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INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

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RADIO FREQUENCY SPECTRUM REGULATIONS

REASONS DOCUMENT

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1 Introduction

1.1 This Reasons Document provides the background and basis for the decisions made in finalising final radio frequency spectrum assignment plans (RFSAPs) for the IMT450, IMT850 and IMT1500 bands. The RFSAPs follow from an inquiry for the implementation of the radio frequency migration plan and the IMT roadmap (Government Gazette 45247), the findings of that inquiry (Government Gazette 45690), a first consultation on the Draft RFSAPs for the IMT450, IMT850 and IMT1500 bands (Government Gazette 46160, notices 1961, 1965 and 1967), and a follow-up second consultation (Government Gazette 48078, notices 3064, 3065, and 3066) on these bands.

1.2 The reasons for the decisions on each of the three bands are provided in the respective sections that follow this one. For each band, the Authority provides highlights from the RFSAP, a summary of general comments and the Authority's analysis of those comments, and detailed stakeholder comments and the Authority's analysis.

2 450 - 470 MHz (IMT450)

2.1 Highlights from RFSAP

2.1.1 The Authority has developed an RFSAP for the 450 - 470 MHz band allocating this band primarily for the International Mobile Telecommunications (IMT) and digital services only, allowing for temporary coexistence with analogue narrowband services that do not interfere with IMT, such as those used by Transnet. The Authority has decided to implement the D14 band plan, which provides for 2x5 MHz. The RFSAP also considers exclusion zones that may be published to accommodate some Government services. All other users will need to switch off their services in the band and vacate. A migration plan to clear the band has been in place since the publication of Government Gazette Number 38755, 30 March 2015, which set out the end of the dual-illumination period in 2022.

2.2 General Comments and the Authority's Analysis

General Comments:

2.2.1 There is significant interest in this band, with a number of parties suggesting it can be used for IMT, and there is also demand for alternative uses. The band is thus in high demand.

2.2.2 Stakeholders, including Cell C, MTN, Telkom and Vodacom, are in support of the allocation of this band to IMT using the D14 band plan. In earlier submissions, Huawei, Liquid Telecoms, Nokia, SACF, Telkom, Transnet and Vodacom were all in support of allocating this band to IMT.

2.2.3 Telkom has proposed that their Swiftnet assignment be retained in this band and used for narrowband services. Vodacom commented that the Authority should allocate this band exclusively to IMT services, with no secondary services to be made available in this band. In Cell C's submissions, they state the methodology used by the Authority to determine the demand for this band outweighing supply is unclear. They further comment that any Government service utilising this band needs to be migrated out. MTN has requested the Authority to list which operators currently have spectrum assigned in this band. Transnet has

asserted that they will help in harmonising the band with SADC members and will supply a migration plan to ensure a smooth transition to IMT technologies.

Authority's Analysis:

2.2.4 There is consensus among stakeholders on the use of the 450 MHz band for IMT, applying the D14 band plan. Transnet has requested that they continue to share this band despite being required to migrate since 2015. Transnet made a number of mitigating representations to the Authority in this regard which are credible, for example that the destination band of 406.1 - 410 MHz or 406 - 426 MHz that they were to migrate to turned out to not be an appropriate band for them since there is no digital equipment to test in that band for their current analogue services. Transnet demonstrated willingness to migrate to digital by carrying out a trial with LTE equipment. Transnet conducted a Digital trial and pilot tests in the remote area of Thabazimbi, and has a clear preference now for an IMT450 digital solution for all its 2500 locomotives and 15000 handheld devices across RSA. Transnet would have to rely on the new IMT450 licensee in the band to facilitate the digital switchover of its current analogue communication services for all its locomotives. The Authority also considers the Transnet's current services as critical national infrastructure (CNI) and safety communications systems. It would be disproportionate to force them to shut down given these circumstances. Rather, a migration plan needs to be put in place with the licensee ultimately awarded spectrum in the band.

2.2.5 Telkom/Swiftnet, by contrast, do not present any such set of mitigating circumstances as to why it has not migrated out of the band even though this has been a requirement since 2015. For instance, Telkom/Swiftnet has never carried out a trial to migrate out of the band that the Authority is aware of. Their infrastructure is not critical and there are no safety implications in respect of migrating them out of the band. The Authority thus considers that Swiftnet has no equivalent mitigating circumstances to Transnet, and that it is therefore proportionate and right that they vacate the band.

2.3 Detailed Stakeholder Comments

2.3.1 The table below provides a summary of pertinent feedback from stakeholders, to recent inquiries and consultations, with the Authority's analysis on that feedback.

		Authority's analysis
450 Alliance	March 2023: 450 MHZ Alliance supports the proposed RFSAP. They propose a slow migration starting with 1.5 MHz, then 3 MHz, then 5 MHz. They also have proposals around detailed technical specifications. May 2022: The 450 MHz Alliance supports the Authority's proposals.	The 450 MHz Alliance's support is acknowledged. [ICASA: to consider migration proposal and detailed technical specifications]. ICASA has since had technical meetings with the 450 MHz Alliance.
Cell C	March 2023: The device ecosystem for 3GPP and Band B31 are maturing, and so the Band 14 plan makes sense. LTE 450 supports M2M and IoT applications, where strong growth is expected from 2021 onwards. The band ought to be cleared of other users. Cell C reiterated its point about the methodology for determining whether demand exceeds supply. February 2022: Cell C states that the government services in this band need to be migrated out. Cell C is unsure of the methodology the Authority	Cell C's comments about the band plan support the Authority's position. Transnet needs to remain in the band, for the reasons explained above in the main text. There is significant interest in this band, with a number of parties suggesting it can be used for IMT, and there is contestation for use of this band by other stakeholders, suggesting it is indeed in high demand. Demand clearly exceeds supply, since there is only 2 x 5MHz

	used to determine that the demand for this band outweighs the supply.	available in the band, likely suitable for only one licensee. This is a common feature of IMT bands, which have substantial commercial value in South Africa.
Eskom	May 2022: Eskom commented that they use 450 - 453 MHz paired with 460 - 463 MHz for fixed UHF links services. They have largely migrated across to 1.4 GHz even though there are large obstructed areas in this band and its use is prohibited in the KCAAA. Request to be included next to government services in this band.	The Authority has decided that all incumbents, except Transnet, be migrated out of this band, and this should not affect Eskom substantially, since it has already largely migrated.
eThekwini Municipality	February 2022: eThekwini Municipality raised concerns about the allocation of the band to IMT, as they feel it would be better served as a specialised PPDR network, which has high availability, dedicated capacity, prioritised capacity, extensive coverage and fits better within the procurement rules.	The Authority has allocated alternative bands for PPDR services that eThekwini Municipality and similar stakeholders can use for PPDR services. There is no new evidence showing that the value of PPDR services outweighs the value of IMT services in this band, given the alternative bands the Authority has made available for PPDR.
MTN	March 2023: Approves of the Band 14 arrangement. Comments on differences in ICASA documents regarding the radio frequency spectrum assigned to Transnet in this band which adds 2MHz of spectrum bandwidth within IMT450 to Transnet, and requests clarity on this. February 2022: MTN does not consider the ecosystem for this band to be mature yet. Requests clarity on the current assignments in this band.	The Authority is in the process of developing a radio frequency spectrum register which will include all current assignments, save for any government services that are of a sensitive nature.
SANDF	December 2021: The SANDF commented about their concerns for safety of life issues in parts of this band.	The Authority will consider exclusion zones for government services where applicable.
Telkom	March 2023: Telkom is in support of the allocation of this band to IMT. Telkom proposes its Swiftnet assignments will not interfere with IMT deployments. Telekom states that if Swiftnet is expected to migrate from this band, the Authority needs to issue a notice, including a designation band for the migration, to Swiftnet. February 2022: Telkom is in support of the Authority's proposal to apply the D14 (3GPP Band 31 plan). Telkom makes the same comments as in December 2021 regarding unaffected fixed links, existing users and exclusion zones. December 2021: Telkom considers that unaffected fixed links should not be migrated out of the band. Telkom proposes that the Authority makes available the locations of all deployments in the band (including government services) so new users can plan around this, and Telkom similarly recommends that exclusion zones be clearly identified.	The Authority is in the process of developing a radio frequency spectrum register which will include all current assignments, save for any government services that are of a sensitive nature. Telkom needs to migrate out of this band, for the reasons explained in the text above. See The Authority Analysis on the IMT450 Band above.
Transnet	March 2023: Transnet supports the D14 plan, and acknowledges uses of the band for PPDR or	See The Authority Analysis on the IMT450 Band above.

	machine type communication. Transnet would also include the designation of this band for mission critical communication needs. Transnet requests a commitment from the Authority to set up exclusion zones in this band, to protect any government services. Transnet undertakes to manage all coordination issues to eliminate interference in the bands, including cross-border. May 2022: Transnet requests additional time for the migration to IMT, as they currently use the band for various services and have experienced harmful interference at the borders of South Africa. Transnet has requested this band to not be auctioned, but rather to be used by state enterprises in line with the national development plan, rail policy etc. Transnet has indicated that it already has plans to deploy an IMT network.	Exclusion zones are considered in the RFSAP. The Authority acknowledges Transnet's undertakings to manage coordination to eliminate interference. This will need to be incorporated in a migration plan developed with the licensee awarded spectrum in the band. See The Authority Analysis on the IMT450 Band above.
Vodacom	March 2023: Vodacom is concerned that Transnet remaining in the band will impact on IMT deployments. Vodacom also suggests that there are complementary bands below 450 MHz that might also be used for IMT, and incumbents using the spectrum for PPDR services. These bands, including 380 - 400 MHz & 410 - 430 MHz, should not be destination bands for migration. February 2022: Vodacom is in support of the Authority's proposal to apply the D14 (3GPP band 31 plan). Vodacom states the Authority should consider this band for IMT services only, with no secondary services. They propose 335.4 - 387 MHz band for migration.	For the reasons explained above in the main text, Transnet's links need to remain in the band. Additional IMT bands below 450 MHz will be considered by the Authority for future RFSAPs.

3 825 - 830 MHz and 870 - 875 MHz (IMT850)

3.1 Highlights from RFSAP

3.1.1 The Authority has developed an RFSAP for this band in order to provide for the migration of the sole incumbent out of this band so as to fully free up the IMT800, which has already been partly auctioned. The incumbent is to be migrated to the IMT900 band. The RFSAP will be repealed once this migration has taken place.

3.2 General Comments and the Authority's Analysis

General Comments:

3.2.1 Stakeholders largely agree on the migration of the incumbent operator to an alternative band; however each stakeholder presented different recommendations and reasonings on which the alternative band for migration should be.

3.2.2 Liquid, the incumbent in the 850 MHz band, commented that the position advanced by the draft IMT850 RFSAP stands to benefit both the affected operators, their subscribers, and South African consumers generally. Liquid welcomes the migration of its legacy IMT850 assignment to the 900 MHz destination band.

3.2.3 Telkom proposes that IMT450 is a more appropriate alternative to IMT850 than IMT900, since IMT450 band is much less valuable based on auction results, and IMT900 spectrum assigned to Liquid might be used to provide roaming or similar services to MTN and/or Vodacom, which would harm competition. MTN does not object to the proposal but states that the RFSAP for IMT900 currently provides for an auction, which would no longer be applicable if the spectrum is assigned to Liquid. Vodacom's recommendations are the following bands as replacement bands: 2010 - 2025 MHz or 1x10 MHz in 2300 MHz. Cell C states that it is unclear how the Authority has reached its decision to assign the incumbent in the 850 MHz band prime IMT900 MHz spectrum in circumstances where Cell C, for instance, had to forego some spectrum in the same band with no target band for migration. In the past in respect of IMT2600, additional spectrum was awarded to licensees during migration.

3.2.4 Nokia states that all existing transmissions from 825 - 830 MHz paired with 870 - 875 MHz band should be cleared, and no new assignment for these bands should be approved.

The Authority's Analysis:

3.2.5 The Authority will consider the potential impact on competition from migrating the incumbent to the 900MHz band as a result of the submissions made by Telkom for this band before a new licence for the band is issued to Liquid, including obligations to mitigate any future competition harms. Cell C's concerns compare quite different situations, with Cell C foregoing a very small amount of spectrum together with MTN and Vodacom in order to free-up the band. This compares to Liquid foregoing all its valuable sub-1GHz spectrum in the present matter. In this case, Liquid is foregoing almost 2x5 MHz in the 850 MHz band, and is being migrated to 2x5 MHz in IMT900, and so it is not migrating to a different band with a significantly different physics. Responses by Cell C, Telkom, and Vodacom do not provide significant evidence of harm to them against Liquid's migration to 900 MHz. All these main operators possess valuable

sub-1GHz spectrum too. Therefore, the Authority has decided to proceed with the consultation's proposal of IMT900 as the destination band for Liquid.

3.2.6 Regarding alternatives proposed by Telkom and Vodacom:

- 450 MHz: This band has quite different physics characteristics to the IMT850 band, since the 450 MHz band will likely have fixed-wireless characteristics, while 900 MHz provides for a fully-mobile offering as IMT850 did.
- 2010 - 2025 MHz: This band does not have the same propagation characteristics as sub-1 GHz spectrum. Furthermore, the ecosystem for IMT/FWA in the band is not highly developed, and PMSE is arguably the highest value use of this band to date. HIBS is also proposed in this band for Region 1, subject to WRC 2023 deliberations.[1] It was also *not* on the list of alternative destination bands consulted on in the second consultation. This band is therefore not suitable as a target for migration.
- 2300 MHz: This band does not have the same propagation characteristics as sub-1 GHz spectrum.

3.3 Detailed stakeholder comments

3.3.1 The table below provides a summary of pertinent feedback from stakeholders to recent inquiries and consultations, with the Authority's analysis on that feedback.

		Authority Analysis
Cell C	March 2023: Cell C commented that the Authority should be consistent in its approach to migrating licensees to ensure regulatory certainty. In particular, the Authority seems to be treating Cell C differently when requiring them to relinquish spectrum in the 900MHz band with no target band for migration, while offering Liquid a migration option in return for vacating the 850 MHz band. In previous migrations in respect of IMT2600, additional spectrum was awarded. Cell C further states the Authority needs to ensure they comply with the Electronic Communications Act, and in particular the non-discrimination requirements.	See comments in text above in response to Cell C's concerns.
Huawei	February 2022: Huawei do not recommend the introduction of LTE in this band in Africa, due to the overlap with existing bands and planned 800 MHz bands.	This is noted, the RFSAP will be repealed once the migration is complete.
Liquid Telecoms	March 2023: Liquid Telecoms comments the position advanced by the Draft IMT850 RFSAP stands to benefit affected operators, their subscribers, and South African consumers generally. Liquid Telecoms concurs with the legal framework applied in the implementation of the final IMT850 RFSAP and welcomes the migration of legacy IMT50 assignment to the destination band, 2x5 MHz in IMT900 extending from 900 - 905 MHz. December 2021: Liquid Telecoms comments that the 825 - 830/870 - 875 MHz band is currently unused and is unusable for the device system for IMT.	The Authority notes Liquid's approval for the RFSAP.
MTN	March 2023: Does not object to the proposal of migrating the sole incumbent from the band to protect the assignments of operators in the neighbouring 800 MHz	ICASA will amend and reissue the IMT900 RFSAP.

[1] Agenda Item 1.1 at WRC-23 (Res. 247)

	band. Suggests that the IMT900 RFSAP be amended to reflect that an ITA will no longer be possible here. February 2022: MTN does not object to the proposal but does clash with RFSAP for IMT900. Recommends the Authority amend this assignment to not be in breach of their own regulations.	The IMT850 MHz RFSAP will be repealed once the migration has taken place.
Nokia	March 2023: Acknowledges the Authority's proposal to repeal IMT850 RFSAP, and notes that no new assignments will be approved.	Nokia's submissions do not suggest any changes to the RFSAP.
Telkom	March 2023: The 450 MHz band is more suitable since it is less valuable than 900MHz based on auction outcomes. If IMT900 is considered by the Authority as the replacement for IMT850, then Telkom requests the Authority to critically consider the use of 2x5 MHz assignment in IMT900 by the IMT850 incumbent licensee, where the approval is granted for the use of IMT900 band to ensure there is no negative impact on competition, since this spectrum is likely to be shared with mobile incumbents MTN and Vodacom. May 2022: Telkom commented that in several places, the content in the IMT850 RFSAP is in fact the same as the IMT800 RFSAP and the lines between the two plans are crossed several times, suggesting various corrections. February 2022: Telkom stated the Authority had planned to use the 'lower' part of this band for IMT but is unclear on what exactly this will entail. Telkom proposes that IMT450 is more appropriate alternative to IMT850 than IMT900.	See response above in main text regarding competition concerns and differing values. As explained above, the RFSAP for 850 MHz will be repealed once the migration has taken place.
Vodacom	March 2023: Vodacom proposes that the 850 MHz incumbent be migrated to IMT 2010-2025 MHz (1x15 MHz) or 1 x 10 MHz in 2300 MHz. 450 MHz is not suitable for migration as it is a critical coverage band. IMT750 is an unsuitable band as the incumbent doesn't have any low-band spectrum holdings, and it won't be possible to provide services on it. 2.3 GHz is a possible destination band, being used initially for fixed links before being harmonised for IMT. It is most suited to the current incumbent in IMT850. 3.3 GHz is a 5G only band that does not allow the current incumbent to deploy the services offered in IMT850, and it would result in an inefficient use of the spectrum. 26 GHz band is considered in high demand and should rather be allocated in contiguous blocks and is not suited to the current incumbent. February 2022: Vodacom recommends negotiating with Liquid to find a suitable alternative band to migrate to as they are currently not using the frequency. Vodacom proposes 2010 - 2025MHz. December 2021: Vodacom recommends negotiating with Liquid to find a suitable alternative band to migrate to as they are currently not using the frequency.	See the discussion above on reasons for not selecting alternative bands.

