SCCOM
SWAZILAND COMMUNICATIONS COMMISSION

GENERAL NOTICE NO. 13, 2017

PROPOSED DECISION IN TERMS OF SECTION 32 OF THE SWAZILAND COMMUNICATIONS COMMISSION ACT, 2013: INTERNATIONAL MOBILE TELECOMMUNICATIONS (IMT) BAND PLAN AND ROADMAP FOR CONSULTATION

INVITATION FOR WRITTEN REPRESENTATIONS.

The Swaziland Communications Commission, hereinafter referred to as the Commission, has developed an IMT band plan and Roadmap in accordance with Section 34 of the Electronic Communications Act,2013 and authorized by Regulation 5 of the Electronic Communications (Radio Communications and Frequency Spectrum) Regulations, 2016.

Regulation 5 provides that the National Frequency Allocation Plan falls under the Radio Frequency Plan and shall be detailed and provide a description of how a band is allocated.

The IMT band plan and Roadmap gives channelling structure for currently assigned IMT frequency spectrum (IMT900, IMT1800 and IMT2100) and also makes recommendations on how new IMT spectrum (700, 800 and 2600MHz) which has been made available will be used.

A copy of the proposed Decision document is available on the Commission's website at www.sccom.org.sz and at the Commission's offices at Mbabane Office Park 4th floor, North Wing Mhlambanyatsi Road.

The provisions of Section 32 of the SCCOM Act, 2013, allow for stakeholders and interested persons to make comments on proposed decisions of the Commission. The public is hereby invited to submit their written representations on the proposed Decision to publish a Radio Frequency Spectrum pricing model published herewith by the Commission.

Written representations with regard to the proposed Decision must be submitted to the Commission no later than 17h00 on 19th November 2017 by post to Swaziland Communications Commission, P.O. Box 7811 Mbabane, hand delivered or electronically to legal@sccom.org.sz

Mvilawemphi Dlamini
Chief Executive

SWAZILAND COMMUNICATIONS COMMISSION

Proposed IMT roadmap for consultation

Version 2

4th October 2017

Contents

Table of Figures

Table of Tables

1 Introduction

1.1 Background

Mobile telecommunications services are a are a critical component in the communications landscape, not only in the country but in other developing economies. According to a recent study by the Commission, mobile telecommunications subscribers account for more than 70% of subscribers in the country, and with the recent introduction of a third telecommunications service provider early in the year, this number is most likely going to grow. It is common knowledge that radio frequency spectrum resources are a bedrock of mobile telecommunications services and as such, considerable efforts need to be put to ensure adequate availability of spectrum and efficient management thereof. The timely assignment of appropriate spectrum will allow operators to cost effectively address the increasing data traffic demands placed on their networks. Moreover, the release of additional spectrum will spur the next wave of mobile innovation and economic growth in Swaziland. The Commission also recognises that IMT radio frequency spectrum is an important component of meeting the goals of The National Development Strategy (NDS) and the National Information and Communication Infrastructure (NICI) plan.

In the country, the management and use of radio frequency spectrum resources is guided by the Electronic Communication Act and the Electronic Communications (Radio Communications and Frequency Spectrum) Regulations, 2016. The National Frequency Allocation Plan (NFAP) further provides a clear structure on the allocation of spectrum resources to different services. The current NFAP identifies a number of spectrum bands for the deployment of mobile telecommunications services.

Currently, mobile operators deploy networks over well-established frequency bands (IMT900, IMT1800 and IMT2100), but not all the available spectrum in these bands have been fully assigned and some assignments are not utilised, including those in the 850 MHz band for CDMA 850. An analysis of the spectrum assignments in Swaziland reveals that certain frequency bands, which have been earmarked for IMT services, are occupied by legacy or non-IMT systems. It is therefore imperative that the appropriate frequency migrations and technological upgrades (either 4G or 5G) are implemented, in order to ensure that Swaziland derives the maximum technical and socio-economic benefits from IMT spectrum usage. Accordingly, a number of key decisions on some of the frequency bands need to be taken into account, e.g. for the frequency bands 450 MHz, 850 MHz and 2600 MHz, decisions are required regarding their future use cases. The key issue here is assessing the costs and risks of maintaining legacy systems versus implementing a new IMT system.

As already indicated above, currently mobile telecommunications services are deployed over the well-established frequency bands (IMT900, IMT1800 and IMT2100). While the current assignment and usage of these bands is based on international and regional conventions and best practices on the management and use of radio frequency spectrum resources, the Commission recognises that there is a legal and regulatory requirement to propose band channelling arrangement for the different services in accordance with national priorities and the national frequency allocation plan (NFAP). The introduction of

new spectrum bands for the provision of mobile telecommunications in the NFAP, e.g. 700Mz, 800MHz, 1500 MHz, 3300-3400MHz, etc requires that clarity is provided at national level on how these bands will be assigned and used in the country. These new spectrum bands that have been made available for mobile telecommunications services already have some legacy services, non-IMT occupying the bands. The proposed IMT roadmap seeks to outline the process and timelines to be followed in making these new spectrum bands available to existing and future service providers. In accordance with the tenants of the Electronic Communications Act, the proposed channelling plan and roadmap are based on the principles of technological neutrality. The Commission is desirous to promote the use of radio frequency spectrum resources to achieve the much-desired socio-economic transformation of the country.

1.2 Intentions of the Commission

The Commission, in accordance with the Electronic Communications Act 2013 [Act No. 09 of 2013] and the Electronic Communications (Radio Communications and Frequency Spectrum) Regulations 2016), intends to publish **a band plan and a road map** for International Mobile Telecommunications (IMT) frequency spectrum which gives channelling structure for currently assigned IMT frequency spectrum and also makes recommendations on how new IMT spectrum which has been made available will be used.

The Radio Communications and Frequency Spectrum Regulations 2016 state the following requirements in relation to radio frequency spectrum band plans:

5. (1) The Commission may in accordance with section 34 of the Act, prepare a national frequency allocation plan.

(2) The National Frequency Allocation plan shall fall under the Radio Frequency Plan and shall be detailed and provide a description of how a band is allocated.

(3) Radio Frequency Spectrum Band Plans shall specify the purposes for which bands may be used, arising from Government policy initiatives or public demand.

(4) Radio Frequency Spectrum band plans may specify or propose –

(a) detailed frequency channelling arrangements;

(b) technical and other requirements; or

(c) principles or assignment and implementation for the detailed allocation of the radio frequency spectrum between types of services.

(5) Radio Frequency Band Plans shall be subject to consultation.

The document presents the following decisions and plans for the different IMT frequency bands:

- 450-470MHz

  It has been identified that this band is currently occupied by PMR services in Swaziland and it will require that these services be migrated to leave this band

open for deployment for IMT services. Depending on the requirements and the speed of migration, this spectrum may be assigned in the 10-15-year period. The Commission proposes that the usage of this band is reserved for incumbent services in the short to medium term periods.

- IMT-700

  Following the successful completion of the Analogue to Digital Migration of terrestrial television systems, thereby making the Digital Divident 2 spectrum available. The Commission proposes to make this band available for IMT immediately in the country. Currently, this band has not been assigned to any service provider, however engagements with neighbouring states (South Africa and Mozambique) will be required as they are currently implementing their analogue to digital migration of the terrestrial television systems. The channelling configuration A7 in Recommendation M.1036-5 is proposed to be adopted to ensure compatibility with the proposed IMT800 channelling arrangement A3. The Commission proposes that this band is licensed in the next 5-10-year timeframe as this will allow sufficient time for the ecosystem to mature.

- IMT-750

  The Commission proposes this band to be available for assignment using the 20 MHz SDL option in accordance with channelling configuration A10 in ITU-R Recommendation M.1036-5. This option makes efficient use of spectrum due to the fact that only one 5 MHz guard band is required. IMT750 will be licensed within the 5-10-year timeframe.

- IMT-800

  This is digital dividend 1 which has been made available for IMT deployment. The channelling configuration A3 of Recommendation M.1036-5 will be used as this is aligned with the SADC channelling plan. IMT800 will also be assigned within the next year due to the high demand for this band. The remaining 2x10 MHz in IMT800 could be assigned within the 5-10-year timeframe, given that CDMA systems would need to be migrated out of this band.

- IMT850

  For this band, the Commission may migrate the CDMA 850 licensee to an alternative frequency location, introduce SDL 821-826 MHz and extend GSM-R uplink by 1 MHz so that it spans the frequency range 875 – 880 MHz. The envisaged railway development in Swaziland justifies the preservation of spectrum for GSM-R applications. In this regard, the Commission recommends using the 800 MHz band for IMT services using the channelling configuration A3.

Proposed IMT roadmap for consultation

- IMT900

  As this band is currently widely used for IMT services, the Commission recommends the continued usage of the band without constraints to specific technologies, e.g. 2G. The channelling configuration A2 in Recommendation M.1036-5 will be adopted for this band as this is aligned with Commission's current assignment of the band. This channelling configuration is aligned to the current assignment structure. The remaining bandwidth in IMT900 will also be assigned within the next 5 years so that potential licensees can immediately benefit from its mature ecosystem. Moreover, it is recommended that licensees re-farm the band for LTE technology within the 5 to 10-year timeframe.

- IMT 1800

  As this band is currently widely used for IMT services, the Commission recommends the continued usage of the band without constraints to specific technologies, e.g. 2G, LTE. The channelling arrangement B4 in Recommendation M.1036-5 is adopted for the frequency range spanning (1710-1785MHz // 1805-1880 MHz) bearing cognizance that the Commission has already licensed users in accordance with the abovementioned frequency arrangement.

