RS) coordination

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

The case of partial channel overlap has not been studied but, due to DM RS occupying resource blocks of separate users, there is a risk of DM RS collisions between neighbouring networks when the subcarriers' positions coincide (the frequency offset between central carriers of neighbouring networks is 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 basic planning procedure only 30 DM RS sequence groups with favourable correlation characteristics are available: {0...29}. In this case each cell could be assigned one of the 30 DM RS sequence groups providing a cluster size of 30.
- It is possible to extend each DM RS sequence group to generate up to 12 time-shifted sequence groups by applying the cyclic shift parameter stated in 3GPP TS 36.211. For 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 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 a limited number of groups are 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 only recently during first trials of LTE and caused throughput loss as well as time alignment problems.

- Another approach for DM RS coordination is to implement dynamic DM RS sequence group allocation also called pseudo-random group hopping. In this method, nearby cells are grouped into clusters of up to 30 cells and within each cell cluster the same hopping pattern is used. At the border of two clusters, inter-cell interference is averaged since two different hopping patterns are used. There are 17 defined hopping patterns, numbered {0...16}, which leads to some minor inequality in the case of apportioning these patterns between neighbouring countries. Even in a trilateral case, each operator will have at least 5 hopping patterns available near the border which should be enough for planning purposes. It should be noted the pseudo-random group hopping option could be absent in the first generations of LTE equipment.

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

2. Physical Random Access Channel (PRACH) coordination

Another radio network parameter which 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 is usually the same for all cells, again because the PRACH-to-PRACH interference case is the more favourable one; and
- cell-specific root sequences are used to distinguish between PRACH requests addressed to different cells.

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

In early implementation, it is possible that a very limited number of frequency positions will be supported by LTE equipment which will not be enough to coordinate in the trilateral

case. In such cases, root-sequence repartition could be used. There are 838 root sequences in total, to be distributed between cells, numbered {0..837}. There are two numbering schemes for PRACH root sequences (physical and logical) and only logical root sequences numbering needs be used for coordination. Unfortunately, the process of root sequences planning doesn't involve direct mapping of root sequences between cells because the number of root sequences needed for one cell is dependent on the cell range. The table showing such interdependency is presented below:

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

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

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

Appendix D Interference Resolution Process

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 [deg];

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 [deg]

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 mutual consent.

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