4 1427 - 1518 MHz (IMT1500)

4.1 Highlights from RFSAP

4.1.1 The Authority has developed an RFSAP assigning the band 1427 - 1518 MHz to IMT, expanding the original proposal which ended at 1492 MHz as the upper bound. The Authority has decided that the 1427 - 1517 MHz Band would be both allocated to Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL) and to IMT 5G-NR TDD/SDL.

4.2 General Comments and the Authority's Analysis

General Comments:

4.2.1 There are disagreements among stakeholders on the proposed RFSAP for this band, mainly between satellite providers and the mobile operators, and between the latter regarding TDD versus MFCN SDL.

4.2.2 The satellite providers, including the GSOA, Inmarsat, and Thuraya/Yahsat, all commented that there are mobile satellite services (MSS) adjacent to 1518 MHz, the upper bound of the Authority's proposed IMT band. MSS are used for maritime applications and in aircraft, and are used in the agriculture and mining sectors, among others. They stress the all-weather resiliency of the L-band used for MSS. They stress that satellite services are available in locations where mobile networks are not. There are studies that show IMT deployments between 1492 MHz and 1518 MHz will cause harmful interference to MSS above 1518 MHz. The mobile operators and equipment vendors Huawei and Nokia, on the other hand, support the Authority's proposal to implement IMT in most of the band.

4.2.3 Cell C, MTN and Vodacom are proposing a TDD band plan for efficient spectrum usage. Telkom states an MFCN SDL configuration is best as it would be in alignment with Europe's approach, and proposes an upper bound of 1517 MHz to provide 1MHz protection to MSS services. MFCN SDL (Band 32 SDL) also allows for carrier aggregation with 800MHz and 900MHz spectrum, and there is a substantial ecosystem developed for this. 5G-NR TDD/SDL (Bands 75/76) in IMT1500 is still the subject of compatibility studies in the ITU's Working Party (WP) 5D, whereas MFCN SDL is already well studied in ECC Recommendations such as ECC/DEC/(17)06[2]. Nokia explains that the 5G-NR SDL and TDD configurations both have limited ecosystems, though there are currently more 5G-NR SDL devices. At the same time, the selection of MFCN TDD in markets in Africa, Asia, Middle East and Latin America mean that the TDD ecosystem will develop too.

The Authority's Analysis:

4.2.4 The responses to the consultation for this band were particularly impressive. Some stakeholders made a very evidenced-based case for preferring Mobile/Fixed Communications Networks Supplemental

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

Downlink (MFCN SDL), particularly Band 32 SDL, in this 1427-1517MHz band over IMT 5G-NR TDD/SDL (Bands 75/76). They cited both the much more plentiful devices ecosystem for Band 32 SDL as well as the many countries in Europe that have made decisions to deploy Band 32 SDL in this band, particularly in 1451 - 1492 MHz and less so in 1427 - 1452/1492 -1518 MHz.

4.2.5 The Authority has carefully considered all these sets of representations from IMT and Satellite Stakeholders, as well as other stakeholders. The Authority has decided that the 1427 - 1517 MHz Band will be allocated both to Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL) and to IMT 5G-NR TDD/SDL. To address the out-of-band emission concerns of the Satellite community, the new licensees closer to the top of the band (i.e. closer to 1528MHz) would be required to reduce the allowed EIRP down to 58 dBm/5MHz [instead of 61 dBm/5MHz] in order to minimise out-of-band interference into satellite terminals using 1518 - 1525 MHz. Specifically, Base Station transmissions in 1512 - 1517 MHz should not exceed 58 dBm/5MHz EIRP as recommended per ECC/DEC/(17)06. Furthermore, 1517 - 1518 MHz is designated as a guard band to provide 1 MHz of further protection to MSS services. The Authority acknowledged that in exceptional cases, there may be a case for geographical separation of IMT and MSS systems, including PFD limits at ports/waterways and airports to ensure that IMT base stations keep adequate separation from ship earth stations and aircraft earth stations (ESIMs). If these scenarios are likely to arise in the future, the Authority will work with future licensees to mitigate such risks using geographical separation.

4.3 Detailed Stakeholder Comments

4.3.1 The table below provides a summary of pertinent feedback from stakeholders, to recent inquiries and consultations, with the Authority's analysis on that feedback.

		Authority's Analysis
Cell C	March 2023: Cell C approves of ICASA's proposal for the band. A TDD configuration is the best means of arranging this band. Existing users of this band may cause interference, but in-band migration can be easily managed to resolve this. There is sufficient bandwidth in 1300 - 1427 MHz to accommodate incumbents. They reiterate their question about why the Authority considers that demand exceeds supply. February 2022: Cell C welcomes the proposal to allocate the entire 1427 - 1518 MHz contiguous band for IMT services as this is the most efficient use of available spectrum. They note though that a TDD configuration allows for more efficient spectrum usage (adaptability to allow for adjustments and corrections based on current use case patterns / requirements). Cell C is unclear with regards to how and what methodology was used to determine that demand exceeds supply in IMT1500 band. Cell C recommends Authority include in regulations the	European auctions/competitive processes have realised high bids for sub-parts of this band. For example in 2015, Italy raised EUR462m selling L-Band spectrum in the 1452 MHz - 1492 MHz range[3]. In the same year, UK operators Vodafone and H3G bought the equivalent spectrum for £200M[4]. In the consultation, many submissions were made on this band by a variety of operators, suggesting there is substantial interest (if not demand), as is the case for many IMT bands. Given that there is only approximately 90 MHz available in the band, and there were comments from 4 mobile operators saying they approve of IMT in the band, a maximum of approximately 20 MHz per operator is possible if all four operators applied. Licensees have recently bid in the Authority's auction for significantly more spectrum at very high valuations. There are also operators

[3] Italy raises EUR462m selling L-Band spectrum (commsupdate.com) - https://www.commsupdate.com/articles/2015/09/11/italy-raises-eur462m-selling-l-band-spectrum/
[4] Qualcomm sheds UK spectrum holdings for £200 million | TelecomTV

	reasons for the determination that this band demand exceeds supply.	that have IMT spectrum but did not comment, and who may seek spectrum in this band. Furthermore, Nokia recommends 40 MHz per licensee, as mentioned below. There is thus limited supply relative to demand. This means that a competitive ITA process is appropriate.
Huawei	February 2022: Huawei recommend this band be released together with 1427 - 1452 MHz and 1492 - 1518 MHz for IMT licensing purposes. They propose this will be a more efficient use of the band. Huawei also proposes the arrangement for this band should be TDD Band n50+n51 and not merely for supplementary downlink.	The Authority notes Huawei's support for the Authority's proposed RFSAP. See the Authority's Analysis above for IMT1500.
MTN	March 2023: MTN supports the rendering of the entire spectrum within this band in a G3 channel arrangement for the future assignment in the medium term. February 2022: MTN, recommend this band be released together with 1427 - 1452 MHz and 1492 - 1518 MHz for IMT licensing purposes. They propose this will be a more efficient use of the band. MTN states there is no economic value in licensing this band for now. December 2021: MTN recommend this band be released together with 1427 - 1452 MHz and 1492 - 1518 MHz for IMT licensing purposes, proposing this will result in more efficient use of the band.	The Authority notes MTN's support for the Authority's proposed approach. See the Authority's Analysis above for IMT1500.
Nokia	March 2023: Nokia notes the TDD and SDL ecosystems are currently limited but will continue to grow. There are currently more devices available for the SDL configuration. Nokia provides the equipment for both 5G-NR configurations, TDD and FDD. The decisions made across markets (Latin America, Middle East, Africa and Asia) to allocate 1427 - 1518 MHz spectrum for TDD operations will have a positive impact on the market demand. Nokia expects this ecosystem to grow accordingly. Nokia's recommendation is for the highest contiguous bandwidth per licensee to allow carriers of at least 20MHz, with increments of 10MHz for the efficient use of this spectrum. Licensees should be assigned 40MHz in total in this band. February 2022: Nokia asserts The DD configuration proposed by the Authority, fall into 3GPP standardised sub-bands 1432 - 1517 MHz, complemented at its lower end by 1427 - 1432 MHz. These two sub-bands are 3GPP standardised in TDD configurations – they have little ecosystem. December 2021: Nokia recommend this band be released together with 1427 - 1452 MHz and 1492 - 1518 MHz for IMT licensing purposes. They propose this will be a more efficient use of the band.	See the Authority's Analysis above for IMT1500.

Vodacom	March 2023: Vodacom agrees that the entire band be made available for IMT services in a TDD configuration. This will result in significant consumer benefits due to the provision of capacity for coverage bands, and due to its propagation characteristics. The previous B32 configuration (1452 – 1496 MHz) provided excessive guard bands with adjacent services and was designed for 4G only. There are a range of improvements with the TDD configuration in 3GPP B50/ B51 OR n50/ n51, including the availability of 5G, uplink capability, better coverage for uplink and downlink, and flexibility for deployment. However, Vodacom notes the current limited ecosystem. February 2022: Vodacom stated it was in support, and recommended the Authority monitor the global developments to allow them to react in a timely manner, once there is traction within the ecosystem for this band. Vodacom also recommend this band be released together with 1427 – 1452 MHz and 1492 – 1518 MHz for IMT licensing purposes. They propose this will be a more efficient use of the band. December 2021: Vodacom is in support, recommending the Authority monitors global developments to react in a timely manner once there is traction within the ecosystem for this band.	See the Authority's Analysis above for IMT1500.
GSOA	March 2023: The GSOA has commented that the adjacent frequency band 1518 - 1599 MHz paired with 1626.5 - 1660.5 MHz (L-band) is a core spectrum resource for the deployment of mobile satellite service networks across the globe. L-band MSS networks are catalysing digital transformation across various sectors, from agriculture to mining, to enable connection of IoT assets that are beyond the coverage envelopes of terrestrial networks. GSOA refers to a number of technical studies and reports that recommend the development of a number of compatibility measures to assist administrations in protecting MSS operations in the band 1518 – 1559 MHz. Measures include: • In-band power limits on the effective isotropic radiated power of IMT emitters (base stations and user equipment) • Unwanted emission limits on IMT emitters (base stations and user equipment) • Geographical separation of IMT and MSS systems, including PFD limits at ports/waterways and airports to ensure that IMT base stations keep adequate separation from ship earth stations and aircraft earth stations.	See the Authority's Analysis above for IMT1500.

	• Identifying spectrum below 1518 MHz to serve as a guard band between MSS receivers and IMT emitters. February 2022: GSOA states the adjacent frequency band 1518 - 1599 MHz paired with 1626.5 - 1660.5 MHz and 1668 - 1675 MHz (L-band) is core spectrum resource for deployment of mobile satellite service (MSS) networks across the globe.	
Inmarsat	March 2023: Inmarsat stresses the importance of MSS used in locations where mobile networks are not available and the agricultural sector in particular. MSS are used in maritime and aviation applications. Inmarsat urges the Authority to consider international obligations in operations of its Rescue Coordination Centre ('RCC') as part of an international treaty to support Search and Rescue operations covering the largest navigation areas across the two ocean regions, Atlantic and Indian, and to Antarctica. In their submissions, Inmarsat has proposed that the use of IMT systems based on TDD technology will create significant levels of interference with MSS terminals. This makes the issue particularly difficult, as interference from both IMT base stations and IMT user equipment needs to be considered. This will cause MSS to not operate due to out of band emissions and receiver overload. Inmarsat recommends the Authority consider the potential effects of 5G deployment on incumbents in 1427 - 1517 MHz band and the impact towards critical MSS services deployed in adjacent bands. Inmarsat comments that several interventions may be needed, including on power-flux density limits at ports and airports, unwanted emissions limits of -41 dBm/MHz EIRP, specific limitations in certain areas, including near ships, and power limits of -70 dBm/MHz on user equipment. February 2022: Inmarsat commented in earlier submissions to suggest the potential IMT deployments in this band are limited, and the interference can be experienced with the L-band above 1518 MHz if the 1492 - 1518 MHz band is used for IMT. Inmarsat comments the proposed use of IMT systems based on TDD technology makes the issue particularly difficult – need to consider interference from both IMT base stations and IMT user equipment. This will cause MSS to not operate due to out of band emissions and receiver overload. The Authority should consider potential effects of 5G deployment on incumbents in 1427 - 1517 MHz band and the impact towards critical MSS services deployed in adjacent bands.	See the Authority's Analysis above for IMT1500.
Yahsat and Thuraya	March 2023: Yahsat and Thuraya submit the proposal to open the entire band to IMT is detrimental to adjacent bands (1518 - 1559 MHz) and sensitive MSS terminals. This creates a risk to	See the Authority's Analysis above for IMT1500.

	the current and future MSS operations in South Africa. Yahsat and Thuraya recommend the establishment of suitable technical and regulatory conditions to guarantee interference free operations of MSS networks in South Africa. The introduction of 5G into this band could jeopardise the continued reliability of essential satellite communication systems, and cause disruptions to critical operations in South African territory. February 2022: Yahsat and Thuraya recommend only considering the bands below 1492 MHz for IMT operations, to avoid major compatibility issues with MSS. Introducing 5G in this band could jeopardise the continued reliability of essential satellite communication systems, disrupting critical operations in SA territory.	

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

NO. 3244 **31 March 2023**

HEREBY ISSUES A NOTICE REGARDING THE FINAL RADIO FREQUENCY ASSIGNMENT PLAN FOR THE IMT1500 FREQUENCY BAND IN TERMS OF REGULATION 3 OF THE RADIO FREQUENCY SPECTRUM REGULATIONS, 2015.

1. The Independent Communications Authority of South Africa ("the Authority"), hereby publishes the **Final Radio Frequency Spectrum Assignment Plan for the frequency band 1427 MHz to 1518 MHz for public consultation** in terms of Regulation 3 of the Radio Frequency Spectrum Regulations, 2015, read with Regulation 5 of the Radio Frequency Migration Regulations, 2013, and the International Mobile Telecommunications (IMT) Roadmap 2014 and 2019.

DR CHARLES LEWIS
ACTING CHAIRPERSON

Radio Frequency Spectrum Assignment Plan

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

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
"5G NR"	means 5G New Radio (NR) - the global standard for a unified, more capable 5G wireless air interface
"Act"	means the Electronic Communications Act, 2005 (Act No. 36 of 2005) as amended
"CRASA ECC"	means the Communications Regulators' Association of Southern Africa (CRASA) Electronic Communications Committee (ECC)
"DM RS"	means Demodulation Reference Signal
"ECC/REC (11)04"	means ECC Recommendation (11)04 – Cross-border Coordination for Mobile/Fixed Communications Networks (MFCN) in the frequency band 790-862 MHz, Edition 3 February 2017. Amended 18 November 2022.
"ECC/REC (15)01"	means ECC Recommendation (15)01 – (15)01 – ECC Recommendation (15)01 "Cross-border coordination for Mobile/Fixed Communications Networks (MFCN) in the frequency bands: 694-790 MHz, 1427-1518 MHz and 3400-3800 MHz". Amended on 14 February 2020. Amended 10 June 2022.
"ECC"	means Electronic Communications Committee (ECC) within the European Conference of Postal and Telecommunications Administrations (CEPT)
"FDD"	means Frequency Division Duplex
"HCM"	means Harmonised Calculation Method
"HIPSSA"	means Sub-Saharan Africa Assessment Report on Harmonization of ICT Policies in Sub-Saharan Africa
"ICNIRP"	means International Commission on Non-Ionizing Radiation Protection (ICNIRP)
"IMT"	means International Mobile Telecommunications
"IMT1500"	means IMT in the band 1427 MHz to 1518 MHz
"ITA"	means Invitation to Apply
"ITU"	means the International Telecommunication Union
"ITU-R"	means the International Telecommunication Union Radiocommunication Sector

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

2 Purpose

2.1 A Radio Frequency Spectrum Assignment Plan (RFSAP) for the band IMT1500 provides information on the requirements attached to using a frequency band in line with the allocation and other information in the National Radio Frequency Plan (NRFP). This information includes technical characteristics of radio systems, frequency channelling, coordination, and details on the required migration of existing users of the band and the expected method of assignment.

2.2 The feasibility study concerning the 1452 MHz to 1492 MHz band[1] which was mandated by the Frequency Band Migration Regulation and Plan contained in the IMT Roadmap 2014[2], and the IMT Roadmap 2019[3], both concluded that the Authority proceeds with an RFSAP for IMT in

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

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

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

this band. The feasibility study concerning the 1429 MHz - 1452 MHz band[4] was mandated by the Frequency Band Migration Regulation and Plan contained in the IMT Roadmap 2014[5], as well as the IMT Roadmap 2019[6].

2.3 Considering the duties of the Authority under the Electronic Communications Act ("ECA") (Act No. 36 of 2005), the Authority proposed to also implement the Radio Frequency Assignment Plan for the frequency range from 1492 MHz to 1517 MHz - in addition to the 1429 MHz - 1452 MHz band above. Therefore, in effect, the Authority proposed to proceed with an RFSAP for IMT1500 for the entire frequency band 1427 MHz to 1517 MHz in the Consultation on the Draft Assignment Plan[7].