  The Commission will also consider migration of DRMASS and point to point links out of IMT800 to allow full assignment of the band within the next 5 years.

- IMT 2100

  As this band is currently widely used for IMT services, the Commission recommends the continued usage of the band without constraints to specific technologies, e.g. 3G. The channelling arrangement B4 in Recommendation M.1036-5 for the IMT 2100 FDD and IMT2100 TDD, which spans respective frequency ranges 1920-1980 // 2110-2170 MHz and 2010 – 2025 MHz, will be implemented. The current IMT2100 assignments are in accordance with this channelling arrangement. Point-to-point links contained in IMT2100 will be migrated out to allow full assignment of the band within the 5-10-year timeframe. All available spectrum in the IMT2100 extension band and IMT2100 TDD will be assigned within the 5-10-year timeframe.

- IMT2300

  For the IMT2300, the channelling arrangement E1 in Recommendation M.1036-5 will be adopted. The Commission will consider to Migrate out legacy DRMASS and DECT systems and assign all IMT2300 spectrum within the 5-10-year timeframe.

- IMT2600

  The channelling arrangement B4 in Recommendation M.1036-5 will be implemented for the IMT 2600 FDD and IMT2600 TDD, which span respective frequency ranges 2500-2570//2620-2690 MHz and 2570 – 2620 MHz be adopted.

The current usage of the band by fixed wireless systems e.g WiMAX systems means that even though it is earmarked for IMT services, the band cannot be immediately available in the short to medium term. Incumbent services will need to be migrated out to enable the assignment of IMT200 FDD in the 5-10-year time frame. Moreover, IMT2600 TDD can be assigned in the 5-10-year time frame.

- IMT3300 (3300 – 3400 MHz):
  In accordance with the National Frequency Allocation Plan (NFAP) and the SADC Frequency Allocation Plan, this band has been identified for IMT assignments. However, since studies are currently ongoing as part of the WRC-19 process, the appropriate or corresponding channelling arrangements for the band are still being developed. This means that the band cannot be used in the short to medium term periods. The Commission proposes that this band is reserved for future 5G services deployments.

- IMT3300 (3300 – 3400 MHz):
  In accordance with the National Frequency Allocation Plan (NFAP) and the SADC Frequency Allocation Plan, this band has been identified for IMT assignments. However, since studies are currently ongoing as part of the WRC-19 process, the appropriate or corresponding channelling arrangements for the band are still being developed. This means that the band cannot be used in the short to medium term periods. The Commission proposes that this band is reserved for future 5G services deployments.

- Assignments of high frequency bands > 10 GHz: in future, based on the outcomes of WRC-19 agenda item 1.13.

In line with the above, the following systematic high level 15-year plan for spectrum assignment, frequency migration, technology upgrade and review of spectrum usage is proposed.

1.2.1 Programme for the first 5 years

1. **Frequency Migration to Permit Spectrum Assignment**
   (a) Migration of STL (studio links) from the IMT800 band into frequency bands that accommodate fixed services to allow full assignment of IMT800.
   (b) Migration of DRMASS and microwave links from IMT1800 and IMT 2100 in order to permit the full assignment of these frequency bands.
2. **Assignments**
   (a) Initial assignment of 2x20 MHz in IMT800, noting that the current CDMA 850 assignment prevents the full assignment of the band.
   (b) Assign all unassigned radio frequency spectrum within the IMT900, IMT1800 and IMT2100 bands
3. **Refarming to Promote Technological Upgrade**
   (a) Refarming of existing assignments to the next generation of IMT technology is expected to be carried out by operators.
      (i) A large portion of existing IMT spectrum assignments are expected to remain deployed for 2G in order to support GSM voice services.
      (ii) Refarming options for the IMT 900 band include:

- Refarming IMT900 for 3G depending on the terminal penetration
- Refarming IMT900 for 4G (LTE) – this option is highly recommended; however, a push for LTE terminal penetration needed

(iii) Refarming IMT1800 for 4G (LTE) is highly recommended with subsequent upgrades to 5G

1.2.2 Programme for 5-10 years

1. Review of Spectrum Usage

A review of the potential future use cases associated with the following bands must be undertaken:

(a) For 450 MHz, review options for the potential future use cases PMR or IMT. Note the implementation of IMT will require the migration of existing PMR users.

(b) For 850 MHz, review options for potential future use cases CDMA, GSM-R or PPDR. Note that the adoption of the CDMA850 option will effectively prevent the assignment of the remaining 2x10 MHz of bandwidth in the 800 MHz band.

(c) For 2600 MHz FDD, review options for the dual implementation of WiMAX and LTE or the sole implementation of WiMAX or LTE technologies.

(d) For the centre gap of the 700 MHz band, review options to deploy PPDR in the centre gap of in unused (non-standardised frequency ranges)

The required assignment, migration or refarming actions that emanate from the aforementioned determinations may be executed within the 5 - 10 year period or later.

2. Refarming to Permit Spectrum Assignment

(a) Migration of FWA (DRMASS and DECT) in the 2300-2480MHz band and migration of users to new technologies (including LTE in the IMT1800, IMT2100 and IMT2600 bands).

3. Assignments

(a) Assignment of IMT700 MHz, IMT2100 extension and TDD bands, IMT2300, IMT2600 TDD

(b) Partial of full assignment of IMT750, depending on the preference for PPDR implementation and the associated spectrum requirements of such PPDR systems.

(c) Potential assignment of remaining 2x10 MHz of IMT800

(d) Potential partial or full assignment in IMT2600 FDD noting the review of spectrum usage in this band is ongoing.

1.2.3 Programme for 10-11 years

1. Assignments

(a) Assignment of IMT1500 based on ITU recommended channelling arrangements; possible assignment scenarios include:

(i) Assignment of 40 MHz Supplementary Downlink associated with IMT700, IMT800 or IMT900 band or to PPDR850 or PDR750 depending on demands for PPDR in emergencies, based on state of the art experiences

(ii) Assignment of the 2x20 MHz

(b) Assignment of IMT3500 as TDD as initial 5G capacity-bands

(c) Assignments of high frequency bands > 10 GHz in future, based on the outcomes of WRC-19 agenda item 1.13.

A key consideration of the timing of deployment of a band is equipment and end-user device ecosystem. There is no point in deploying a band before the ecosystem is firmly established and deployed in the region. Conversely, it is equally appropriate to fully assign bands such as the 900, 1800 and 2100 MHz bands where a mature eco-system already exists, even if this means having to migrate out existing non-IMT or legacy systems.

Proposed IMT roadmap for consultation

The road map and channelling arrangement recommendations are summarised in the table below.

Table 1: Summary of indicative recommendations for IMT bands

Band (MHz)	**Channelling arrangements**	**M.1036-5 Frequency Arrangements**	**BW**	**0-5 Years**	**5-10 years**	**10-15 years**
450	450-470 MHz *(channelling options pending)*	-	<20 MHz		Determination regarding PMR or IMT use case. If IMT use case adopted, the migration of current users should be initiated followed by the assignment of IMT450. Depending on the speed of migration, IMT450 may have to be assigned in the 10-15 year timeframe.	
700 FDD	703–733 MHz // 758–788MHz	A7	2×30 MHz		Assign 2x30 MHz	
750 TDD SDL	733-758MHz	A10	20 MHz		Assign up to 20 MHz SDL in 738-758MHz or TDD, noting PPDR implementation will reduce spectrum available for SDL	
800	791-821 MHz // 832-862 MHz	A3	2×30 MHz	Migrate out studio links and assign 2×20 MHz initially	Assign remaining 2x10 MHz	

Proposed IMT roadmap for consultation

850	SDL 821-826MHz (5MHz) + GSM R **OR** 2*5MHz FDD (827-832MHz // 872-877MHz)	-	1×5MHz SDL OR 2*5MHz FDD		Migrate CDMA licensees and introduce SDL 821-826 MHz and extend GSM-R uplink by 1 MHz so that it spans the frequency range 875 – 880 MHz.	
GSM-R	876-880MHz // 921-925MHz				Pending adoption by Swazi Rail and potential extension of the band to 2x5MHz for FRMCS	
900	880-915 MHz // 925-960 MHz	A2	2×35 MHz	Assign remaining 2x5MHz (885-890//930-535	Licensees to consider refarming to LTE technology.	
1500	1452-1492 MHz *(channelling options pending)*	-	2x20 MHz FDD + 40MHz SDL possible			Assignment based on ITU recommended channelling arrangements.
1800	1710-1785MHz// 1805-1880 MHz	B4	2×75 MHz	Migrate out microwave links and DRMASS Assign remaining 2x25MHz (1760-1785 // 1855-1880 MHz)		
2100 (FDD)	1920-1980MHz// 2110-2170 MHz	B4	2×60 MHz	Migrate out microwave links Assign remaining spectrum 1965-1980 // 2155-2170MHz and 1950-1955 // 2140-2145MHz		
2100 extension	1980-2010MHz// 2170-2200 MHz (Extension band)	-	2x30 MHz		Assignment of 2x30 MHz IMT2100-extension bands depending on coexistence.	
2100 (TDD)	1900-1920 MHz, 2010-2025 MHz	-	35 MHz		Assign all available spectrum in IMT2100 TDD	
2300	2300-2400 MHz	E1	100 MHz		Migrate out DRMASS. Assign 2300-2400 MHz as TDD	

Proposed IMT band plan and Roadmap

Proposed IMT roadmap for consultation

2600	2500-2570 // 2620-2690 MHz FDD 2570-2620 MHz TDD	C1	2×70 MHz FDD 50 MHz TDD		Migrate out microwave and WiMAX Assign 2x70 MHz FDD and 50 MHz TDD spectrum	
3300	3300 - 3400 MHz	-	100MHz			Assignment with 3400-3600 pending outcome of studies being conducted in ITU-R working party 5D.
3500	3400-3600 MHz	F1	200MHz	Reserve for 5G	Reserve for 5G	Assignment of IMT3500 as TDD as initial 5G capacity-bands
3700	*3600-3800 MHz*		*200MHz*			Assignment only if adopted for Africa
4900	4800–4990 MHz	-	190MHz			Assignment if adopted for Region 1 including Africa
High Bands	24.25-27.5 GHz2, 37-40.5 GHz, 42.5-43.5 GHz, 45.5-47 GHz, 47.2-50.2 GHz, 50.4-52.6 GHz, 66-76 GHz and 81-86 GHz, 31.8-33.4 GHz, 40.5-42.5 GHz and 47-47.2 GHz,					Await the outcome of the studies on these bands

Proposed IMT roadmap for consultation

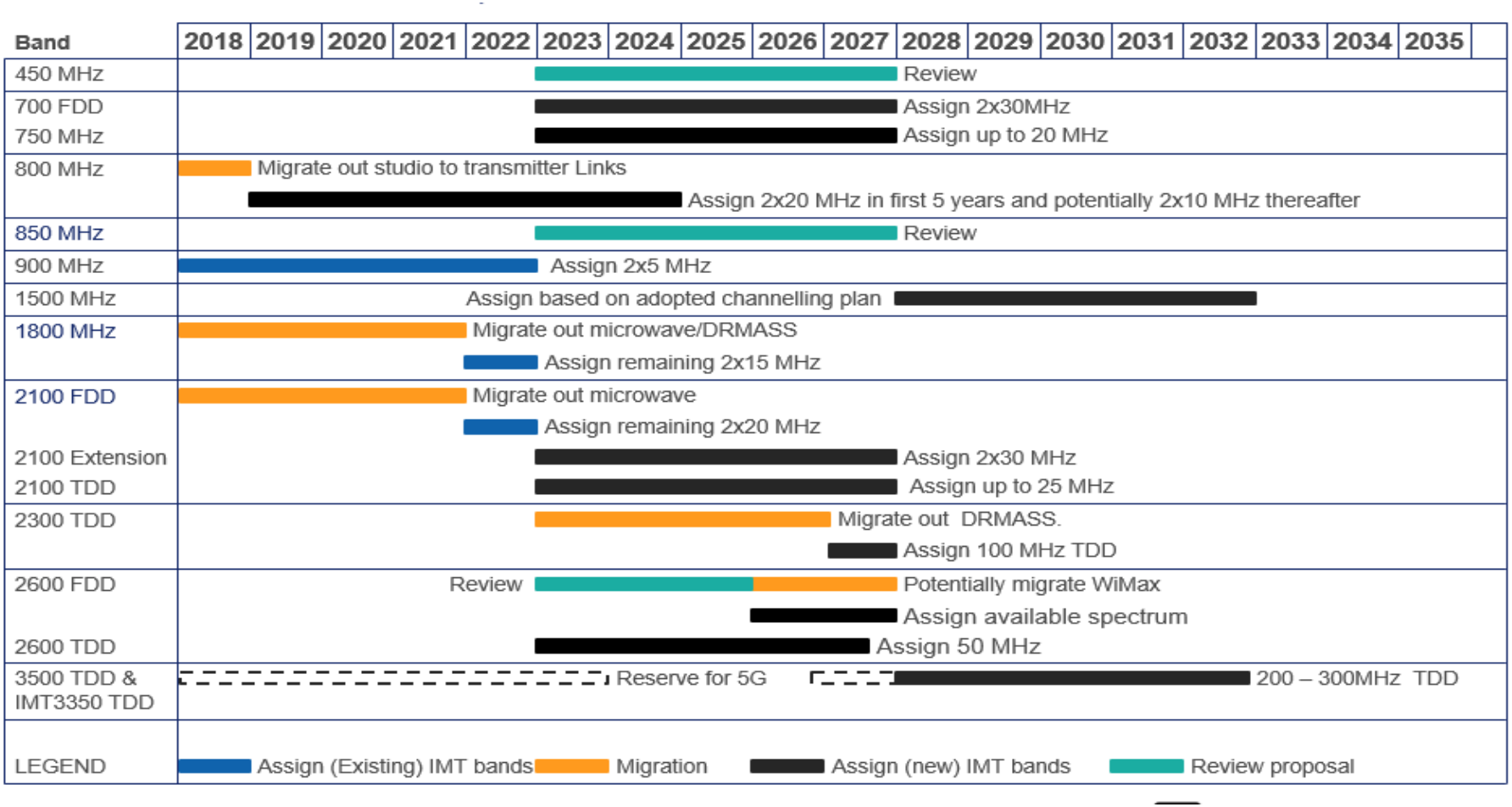


Figure 1: Summary of indicative recommendations for IMT bands

1.3 Invitation to comment

In accordance with Section 32 of the Swaziland Communications Commission Act, the Commission invites comments on the proposed IMT band plan and roadmap.

2 Introduction to IMT

2.1 What is IMT? [1]

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

1. 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;
2. compatibility of services within IMT and with fixed networks;
3. capability of interworking with other radio access systems;
4. high-quality mobile services;
5. user equipment suitable for worldwide use;
6. user-friendly applications, services and equipment;
7. worldwide roaming capability; and
8. enhanced peak data rates to support advanced services and applications.

Over the past 25 years, the ITU has developed the IMT system framework of standards for mobile telephony and continues to lead international efforts involving governments and industry players to produce the next generation of standards for global mobile communications.

The term ‘IMT’ should be the root name that encompasses both IMT-2000 and IMT-Advanced collectively.

Terminology

2.2 Terminology for IMT bands

Details are given below, but for the sake of brevity.

IMT 2000 – refers to 3G

IMT Advanced refers to 4G

IMT 2020 is taken to mean 5G

The original 2G technologies of GSM and CDMA do not explicitly fall under the IMT umbrella, but GSM services operate in bands identified for IMT.

In this report, the reference to a band as IMT (e.g. IMT 800 or IMT 900) means that the

[1] from Recommendation ITU-R M.1645

band follows one of the ITU Channel plans for IMT (generally stated in M 1036/5). Where necessary, the widely understood 3GPP band number and general name is given to identify the specific band option adopted.

For example, the 900 band for IMT used in Region 1 is channelling arrangement A2 (880-915 MHz paired with 925 – 960 MHz) with the 3GPP number band 8 and it is also known as E-GSM. In the South African Radio Frequency Spectrum Assignment Plans, this is referred to as IMT 900 and the same nomenclature may be followed here.

2.3 IMT 2000

IMT-2000 (International Mobile Telecommunications 2000) is a term coined by the global cellular community to produce a globally-co-ordinated definition of 3G mobile technologies. IMT-2000 networks have been widely deployed since 2000.

According to the ITU, IMT-2000 systems are third generation (3G) mobile systems, which provide access to a wide range of telecommunications services, supported by the fixed telecommunication networks (e.g. PSTN/ISDN/Internet Protocol (IP)), as well as to other services which are specific to mobile users.

The specifications for the initial releases of IMT-2000 are defined in Recommendation ITU R M.1457. The term ‘IMT-2000’ should also encompass its enhancements and future developments.

2.4 IMT Advanced

The term ‘IMT-Advanced’ refers to systems, system components and related aspects that include new radio interfaces supporting new capabilities of systems beyond IMT-2000.

ITU has now specified standards for IMT-Advanced. IMT-Advanced provides next-generation global wireless broadband communications using a wide range of packet-based telecommunication services supported by mobile and fixed networks.

IMT-Advanced will use radio-frequency spectrum much more efficiently making higher data transfers possible on less bandwidth in order to enable mobile networks to accommodate the dramatic increase in data traffic that is expected in the coming years.

IMT-Advanced systems support low to high mobility applications and a wide range of data rates in accordance with user and service demands in multiple-user environments. IMT-Advanced also has capabilities for high quality multimedia applications within a wide range of services and platforms, providing a significant improvement in performance and quality of service.