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

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

3 General

3.1 Technical characteristics of the equipment used in IMT1500 systems will conform to all applicable South African standards, international standards, International Telecommunications Union (ITU) and its Radio Regulations as agreed upon and adopted by South Africa.

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

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

3.4 The proposed allocation of this frequency band and the information in this Second Draft Radio Frequency Spectrum Assignment Plan are subject to review.

3.5 Frequency bands identified for IMT include the band 1427 MHz to 1518 MHz.

3.6 The feasibility study conducted for the frequency range from 1452 MHz to 1492 MHz band[8]

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

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

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

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

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

concluded that the band would be used for IMT-TDD. The feasibility study conducted for the frequency range from 1429 MHz - 1452 MHz band[9] concluded that the band would be used for IMT-TDD or IMT-SDL. The subsequent consultation with stakeholders on the Draft 1452 MHz to 1492 MHz RFSAP saw little appetite for this spectrum in the short-term along with clear calls for the Authority to publish an RFSAP for the entire 1427 MHz to 1517 MHz band.

3.7 Through a RFSAP consultation[10], the Authority *provisionally* agreed and proposed a RFSAP for the entire 1427 MHz to 1517 MHz band.

3.8 Considering international trends, the Authority proposed to maintain the same duplexing arrangement as was proposed for the 1452 MHz - 1492 MHz RFSAP, i.e., IMT-TDD, for the remainder of the band for consistent and efficient 'use of spectrum'. Therefore, the Authority proposed that IMT-TDD band plan would be used for the whole band, that is, 1427 MHz to 1517 MHz.

3.9 In the RFSAP consultation[11], the Authority noted that it was fully aware with its IMT-TDD proposal that Mobile/Fixed Communications Networks Supplemental Downlink (IMT MFCN SDL) is also feasible in the band. This was yet another key reason for this consultation on the entire band. For example, the consultation acknowledged that the frequency band 1429 MHz - 1452 MHz provides a total bandwidth of 23 MHz TDD or SDL. It noted that twenty-four (24) European countries have implemented ECC/DEC/ (13)03 and 14 implemented ECC/DEC/ (17)06 and both these Decisions look at using a part of the band for Supplemental Downlink (SDL).

3.10 The consultation noted existing international experience in using the band for IMT services, e.g. ECC/DEC/(17)06[12] on the harmonised use of the frequency bands 1427 - 1452 MHz and 1492 - 1518 MHz wherein Mobile/Fixed Communications Networks Supplemental Downlink (IMT MFCN SDL) has already been implemented[13]. The latter was a key reason for the Authority proposing to assign the entire 1427 MHz - 1517 MHz band for IMT, albeit IMT TDD.

3.11 The consultation noted that Footnote 5.341 in the National Frequency Plan for South Africa recognises the utilisation of band 1400 MHz - 1727 MHz for passive research for the search for intentional emissions of extra-terrestrial origin. Therefore, the Resolution 750 (Rev.WRC-19) applies[14] - yet another reason to justify the RFSAP consultation. The consultation therefore sought the views of the Search for Extra-terrestrial Intelligence (SETI) community. None was received.

3.12 The consultation also noted that the Authority is aware that [in other jurisdictions] this band currently has satellite services in it as well as adjacent to it, plus passive radio astronomy (which means very low emission limits around 1427 MHz). The "neighbour" licensees closer to the upper 1517 MHz part of the band, for example, reduce the allowed EIRP down to 58 dBm/5 MHz for

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

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

11 *Ibid.*

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

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

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

as recommended per ECC/DEC/(17)06[15]. The consultation therefore sought the views of the Satellite Industry, which were received.

3.13 Responding to the Consultation on the Draft Assignment Plan for this band[16], some stakeholders made a very evidenced-based case for *preferring* Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL), particularly LTE Band 32 (1452 - 1492 MHz) SDL, in this 1427 - 1517 MHz Band over IMT 5G-NR TDD/SDL (Bands 75/76). They cited both the much more plentiful devices ecosystem for Band 32 SDL as well as the many countries in Europe[17] that have made decisions to deploy Band 32 SDL in this band.

3.14 The Satellite Community made equally evidenced representations of the risks of IMT base stations' [in the 1427 - 1517 MHz band] out-of-band interference into satellite terminals using 1518 - 1525 MHz. Some satellite players even argued for all IMT base station transmissions to stop at 1492 MHz to protect satellite terminals using 1518 - 1525 MHz.

3.15 The Authority has carefully considered both these sets of representations from IMT and Satellite Stakeholders, as well as other stakeholders.

3.16 The Authority has decided that the 1427 - 1517 MHz Band will be allocated both to Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL) and to IMT 5G-NR TDD/SDL. To address the out-of-band emission concerns of the Satellite community, the new licensees closer to the top of the band (i.e. closer to 1518MHz) would be required to reduce the allowed EIRP down to 58 dBm/5MHz (see Section 5.5). 1517 - 1518 MHz is also designated as a guard band between MSS and IMT. The Authority justifies its decisions made at the conclusion of two consultations in the accompanying Reasons Document published with this RFSAP.

3.17 The Authority notes that its decision above is consistent with the National Radio Frequency Plan 2021, published in Government Gazette 46088 (Notice 911 of 2022). The Plan allocates the frequency band to Mobile on a Primary Basis, and identifies for use by International Mobile Telecommunications (IMT) through National Footnote 9 (NF9).

3.18 The requirements for the family of standards which can provide IMT1500 services include, but are not limited to:

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

3.19 Typical technical and operational characteristics of IMT systems, as identified by the ITU, are described in the following documents[18:]

- Recommendation ITU-R M.2012-5 (02/2022): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT Advanced);
- Report ITU-R M.2074-0 (2006): Report on Radio Aspects for the terrestrial component of IMT-2000 and systems beyond IMT-2000;

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

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

[17] ECO Documentation (cept.org) - https://docdb.cept.org/implementation/1016

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

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

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

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

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

4 Channelling Plan

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

4.2 The channel arrangements considered are based on the Recommendation ITU-R M.1036-6 [19].

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

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

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

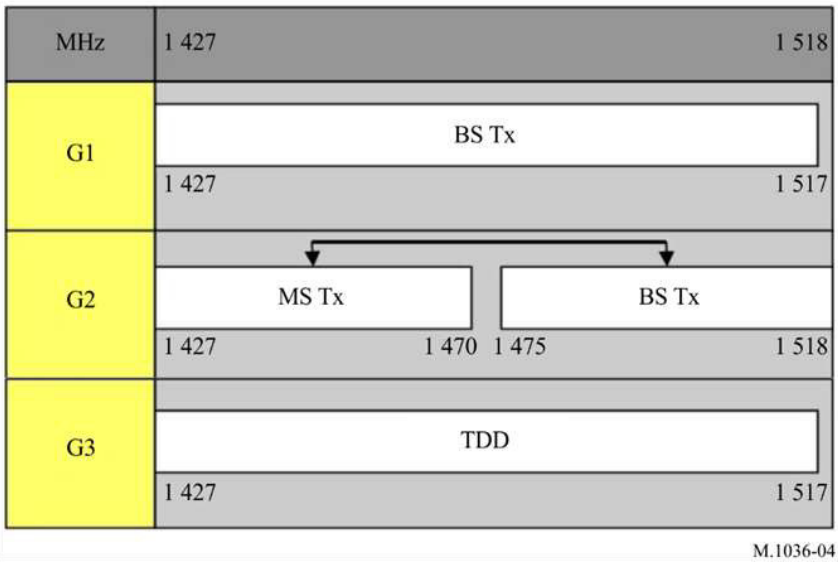

Figure 1: Channel arrangements for IMT1500 ***(Source ITU)***

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

5 Requirements for usage of radio frequency spectrum

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

5.2 Historically, in Region 1, parts of this this band – specifically 1452 MHz to 1492 MHz – has been allocated to T-DAB and S-DAB. However, there has been a trend for other services to replace DAB in this band, including in Africa. There is also a clear trend of IMT seeking an exclusive identification of the band.

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

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

5.5 Maximum radiated power:

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

5.5.1.1 Base Station transmissions in 1512 - 1517 MHz should not exceed 58 dBm/5 MHz EIRP as recommended per ECC/DEC/(17)06[20] and special unwanted emissions limits may need to be satisfied;

5.5.1.2 1517 - 1518 MHz is designated as a guard band to provide 1 MHz further protection to MSS services;

5.5.2 Mobile Station transmissions should not exceed 23 dBm EIRP;

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

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

5.5.4 On a case-by-case basis the Authority acknowledges that in unique scenarios, there may be a case for geographical separation of IMT and MSS systems, including PFD limits at seaports/waterways and at airports to ensure that IMT base stations keep adequate separation from ship earth stations and aircraft earth stations (ESIMs). If these scenarios are likely to arise in the future, the Authority will work with future licensees to mitigate such risks using geographical separation.

5.5.5 Where appropriate, subscriber terminal stations should comply with the technical specification outlined under the latest version of 3GPP specifications, e.g., TS 36.521-1 for LTE, 38.521-1 for 5G New Radio (NR);

5.6 ICNIRP Guideline compliance is required, where applicable; and

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

6 Implementation

6.1 The Authority has extended the frequency band to 1517 MHz in order for the implementation of G3 channel arrangement to cover the whole band, i.e., 1427 MHz to 1517 MHz band, in accordance with recommendation ITU-R M.1036-6.

6.2 No new assignments in the band 1427 MHz to 1517 MHz will be approved unless they comply with this RFSAP.

6.3 The Final RFSAP will come into force upon publication in the Government Gazette.

7 Coordination Requirements

7.1 Cross Border Frequency Coordination will abide by the Harmonised Calculation Method for Africa (HCM4A) Agreement. This follows the 3rd CRASA AGM that agreed that CRASA should implement the Cross Border Frequency Coordination Harmonised Calculation Method for Africa (HCM4A) Agreement.

7.2 The ECC had noted the need for greater understanding of the concept and need for harmonisation in the signing of the HCM4A Agreement by SADC Member States if the implementation of the Agreement was to be effective. The ECC, therefore, agreed to convene a workshop on HCM4A and requested CRASA Members to consider signing the agreement. These activities were part of the Frequency Planning Sub Committee (FPSC) Operations Plan 2015/16.

7.3 At the 5th CRASA AGM, Swakopmund, Namibia – 07-08 April 2016 [5], the subject of Cross Border Frequency Coordination using the Harmonised Calculation Method for Africa (HCM4A) was discussed in detail, following similar efforts in Europe. The Resolution CRASA/AGM/15.16/07 stipulates, "The AGM urged CRASA Members to prioritise the motivation to their administrations who are yet to indicate their interest to sign the Harmonised Calculation Method for Africa (HCM4A), to do so as soon as possible".

7.3.1 Therefore, coordination would follow the HCM4A as detailed in Sub-Saharan Africa Assessment Report on Harmonization of ICT Policies in Sub-Saharan Africa[21] (HIPSSA)

7.4 A harmonised calculation method (HCM4A) brings these benefits

7.4.1 Based on HCM Agreement used in Europe

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

7.4.2 Optimise spectrum usage;

7.4.3 Prevent harmful interferences;

7.4.4 Confer an adequate protection for stations;

7.4.5 Define technical provisions and administrative procedures;

7.4.6 Quick assignment of preferential frequencies; Transparent decisions through agreed assessment procedures; Quick assessment of interference through data exchange

7.5 HCM4A involves all 4 subregions of Africa. This means the HCM4A projects include performing a survey and a comparative analysis of existing administrative and technical procedures related to bilateral and multilateral cross-border frequency coordination agreements across the 4 geographical sub-regions as defined by the African Union (AU), namely,

7.5.1 **Central Africa:** (Burundi, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Sao Tome, and Principe);

7.5.2 **East Africa:** (Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Mauritius, Rwanda, Seychelles, Somalia, Sudan, Tanzania, Uganda);

7.5.3 **Southern Africa:** (Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe); and

7.5.4 **West Africa:** (Benin, Burkina-Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Sierra Leone, Senegal, Togo).

7.6 HCM4A also comes with a software tool for Sub-Saharan Africa[22, 23]

7.6.1 Optimise spectrum usage by accurate interference field strength calculations;

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

7.6.3 Establish models for computer-aided interference range calculations

7.6.4 Harmonise parameters: objectively predictable towards transparent decisions

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

7.8 The following field strength thresholds have to be assured based on ECC/REC (15)01 [24]. Operator-to-operator coordination may be necessary to avoid interference.

Non-advanced antenna systems (AAS) Supplementary Downlink (SDL) base stations of wideband systems on both sides of the border line with centre frequencies not aligned for all PCIs or with synchronisation signal[25] centre frequencies aligned and for preferential PCIs may be used

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

[23] PowerPoint Presentation (itu.int) https://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/Documents/Events/2017/May%20BKK/Presentations/HCM%20and%20HCM4A%20BKK%20201705 04%20IB.pdf

[24] ECC Recommendation (15)01 Cross-border coordination for Mobile/Fixed Communications Networks (MFCN) in the frequency bands: 694-790 MHz, 1427-1518 MHz and 3400-3800 MHz. Approved 13 February 2015. Amended on 14 February 2020. Latest amended on 10 June 2022.

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

without coordination with a neighbouring country if the mean field strength of each cell produced by base station does not exceed the values of 65 dBµV/m/5 MHz at a height of 3 m above ground at the border line between countries, and 47 dBµV/m/5 MHz at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.
Non-AAS SDL base stations of wideband systems on both sides of the border line with synchronisation signal centre frequencies aligned and for non-preferential PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by base station does not exceed the value of 47 dBµV/m/5 MHz at a height of 3 m above ground at the border line between neighbouring countries.

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

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

Table 2: Wideband Systems Field strength Levels

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

For field strength predictions, the calculations should be made according to Annex 2. In the case of channel bandwidth other than 5 MHz, a factor of $10 \times \log_{10}$ (channel bandwidth /5 MHz), should be added to the field strength levels.
If neighbouring administrations wish to agree on frequency coordination based on preferential frequencies, whilst ensuring equitable treatment of different operators within a country, the Authority will add these into the mutual agreements.

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

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

7.11 In the event of any interference, the Authority will require affected parties to carry out coordination. In the event that the interference continues to be unresolved after 24 hours, the affected parties may refer the matter to the Authority for a resolution. The Authority will decide upon the necessary modifications and schedule of modifications to resolve the dispute. The

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

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

7.13 ITU-R M.1036-6 indicates a possible need for addressing IMT – Mobile-satellite service (MSS) coexistence: "With respect to IMT in the frequency band 1492 - 1518 MHz and the MSS in the frequency band 1518 - 1525 MHz, ITU-R studies are being conducted in accordance with Resolution 223 (Rev.WRC-15) to provide possible technical measures to facilitate adjacent band compatibility. The implementation of the frequency arrangements and the text of this Note may need to be reviewed and revised taking into account the results of these studies, which are intended to be included in ITU-R Reports and ITU-R Recommendations, as appropriate. Based on the current results of these ongoing studies, one of a number of possible measures to facilitate adjacent band compatibility, is for administrations to consider additional frequency separation below 1 518 MHz at the upper part of G1, G2, or G3 (e.g. a total separation of different values up to 6 MHz). Moreover, when implementing these frequency arrangements, administrations are also encouraged to take into account the results of the compatibility studies, e.g. in order to address IMT-MSS coexistence in certain areas (around seaports and airports, etc.)." Report ITU-R RS.2336 [26], Report ITU-R M.2324 [27] and Recommendation ITU-R M.1459 [28] as well as ECC/DEC/(17)06 [29], ECC/DEC/(13)03 [30], ECC Report 227[31], ECC Report 269 [32], ECC Report 263 [33] , and ECC Report 299 [34] may provide additional information (such as base station unwanted emissions, the minimum in-band blocking characteristic for land mobile earth stations receivers, and restrictions on base station power in 1512 - 1517 MHz not to exceed 58 dBm/5MHz EIRP).

7.14 Should ultrawide bandwidth (UWB) material sensing devices be introduced, CEPT Report 69 [35] provides recommended maximum mean EIRP spectral density and maximum peak EIRP (defined in 50 MHz) values.

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

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

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

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

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

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

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

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

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

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

8 Assignment

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

9 Amendment

9.1 The feasibility study concerning the 1429 MHz - 1452 MHz band[36] stated the Authority's plan to proceed with IMT (TDD or SDL) for the band following an RF migration plan for the band. The feasibility study conducted for the frequency range from 1452 MHz to 1492 MHz determined that this band should be assigned exclusively for IMT.

9.2 Considering the international trends, the Authority plans to assign the full band, i.e. from 1427 MHz to 1517 MHz, exclusively for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL) and IMT TDD/SDL. Existing radio frequency licensees in the band would need to have their licences amended to reflect new destination bands.

9.2.1 Therefore, existing radio frequency spectrum licences for the use of the band will be amended to a different destination band as necessary.

10 Radio Frequency Migration.

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

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

Appendix A National Radio Frequency Plan.

Table 3 shows an extract from the National Frequency Plan for South Africa. The Authority notes that the Digital Sound Broadcasting Regulations[37] were recently published, in 2021, and the 1427 MHz – 1518 MHz band is no longer included for Terrestrial Digital Audio Broadcasting.