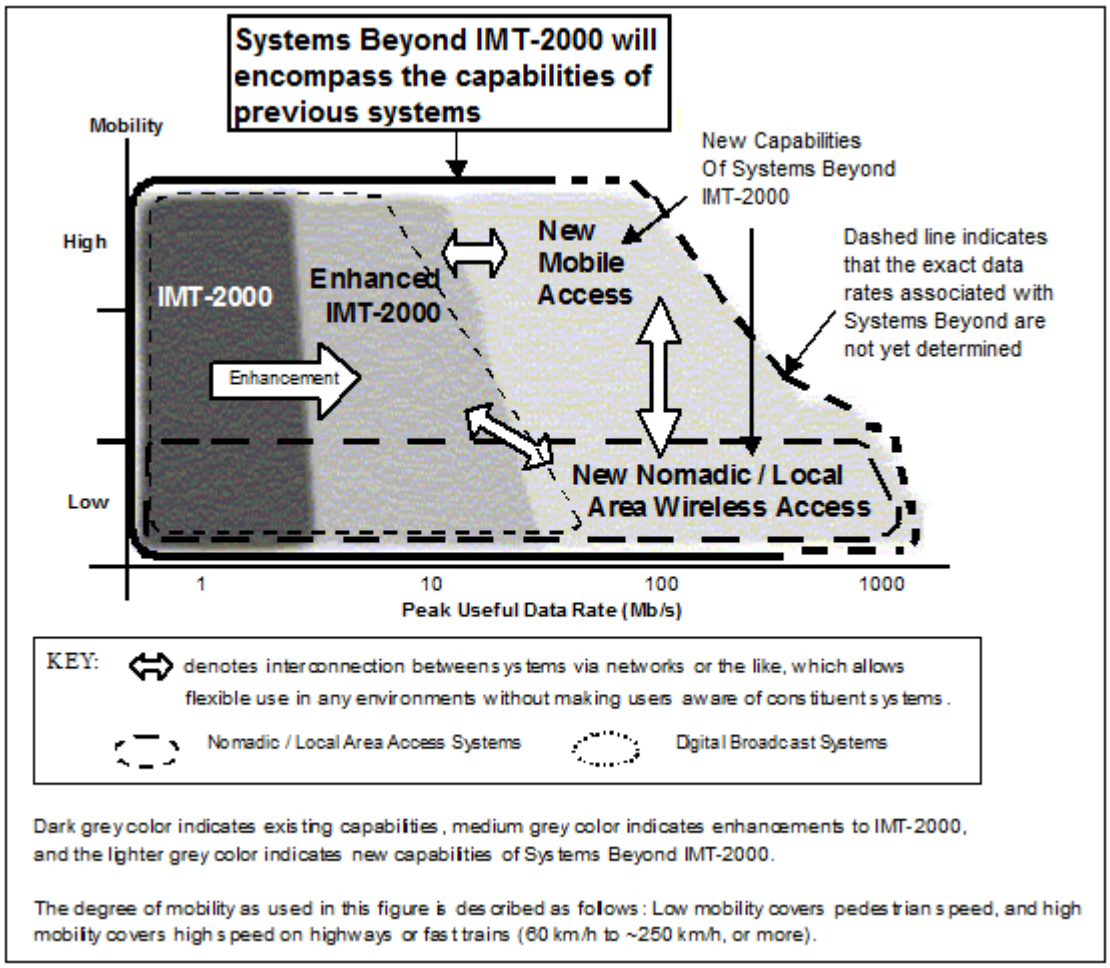


Figure 2: IMT Systems now and in the future *(Source: ITU)*

2.5 IMT 2020

In early 2012, ITU-R embarked on a programme to develop “IMT for 2020 and beyond”, setting the stage for 5G research activities that are emerging around the world.

Through Working Party 5D, ITU’s Radiocommunication Sector (ITU-R) has finalized its view of a timeline towards IMT-2020. The detailed investigation of the key elements of 5G are underway.

In September 2015, ITU-R finalized its “Vision” of the 5G mobile broadband connected society. This view of the horizon for the future of mobile technology will be instrumental in setting the agenda for the World Radiocommunication Conference 2019, where deliberations on additional spectrum are taking place in support of the future growth of IMT. ITU notes that the framework of standards for International Mobile Telecommunications (IMT), encompassing IMT-2000 and IMT-Advanced, spans the 3G and 4G industry perspectives and will continue to evolve as 5G with IMT-2020.

Proposed IMT roadmap for consultation

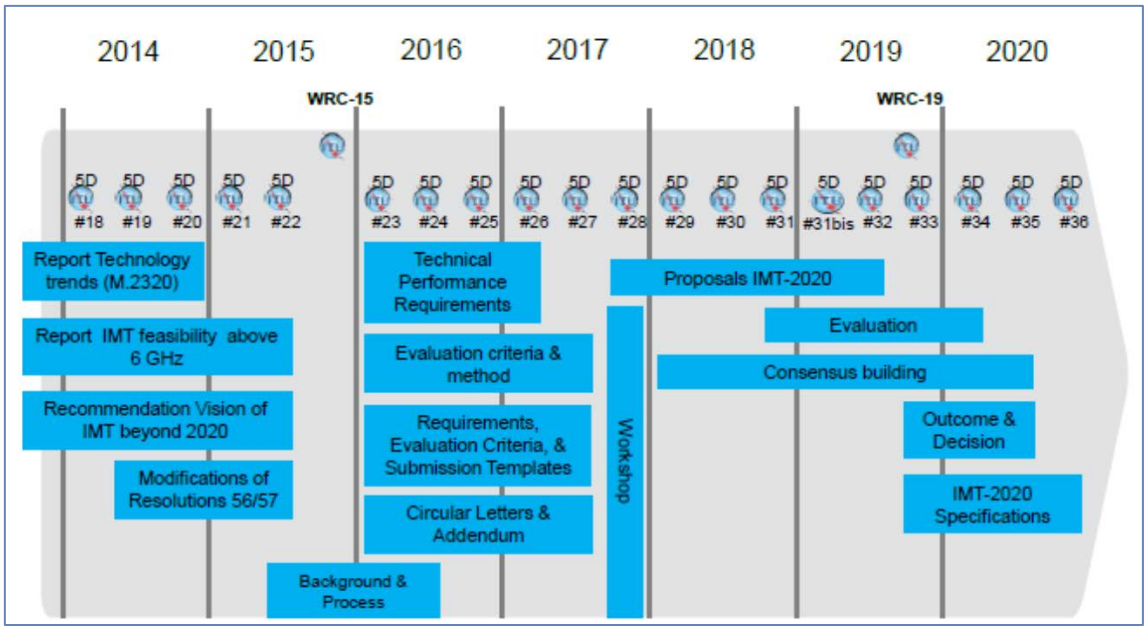


Figure 3: Detailed Timeline and process for IMT 2020 *(Source: ITU)*

2.6 Demand for IMT Spectrum

2.6.1 Overview

The demand for spectrum can be broken down into two separate components:

1. The requirement for coverage.
2. The requirement for capacity.

For coverage, especially in rural areas, the demand is for lower bands with high propagation characteristics that allow a large sea to be covered from a transmitter. It is to provide such coverage with an acceptable level of capacity that the digital dividend 700 and 800 MHz bands were so important and why the 450 MHz band is considered for IMT despite the small capacity as this band can serve the unserved.

The requirement for capacity in any country is a function of the peak demand for capacity at hot spots and these are very localised and are a function of densities of demand. The projection of how much IMT spectrum a country actually needs is therefore difficult and can prove to be contentious, especially in view of the consideration that:

1. High demand for capacity can be met by investment in more base station transmitters and careful coverage planning.
2. High demand for capacity can also be met by fibre to the home.
3. High demand for spectrum can also be met by small cell and WiFi offloading.

The baseline model for estimating radio frequency spectrum requirements for Terrestrial IMT has been carried out by the ITU in ITU-R M.2290-0 following earlier studies. This is the basis upon which the World Radio conferences have been continually been seeking additional spectrum for capacity.

The ITU model is explained below.

2.6.2 ITU Forecasts of overall IMT demand

In Report ITU-R M.2290-0 (12/2013) future spectrum requirements are estimated for terrestrial IMT. From this report it is clear that the growth in mobile traffic is expected to increase over the next few years. In order to reflect the increasing traffic demand, new, updated market attributes for the lower user density and higher user density settings are provided.

In 'Report ITU-R M.2078-0 (2006), Estimated spectrum bandwidth requirements for the future development of IMT-2000 and IMT-Advanced', the new traffic volumes for the spectrum requirement estimations in 2020 are derived by considering traffic growth ratios from the market studies presented in 'Report ITU-R M.2243-0 (2011) Assessment of the global mobile broadband deployments and forecasts for International Mobile Telecommunications'. The report relies on several mobile traffic forecasts beyond 2010, provided by different organisations. Most of these forecasts consider mobile traffic in the years 2011-2015, while only one makes projections for the year 2020, anticipating a 33-fold traffic growth ratio in 2020 compared with 2010.

It should be noted that the 2nd-order polynomial function estimates conservative traffic growth, while the 3rd and 4th-order polynomial functions provide more aggressive growth corresponding to approximately 40 to 170-fold and 80 to 240-fold growth ratios, respectively.

The spectrum requirements are distributed and calculated for Radio Access Technology Group 1 (RATG 1) (i.e. pre-IMT, IMT-2000 and its enhancements) and RATG 2 (i.e. IMT-Advanced) for the year 2020.

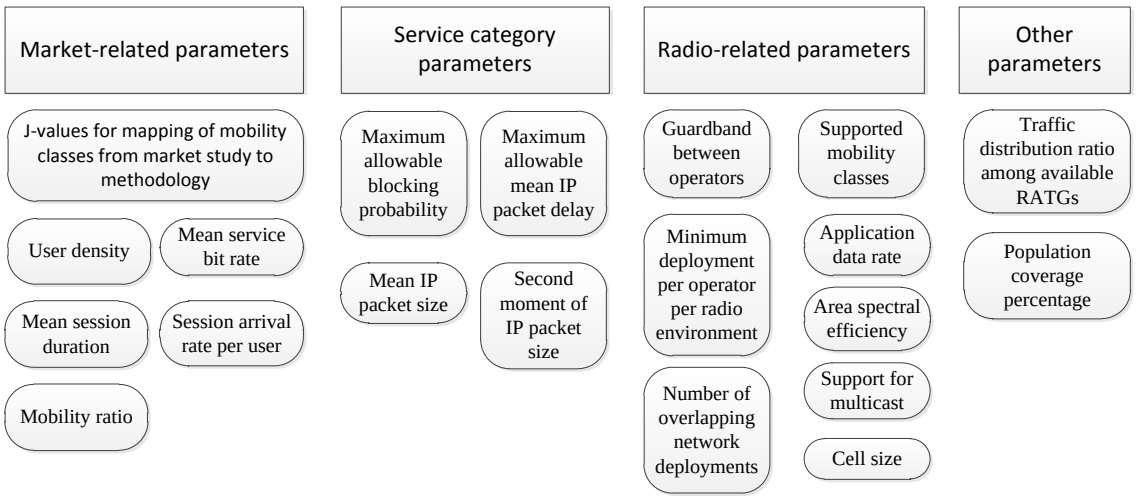


Figure 4: Input parameter overview for IMT spectrum demand estimation

The use of two market settings, lower and higher user density settings, allows for modelling of the differences in markets between different countries. The two settings will result in two final spectrum requirements for IMT systems and the needs of the different countries could lie between these two extremes.