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

[37] Electronic Communications Act: Regulations: Digital Sound Broadcasting Services (www.gov.za)

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

Table 3: National Radio Frequency Plan South Africa for 1427-1518 MHz band[38]

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

Appendix B Propagation Model

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

Path specific model

Where appropriately detailed terrain data is available, the propagation model for interference field strength prediction is the latest version of ITU-R Rec. P.452 [39]. 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[40]. The values for those receiver locations within the neighbouring country would be used to construct a histogram of path loss – and if more than 10% of predicted values exceed the threshold, the station should be coordinated.

Site general model

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

Area calculations

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

For evaluation:

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

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

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

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

height of 3 m above ground.

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

It is recommended that during area calculations, not only detailed terrain data but also clutter data be taken into account. Use of correction factors for clutter is crucial in particular where the border area is 'open' or 'quasi-open' from the point of view of clutter or where the interfering base station is just a few kilometres from a border line.
If the distance between a base station and a terrain point of a border line is closer than or equal to 1 km, the free space propagation model needs to be applied. Furthermore, if there is no terrain obstacle within the 1st Fresnel zone, the free space propagation model should be applied.

If clutter data is not available, it is proposed to extend the usage of the free space propagation model to a few kilometres, depending on the clutter situation in border areas.
For area type interference calculations, propagation models with path-specific terrain correction factors are recommended (e.g., the latest Recommendation ITU–R P.1546[42] with the Terrain Clearance Angle correction factor TCA, HCM [43] method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812 [44], [45]).

As to correction factors for clutters 'open area' and 'quasi-open area', 20 dB and 15 dB should be used, respectively. Recommendation ITU–R P.1406 [46] and/or ITU-R P.2108 [47] 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.

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

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

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

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

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

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

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE[48]

The following is extracted from ECC/REC (11)05 as an operational example and can be adapted for the SADC countries for LTE. A respective extract from ECC/REC (15)01 may be considered for expanding the same onto NR.

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

3GPP TS 36.211[49] defines 168 "unique physical-layer cell-identity groups" in §6.11, numbered 0…167, hereafter called "PCI groups" for LTE. Within each PCI group, there are three separate PCIs giving 504 PCIs in total.

Administrations should agree on a repartition of these 504 PCIs on an equitable basis when channel centre frequencies are aligned, as shown in the table below. It has to be noted that dividing the PCI groups or PCIs is equivalent. Each country should only use their own preferential PCIs close to the border and can use all PCIs away from the border. This transition distance between "close to the border" and "away from the border" should be agreed between neighbouring countries.

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

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

Four types of countries are defined in a way such that no country will use the same code set as any one of its neighbours. The following lists describe a sample distribution for African countries:
***Country type 1*:** Botswana, Cameroon, Comoros, Democratic Republic of the Congo, Ghana, Guinea-Bissau, Kenya, Liberia, Malawi, Mauritius, Niger, Republic of the Sudan, Swaziland;
***Country type 2*:** Algeria, Angola, Benin, Cape Verde, Chad, Cote d'Ivoire, Egypt, Ethiopia, Madagascar, Senegal, United Republic of Tanzania, Zimbabwe;
***Country type 3*:** Burkina Faso, Congo, Djibouti, Equatorial Guinea, Guinea, Mauritania, Nigeria, Rwanda, Sao Tome and Principe, Seychelles, South Africa, South Sudan, Tunisia, Zambia;
***Country type 4*:** Burundi, Central African Republic, Eritrea, Gabon, Gambia, Lesotho, Libyan Arab Jamahiriya, Mali, Morocco, Mozambique, Namibia, Sierra Leone, Somalia, Togo, Uganda.

(Note: A sample country type map can be found in the figure below).

[48] ECC/REC (11)05

[49] 3GPP TS 36.211 "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation". (https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2425 , also provided in ETSI TS 136 211). In comparison, 3GPP 38.211 (and ETSI TS 138 211) define NR Physical channels and modulation, in NR 2-step identification using PSS/SSS detection of the Physical Cell ID (same as LTE), the number of different cell IDs has been increased from 504 in LTE to 1008 for NR. Thus, for the deployment of LTE systems only the PCIs between 0 to 503 should be used and for NR systems PCIs between 0 to 1007 may be used.

Figure 2: **Country type map/PCI distribution map**

For each type of country, the following tables and figure describe the sharing of the PCIs with its neighbouring countries, with the following conventions of writing:

	Preferential PCI
	Non-preferential PCI

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

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

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						

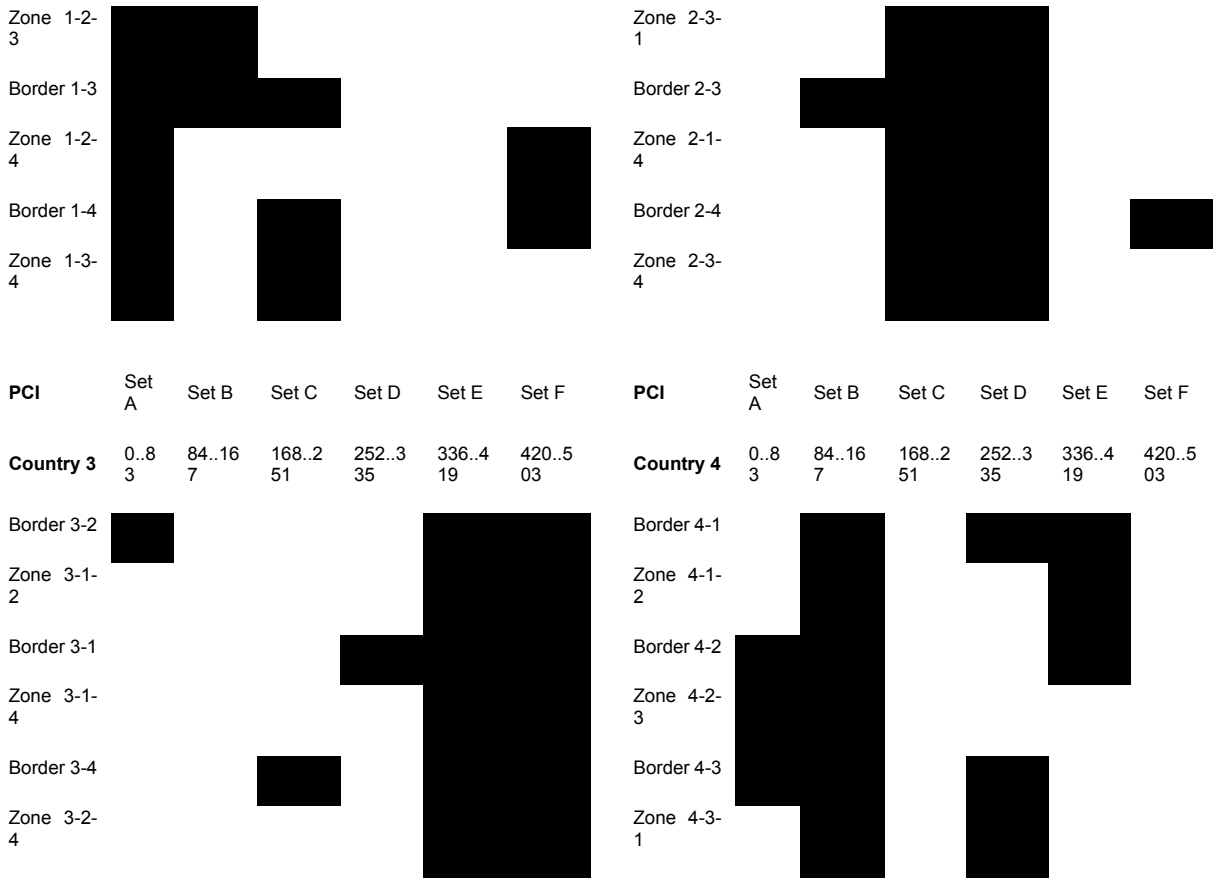

Table 4: Sharing of PCIs between Countries

Notes

1) All PCIs are available in areas away from the border.

2) In certain specific cases (e.g. if Angola and Botswana happened to have the same Country type/PCI code) where the distance between two countries of the same type number is very small (below a few tens of kilometres), it may be necessary to address the situation in bilateral /multilateral coordination agreements as necessary, and may include further subdivision of the allocated codes in certain areas.

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

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

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

border deployment, it is difficult to assess the benefits of such optimisation. The following guidance provides the basis for operators to consider in border areas in cases of high levels of uplink interference.

1. Demodulation Reference Signal (DM RS) coordination

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

The case of partial channel overlap has not been studied but, due to DM RS occupying resource blocks of separate users, there is a risk of DM RS collisions between neighbouring networks when the subcarriers' positions coincide (the frequency offset between central carriers of neighbouring networks is a multiple of 300 kHz). Some minor benefits from DM RS coordination in these particular cases could be expected.

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

- In the basic planning procedure, only 30 DM RS sequence groups with favourable correlation characteristics are available: (0…29). In this case, each cell could be assigned one of the 30 DM RS sequence groups providing a cluster size of 30.
- It is possible to extend each DM RS sequence group to generate up to 12 time-shifted sequence groups by applying the cyclical shift parameter stated in 3GPP TS 36.211. For example, each tri-sector site could be assigned one DM RS sequence group with each co-sited cell having its own cyclical shift of $2\pi/3$, which provides cluster size 30 with only 10 DM RS sequence groups. The latter case corresponds well to the case of DM RS sequence group repartition between neighbouring countries when only a limited number of groups are available for network planning. The drawback of DM RS sequence group cyclical shift is a loss of orthogonality of DM RS due to fading channels which has been found during first trials of LTE and has caused throughput loss as well as time alignment problems.
- Another approach for DM RS coordination is to implement dynamic DM RS sequence group allocation, also called pseudo-random group hopping. In this method, nearby cells are grouped into clusters of up to 30 cells and, within each cell cluster, the same hopping pattern is used. At the border of two clusters, inter-cell interference is averaged since two different hopping patterns are used. There are 17 defined hopping patterns, numbered (0…16), which lead to some minor inequality in the case of apportioning these patterns between neighbouring countries. Even in a trilateral case, each operator will have at least 5 hopping patterns available near the border, which should be enough for planning purposes. It should be noted the pseudo-random group hopping option could be absent in the first generations of LTE equipment.

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

2. Physical Random Access Channel (PRACH) coordination

Another radio network parameter that is considered during radio network planning is PRACH configuration which is needed to distinguish random access requests addressed to different cells. PRACH resources are allocated by specifying the PRACH Resource Block time positions within the uplink frame, their frequency position within the LTE channel bandwidth and by apportioning cell-specific root sequences. During radio network planning these parameters are usually used in the following way:

- Time positions for PRACH resource allocations are usually used to create time collision of PRACH resources of co-sited/frame synchronised cells because PRACH-to-PRACH interference is usually

less severe than PUSCH-to-PRACH interference;

- Frequency positions within the LTE channel bandwidth are usually the same for all cells, again because the PRACH-to-PRACH interference case is the more favourable one; and
- Cell-specific root sequences are used to distinguish between PRACH requests addressed to different cells.

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

In an early implementation, it is possible that a very limited number of frequency positions could be supported by LTE equipment which will not be enough to coordinate in the trilateral case. In such cases, root-sequence repartition could be used. There are 838 root sequences in total, to be distributed between cells, numbered (0…837). There are two numbering schemes for PRACH root sequences (physical and logical) and only logical root sequences numbering needs to be used for coordination. Unfortunately, the process of root sequences planning doesn't involve direct mapping of root sequences between cells because the number of root sequences needed for one cell is dependent on the cell range. The table showing such interdependency is presented below:

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

Table 5: **PRACH – Range Interdependency**

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

speed cells. For simplicity of cross-border coordination, it is proposed to ignore these properties.

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

Additional guidance for cross-border coordination of synchronised and unsynchronised LTE and 5G/NR TDD systems may be found in ECC/REC/ (15)01 [9] and ECC Report 296 [50].

[50] ECC Report 296: "National synchronisation regulatory framework options in 3400-3800 MHz: a toolbox for coexistence of MFCNs in synchronised, unsynchronised, and semi-synchronised operation in 3400-3800 MHz", March 2019.

Appendix D Frequency Coordination Process

Technical procedures related to bilateral and multilateral cross-border frequency coordination agreements for the 4 geographical sub-regions are defined by the African Union which includes the Southern African sub-region of 10 countries. Cross-Border Frequency Coordination and interference resolution should follow the Harmonized Calculation Method for Africa (HCM4A) [51] .

When requesting coordination, the relevant characteristics of the base station and the code or PCI group number should be forwarded to the Administration affected. All of the following characteristics should be included:

a) carrier frequency (MHz);
b) name of transmitter station;
c) country of location of transmitter station;
d) geographical coordinates (latitude, longitude);
e) effective antenna height (m);
f) antenna polarisation;
g) antenna azimuth (degrees);
h) antenna gain (dBi);
i) effective radiated power (dBW);
j) expected coverage zone or radius (km);
k) date of entry into service (month, year);
l) code group number used; and
m) antenna tilt (degrees)

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

If no reply is received by the Administration requesting coordination within 30 days, it may send a reminder to the Administration affected. An Administration not having responded within 30 days following communication of the reminder will be deemed to have given its consent, and the code coordination may be put into use with the characteristics given in the request for coordination.

The periods mentioned above may be extended by common consent.

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

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

NO. 3245 **31 March 2023**

HEREBY ISSUES A NOTICE REGARDING THE FINAL RADIO FREQUENCY ASSIGNMENT PLAN FOR THE IMT850 FREQUENCY BAND IN TERMS OF REGULATION 3 OF THE RADIO FREQUENCY SPECTRUM REGULATIONS, 2015.

1. The Independent Communications Authority of South Africa ("the Authority"), hereby publishes the **Final Radio Frequency Spectrum Assignment Plan for the frequency band 825 MHz to 830 MHz and 870 MHz to 875 MHz** in terms of Regulation 3 of the Radio Frequency Spectrum Regulations, 2015, read with Regulation 5 of the Radio Frequency Migration Regulations, 2013, and the International Mobile Telecommunications (IMT) Roadmap 2014 and 2019.

DR CHARLES LEWIS
ACTING CHAIRPERSON

Radio Frequency Spectrum Assignment Plan

Rules for Services operating in the Frequency Band
from 825 MHz to 830 MHz and
870 MHz to 875 MHz
(IMT850)

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1 Glossary

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

"3GPP"	means the 3rd Generation Partnership Project (3GPP), which consists of six telecommunications standard development organisations
"Act"	means the Electronic Communications Act, 2005 (Act No. 36 of 2005) as amended
"CRASA ECC"	means the Communications Regulators' Association of Southern Africa (CRASA) Electronic Communications Committee (ECC)
"DM RS"	means Demodulation Reference Signal
"ECC/REC (11)04"	means ECC Recommendation (11)04 - Cross-border Coordination for Mobile/Fixed Communications Networks (MFCN) in the frequency band 790-862 MHz, Edition 3 February 2017
"ECC"	means Electronic Communications Committee (ECC) within the European Conference of Postal and Telecommunications Administrations (CEPT)
"FDD"	means Frequency Division Duplex
"HCM"	means harmonised calculation method
"**HIPSSA**"	means Sub-Saharan Africa Assessment Report on Harmonization of ICT Policies in Sub-Saharan Africa
"ICNIRP"	means International Commission on Non-Ionizing Radiation Protection (ICNIRP)
"IMT"	means International Mobile Telecommunications
"IMT850"	means IMT in the 850 MHz band (825 MHz to 830 MHz and 870 MHz to 875 MHz)
"ITA"	means an Invitation to Apply
"ITU"	means the International Telecommunication Union
"ITU-R"	means the International Telecommunication Union Radiocommunication Sector
"LTE"	means Long Term Evolution, which is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies
"NRFP"	means the National Radio Frequency Plan 2013 for South Africa
"PCI"	means Physical-Layer Cell Identities
"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 the World Radiocommunication Conference 2012 held in Geneva
"WRC-15"	means the World Radiocommunication Conference 2015 held in Geneva
"WRC-19"	means the World Radiocommunication Conference 2019 held in Sharm el-Sheikh

2 Purpose

2.1 A Radio Frequency Spectrum Assignment Plan (RFSAP) provides information for the band IMT850 on the requirements attached to using a frequency band in line with the allocation and other information in the National Radio Frequency Plan (NRFP). This information includes technical characteristics of radio systems, frequency channelling, coordination, and details on required migration of existing users of the band and the expected method of assignment.

2.2 The feasibility study[1] consultation concerning the band 825 to 830 MHz and 870 to 875 MHz, mandated by the Frequency Band Migration Regulation and Plan contained in the IMT Roadmap 2014[2] and IMT Roadmap 2019[3], concluded that the Authority proceeds with an RFSAP for IMT in the lower part i.e., 825 - 830 MHz of this band. The lower part i.e., 825 - 830 MHz, now falls in the guard band of Region 1 800 MHz band plan (i.e., 832 - 862/791 - 821 MHz). The upper part of the band i.e., 870 - 875 MHz (paired with 825 - 830 MHz) falls outside the IMT800 band plan.

2.3 Further, this RFSAP is to ensure the protection of the assignments operating IMT Systems in accordance with the "Final Radio Frequency Spectrum Assignment Plan for the frequency band 791 to 821 MHz and 832 to 862 MHz", published in Government Gazette 47788 (Notice 2888 of 2022)

2.4 Therefore, immediately post the clearance date of the current sole IMT850 MHz incumbent Licensee from this band, the Authority will repeal this IMT850 MHz RFSAP.