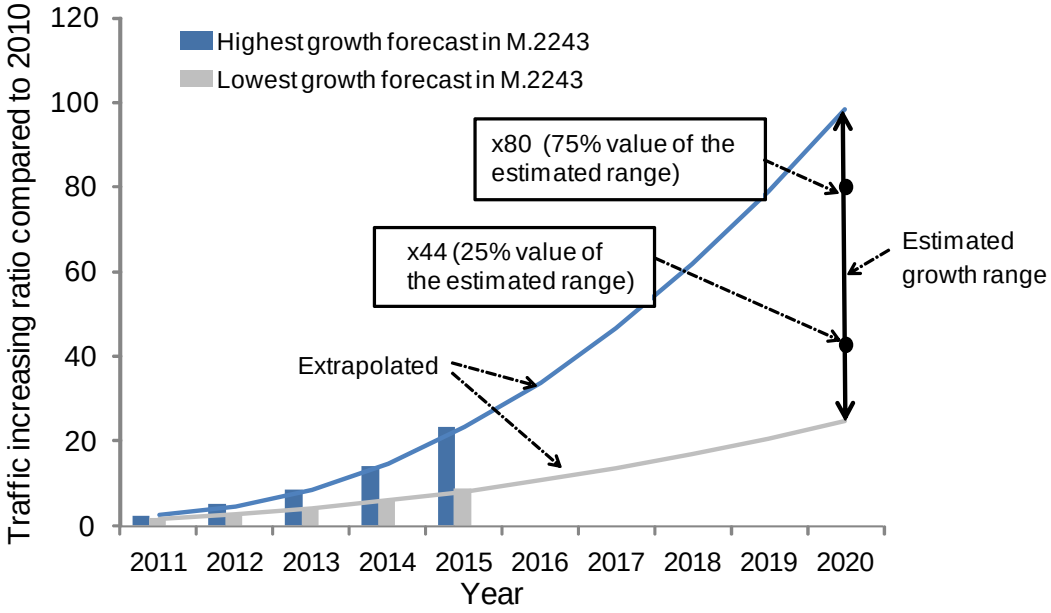


Figure 5: Mobile traffic forecasts toward 2020 by extrapolation *(Source: ITU)*

Table 2 depicts the Radio Parameters for RATG 1 (pre-IMT2000, IMT2000) whilst Table 3: Radio parameters for RATG 2 (IMT advanced)

In Table 4 the spectral efficiency parameters for RATG1 and RATG 2 (IMT-Advanced) are shown, indicating spectral densities which generate the capabilities of the networks. Based on these (and further parameters) the overall spectrum demand is estimated and provided in Table 5.

The spectrum efficiency values are to be used only for spectrum requirement estimations given in 'Recommendation ITU-R M.1768-1 (04/13) 'Methodology for calculation of spectrum requirements for the terrestrial component of International Mobile Telecommunications'. These values are based on a full buffer traffic model in accordance with 'Report ITU-R M.2135-1 (2009) Guidelines for evaluation of radio interface technologies for IMT-Advanced'. In practice, such spectrum efficiency values are unlikely to be achieved due to the random nature of traffic, errors caused by radio channel conditions or packet losses. This means, if too high capacity assumptions are used, this will lead to lower spectrum demands. On the contrary, not all applications need 20 Mbps. Therefore, the results given in Table 5 should be used as a general indication of how much spectrum is needed, even if it might be in 2025 instead of 2020.

Proposed IMT roadmap for consultation

Parameters	Macro cell	Micro cell	Pico cell	Hot spot
Application data rate (Mbps)	20	40	40	40
Supported mobility classes	Stationary/ pedestrian, low, high	Stationary/ pedestrian, low	Stationary/ pedestrian	Stationary/ pedestrian
Guard band between operators (MHz)	0			
Minimum deployment per operator per radio environment (MHz)	20	20	20	20
Granularity of deployment per operator per radio environment (MHz)	20	20	20	20
Support for multicast	Yes			
Number of overlapping network deployment	1			

Table 2: Radio parameters for RATG 1 (pre-IMT2000, IMT2000):

Parameters	Macro cell	Micro cell	Pico cell	Hot spot
Application data rate (Mbps)	50	100	1 000	1 000
Supported mobility classes	Stationary/ pedestrian, low, high	Stationary/ pedestrian, low	Stationary/ pedestrian	Stationary/ pedestrian
Guard band between operators (MHz)	0			
Support for multicast	Yes			
Minimum deployment per operator per radio environment (MHz)	20	20	120	120
Granularity of deployment per operator per radio environment (MHz)	20	20	20	20
Number of overlapping network deployment	1			

Table 3: Radio parameters for RATG 2 (IMT advanced)

RATG1: Unicast area spectral efficiency (bit/s/Hz/cell)				
Tele-density	Radio environments			
	Macro cell	Micro cell	Pico cell	Hot spot
Dense urban	2	4	4	4
Suburban	2	4	4	4
Rural	2	4	4	4

RATG2: Unicast area spectral efficiency (bit/s/Hz/cell)				
Tele-density	Radio environments			
	Macro cell	Micro cell	Pico cell	Hot spot
Dense urban	4	5	5	7.3
Suburban	4	5	5	7.3
Rural	4	5	5	7.3
Dense urban	4	5	5	7.3

Table 4: Spectral efficiency parameters for RATG1 and RATG 2 (IMT advanced)

	Total spectrum requirements for RATG 1	Total spectrum requirements for RATG 2	Total spectrum requirements RATGs 1 and 2

Proposed IMT band plan and Roadmap

Lower user density settings	440 MHz	900 MHz	1 340 MHz
Higher user density settings	540 MHz	1 420 MHz	1 960 MHz

Table 5: Total spectrum requirements in the year 2020

Note however, that there has been criticism of the results of the ITU model, especially by satellite operators, the Global VSAT Forum (GVF) noting *that input data used in the Report ITU-R M.2290 model are at least two orders of magnitude (a factor of 100 or more) too high and that the results contained in Report ITU-R M.2290-0 are incorrect*. [2]

2.6.3 Other forecasts of IMT Spectrum requirements

Other countries and the GSM Association have also produced estimates on total spectrum requirements by 2020, as summarised in the table below.

Summary of national spectrum requirements							
Source	**US**	**Australia**	**Russia**	**China**	**GSMA6**	**India**	**UK**
Estimation year	Until 2014	Until 2020	2020	2015, 2020	2020	2017, 2020	2020
Spectrum require-ments	Additional require-ment of 275 MHz by 2014	Total requirement of **1 081 MHz** (Additional requirement of 300 MHz by 2020)	Total requirement of **1 065 MHz** (Additional requirement of 385 MHz by 2020)	Total requirement of 570-690 MHz (by 2015) Total requirement of 1 **490-1 810 MHz** (by 2020)	Total requirement of **1 600-1 800** MHz for some countries	Additional requirement of 300 MHz by 2017 Additional requirement of another 200 MHz by 2020	Total requirement of **775-1 080 MHz for the low demand setting** Total requirement of **2 230-2 770 MHz for the** high demand setting
Methodology	Using an original methodology	Using an original methodology	Using an original methodology	Using the methodology in Rec. ITU-R M.1768-1	Using a new methodology complementing the methodology in Rec. ITU-R M.1768-1	Using an original methodology	Using the methodology in Rec. ITU-R M.1768-1

Source: ITU-R M.2290-0

Table 6: Summary of national spectrum requirements

2.6.4 Bandwidth available for Swaziland

If all the bands considered in the IMT roadmap are taken into consideration, then the total bandwidth that would be made available is as indicated in the following table.

Band	Frequency band	Max BW in MHz
450 MHz	450 – 470 MHz (assuming maximum bandwidth)	10
700 MHz	703-733 // 758-788 MHz (assumed)	60

[2] GVF - Future Spectrum Requirement Estimation for Terrestrial IMT

800 MHz	791 – 821 MHz // 832 – 862 MHz (assumed)	60
850 MHz	Assuming 2x5MHz in band 5	10
900 MHz	880 – 915 MHz // 925 – 960 MHz	70
1500 MHz	1452-1492 MHz (assuming maximum bandwidth)	40
1800 MHz	1710 – 1785 MHz // 1805 – 1880 MHz	150
2100 MHz	1920 – 1980 MHz // 2110 – 2170 MHz	120
2100 MHz (TDD)	1900 – 1920 MHz, 2010 – 2025 MHz	35
2300 MHz	2300 – 2400 MHz (assuming maximum bandwidth)	100
2600 MHz	2500 – 2570 // 2620-2690 MHz FDD (assumed)	140
2600 MHz	2570– 2620 MHz TDD (assumed)	50
3300 MHz	3300-3400 assuming maximum bandwidth)	100
3500 MHz	3400-3600 (assumed)	200
	Maximum Total BW	**1145**

Table 7: Bandwidth available in Swaziland

This is a maximum value not taking into account guard bands or channelling arrangements where these are not confirmed, the achievable value is closer to 1100 MHz.

What is most important in the Swaziland context is the availability of the main sub 1GHz coverage bands (700, 800 and 900), with the 1800 and 2600 MHz bands to provide capacity in urban areas.

3 Laws and Regulations

This sections gives an overview of the existing regulations and recommendations that define the allocation of frequencies in relation to the International Telecommunications Union and SADC.

An overview is also made of the laws and regulations in Swaziland that are relevant.

3.1 International Framework for Frequency Usage

The international framework for IMT cascades from the ITU downwards. Swaziland is in Region 1 of the ITU. The African Telecommunications Union (ATU) will in general seek to harmonize frequency arrangements for the African continent, while in Southern Africa, SADC will seek to harmonise arrangements across the sub region. Swaziland, will in general, maintain consistency with the SADC Frequency Allocation Plan.

The allocation of spectrum to mobile services and the subsequent identification of IMT frequency bands is made at the ITU level, via specific WRC agenda items. Looking forward, WRC-19 agenda item 1.13 will consider the identification of frequency bands for the future development of IMT, including possible additional allocations to the mobile service on a primary basis, in accordance with Resolution 238 (WRC-15).

There is an ongoing programme at ITU level to progressively identify bands for IMT.

3.2 ITU Radio Regulations

The relevant articles and resolutions, as contained in the Radio Regulations, are reflected below.

3.2.1 Article 5 of the ITU Radio Regulations

The use of the frequency bands is as determined as per Article 5 of the ITU Radio Regulations, currently applicable is the edition of 2016.

3.2.2 Resolutions

The Resolutions of the World Radio Conferences directly applicable to IMT from the Radio Regulations are as follows.

RESOLUTION 212 (REV.WRC-15) - Implementation of International Mobile Telecommunications in the frequency bands 1 885-2 025 MHz and 2 110-2 200 MHz

RESOLUTION 223 (REV.WRC-15) - Additional frequency bands identified for International Mobile Telecommunications

RESOLUTION 224 (REV.WRC-15) - Frequency bands for the terrestrial component of International Mobile Telecommunications below 1 GHz

RESOLUTION 235 (WRC-15) - Review of the spectrum use of the frequency band 470-960 MHz in Region 1

RESOLUTION 238 (WRC-15) - Studies on frequency-related matters for International Mobile Telecommunications identification including possible additional allocations to the

mobile services on a primary basis in portion(s)of the frequency range between 24.25 and 86 GHz for the future development of International Mobile Telecommunications for 2020 and beyond

RESOLUTION 749 (REV.WRC-15) - Use of the frequency band 790-862 MHz in countries of Region 1 and the Islamic Republic of Iran by mobile applications and by other services

RESOLUTION 760 (WRC-15) - Provisions relating to the use of the frequency band 694-790 MHz in Region 1 by the mobile, except aeronautical mobile, service and by other services

Related resolutions include

RESOLUTION 221 (REV.WRC-07) - Use of high altitude platform stations providing IMT in the bands1 885-1 980 MHz, 2 010-2 025 MHz and 2 110-2 170 MHz in Regions 1 and 3 and 1 885-1 980 MHz and 2 110-2 160 MHz in Region 2.

RESOLUTION 761 (WRC-15) - Compatibility of International Mobile Telecommunications and broadcasting-satellite service (sound) in the frequency band 1 452-1 492 MHz in Regions 1 and 3

Recommendations

Recommendations that have been incorporated by reference in the Radio regulations include

RECOMMENDATION 207 (REV.WRC-15) - Future IMT systems

3.3 ITU-R Recommendations

The key document regarding arrangements for bands identified for IMT is

Recommendation ITU-R M.1036-5 (10/2015) Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations (RR).

This recommendations is reflected and considered in the analysis of each IMT band in Chapter 6 below.

3.4 SADC Frequency Allocation Plan (FAP)

The latest SADC Frequency Allocation Plan (SADC FAP) 8.3kHz – 3000GHz is as revised in July 2016.

This plan with respect to IMT is reflected and considered in the analysis of each IMT band in Chapter 6.

3.5 Swaziland frequency allocations

The latest frequency allocation table is The National Frequency Allocation Plan (NFAP) 2017.

The NFAP 2017 Swaziland allocations are largely consistent with the SADC FAP 2016.

Proposed IMT roadmap for consultation

The frequencies indicated for terrestrial IMT in the “Utilization” column of the NFAP 2017 follow the ITU-R Recommendation M.1036-5 Frequency arrangements code and 3GPP band number given as appropriate.

Indicated as IMT in Utilization Column of NFAP 2017	**Current Status**
450 – 470 MHz	PMR assignments
694 -790MHz is indicated as IMT	No assignments Digital Dividend 2 – no IMT channel arrangements or assignments - 703 – 733MHz // 758 – 788MHz anticipated.
790-862MHz is indicated as IMT	There are assignments for broadcast studio – transmitter links in the band between 850-860MHz. Digital Dividend 1 – no IMT channel arrangements or assignments to date - 832 – 862MHZ // 791 – 821 MHz anticipated.
862-876 MHz paired with 824-849 MHz is indicated as IMT as in the SADC FAP – this would appear to refer to the IMT 850 band (band 5 a.k.a. CLR band) but the downlink (rx) should be 869 – 894MHz not 862-876 MHz.	870.495-875.415MHz // 825.495-830.415 MHZ assigned to SPTC for the provision of 2G (CDMA) services but it is currently unused.
876 – 880 MHz paired with 921-925 MHz, which is part of the GSM-R band.	Unassigned.
880-915 MHz paired with 925 – 960 MHz – this is M.1036-5 A2 (3GPP-band 8) (a.k.a. E-GSM or IMT900).	MTN, SPTC and Swazi Mobile have assignments in this frequency. Assigned to all operators for ‘GSM’. The 885-890MHz // 930-935MHz portion of the frequency band remains unassigned.
1452 – 1518 MHz	Unassigned. Part of the 1427 – 1518 MHz band Identified for IMT as per Resolution 223 (Rev WRC 15).
1710-1785MHz paired with 1805-1880 MHz which is M.1036-5 B2 (3GPP-band 3) (a.k.a. DCS or IMT 1800)	MTN, SPTC and Swazi Mobile have assignments in this frequency band for GSM (2G/4G).

Proposed IMT roadmap for consultation

	The 1760-1785 // 1855-1880 MHz remains unassigned due to the deployment of microwave links and DRMASS in this frequency range.
1900 – 1920 MHz – this is 3GPP-band 33 a.k.a. IMT 2100 TDD.	Unassigned.
1920 – 1980 MHz paired with 2110-2170 MHz which is M.1036-5 B1 (3GPP-band 1) a.k.a IMT 2100 FDD.	MTN, SPTC and Swazi Mobile each have assignments in this frequency band for 3G. The frequency ranges1965-1980MHz // 2155-2170MHz and 1950-1955 // 2140-2145MHz are not assigned for GSM (3G) and contain microwave assignments.
2010-2025 - 3GPP-band 34 – a.k.a. IMT 2100 TDD	Unassigned
2300 – 2400 which is M.1036-5 E1 (3GPP-band 40) a.k.a. IMT 2300 TDD	Assigned to SPTC and utilised for Fixed Wireless Access (DRMASS)
2500-2690 MHz –M.1036-5 Frequency arrangements Not Indicated.	Majority of the frequency band is unassigned. Swazi Mobile have two fixed assignments (PTP microwave) in this frequency band and there is a SPTC WiMAX assignment (2490-2540) WiMAX
3300 – 3400 MHz	Unassigned Identified for IMT as per Resolution 223 (Rev WRC 15).
3400 – 3600 MHz M.1036-5 Frequency arrangements Not Indicated	Unassigned

Table 8: IMT bands identified in the NFAP 2017 and current usage

See the annex for the current utilisation of IMT bands.

3.6 Swaziland laws and regulations with respect to frequency allocations.

3.6.1 The Electronic Communications Act, 2013

The Electronic Communications Act, 2013 sets the overall rules of the electronic communications sector including broadcasting, but does not cover issues of content

The section of the Electronic Communications Act, 2013 relevant to issues of radio frequency spectrum is:

Part VII – Radio Frequency Management.

34.(1) notes that *The Commission shall be responsible for managing the efficient and effective use of radio frequency spectrum, including spectrum and orbital locations used by satellite services*, Pertinent to this report are the following considerations:

(a) after consultation with all major stakeholders including the sound and television broadcasting industries in accordance with section 32 of the Swaziland Communications Commission Act, recommend a national frequency allocation plan which may be revised periodically, as necessary;

(b) assign radio frequency spectrum or groups of radio frequency spectrum in accordance with the national frequency plan and with publicly availably national policies;

(c) ……. *ensuring efficient usage, planning of radio frequency spectrum allocation and radio frequency spectrum assignment, and for making spectrum-occupancy related information available to the industry and consumers;*

(d) in collaboration with the Minister, make and publicise decisions necessary for the management and the use of the radio frequency spectrum;

(f) in the allocation and assignment of radio frequency spectrum, give due regard to the requirements of safety and emergency services;

(g) where necessary, specify compatibility standards for the interoperability of radio frequency equipment and ensure that the standards are adhered to;

3.6.2 Swaziland Communications Commission Bill, 2010

The act establishes the Swaziland Communications Commission and establishes its powers to regulate electronic communications including broadcasting, which includes content.