2.5 In addition, the Authority, shall, in accordance with Regulation 6 of the Radio Frequency Migration Regulations 2013, published in Government Gazette 36334 (Notice 352 0f 2013), publish a notice to inform users to be migrated about their Radio Frequency Spectrum licenses to be amended.

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

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

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

2.6 In the 2nd Consultation on the Draft Assignment Plan for this band[4], the Authority consulted on the destination band (see Section 8 Destination Options for Incumbent Licensee Migration) for the incumbent.

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

3 General

3.1 Technical characteristics of the equipment used in IMT800 systems shall conform to all applicable South African standards, international standards, International Telecommunications Union (ITU) and its radio regulations as agreed to and adopted by South Africa

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

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

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

3.5 The Frequency band 694 to 960 MHz is associated with footnote 5.317A identifying the band for IMT in Table 9 extracted from the edition 2020 of the Radio Regulations (RR), Article 5 for ease of reference. The Frequency Band 825 to 830 MHz and 870 to 875 MHz falls with the frequency range 694 to 960 MHz and has been identified for IMT through National Foot Note 9 (NF9) in the National Radio Frequency Plan 2021, published in Government Gazette 46088 (Notice 911 of 2022)

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

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

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

3.8 Typical technical and operational characteristics of IMT systems as identified by the ITU are

[4] 2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf (icasa.org.za) - https://www.icasa.org.za/uploads/files/2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf

described in the following documents[5]:

- Recommendation ITU-R M.2012-5 (02/2022): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT Advanced);
- Report ITU-R M.2241-0 Compatibility studies in relation to Resolution 224 in the bands 698 - 806 MHz and 790 – 862 MHz;
- Report ITU-R M.2074-0 (2006): Report on Radio Aspects for the terrestrial component of IMT-2000 and systems beyond IMT-2000;
- Recommendation ITU-R M.1645 (06/2003): Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000;
- Recommendation ITU-R M.1036-6 (10/2019): Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations (RR); and
- Recommendation ITU-R M.2150-1 (02/2022): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2020 (IMT-2020).

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

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

4 Channelling Plan

4.1 The inclusion of the frequency block 825 - 830 MHz into the 832–862 MHz paired with 791–821 MHz provides a total bandwidth of:

- 2×30 MHz FDD for IMT800

4.2 Channel arrangements for the IMT800 band are based on the Region 1 recommendation by the ITU. The lower part, i.e., 825 MHz to 830 MHz, now falls in the guard band of the 800 MHz band plan in ITU Region 1 (i.e., 832 - 862/791 - 821 MHz).

Frequency arrangements	Paired arrangements (FDD)				Un-paired arrangements (TDD) (MHz)
	Mobile station transmitter (MHz)	Centre gap (MHz)	Base station transmitter (MHz)	Duplex separation (MHz)	
A3	832 - 862	11	791 - 821	41	None

Table 1: Frequency arrangements in the 791-862 MHz frequency range

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

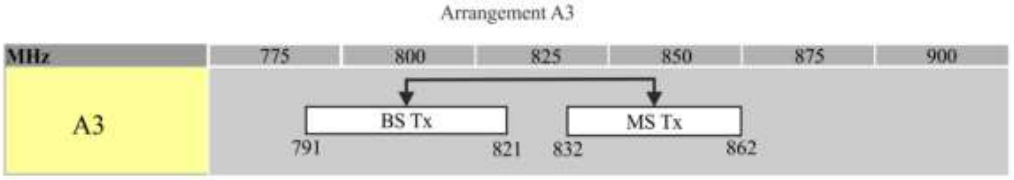

Figure 1: Frequency arrangements for IMT 800 A3 (BS=base station, MS=mobile station, Tx=transmitter)

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 the NRFP is shown in **Error! Reference source not found.**.

5.6 Maximum radiated power

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

5.6.2 Mobile Station transmissions should not exceed 23 dBm EIRP.

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

5.6.4 Where appropriate, subscriber terminal stations should comply with the technical specification outlined under the latest version of 3GPP specifications, e.g., TS 36.521-1 for LTE, 38.521-1 for 5G New Radio (NR).

5.7 ICNIRP Guideline compliance is required, where applicable; and

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

6 Implementation

6.1 The Feasibility Study[6] conducted for this band stated the Authority's plan to proceed with the implementation of the RF migration plan *partly* for the benefit of the important 800 MHz band, specifically the 790 MHz to 862 MHz band already partly auctioned. The study proposed the following two steps for the consultation:

6.1.1 Clear the 825 MHz to 830 MHz and 870 MHz to 875 MHz band as per the current

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

regulations.

6.1.2 Assure the licencing to IMT System conforming to the ITU frequency arrangement A3 arrangement as a part of the 800 MHz band plan in ITU Region 1 (i.e., 832 - 862 / 791 - 821 MHz). This is because this 800 MHz 3GPP Band 20 band plan is one of the most important sub 1 GHz bands for IMT deployment in Region 1. There is a significantly matured global ecosystem developed for this band.

6.2 This Radio Frequency Spectrum Assignment Plan (RFSAP) comes into effect upon publication of the final RFSAP in the Government Gazette.

6.3 The Authority concluded from the Feasibility Study[7] consultation concerning the Band 825 to 830 MHz and 870 to 875 MHz (i.e., the IMT850) that no new assignments in this band will be approved.

6.4 Indeed as noted earlier in Section 2.4 and 2.5 immediately post the clearance of the current IMT850 Licensee from this band, through the amendment of the incumbent's license for the destination band, the Authority will repeal this IMT850 RFSAP.

7 Co-ordination Requirements

7.1 Cross Border Frequency Coordination will abide by the Harmonised Calculation Method for Africa (HCM4A) Agreement. This follows the 3rd CRASA AGM that agreed that CRASA should implement the Cross Border Frequency Coordination Harmonised Calculation Method for Africa (HCM4A) Agreement.

7.2 The ECC had noted the need for greater understanding of the concept and need for harmonisation in the signing of the HCM4A Agreement by SADC Member States if the implementation of the Agreement is to be effective. The ECC, therefore, agreed to convene a workshop on HCM4A and requested the CRASA Members to consider signing the agreement. These activities were part of the Frequency Planning Sub Committee (FPSC) Operations Plan 2015/16.

7.3 At the 5th CRASA AGM, Swakopmund, Namibia – 07-08 April 2016[8], the subject of Cross Border Frequency Coordination using the Harmonised Calculation Method for Africa (HCM4A) was discussed in detail, following similar efforts in Europe. The Resolution CRASA/AGM/15.16/07 stipulates, "The AGM urged CRASA Members to prioritise the motivation to their administrations who are yet to indicate their interest to sign the Harmonised Calculation Method for Africa (HCM4A), to do so as soon as possible".

7.3.1 Therefore, coordination would follow the HCM4A as detailed in Sub-Saharan Africa Assessment Report on Harmonization of ICT Policies in Sub-Saharan Africa[9] (HIPSSA).

7.4 A harmonised calculation method (HCM4A) brings these benefits

7.4.1 Based on HCM Agreement used in Europe

7.4.2 Optimise spectrum usage;

7.4.3 Prevent harmful interferences;

7.4.4 Confer an adequate protection for stations;

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

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

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

7.4.5 Define technical provisions and administrative procedures;

7.4.6 Quick assignment of preferential frequencies;

7.4.7 Transparent decisions through agreed assessment procedures;

7.4.8 Quick assessment of interference through data exchange

7.5 HCM4A involves all 4 sub regions of Africa. This means the HCM4A projects include performing a survey and a comparative analysis of existing administrative and technical procedures related to bilateral and multilateral cross-border frequency coordination agreements across the 4 geographical sub-regions as defined by the African Union (AU), namely,

7.5.1 **Central Africa** (Burundi, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Sao Tome, and Principe);

7.5.2 **East Africa** (Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Mauritius, Rwanda, Seychelles, Somalia, Sudan, Tanzania, Uganda);

7.5.3 **Southern Africa** (Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe);

7.5.4 **West Africa** (Benin, Burkina-Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Sierra Leone, Senegal, Togo). Optimise spectrum usage by accurate interference field strength calculations;

7.6 HCM4A also comes with a software tool for Sub-Saharan Africa [10]

7.6.1 Optimise spectrum usage by accurate interference field strength calculations;

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

7.6.3 Establish models for computer-aided interference range calculations

7.6.4 Harmonise parameters: objectively predictable towards transparent decisions

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

7.8 The following field strength thresholds have to be assured based on (ECC/REC (11)04 for 790 - 862 MHz. 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 55 dBµV/m/5 MHz at a height of 3 m above ground at the border line between countries and does not exceed a value of 29 dBµV/m/5 MHz at a height of 3 m above ground at a distance of 9 km inside the neighbouring country.
In the case that LTE is deployed on both sides of the border, the field strength levels can be increased to 59 dBµV/m/5 MHz at the border (0 km) and 41 dBµV/m/5 MHz at 6 km from the border line inside the neighbouring country for preferential PCI codes (discussed in Appendix C). For the use of non-preferential PCI codes and aligned centre frequencies, the trigger field strength level is 41 dBµV/m/5 MHz at the border.
If TDD is in operation across both sides of a border and is synchronised across the border, then field strength levels are the same as for LTE-to-LTE coordination case. For unsynchronised TDD, the trigger field strength level is 24 dBµV/m/5 MHz at the border.
For field strength predictions, the calculations should be made according to Appendix B. In cases

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

of other frequency block sizes, $10*\log_{10}$ (frequency block size / 5 MHz) should be added to the field strength values, e.g.:

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

Table 2: Field Strength Adjustments

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

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

7.10 Specific information regarding coordination may be found in **Error! Reference source not found.** taken from ECC/REC (11)05.

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

7.12 Assignment holders shall 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 Destination Options for Incumbent Licensee Migration

8.1 The Authority considered the process of identifying the designation band for the incumbent in the 825 MHz to 820 MHz and 870 MHz to 875 MHz bands to migrate to.

8.2 In undertaking this process, three consequential issues arose and were considered:

[11] This information is available in the first edition of ECC/REC (11)04 (also, per Report ITU-R M.2241 (11/2011): Compatibility studies in relation to Resolution 224 in the bands 698-806 MHz and 790-862 MHz).

8.2.1 What is an 'equivalent' destination spectrum band and 'equivalent' amount of spectrum?

8.2.2 What is the process for resolving the identification and concluding of the destination band/amount acceptable?

8.2.3 What attributes should such a process possess?

8.3 Taking into consideration the provisions of Regulations 5 (2) and 5 (3) of the Radio Frequency Migration Regulation 2013, the Authority settled on the attributes of Fairness, Reasonableness, Non-Discrimination and Transparency.

8.4 The table below illustrates the frequency bands that were assessed for consideration as potential destination bands for the current licensee in this band in the Consultation[12].

Item	Proposed destination	Bandwidth available	Factors considered	Availability
1.	450 MHz	2 x 5 MHz	The Radio Frequency Spectrum Assignment is currently under consultation in order to access the extent to which the incumbent can be migrated. It is therefore a challenge to assess availability in future given the dynamics and challenges posed by the current incumbent.	01 April 2025
2.	700 MHz	2 x 30 MHz	Not available due to the recent Licensing process	01 April 2023
3.	IMT750	1 x 20 MHz	IMT750 has a 20 MHz Supplementary Downlink (SDL) with a 5 MHz guard band between the uplink and SDL downlink. The Frequency Band is subject to the Transitional arrangements in terms of the Analogue Television Switch off Process currently underway. The challenge in considering the IMT850 is that the Channel arrangements are for a Frequency Division Duplex (FDD), whereas the IMT750 is a supplementary Downlink only where the uplink is unavailable.	01 April 2023
4.	800 MHz	2 x 30 MHz	Not available due to the recent Licensing process	01 April 2023
5.	900 MHz	2 x 5 MHz	This spectrum band is earmarked to be assigned through an Invitation to Apply that will be published for a new assignment in the frequency block 900 - 905 / 945 - 950 MHz. However, the Authority may amend Provision 8.1 under "Assignment" of the Radio Frequency Spectrum Assignment Plan for IMT900, in order to implement a possible Migration into this band.	01 April 2024
6.	1500 MHz	90 MHz	The Radio Frequency Spectrum Assignment is currently under consultation in order to seek the optimum allocation for this band. Not a sub-1 GHz spectrum band.	01 April 2024
7.	2.3 GHz	40 MHz	Not a sub-1 GHz spectrum band.	01 April 2024
8.	2.6 GHz	190 MHz	Not available due to the recent Licensing process	22 May 2020
9.	3.3 GHz	100 MHz	Not a sub-1 GHz spectrum band.	01 April 2023
10.	26 GH.		Not available. The Radio Frequency Migration Plan and the IMT Roadmap are yet to be developed prior to the development of the RFSAP for this band.	To be determined

[12] 2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf (icasa.org.za) - https://www.icasa.org.za/uploads/files/2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf

Table 3: Consideration of Incumbent 850MHz Destination Band Options

9 Assignment

9.1 The Authority has already partly assigned via an auction the spectrum in 791-821 MHz paired with 832-862 MHz band through an Invitation to Apply[13] in line with regulations developed in terms of Section 31(3) of the Electronic Communications Act (Act No. 36 of 2005).

9.2 As noted in Section 2.3, post the clearance of the current IMT850 MHz Licensee from this band, the Authority will repeal this IMT850 MHz RFSAP.

10 End of Transitional Arrangements

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

11 Assignment

11.1 Existing radio frequency spectrum licences for the use of the band will be amended to align with the destination frequency band in accordance with Regulation 6 of the Radio Frequency Migration Regulations 2013

11.2 This RFSAP shall be repealed once the incumbent spectrum licensee in the band clears the band, and its Radio Frequency Spectrum Licence has been amended.

12 Radio Frequency Clearance and Migration

12.1 Since this IMT850 RFSAP will be repealed, all existing transmissions from 825 to 830 MHz paired with 870 to 875 MHz band should be cleared. The Authority understands that the sole licensee in this band has already switched off its network in the IMT850 band, and therefore the spectrum is currently already unutilised.

12.2 The current licensee in the band should fully clear the band by the 31st of March 2024.

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

12.4 After the 2nd Consultation on the Draft Assignment Plan for this band[14], the Authority has decided that - as of 1st of April 2024 - the sole licensee of this IMT850 band is assigned the 2 x 5 MHz spectrum in the IMT900 band as depicted in Figure 2.

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[13] Electronic Communications Act: Licensing process for international mobile applications in respect of the provision of Mobile Broadband Wireless Access Services: Invitation To Apply, Government Gazette No. 45628, 10 December 2021

[14] 2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf (icasa.org.za) - https://www.icasa.org.za/uploads/files/2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf

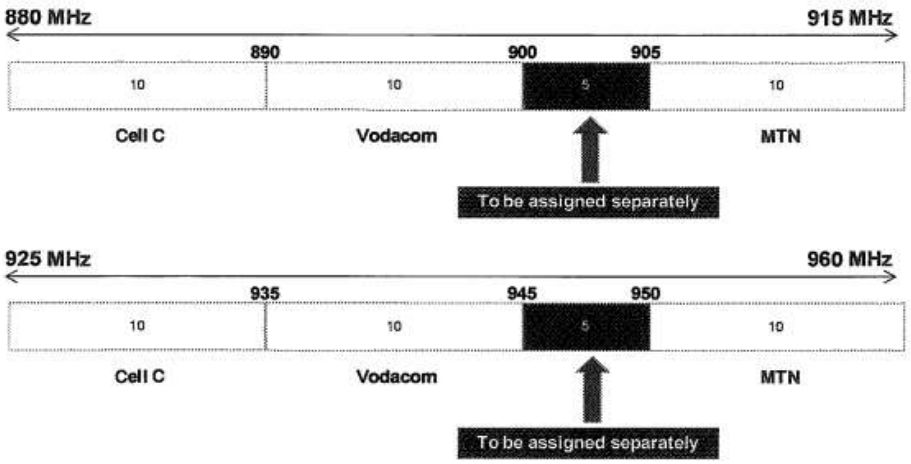

Figure 2: New Proposed FDD assignment in the 900 MHz band for the Licensee migrating from the soon-to-be-repealed IMT 850 MHz Band

12.5 The Authority justifies its decision on its choice [of the IMT 900MHz band] made at the conclusion of two consultations in the accompanying Reasons Document published with this RFSAP.

13 Repeals

The Authority hereby repeals the following upon publication of this assignment plan:

- Government Gazette Number 42337 (Notice 165 of 2019), the current existing RFSAP for this 825 to 830 MHz paired with 870 to 875 MHz band, is repealed on publication of this RFSAP.

- This present IMT 850 MHz RFSAP will be repealed on the 1st of April 2024.

Appendix A National Radio Frequency Plan

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

ITU Region 1 allocations and footnotes	South African allocations and footnotes	Typical Applications	Notes and Comments
790 - 862 MHz FIXED MOBILE except aeronautical mobile 5.316B 5.317A BROADCAS TING 5.312 5.319	790 - 862 MHz FIXED MOBILE except aeronautical mobile 5.316B 5.317A NF9 5.312A 5317A	Fixed Links (856 – 864.1 MHz) Wireless Access (827.775 – 832.695 MHz) IMT800 MTX (832 - 862 MHz) IMT850 MTX (825 – 830 MHz)	Paired with 868.1 – 876 MHz Paired with 827.775- 832.695 MHz Paired with BTX (791 – 821 MHz) Paired with BTX (870 – 875 MHz) International Mobile Telecommunication Roadmap (GG No. 42829 Notice 600 of 2019). Radio Frequency Spectrum Assignment Plan (GG 38640 Notice 271 and 272 of 2015) as amended IMT in accordance with ITU-R Recommendation ITU-R M.2090 latest version and Resolution **760 (WRC-15**) applies Recommendation ITU-R M.1036-6 Consideration of the future spectrum needs of Broadband Public Protection and Disaster Relief (PPDR) in the range 694-790 MHz as described in the most recent ITU-R M.2015, while taking into account studies called for by Resolution 646 (WRC15) for technical and operational measures. Band IV/V analogue television is to be migrated to digital television and ensure harmonisation with SADC. WRC-07, WRC-12 and WRC-15 allocated this band to Mobile service except aeronautical mobile and identified it for IMT. Fixed links operating in this band will have to be migrated in order to accommodate IMT. Radio Frequency Spectrum Assignment Plan GG 42337 Notice 165 of 2019 Radio Frequency Spectrum Assignment Plan (GG 38640 Notice 273 of 2015) as amended Radio Frequency Spectrum Assignment Plan GG 41082 Notice 648 of 2017
862-890 MHz	**862-890 MHz**		

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

Table 4: National Radio Frequency Plan for South Africa for 825 to 830/870 to 875 MHz band[15]

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

Appendix B Propagation Model

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

Path specific model

Where appropriately detailed terrain data is available, the propagation model for interference field strength prediction is the latest version of ITU-R Rec. P.452 [16]. For the relevant transmitting terminal, predictions of path loss would be made at *x* km steps along radials of *y* km at *z* degree intervals[17]. The values for those receiver locations within the neighbouring country would be used to construct a histogram of path loss – and if more than 10% of predicted values exceed the threshold, the station should be 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" [18]. This model is to be employed for 50% locations, 10% time and using a receiver height of 3 m. For specific reception areas where terrain roughness adjustments for improved accuracy of field strength prediction are needed, administrations may use correction factors according to terrain irregularity and/or an averaged value of the TCA parameter in order to describe the roughness of the area on and around the coordination line.
Administrations and/or operators concerned may agree to deviate from the aforementioned model by mutual consent.

Area calculations

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

For evaluation,

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

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

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

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

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

It is recommended that during area calculations, not only detailed terrain data but also clutter data be taken into account. Use of correction factors for clutter is crucial in particular where the border area is 'open' or 'quasi-open' from the point of view of clutter or where the interfering base station is just a few kilometres from a border line.
If the distance between a base station and a terrain point of a border line is closer than or equal to 1 km, the free space propagation model needs to be applied. Furthermore, if there is no terrain obstacle within the 1st Fresnel zone, the free space propagation model should also be applied.

If clutter data is not available, it is proposed to extend the usage of the free space propagation model to a few kilometres, depending on the clutter situation in border areas.
For area type interference calculations, propagation models with path specific terrain correction factors are recommended (e.g., the latest Recommendation ITU–R P.1546[19] with the terrain clearance angle correction factor TCA, HCM[20] method with the terrain clearance angle correction factor or Recommendation ITU–R P.1812 [21, 22]).

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[23] and/or ITU-R P.2108[24] 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.

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

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

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

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

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

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

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE[25]

The following is extracted from ECC/REC (11)05 as an operational example and can be adapted for the SADC countries for LTE. A respective extract from ECC/REC (15)01 may be considered for expanding the same onto NR.

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

3GPP TS 36.211[26] defines 168 "unique physical-layer cell-identity groups" in §6.11, numbered 0…167, hereafter called "PCI groups" for LTE. Within each PCI group, there are three separate PCIs giving 504 PCIs in total.

Administrations should agree on a repartition of these 504 PCIs on an equitable basis when channel centre frequencies are aligned, as shown in the table below. It has to be noted that dividing the PCI groups or PCIs is equivalent. Each country should only use their own preferential PCIs close to the border and can use all PCIs away from the border. This transition distance between "close to the border" and "away from the border" should be agreed between neighbouring countries.

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

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

Four types of countries are defined in a way such that no country will use the same code set as any one of its neighbours. The following lists describe a sample distribution for African countries:
Country type 1: Botswana, Cameroon, Comoros, Democratic Republic of the Congo, Ghana, Guinea-Bissau, Kenya, Liberia, Malawi, Mauritius, Niger, Republic of the Sudan, Swaziland;
Country type 2: Algeria, Angola, Benin, Cape Verde, Chad, Cote d'Ivoire, Egypt, Ethiopia, Madagascar, Senegal, United Republic of Tanzania, Zimbabwe;
Country type 3: Burkina Faso, Congo, Djibouti, Equatorial Guinea, Guinea, Mauritania, Nigeria, Rwanda, Sao Tome and Principe, Seychelles, South Africa, South Sudan, Tunisia, Zambia;
Country type 4: Burundi, Central African Republic, Eritrea, Gabon, Gambia, Lesotho, Libyan Arab Jamahiriya, Mali, Morocco, Mozambique, Namibia, Sierra Leone, Somalia, Togo, Uganda.

(Note: A sample country type map can be found in the figure below).

[25] ECC/REC (11)05

[26] 3GPP TS 36.211 "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation". (https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2425 , also provided in ETSI TS 136 211). In comparison, 3GPP 38.211 (and ETSI TS 138 211) define NR Physical channels and modulation, in NR 2-step identification using PSS/SSS detection of the Physical Cell ID (same as LTE), the number of different cell IDs has been increased from 504 in LTE to 1008 for NR. Thus, for the deployment of LTE systems only the PCIs between 0 to 503 should be used and for NR systems PCIs between 0 to 1007 may be used.

Figure 3: Country type map/PCI distribution map

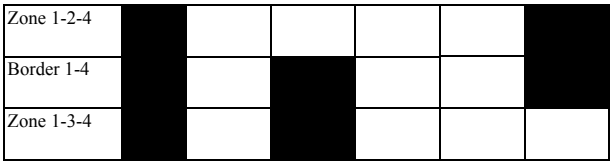
For each type of country, the following tables and figure describe the sharing of the PCIs with its neighbouring countries, with the following conventions of writing:

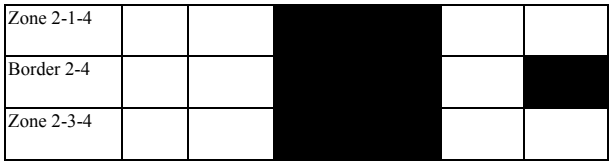
	Preferential PCI
	Non-preferential PCI

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

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

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





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

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

Table 5: Sharing of PCIs between Countries

Notes

1) All PCIs are available in areas away from the border.

2) In certain specific cases (e.g., if Angola and Botswana happened to have the same Country type/PCI code) where the distance between two countries of the same type number is very small (below a few tens of kilometres), it may be necessary to address the situation in bilateral /multilateral coordination agreements as necessary and may include further subdivision of the allocated codes in certain areas.

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

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

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

1. Demodulation Reference Signal (DM RS) coordination

Demodulation reference signals (DM RS) are transmitted in the uplink and used for channel estimation. There is a risk of intercell interference between neighbouring cells even in case of no frame synchronisation. That is why special measures for DM RS allocation between networks in neighbouring

countries occupying the same channel may need to be applied.

The case of partial channel overlap has not been studied but due to DM RS occupying resource blocks of separate users, there is a risk of DM RS collisions between neighbouring networks when the subcarriers' positions coincide (the frequency offset between central carriers of neighbouring networks is a multiple of 300 kHz). Some minor benefits from DM RS coordination in these particular cases could be expected.

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

- In the basic planning procedure, only 30 DM RS sequence groups with favourable correlation characteristics are available: (0…29). In this case, each cell could be assigned one of the 30 DM RS sequence groups providing a cluster size of 30.
- It is possible to extend each DM RS sequence group to generate up to 12 time shifted sequence groups by applying the cyclic shift parameter stated in 3GPP TS 36.211 for LTE. For example, each tri-sector site could be assigned one DM RS sequence group with each co-sited cell having its own cyclic shift of $2\pi/3$, which provides cluster size 30 with only 10 DM RS sequence groups. The latter case corresponds well to the case of DM RS sequence group repartition between neighbouring countries when only a limited number of groups is available for network planning. The drawback of DM RS sequence group cyclic shift is a loss of orthogonality of DM RS due to fading channels which has been found during 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 utilised. There are 17 defined hopping patterns, numbered (0…16), which leads to some minor unfairness in case of apportioning these patterns between neighbouring countries. Even in a trilateral case each operator will have at least 5 hopping patterns available near the border, which should be enough for planning purposes. It should be noted the pseudo-random group hopping option could be absent in the first generations of LTE equipment.

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

2. Physical Random Access Channel (PRACH) coordination

Another radio network parameter that is considered during radio network planning is PRACH configuration which is needed to distinguish random access requests addressed to different cells. PRACH resources are allocated by specifying the PRACH Resource Blocks time positions within the uplink frame, their frequency position within the LTE channel bandwidth and by apportioning cell-specific root sequences. During radio network planning, these parameters are usually used in the following way:

- Time positions for PRACH resource allocations are usually used to create time collision of PRACH resources of co-sited/frame synchronised cells because PRACH-to-PRACH interference is usually less severe than PUSCH-to-PRACH interference;
- Frequency positions within the LTE channel bandwidth are usually the same for all cells, again because PRACH-to-PRACH interference case is a more favourable one.
- Cell-specific root sequences are used to distinguish between PRACH requests addressed to different cells.

For cross-border coordination, it is proposed to use frequency position offsets to exclude the possibility of so-called “ghost” PRACH requests caused by neighbouring networks. The PRACH is configured in

LTE to use only 6 Resource Blocks or 1.08 MHz of the LTE channel bandwidth except in regions used by PUCCH. In case of overlapping or partially overlapping channel bandwidths of neighbouring networks, it is enough to establish non-overlapping PRACH frequency blocks to perform coordination. Because it is difficult to establish an implementation dependent procedure for such allocation, it will be the responsibility of operators to manage such frequency separation during coordination discussions.

In an early implementation, it is possible that a very limited number of frequency positions could be supported by LTE equipment which will not be enough to coordinate in the trilateral case. In such cases, root-sequence repartition could be used. There are 838 root sequences in total to be distributed between cells, numbered (0…837). There are two numbering schemes for PRACH root sequences (physical and logical) and only logical root sequences numbering needs to be used for coordination. Unfortunately, the process of root sequences planning doesn't involve direct mapping of root sequences between cells because the number of root sequences needed for one cell is dependent on the cell range. The table showing such interdependency is presented below:

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

Table 6: **PRACH – Range Interdependency**

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

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

Additional guidance for cross-border coordination of synchronised and unsynchronised LTE and 5G/NR TDD systems may be found in ECC/REC/ (15)01 27 and ECC Report 296 28. The text above is based on these.

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

[28] ECC Report 296: "National synchronisation regulatory framework options in 3400-3800 MHz: a toolbox for coexistence of MFCNs in synchronised, unsynchronised, and semi-synchronised operation in 3400-3800 MHz", March 2019.

Appendix D Frequency Coordination Process

Technical procedures related to bilateral and multilateral cross-border frequency coordination agreements for 4 geographical sub-regions are defined by the African Union which includes the Southern African sub-region of 10 countries. Cross-Border Frequency Coordination and interference resolution should follow the Harmonized Calculation Method for Africa (HCM4A).[29]

When requesting coordination, the relevant characteristics of the base station and the code or PCI group number should be forwarded to the Administration affected. All of the following characteristics should be Included:

a) carrier frequency (MHz)
b) name of transmitter station
c) country of location of transmitter station
d) geographical coordinates (latitude, longitude)
e) effective antenna height (m)
f) antenna polarisation
g) antenna azimuth (degrees)
h) antenna gain (dBi)
i) effective radiated power (dBW)
j) expected coverage zone or radius (km)
k) date of entry into service (month, year)
l) code group number used
m) antenna tilt (degrees)

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

If no reply is received by the Administration requesting coordination within 30 days, it may send a reminder to the Administration affected. An Administration not having responded within 30 days following communication of the reminder shall be deemed to have given its consent, and the code coordination may be put into use with the characteristics given in the request for coordination.

The periods mentioned above may be extended by common consent.

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

INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

NO. 3246 **31 March 2023**

HEREBY ISSUES A NOTICE REGARDING THE FINAL RADIO FREQUENCY ASSIGNMENT PLAN FOR THE IMT450 FREQUENCY BAND IN TERMS OF REGULATION 3 OF THE RADIO FREQUENCY SPECTRUM REGULATIONS, 2015.

1. The Independent Communications Authority of South Africa ("the Authority"), hereby publishes the **Final Radio Frequency Spectrum Assignment Plan for the frequency band 450 MHz to 470 MHz** in terms of Regulation 3 of the Radio Frequency Spectrum Regulations, 2015, read with Regulation 5 of the Radio Frequency Migration Regulations, 2013, and the International Mobile Telecommunications (IMT) Roadmap 2014 and 2019.

DR CHARLES LEWIS
ACTING CHAIRPERSON

Radio Frequency Spectrum Assignment Plan

Rules for Services operating in the Frequency Band
450 MHz 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
"CRASA ECC"	means the Communications Regulators' Association of Southern Africa (CRASA) Electronic Communications Committee (ECC)
"DM RS"	means Demodulation Reference Signal
"ECC/REC (11)04"	means ECC Recommendation (11)04 - Cross-border Coordination for Mobile/Fixed Communications Networks (MFCN) in the frequency band 790-862 MHz, Edition 3 February 2017
"ECC/REC (15)01"	means ECC Recommendation (15)01 - ECC Recommendation (15)01 "Cross-border coordination for Mobile/Fixed Communications Networks (MFCN) in the frequency bands: 694-790 MHz, 1427-1518 MHz and 3400-3800 MHz". Amended on 14 February 2020
"ECC"	means Electronic Communications Committee (ECC) within the European Conference of Postal and Telecommunications Administrations (CEPT)
"FDD"	means Frequency Division Duplex
"HCM"	means Harmonised Calculation Method
"**HIPSSA**"	means Sub-Saharan Africa Assessment Report on Harmonization of ICT Policies in Sub-Saharan Africa
"IMT"	means International Mobile Telecommunications
"IMT700"	means IMT in the 700 MHz band (703 MHz to 733 MHz and 758 MHz to 788 MHz)
"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, which is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies
"NRFP"	means the National Radio Frequency Plan 2021 for South Africa
"PCI"	means 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 2015 held in Geneva
"WRC-19"	means World Radiocommunication Conference 2019 held in Sharm el-Sheikh

2 Purpose

2.1 A Radio Frequency Spectrum Assignment Plan (RFSAP) for the band IMT450 provides information on the requirements attached to using a frequency band in line with the allocation and other information in the National Radio Frequency Plan (NRFP). This information includes technical characteristics of radio systems, frequency channelling, coordination, and details on required migration of existing users of the band and the expected method of assignment.

2.2 The feasibility study consultation concerning the 450 - 470 MHz band[1], mandated by the Frequency Band Migration Regulation and Plan contained in the IMT Roadmap 2014[2] and IMT Roadmap 2019[3], concluded that the Authority proceeds with an RFSAP for IMT in this band.

2.3 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.

2.4 The International Telecommunications Union (ITU) states that International Mobile

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

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

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

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

Key features are:

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

3 General

3.1 Technical characteristics of the equipment used in IMT450 systems will conform to all applicable South African standards, international standards, ITU and its radio regulations as agreed and adopted by South Africa.

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

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

3.4 The allocation of this frequency band and the information in this RFSAP are subject to review.

3.5 Frequency bands identified for IMT include the bands from 450 - 470 MHz.

3.6 Likely use of this band will be for rural mobile broadband, Public Protection and Disaster Relief (PPDR) or machine-to-machine (M2M) communications nationwide.

3.7 The requirements for the standard families which can provide IMT450 services include, but are not limited to:

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

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

- Recommendation ITU-R M.2012-5 (02/2022): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT Advanced);
- Report ITU-R M.2110 (07/2002): Sharing studies between Radiocommunication services and IMT systems operating in the 450-470 MHz band;
- Recommendation ITU-R M.1645 (06/2003): Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000;

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

- Recommendation ITU-R M.1036-6 (10/2019): Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations (RR); and
- Recommendation ITU-R M.2150-1 (02/2022): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2020 (IMT-2020).

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

- Recommendation ITU-R M.2070-1 (02/2017): Generic unwanted emission characteristics of base stations using the terrestrial radio interfaces of IMT-Advanced;
- Recommendation ITU-R M.2071-1 (02/2017): Generic unwanted emission characteristics of mobile stations using the terrestrial radio interfaces of IMT-Advanced;
- Recommendation ITU-R M.2090 (10/2015): Specific unwanted emission limit of IMT mobile stations operating in the frequency band 694-790 MHz to facilitate protection of existing services in Region 1 in the frequency band 470-694 MHz; and
- Recommendation ITU-R M.2101 (02/2017): Modelling and simulation of IMT networks and systems for use in sharing and compatibility studies.

4 Channelling Plan

4.1 The frequency band 450 – 470 MHz provides a total bandwidth of 2×5 MHz FDD or 10 MHz TDD for IMT450.

4.2 The recommended frequency arrangements for implementation of IMT in the band 450 - 470 MHz are summarised in Table 1 and Figure 1.