6. The general functions of the Commission are to –

(g) ensure that all communications services are provided in a manner that will best promote economic and social development;

7. Without derogating from the functions of the Commission under section 6, the Commission shall -

(a) advise the Government on policy and legislative measures in respect of the provision and operation of communications networks and communications services, including radio and television broadcasts, postal services, electronic commerce and data protection in electronic communications;

(b) formulate such rules and regulations to be issued by the Minister as may be necessary for the implementation and proper administration of the policy and legislative measures referred to in paragraph (a);

(k) on approval by the Minister, allocate and authorise the use of radio frequency spectrum;

(p) ensure compliance with national and international communications standards and obligations laid down by international communications agreements to which Swaziland is a party;

3.6.3 **Radio Communications and Frequency Spectrum Regulations, 2016**

With regard to frequency planning

PART II RADIO FREQUENCY PLANNING

National Radio Frequency Plan

4. (1) All spectrum allocations and assignments shall be consistent with the current national radio frequency plan.

(2) Users of radio frequency spectrum shall comply with the provisions of the current national radio frequency plan.

National Frequency Allocation Plan

5. (I) The Commission may, in accordance with section 34 of the Act, prepare a national frequency allocation plan.

(2) The National Frequency Allocation Plan shall fall under the Radio Frequency Plan and shall be detailed and provide a description of how a band is allocated.

(3) Radio Frequency Spectrum Band Plans shall specify the purposes for which bands may be used, arising from Government policy initiatives or public demand.

(4) Radio Frequency Spectrum Band Plans may specify or propose-

(a) detailed frequency channelling arrangements;

(b) technical and other requirements; or

(c) principles or assignment and implementation for the detailed allocation of the radio frequency spectrum between types of services.

(5) Radio Frequency Spectrum Band Plans shall be subject to consultation.

Proposed IMT roadmap for consultation

These Radio Frequency Spectrum Band plans appear to be separate plans dealing with specific bands in a manner similar to the Radio Frequency Spectrum Assignment Plans foreseen in the South African regulations.

PART III RADIO FREQUENCY LICENSING AND ASSIGNMENT

Radio Frequency Spectrum License Exemptions are not relevant to the IMT bands.

The following sections deal with assignment methods.

> *(4) Notwithstanding sub-regulation (3), where the Commission anticipates that the spectrum to be assigned-*
>
> > *(a) is in high demand, in that demand for the spectrum exceeds supply; or*
> >
> > *(b) is considered to be of high economic value.*
>
> *(5) The Commission may use market based approaches, including the competitive bidding process for individual licenses which is provided for in the Licensing regulations, to assign the spectrum.*

The IMT bands are the prime candidate for the use of competitive bidding processes. Even in the event that an Auction is considered inappropriate, a comparative bidding process may be deployed.

PART IV STANDARD TERMS AND CONDITIONS OF RADIO SPECTRUM LICENSES

Obligations of licensees

14. (1) A licensee who has been assigned frequency bands for use shall-

> *(a) maintain and provide, at the Commission's request, an inventory of the assigned frequency bands;*
>
> *(b) keep the licence in force by regular payment of annual fees prescribed by the Commission;*

Duration of a Radio Frequency Spectrum Licence and Renewal*:* These clauses together with the clauses above, effectively state that the duration of a licence is one year and would be renewable annually.

15. (1) The grant of a Radio Frequency Spectrum Licence and assignment shall not be construed as conferring upon the holder a monopoly of the use of the frequency or a right of continued tenure in respect of the frequency.

> *(2) Unless otherwise specified in regulations or in the licence, a Radio Frequency Spectrum Licence shall remain valid for a period of one (1) year until renewed.*
>
> *(3) The Commission shall not unduly refuse a renewal if a licensee-*
>
> > *(a) has paid all the applicable fees;*
> >
> > *(b) has utilised the frequency spectrum resource in an effective and efficient manner;*
> >
> > *and*
> >
> > *(c) has complied with all other reporting and license requirements.*

(15. (1) makes it clear that the practice of being able to renew annually does imply any special right to the spectrum and presumably establishes the Commission's ability to change spectrum use and require assignments to cease in a given band. It is general practice to migrate spectrum users to new spectrum locations but it is not an automatic right.

3.6.4 The Electronic Communications (Licensing) Regulations, 2016

These regulations have limited relevance to the IMT road map.

> *3. These Regulations shall apply to-*
>
> *(c) frequency spectrum licences;*
>
> *Individual Licence*
>
> *5. (l) The Commission may issue an individual licence for-*
>
> *(c) use of certain frequency spectrum bands*

The section dealing specifically with ***Frequency spectrum licence*** notes that:

> *7. (1) In issuing frequency spectrum licences, the Commission may-*
>
> *(a) issue frequency spectrum on a first-come-first served basis provided that the applicant complies with sub-regulation 6; or .*
>
> *(b) use the process set out in sub-regulation 5 in respect of individual licenses to issue a frequency spectrum licence, where the Commission seeks to employ a competitive bidding process to select a licensee, particularly in instances where demand for a spectrum resource, exceeds supply.*

These clauses allow for both the first come first served basis for issuing spectrum licences and the competitive bidding process in a manner consistent with the spectrum regulations. Note that while it is envisaged that a competitive process will apply to spectrum where demand exceeds supply, a competitive bidding process is not restricted to such instances.

3.7 The South African Radio Frequency Assignment Plans for IMT

South Africa has produced an IMT Road map charting the future deployment of IMT in that country. South Africa has also gazetted Radio Frequency Spectrum Assignment Plans (RFSAP) for IMT in the IMT 450, IMT 800, IMT 900, IMT2300, IMT2600 and IMT3500 bands. The RFSAP for IMT 850 has been gazetted for comment to ascertain whether an assignment for 2x5 MHz would be possible.

3.8 The Swaziland Development Context

IMT radio frequency spectrum is an important component of meeting the goals of The National Development Strategy (NDS) and the National Information and Communication Infrastructure (NICI) plan. There is no point to be served by 'conserving' radio frequency spectrum unnecessarily, however it may be appropriate to reserve IMT spectrum for future 5G use in some instances.

Proposed IMT roadmap for consultation

Particular reference van be made to the proposed strategies to achieve the goals set in the ICT policy including:

4. *Building broadband capacity in the information and communications infrastructure and introduce new services to improve universal access and service quality;*

Ultimately, the IMT roadmap is aimed at supporting this strategy.

4 Usage of IMT Spectrum

The purpose of this section is to provide an overview of the use of potential IMT spectrum in Swaziland.

4.1 General usage of spectrum in Swaziland

The radio spectrum in Swaziland is not heavily utilised reflecting the primary based economy. There are only two significant urban centres, Mbabane and Manzini-Matshapa, but there is no sign of general spectrum congestion.

4.2 Current assignments of mobile operators in the established IMT bands

The assignments to the mobile operators in the established IMT bands are indicated below (source SCCOM).

GSM 900 MHz			**1800 MHz**			**2100 MHz (FDD)**		
880 - 915			1710 - 1785			1920 - 1980		
925 - 960			1805 - 1880			2110 - 2170		
45MHz			95MHz			190MHz		
10MHz			20MHz			130MHz		
35 MHz			75 MHz			60 MHz		
10 MHz			20 MHz			15 MHz		
GSM (2G)			GSM (2G/4G)			GSM (3G)		
MTN	SPTC	SML	MTN	SPTC	SML	MTN	SPTC	SML
10	10	10	20	20	10	15	15	10
5MHz			5MHz			5MHz		
5 MHz			25 MHz			25 MHz		
Chl Nr	**CF - UL**	**CF - DL**	**Chl Nr**	**CF - UL**	**CF - DL**	**Chl Nr**	**CF - UL**	**CF - DL**
1	882.50	927.50	1	1712.50	1807.50	1	1922.50	2112.50
2	887.50	932.50	2	1717.50	1812.50	2	1927.50	2117.50
3	892.50	937.50	3	1722.50	1817.50	3	1932.50	2122.50
4	897.50	942.50	4	1727.50	1822.50	4	1937.50	2127.50
5	902.50	947.50	5	1732.50	1827.50	5	1942.50	2132.50
6	907.50	952.50	6	1737.50	1832.50	6	1947.50	2137.50
7	912.50	957.50	7	1742.50	1837.50	7	1952.50	2142.50
			8	1747.50	1842.50	8	1957.50	2147.50
			9	1752.50	1847.50	9	1962.50	2152.50
			10	1757.50	1852.50	10	1967.50	2157.50
			11	1762.50	1857.50	11	1972.50	2162.50
			12	1767.50	1862.50	12	1977.50	2167.50
			13	1772.50	1867.50			
			14	1777.50	1872.50			
			15	1782.50	1877.50			

Table 9: Current IMT assignments in the 900, 1800 and 2100 MHz bands (SCCOM)

SPTC also has CDMA 850 assignments (870.495--875.415MHz paired with 825.495--830.415 MHz), but these are currently not used.

4.3 Current assignments to broadcasters in the UHF band

The transition to digital terrestrial television is complete and currently there are no broadcast assignments above 694 MHz, although broadcast studio transmitter links are still deployed in the band between 850-860MHz. It is imperative that these links are migrated to appropriate fixed service allocations.

Digital terrestrial Television is provided via a single Multiplexer of 8MHz centred on 570 MHz and up to 4 Multiplexers are envisaged for Swaziland.

5 IMT Band Plan Development

This section will address the identification of the general and special usage of the frequency bands 700, 800, 900, 1800, 2100 and 2600MHz in Swaziland and with consideration to the IMT-bands 450, 1500, 2300 and 3300-3800MHz.

IMT systems in general support low to high mobility applications and a wide range of data rates in accordance with user and service demands in multiple user environments. IMT also has capabilities for high quality multimedia applications within a wide range of services and platforms, providing a significant improvement in performance and quality of service.

The features of IMT enable it to address evolving user needs as the capabilities of IMT systems are being continuously enhanced in line with user trends and technology developments. IMT will operate in the bands identified in Article 5 of the ITU Radio Regulations (RR).