Frequency arrangements	Paired arrangements				Unpaired arrangements (e.g., for TDD) (MHz)
	Mobile station transmitter (MHz)	Centre gap (MHz)	Base station transmitter (MHz)	Duplex separation (MHz)	
D8					450 - 470 TDD
D12	450.0 - 455.0	5.0	460.0 - 465.0	10	None
D13	451.0 - 456.0	5.0	461.0 - 466.0	10	None
D14	452.5 - 457.5	5.0	462.5 - 467.5	10	None

Table 1: Frequency arrangements in the band 450 - 470 MHz

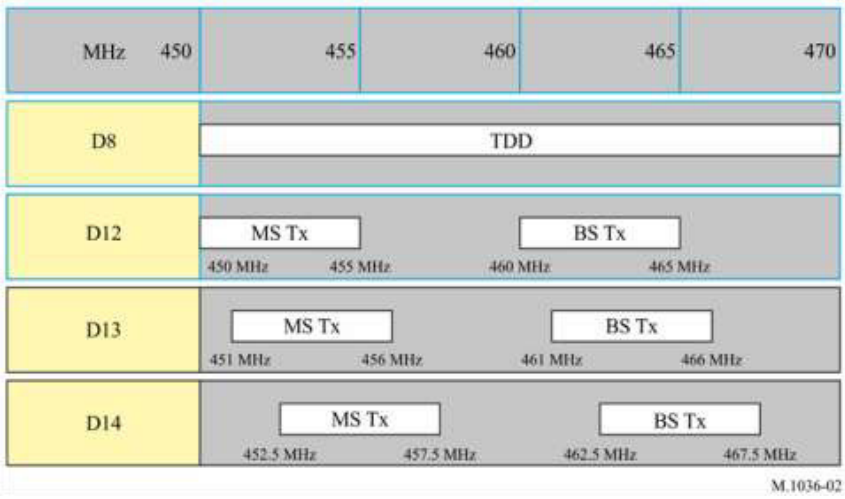

Figure 1: Frequency arrangements in the band 450 - 470 MHz (i.e., D8, D12, D13 and D14)

Both D13 and D14 configurations are most widely being considered or used around the world for IMT and PPDR systems in the 450-470 MHz band. The ecosystem for these band arrangements is currently available and rapidly emerging[5].

5 Requirements for usage of radio frequency spectrum

5.1 This section 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; narrowband services capable of coexistence with IMT may also be permitted. PPDR-supporting, M2M and mission critical communication services might be implemented via IMT.

5.3 Only systems using digital technologies that promote spectral efficiency will be issued with an assignment in the band. 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 the NRFP is shown in Appendix A.

5.6 Maximum radiated power:

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

5.6.2 Mobile Station transmissions should not exceed 23 dBm EIRP;

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

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

5.6.4 Where appropriate, subscriber terminal stations should comply with the technical specification outlined under the latest version of 3GPP TS 36.521-1 and 3GPP TS 38.521-1 for 5G NR connected to the relevant technology (e.g., LTE/LTE-Advanced/NR).

5.7 ICNIRP Guideline compliance is required, where applicable; and

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

6 Implementation

6.1 Following clear and preferred feedback after the Feasibility Study[6] consultation with stakeholders (including the first and even a second[7] Consultation on Draft Assignment Plans for this band), the Authority has decided to proceed with licensing to the D14 band plan (i.e. 3GPP Band 31) for this band.

6.2 The Feasibility Study consultation conducted for this band concluded that the Authority proceeds with the *implementation* of the RF migration plan for the 450 MHz band in the following three steps for the consultation:

6.2.1 Clear the band as per the current regulations; as per the date of the Government Notice[8].

6.2.2 Licence to IMT System using 3GPP Band 31 (D14) arrangements.

6.2.3 Licencing of additional services, including Narrowband services capable of coexistence with IMT (e.g. IoT, M2M, PPDR, etc.), would be permitted and licensed. PPDR-supporting or M2M services might be implemented via IMT too.

6.3 The Authority recognises there are Government services used in this band. The Authority confirms that it will develop exclusion zones as part of any new IMT licensing (via an ITA) in order to protect them, where absolutely required. Transnet (in particular) would furnish and publish a clear digital migration plan and provide information which would enable the Authority to publish the necessary technical transmission parameters and locations of legacy services with a future Invitation to Apply (ITA) published for new assignments for this band.

6.4 This Radio Frequency Assignment Plan comes into effect upon publication of the final RFSAP in the Government Gazette.

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

7 Coordination Requirements

7.1 Cross Border Frequency Coordination will abide by the Harmonised Calculation Method for Africa (HCM4A) Agreement. This follows the 3rd CRASA AGM[9] that agreed that CRASA

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

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

[8] Government Gazette Number 38640, 30 March 2015

[9] Maseru, Lesotho, 2014

should implement the Cross Border Frequency Coordination Harmonised Calculation Method for Africa (HCM4A) Agreement.

7.2 The ECC had noted the need for a greater understanding of the concept and need for harmonisation in the signing of the HCM4A Agreement by the SADC Member States if the implementation of the Agreement was to be effective. The ECC, therefore, agreed to convene a workshop on HCM4A and requested CRASA Members to consider signing the agreement. These activities were part of the Frequency Planning Sub Committee (FPSC) Operations Plan 2015/16.

7.3 At the 5th CRASA AGM, Swakopmund, Namibia – 07-08 April 2016[10], the subject of Cross Border Frequency Coordination using the Harmonised Calculation Method for Africa (HCM4A) was discussed in detail, following similar efforts in Europe. The Resolution CRASA/AGM/15.16/07 stipulates, "The AGM urged CRASA Members to prioritise the motivation to their administrations who are yet to indicate their interest to sign the Harmonised Calculation Method for Africa (HCM4A), to do so as soon as possible".

7.3.1 Therefore, coordination would follow the HCM4A as detailed in Sub-Saharan Africa Assessment Report on Harmonization of ICT Policies in Sub-Saharan Africa[11] (HIPSSA)

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

7.4.1 Based on the HCM Agreement used in Europe;

7.4.2 Optimize spectrum usage;

7.4.3 Prevent harmful interferences;

7.4.4 Confer an adequate protection for stations;

7.4.5 Define technical provisions and administrative procedures;

7.4.6 Quick assignment of preferential frequencies;

7.4.7 Transparent decisions through agreed assessment procedures;

7.4.8 Quick assessment of interference through data exchange.

7.5 HCM4A involves all 4 sub regions of Africa. This means the HCM4A project includes performing a survey and a comparative analysis of existing administrative and technical procedures related to bilateral and multilateral cross-border frequency coordination agreements across the 4 geographical sub-regions as defined by the African Union (AU), namely:

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

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

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

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

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

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

7.6 HCM4A also comes with a software tool for Sub-Saharan Africa[12]

7.6.1 Optimise spectrum usage by accurate interference field strength calculations;

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

7.6.3 Establish models for computer-aided interference range calculations;

7.6.4 Harmonise parameters: objectively predictable towards transparent decisions.

7.7 As per ECC/REC T/R 25-08 [[13]] and in ECC/REP 276 [[14]], the following field strength thresholds have to be assured. Operator-to-operator coordination may be necessary to avoid interference.

7.7.1 Indicative coordination threshold[15] E_{th} for analogue or digital land mobile systems (in order to avoid harmful interference between stations located in neighbouring countries, indicative coordination thresholds are established which should not be exceeded without coordination between neighbouring countries) is expressed as $E_{th} = 20 + 10 \times \log_{10}$(channel bandwidth (MHz)/ 0.025), in dBµV/m, and provided at the border-line for the co-channel, 50% locations, 10% time.

For the typical channel bandwidth of 5 MHz, this corresponds to the value of the indicative coordination threshold of 43 dBµV/m/5 MHz for 10 m antenna height above ground. Converted for a receiving antenna height of 3 m using ITU-R P.1546 [16], the indicative coordination threshold is written as 53.3 dBµV/m/5 MHz (using HCM [17], the threshold is 52 dBµV/m/5 MHz).

7.7.2 **IoT vs Broadband**: Field strength levels for cross-border coordination between FDD land mobile systems using narrowband (typical in the Internet of Things (IoT)) preferential channels up to 25 kHz and systems using a channel greater than 1 MHz (more common in broadband applications) may be found in Annex 3 of ECC/REC T/R 25-08:

This section considers the coordination between preferential channels of land mobile systems up to 25 kHz on one side and land mobile systems with a channel greater than 1 MHz on the other side of the border. An illustration of such scenario, with an overlapping narrower channel and wider channel land mobile systems across the border,

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[12] PowerPoint Presentation (itu.int) https://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/Documents/Events/2017/May%20BKK/Presentations/HCM%20and%20HCM4A%20BKK%20201705 04%20IB.pdf

[13] ECC Recommendation TR 25-08 "Planning criteria and cross-border coordination of frequencies for land mobile systems in the range 29.7-470 MHz", Amended 28 September 2018.

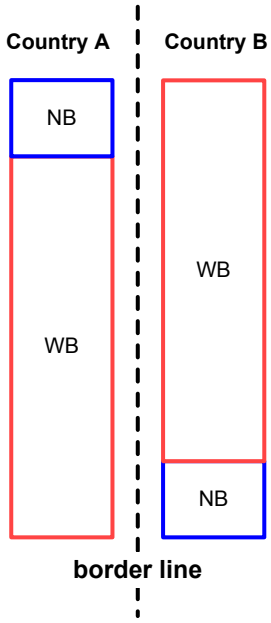
[14] ECC Report 276 "Thresholds for the coordination of CDMA and LTE broadband systems in the 400 MHz band", 27 April 2018.

[15] The approach used for setting up the "COMMON UNDERSTANDING ON THE NEED FOR COORDINATION OF RADIO STATIONS BETWEEN SWEDEN AND LITHUANIA IN THE FREQUENCY BAND 450-470 MHz" (https://www.pts.se/globalassets/startpage/dokument/legala-dokument/avtal/ovriga-lander/50_common-understanding-swe-ltu_450mhz_180116_dnr18-431.pdf)

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

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

is shown in the following figure (where NB refers to narrowband and WB refers to wideband):



The following should be taken into account:

- ECC Report 276 **Error! Reference source not found.** provides a technical background for cross-border coordination of systems with a channel greater than 1 MHz in the 450-470 MHz and proposes a method which can be applied in bilateral or multilateral agreements that allow for higher cross-border coordination thresholds for wideband systems in the 450 MHz band in situations where no or some overlap of narrowband and wideband allocations across the border occurs. In consequence, it means that land mobile systems up to 25 kHz keep their existing preferential rights and may extend them to all non-preferential channels in the overlapping range, if preferential rights of other administrations involved are not affected;
- The overlap is typically as small as a few hundred kiloHertz. ECC Report 276 does not cover the case of full overlap between land mobile systems up to 25 kHz on one side and land mobile systems with a channel greater than 1 MHz on the other side of the border;
- In the situation where land mobile systems up to 25 kHz use preferential rights not to the full extent, i.e. they do not generate the maximum allowed field strength at a distance of 40 km or 50 km in the territory of the neighbouring administration, solutions should be found between administrations or operators. One possible solution would be to increase the radiated power of the preferential system to the extent possible under preferential rights conditions. If not possible, a reduction of the radiated power of the system with a channel bandwidth > 1 MHz within the preferential frequency of the system with channel bandwidth up to 25 kHz may be considered;
- The two most common preferential regimes for narrowband systems were considered, both defined as the field strength threshold of 20 dBµV/m at 10 m height in 25 kHz at a distance inside the neighbouring country: Preferential Regime a) at 40 km distance and Preferential Regime b) at 50 km distance. The

proposed coordination thresholds for a partial overlap of narrowband land mobile systems up to 25 kHz on one side and wideband land mobile systems with a channel greater than 1 MHz on the other side of the border at a height of 10 m above ground are summarised in the following table (where "@" stands for "at a distance inside the neighbouring country"):

	Preferential Regime a) at 40 km distance	Preferential Regime b) at 50 km distance
System up to 25 kHz **using preferential frequency**	20 dBµV/m/25 kHz**@40 km beyond the borderline**	20 dBµV/m/25 kHz**@50 km beyond the borderline**
System up to 25 kHz **using NON-preferential frequency**	20 dBµV/m/25 kHz**@0 km (on the borderline)**	20 dBµV/m/25 kHz**@0 km (on the borderline)**
System with a channel greater than 1 MHz	41 dBµV/m/25 kHz**@0 km (on the borderline)**	48 dBµV/m/25 kHz**@0 km (on the borderline)**
Note 1: Predictions for calculations: 50% location probability, 10% time probability **Note 2:** If a channel bandwidth other than 25 kHz is used, then a bandwidth conversion factor of 10 x Log_{10} (channel bandwidth / 25 kHz) should be added to the field strength values. **Note 3:** For narrowband land mobile systems using preferential frequencies and bandwidth greater than 25 kHz (e.g. 50 kHz, 100 kHz, 150 kHz or 200 kHz), indicative coordination threshold levels should be applied within every 25 kHz bandwidth within the channel spacing.		

Note: Partially different coordination thresholds are used for coordination between Sweden and Germany[18]:

- To protect simplex narrowband systems PMR/PAMR *uplink* used close to the border from a Mobile/Fixed Communications Networks *downlink* (with receiving antenna at 10 m height), the coordination field strength is:
  14 +10 x log10 (BW (in MHz) / 0.025 MHz) (dBµV/m)

  This coordination threshold is 6 dB stricter than the ECC's one.
- To protect duplex narrowband systems PMR/PAMR used close to the border (with receiving antenna at 10 m height), the coordination field strength is:
  20 + 10 x log10 (BW (in MHz) / 0.025 MHz) (dBµV/m)
- In these expressions, BW stands for the bandwidth of the channel, in MHz.
- To protect Mobile/Fixed Communications Networks *uplink* from simplex narrowband systems PMR/PAMR *downlink* used close to the border (with receiving antenna at 10 m height), the coordination field strength is 20 dBµV/m.

[18] Detailed in the document: "Agreement between the German Federal Network Agency and the Swedish Post and Telecom Authority concerning the use of the frequency bands 452.5 - 457.5 MHz and 462.5 - 467.5 MHz for Land Mobile Service Stations in the border areas", Feb 2017

This threshold is more relaxed than the one from ECC/REC T/R 25-08 as even narrower channels do not receive a lower threshold value.

7.7.3 **Broadband vs. broadband coordination**: field strength levels for cross-border coordination between FDD land mobile systems with channels greater than 1 MHz in the frequency bands 450 - 470 MHz may be found in Annex 3 of ECC/REC T/R 25-08.

Field strength trigger values for LTE vs LTE and CDMA vs. CDMA systems:

- Base stations using the same technologies on both sides of the border line with centre frequencies not aligned, or using preferential PCIs codes given in Annex 5 of ECC/REC T/R 25-08 with centre frequencies aligned may be used without coordination between neighbouring countries if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 55 dBµV/m/5 MHz at a height of 3 m above ground at the border line between neighbouring countries and does not exceed a value of 37 dBµV/m/5 MHz at a height of 3 m above ground at a distance of 10 km inside the neighbouring country.
- Base stations using the same technologies on both sides of the border line with centre frequencies aligned and using non-preferential PCIs may be used without coordination between neighbouring countries if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 37 dBµV/m/5 MHz at a height of 3 m above ground at the border line between neighbouring countries.

  Note: For the same conditions a lower planning coordination threshold of 29 dBµV/m/5 MHz exists between Norway and Sweden and also Germany and Sweden.[19]

Field strength trigger values between LTE and CDMA:

- In the case of different technologies used on opposite sides of the border line, with centre frequencies aligned or not aligned, base stations may be used without coordination with a neighbouring country if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 55 dBµV/m/5 MHz at a height of 3 m above ground at the border line between neighbouring countries and does not exceed a value of 37 dBµV/m/5 MHz at a height of 3 m above ground at a distance of 10 km inside the neighbouring country.
- Summary for LTE and CDMA combinations:
- The trigger values of field strength (dBµV/m/5 MHz) at a height of 3 m above ground for FDD LTE/CDMA systems, in the case of no overlap between narrowband and wideband assignments are summarised in the following table (where "@" stands for "at a distance inside the neighbouring country"):

[19] Detailed in the documents: "Agreement between the Norwegian Communications Authority and the Swedish Post and Telecom Authority concerning the use of the frequency bands 452.5 - 457.5 MHz and 462.5 - 467.5 MHz for Land Mobile Service Stations in the border areas", February 2017 and the "Agreement between the German Federal Network Agency and the Swedish Post and Telecom Authority concerning the use of the frequency bands 452.5 - 457.5 MHz and 462.5 - 467.5 MHz for Land Mobile Service Stations in the border areas", Feb 2017.

	Non-Preferential frequency usage		
	Centre frequencies aligned		Centre frequencies not aligned
	Preferential PCI codes	Non-preferential codes	All codes
LTE vs. LTE or CDMA vs. CDMA	55 dBµV/m @0km 37 dBµV/m @10km	37 dBµV/m @0km	55 dBµV/m @0km 37 dBµV/m @10km
LTE vs. CDMA	55 dBµV/m @0km 37 dBµV/m @10km		

Notes: *Estimations are based on 50% locations and 10% time. If a channel bandwidth other than 5 MHz is used, then the following bandwidth conversion factor may be utilised: 10 x log$_{10}$ (channel bandwidth / 5 MHz).*

Table 2: Field Strength Trigger Values for FDD LTE/CDMA

7.8 Use of these frequency bands will require HCM4A coordination with the neighbouring countries within the coordination zones, of the above-mentioned distances (such as 0 km and 10 km from the border-line for the broadband case), inside the neighbouring country. The coordination distance is continuously being reviewed, and these may be updated from time to time.

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

7.10 As per ECC/REC (11)04 for 790-862 MHz, stations of IMT systems may be operated without coordination if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 15 dBµV/m/5 MHz at 10% time, 50% of locations at 3 metres above ground level at the border line. Adjusting this value by the ratio of the attenuations in the bands, i.e., 20 × log10(790 MHz / 450 MHz) = 5 dB, the adjusted mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 10 dBµV/m/5 MHz.

7.11 Technical analysis may be conducted by the Authority before an assignment is issued according to Appendix B based on an extract from ECC/REC (11)04.

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

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

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

8 Assignment

8.1 An Invitation to Apply will be published for any new Band 31 assignments in this band in line

with regulations developed in line with Section 31(3) of the Electronic Communications Act (Act No. 36 of 2005).

8.2 Transnet's existing assignment in this frequency band will be amended in accordance with Regulation 6 of the Radio Frequency Migration Regulation 2013, in order to implement the provisions of Section 10.2 below post 1st April 2025.

9 Revocation

9.1 All existing radio frequency spectrum licences as of the 1st of April 2023 are revoked except for cases of some Government licences. The migration started in 2016 and was to be completed in 2022 with Dual Illumination ending in 2022.

10 Radio Frequency Migration

10.1 This RFSAP will come into effect upon publication. The Authority expects an ITA process to commence for this band (Band 31 assignment) post 1st April 2025.

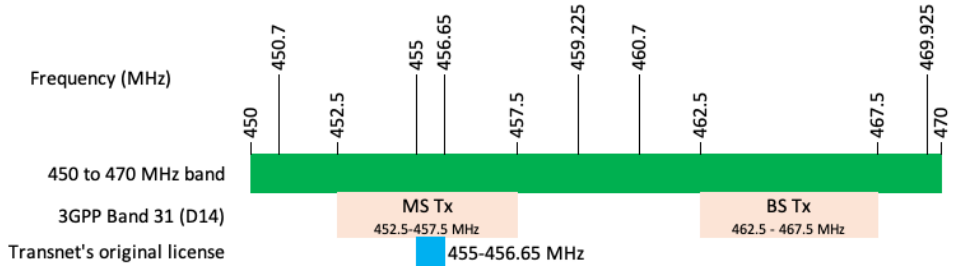


Figure 2: 450 - 470 MHz new licence holder coexistence arrangements

10.2 The Migration Process agreed in 2015/16 noted:

- Migration starts in 2016 and is completed in 2022; and
- Dual illumination stops in 2022[20] .
- **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., 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 - 423 MHz (2×3 MHz);
    - Alternatively, there are 2×4 MHz and 2×3 MHz for TETRA available in 406 - 426 MHz; and
    - Transnet may also migrate to the GSM R.

[20] The announcement of the date for the final Switch-Off of the analogue signal and the end of dual illumination was announced as the 31st of March 2022 by the Minister of Communications and Digital Technologies, Government Gazette, 28 February 2022 No. 45984. The Authority notes the unanimous judgment on 28 June, wherein the Constitutional Court determined that the Government's order declaring the analogue switch-off date as unconstitutional, invalid, and to be set aside.

- **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.
- Potential extensions to the IMT450-band have been identified in order to mitigate potential interference with the direct neighbour bands. These might be reserved in cases of extending 2×5 MHz to 2×10 MHz or to minimise interference.

  Specific Procedure: Existing licensees must migrate according to the specified process unless otherwise exempted by the Authority.

10.3 After the 2nd Consultation on the Draft Assignment Plan for this band[21], the Authority has decided that Transnet stays on in the band. Transnet will be required to work with the new IMT licence holder to ensure Transnet's new digital switchover implementation of its analogue services can co-exist with the new band licence holder.

10.4 All the other licensees in the band whose licences are revoked as of the 1st of April 2023 can obviously no longer claim any interference protection if they are still operating in the band. The Authority also provides some further justifications of its decision made at the conclusion of two consultations in the accompanying Reasons Document published with this RFSAP.

11 Repeals

11.1 These notices will be repealed following the publication of this RFSAP:

11.1.1 (Notice 270 of 2015) of Government Gazette Number 38640 – the prior "Final Radio Frequency Spectrum Assignment Plan for the Frequency Band 450 to 470 MHz".

11.1.2 Government Gazette Number 38640 (Notice 387 of 2015)

[21] 2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf (icasa.org.za) - https://www.icasa.org.za/uploads/files/2nd-Draft-Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-825-MHz-to-830-MHz-and-870-MHz-to-875-MHz.pdf

Appendix A National Radio Frequency Plan

Table 3 shows an extract from the National Radio Frequency Plan for South Africa.

ITU Region 1 allocations and footnotes	South African allocations and footnotes	Typical Applications	Notes and Comments
450-455 MHz FIXED MOBILE 5.286AA 5.209 5.271 5.286 5.286° 5.286B 5.286C 5.286D 5.286E	450-455 MHz FIXED MOBILE 5.286AA NF9 SPACE OPERATION (Earth-to-space) SPACE RESEARCH (Earth-to-space) 5.209 5.286 5.286A 5.286B 5.286C	Fixed links (450 – 453 MHz) Government Services Single Frequency Mobile (453 – 454 MHz) Paging (454 – 454.425 MHz) Trunked Mobile BTX (454.425 – 460 MHz) IMT450 PMR and/or PAMR	Paired with 460 – 463 MHz Paired with MTX (464.425 – 470 MHz) This band is currently used for a variety of fixed and mobile systems in the various SADC countries. ITU-R Recommendation M.1036-6 latest version. Resolution 224 (Rev WRC-19) Radio Frequency Spectrum Regulations as amended (Annex B) (GG. No. 38641, 30 March 2015). Radio Frequency Spectrum Assignment Plan 2015, Government Gazette 38640 (Notice 270 of 2015) International Mobile Telecommunication Roadmap (GG No. 42829 Notice 600 of 2019). New RFSAP to be developed.
455-456 MHz FIXED MOBILE 5.286AA 5.209 5.271 5.286° 5.286B	455-456 MHz FIXED MOBILE 5.286AA NF9 5.209 5.286A 5.286B 5.286C	Government Services Trunked mobile BTX (454.425 – 460 MHz) IMT450	Paired with 464.425 – 470 MHz ITU-R Recommendation M.1036-6 latest version Resolution 224 (Rev WRC-19) Radio Frequency Spectrum Regulations as amended (Annex B) (GG. No. 38641, 30 March 2015). Radio Frequency Spectrum Assignment Plan 2015, Government Gazette 38640 (Notice 270 of 2015) International Mobile Telecommunication Roadmap (GG No. 42829 Notice 600 of 2019). New RFSAP to be developed

5.286C 5.286E			
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 – 460 MHz) IMT450 Government Services	Paired with 464.425 – 470 MHz ITU-R Recommendation M.1036-6 latest version Resolution 224 (Rev WRC-19) Radio Frequency Spectrum Regulations as amended (Annex B) (GG. No. 38641, 30 March 2015). Radio Frequency Spectrum Assignment Plan 2015, Government Gazette 38640 (Notice 270 of 2015) International Mobile Telecommunication Roadmap (GG No. 42829 Notice 600 of 2019). New RFSAP to be developed
459-460 MHz FIXED MOBILE 5.286AA 5.209 5.271 5.286° 5.286B 5.286C 5.286E	459-460 MHz FIXED MOBILE 5.286AA NF9 5.209 5.286A 5.286B 5.286C	Trunked Mobile BTX 454.425 – 460 MHz IMT450 Government Services	Paired with 464.425 – 470 MHz ITU-R Recommendation M.1036-6 latest version Resolution 224 (Rev WRC-19) Radio Frequency Spectrum Regulations as amended (Annex B) (GG. No. 38641, 30 March 2015). Radio Frequency Spectrum Assignment Plan 2015, Government Gazette 38640 (Notice 270 of 2015) International Mobile Telecommunication Roadmap (GG No. 42829 Notice 600 of 2019). New RFSAP to be developed

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) Low Power Mobile Radio (463.975 MHz, 464.125 MHz, 464.175 MHz, 464.325 MHz, 464.375 MHz) Single Frequency Mobile (464.375 – 464.425 MHz) Trunked Mobile MTX (464.425 – 470 MHz) IMT450 Security Systems (464.5375 MHz) Non-specific SRDs (464.5 – 464.5875 MHz) Government Services	Paired with 450 – 453 MHz Paired with BTX (454.425 – 460 MHz) ITU-R Recommendation M.1036-6 latest version Resolution 224 (Rev WRC-19) Radio Frequency Spectrum Regulations as amended (Annex B) (GG. No. 38641, 30 March 2015). Radio Frequency Spectrum Assignment Plan 2015, GG 38640 (Notice 270 of 2015) International Mobile Telecommunication Roadmap (GG No. 42829 Notice 600 of 2019). New RFSAP to be developed
Meteorological-satellite (space-to-Earth) 5.287 5.288 5.289 5.290	Meteorological-satellite (space-to-Earth) Earth exploration-satellite (space-to-Earth) 5.287 5.289		

Table 3: National Radio Frequency Plan for South Africa for 450 - 470 MHz band

Appendix B Propagation Model

Propagation Model

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

Path specific model

Where appropriately detailed terrain data is available, the propagation model for interference field strength prediction is the latest version of ITU-R Rec. P.452 [22]. 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[23]. The values for those receiver locations within the neighbouring country would be used to construct a histogram of path loss – and if more than 10% of predicted values exceed the threshold, the station should be coordinated.

Site general model

If it is not desirable to utilise detailed terrain height data for the propagation modelling in the border area, the basic model to be used to trigger coordination between administrations and to decide if coordination is necessary, is ITU-R Rec. P.1546[24], "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.

Area calculations

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

For evaluation:

- Only 10% of the number of geographical area pixels between the border line (including the border

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

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

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

line) and the 6 km line itself inside the neighbouring country may be interfered with by higher field strength than the trigger field strength value given for the border line in the main text above at a height of 3 m above ground.

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

It is recommended that during area calculations, not only detailed terrain data but also clutter data be taken into account. Use of correction factors for clutter is crucial in particular where the border area is 'open' or 'quasi-open' from the point of view of clutter or where the interfering base station is just a few kilometres from a border line.
If the distance between a base station and a terrain point of a border line is closer than or equal to 1 km, the free space propagation model needs to be applied. Furthermore, if there is no terrain obstacle within the 1st Fresnel zone, the free space propagation model should be applied.
If clutter data is not available, it is proposed to extend the usage of the free space propagation model to a few kilometres, depending on the clutter situation in border areas.
For area type interference calculations, propagation models with path-specific terrain correction factors are recommended (e.g., the latest Recommendation ITU–R P.1546[25] with the Terrain Clearance Angle correction factor TCA, HCM [26] method with the Terrain Clearance Angle correction factor or Recommendation ITU–R P.1812 [27], [28]).
As to correction factors for clutter in 'open area' and 'quasi-open area', 20 dB and 15 dB should be used, respectively. Recommendations ITU–R P.1406 [29] and/or ITU-R P.2108 [30] 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.

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

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

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

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

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

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

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE[31]

The following is extracted from ECC/REC (11)05 as an operational example and can be adapted for the SADC countries for LTE. A respective extract from ECC/REC (15)01 may be considered for expanding the same onto NR.

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

3GPP TS 36.211[32] defines 168 "unique physical-layer cell-identity groups" in §6.11, numbered 0.167, hereafter called "PCI groups" for LTE. Within each PCI group, there are three separate PCIs giving 504 PCIs in total.

Administrations should agree on a repartition of these 504 PCIs on an equitable basis when channel centre frequencies are aligned, as shown in the table below. It has to be noted that dividing the PCI groups or PCIs is equivalent. Each country should only use their own preferential PCIs close to the border and can use all PCIs away from the border. This transition distance between "close to the border" and "away from the border" should be agreed between neighbouring countries.

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

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

Four types of countries are defined in a way such that no country will use the same code set as any one of its neighbours. The following lists describe a sample distribution for African countries:
Country type 1: Botswana, Cameroon, Comoros, Democratic Republic of the Congo, Ghana, Guinea-Bissau, Kenya, Liberia, Malawi, Mauritius, Niger, Republic of the Sudan, Swaziland.
Country type 2: Algeria, Angola, Benin, Cape Verde, Chad, Cote d'Ivoire, Egypt, Ethiopia, Madagascar, Senegal, United Republic of Tanzania, Zimbabwe.
Country type 3: Burkina Faso, Congo, Djibouti, Equatorial Guinea, Guinea, Mauritania, Nigeria, Rwanda, Sao Tome and Principe, Seychelles, South Africa, South Sudan, Tunisia, Zambia.
Country type 4: Burundi, Central African Republic, Eritrea, Gabon, Gambia, Lesotho, Libyan Arab Jamahiriya, Mali, Morocco, Mozambique, Namibia, Sierra Leone, Somalia, Togo, Uganda.

(Note: A sample country type map can be found in the figure below).

For each type of country, the following tables and figure describe the sharing of the PCIs with its neighbouring countries, with the following conventions of writing:

	Preferential PCI

[31] ECC/REC(11)05

[32] 3GPP TS 36.211 "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation". (https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2425, also provided in ETSI TS 136 211). In comparison, 3GPP 38.211 (and ETSI TS 138 211) define NR Physical channels and modulation, in NR 2-step identification using PSS/SSS detection of the Physical Cell ID (same as LTE), the number of different cell IDs has been increased from 504 in LTE to 1008 for NR. Thus, for the deployment of LTE systems only the PCIs between 0 to 503 should be used and for NR systems PCIs between 0 to 1007 may be used.

	Non-preferential PCI

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

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

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

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

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

Table 4: Sharing of PCIs between Countries

Notes

1) All PCIs are available in areas away from the border.

2) In certain specific cases (e.g., if Angola and Botswana happened to have the same Country type/PCI code) where the distance between two countries of the same type number is very small (below a few tens of kilometres), it may be necessary to address the situation in bilateral /multilateral coordination agreements as necessary and may include further subdivision of the allocated codes in certain areas.

Figure 3: **Country type map/PCI distribution map**

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

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

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

1. Demodulation Reference Signal (DM RS) coordination

Demodulation reference signals (DM RS) are transmitted in the uplink and used for channel estimation. There is a risk of intercell interference between neighbouring cells even in case of no frame

synchronisation. That is why special measures for DM RS allocation between networks in neighbouring countries occupying the same channel may need to be applied.
The case of partial channel overlap has not been studied but due to DM RS occupying resource blocks of separate users, there is a risk of DM RS collisions between neighbouring networks when the subcarriers' positions coincide (the frequency offset between central carriers of neighbouring networks is multiple of 300 kHz). Some minor benefits from DM RS coordination in these particular cases could be expected.

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

- In the basic planning procedure, only 30 DM RS sequence groups with favourable correlation characteristics are available: (0…29). In this case, each cell could be assigned one of the 30 DM RS sequence groups providing a cluster size of 30.
- It is possible to extend each DM RS sequence group to generate up to 12 time shifted sequence groups by applying the cyclic shift parameter stated in 3GPP TS 36.211 for LTE. For example, each tri-sector site could be assigned one DM RS sequence group with each co-sited cell having its own cyclic shift of $2\pi/3$, 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 limited number of groups is available for network planning. The drawback of DM RS sequence group cyclic shift is a loss of orthogonally of DM RS due to fading channels which has been found during first trials of LTE and caused throughput loss as well as time alignment problems.
- Another approach for DM RS coordination is to implement dynamic DM RS sequence group allocation, also called pseudo-random group hopping. In this method, nearby cells are grouped into clusters up to 30 cells, and within each cell cluster, the same hopping-pattern is used. At the border of two clusters, inter-cell interference is averaged since two different hopping patterns are utilised. There are 17 defined hopping patterns, numbered (0…16), which leads to some minor unfairness in case of apportioning these patterns between neighbouring countries. Even in a trilateral case each operator will have at least 5 hopping patterns available near the border, which should be enough for planning purposes. It should be noted the pseudo-random group hopping option could be absent in the first generations of LTE equipment.

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

2. Physical Random-Access Channel (PRACH) coordination

Another radio network parameter that is considered during radio network planning is PRACH configuration which is needed to distinguish random access requests addressed to different cells. PRACH resources are allocated by specifying the PRACH Resource Blocks time positions within the uplink frame, their frequency position within the LTE channel bandwidth and by apportioning cell-specific root sequences. During radio network planning, these parameters are usually used in the following way:

- Time positions for PRACH resource allocations are usually used to create time collision of PRACH resources of co-sited/frame synchronised cells because PRACH-to-PRACH interference is usually less severe than PUSCH-to-PRACH interference;
- Frequency positions within the LTE channel bandwidth are usually the same for all cells, again because PRACH-to-PRACH interference case is a more favourable one.
- Cell-specific root sequences are used to distinguish between PRACH requests addressed to different cells.

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

In an early implementation, it is possible that a very limited number of frequency positions could be supported by LTE equipment which will not be enough to coordinate in the trilateral case. In such cases, root-sequence repartition could be used. There are 838 root sequences in total to be distributed between cells, numbered (0..837). There are two numbering schemes for PRACH root sequences (physical and logical) and that only logical root sequences numbering needs to be used for coordination. Unfortunately, the process of root sequences planning doesn't involve direct mapping of root sequences between cells because the number of root sequences needed for one cell is dependent on the cell range.

The table showing such interdependency is presented below:

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

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