5.1 Bands identified for IMT

This section deals with the bands identified for IMT as of WRC 15. The table below reflects the ITU designated frequency ranges and relevant WRC resolutions.

Band (MHz)	**Frequency band**	**WRC Resolution/s**
450	450-470 MHz	224 (Rev. WRC-12)
700	694-790 MHz	232 (WRC-12) and 224 (WRC-12)
800	790 – 862 MHz	224 (Rev. WRC-12) and 749 (Rev. WRC-12)
850	824-849 MHz // 869-894 MHz	224 (Rev. WRC-12) and 749 (Rev. WRC-12)
900	880-915 MHz // 925-960 MHz	224 (Rev. WRC-12) and 749 (Rev. WRC-12)
1500	1427-1518 MHz	223 (Rev.WRC-15)
1800	1710-1785 MHz // 1805-1880 MHz	223 (Rev. WRC-12)
2100 (FDD)	1920-1980 MHz // 2110-2170 MHz 1980-2010 MHz // 2170-2200 MHz	212 (Rev. WRC-07) and 223 (Rev. WRC-12)
2100 (TDD)	1900-1920 MHz, 2010-2025 MHz	212 (Rev. WRC-07) and 223 (Rev. WRC-12)
2300	2300-2400 MHz	223 (Rev. WRC-12) (Note 6)

2600	2500-2690 MHz	223 (Rev. WRC-12) (Note 7)
3350	3300 - 3400 MHz	223 (REV.WRC-15)[3]
3500	3400-3600 MHz	154 (REV.WRC-15)
3700	*3600-3800 MHz*	*widely harmonized for IMT but not globally aligned[4]*
4900	4800 – 4990 MHz	223 (REV.WRC-15): Identified for IMT in some countries only[5]

Table 10: ITU definition of IMT bands

Table 10 lists all currently proposed IMT frequency bands identified by the ITU, relevant ITU Radio Regulation footnotes

5.1.1 Bands with potential for next 5G IMT - <u>not</u> yet designated for IMT

There are significant spectrum blocks that have not been identified for IMT as of yet, but may be identified at future WRCs. In particular, WRC-19 will seek to make mobile allocations and subsequent IMT identifications in the frequency range 24.25 – 86 GHz.

The wide bandwidth provided in the aforementioned frequency ranges is considered critical for the implementation of future 5G systems. Note that the deployment of 5G on a national basis will require an appropriate mix of both high frequency and low frequency spectrum.

The table below lists the specific frequency bands that may be identified for IMT at WRC-19:

Frequency band	**Next decision**	**WRC Resolution/s**
21.4-22 GHz		Partial allocations to mobile services on primary basis Potential for High Altitude platforms => not for IMT
24.25-27.5 GHz	WRC19	Partial allocations to mobile services on primary basis Potential for High Altitude platforms => not for IMT
27.5-29.5GHz		Global deployment of Earth Stations in Motion => not for IMT
31.8-33.4 GHz	WRC19	additional allocations to the mobile service on a primary basis required
37-40.5 GHz	WRC19	Partial allocations to mobile services on primary basis

[3] A number of administrations use the frequency band 3 300-3 400 MHz, which is allocated to the fixed and mobile services on a primary basis in No. 5.429; further study operational measures to enable the coexistence of IMT and radiolocation service in the frequency band 3300-3400 MHz.

[4] 3600-3800 is not adopted in Africa to avoid interference to the C Band satellites that are widely used for broadcast feeds and backhauling

[5] The frequency band 4 800-4 990 MHz is allocated worldwide to the mobile service on a primary basis; and is identified for use by administrations wishing to implement terrestrial IMT systems in No. 5.441A for Region 2 and 5.441B for Region 3;

40.5-42.5 GHz	WRC19	additional allocations to the mobile service on a primary basis required
42.5-45.5 GHz	WRC19	Partial allocations to mobile services on primary basis
45.5-47 GHz	WRC19	Partial allocations to mobile services on primary basis
47-47.2 GHz	WRC19	additional allocations to the mobile service on a primary basis required
47.2-50.2 GHz	WRC-23	Partial allocations to mobile services on primary basis
52.4-52.6 GHz,	WRC19	Partial allocations to mobile services on primary basis
66-76 GHz	WRC19	Partial allocations to mobile services on primary basis
81-86 GHz	WRC19	Partial allocations to mobile services on primary basis

Table 11: Potential future IMT bands

5.2 Overview of IMT bands applicable for Swaziland

The following bands have been identified by the ITU for use by IMT-compatible standards in the Radio Regulations (RR) "Edition of 2016".[6]

For convenience in this document, the designation IMT is used to identify a IMT band and the actual frequency range for ease of reading. For instance, IMT450 refers to the frequency band 450 MHz to 470 MHz. Where necessary, the commonly used band number and 'name' is also used for clarity.

IMT bands		Paired configuration (FDD)	Unpaired configuration (TDD)
Designation	**IMT Range**		
IMT450	450-470 MHz	2×5 MHz	15 MHz
IMT700	694-790 (or 806) MHz	2×45 MHz or 2×30 MHz + 2×3 MHz	
IMT750	734-758 MHz		(10-)25 MHz Or 15MHz for SDL
IMT800	790-862 MHz	2×30 MHz (reverse uplink-downlink)	
IMT850	e.g. 824-829// 869-874 MHz	2×5 MHz	
IMT900	880-960 MHz	2×35 MHz	

[6] www.itu.int/pub/R-REG-RR.

Proposed IMT roadmap for consultation

GSM900-R	876-880// 921-925 MHz	2×4 MHz GSM-R	
IMT1500	1427-1518 MHz	The channelling arrangements in this band are currently under study in ITU-R Working Party 5D	
IMT1800	1710-1880 MHz	2×75 MHz	
IMT2100	1900-2200 MHz	2×60 MHz & 2x30MHz	20 & 15MHz
IMT2300	2300-2400 MHz		100 MHz
IMT2600	2500-2690 MHz	2×70 MHz	(40-)50 MHz
IMT3350	3300 – 3400 MHz	The channelling arrangements in this band are currently under study in ITU-R Working Party 5D	
IMT3500	3400-3600 MHz		200MHz

Table 12: IMT bands

These bands will be discussed more in detail in the following sections.

5.3 450 – 470 MHz

5.3.1 Current Utilisation

In Swaziland, the lowest identified IMT frequency band, 450-470MHz, is widely used for the provision of Public Mobile Radio (PMR) services. Moreover, PMR assignments are contained in the frequency range 335.4-450, but these assignments are generally sparse.

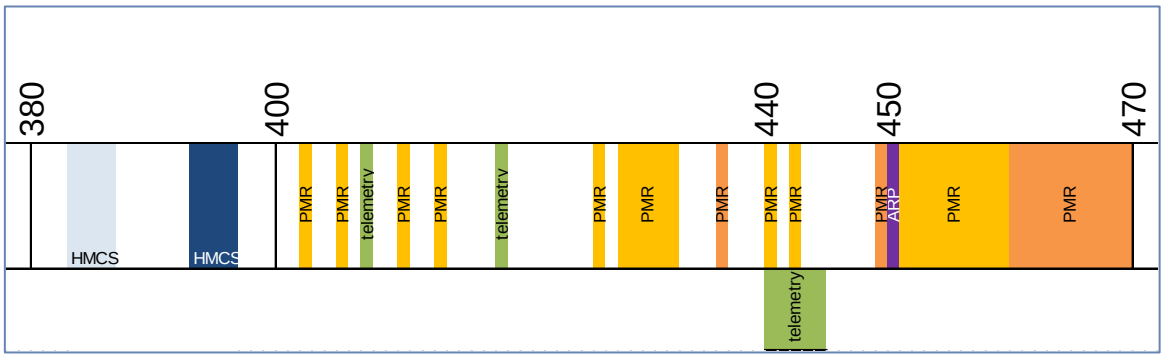


Figure 6: Current spectrum usage in IMT450: PMR assignments

In the event that the 450-470 MHz frequency band is used for IMT (IMT450), the current PMR services will need to be migrated to alternative mobile allocations below 450 MHz Depending on future IMT spectrum demands in the sub 1 GHz range, a potential extension from 380 MHz upwards in order to form a contiguous IMT frequency band of 380 – 470 MHz may be considered. However, the favourable implementation of this proposal will require prior endorsement by a competent WRC.

South Africa has identified the 450-470 MHz band for IMT and subsequently adopted a 2x5 MHz FDD channelling arrangement. In Swaziland, the implementation of IMT450 could be postponed pending the migration of PMR systems from 450 - 470 MHz. Moreover, there is merit in delaying the implementation of IMT450 pending a harmonised SADC directive regarding the possible future use of this frequency band.

5.3.2 ITU-R Recommendations

The ITU Recommendation, ITU-R M.1036-5 (10/2015), sets out the following frequency arrangements for the 450-470 MHz band (IMT450) (see Table 13).

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)	
D1	450.000-454.800	5.2	460.000-464.800	10	None
D2	451.325-455.725	5.6	461.325-465.725	10	None
D3	452.000-456.475	5.525	462.000-466.475	10	None
D4	452.500-457.475	5.025	462.500-467.475	10	None
D5	453.000-457.500	5.5	463.000-467.500	10	None

D6	455.250-459.975	5.275	465.250-469.975	10	None
D7	450.000-457.500	5.0	462.500-470.000	12.5	None
D8					450-470 TDD
D9	450.000-455.000	10.0	465.000-470.000	15	457.500-462.500 TDD
D10	451.000-458.000	3.0	461.000-468.000	10	None

Table 13: Frequency arrangements in the band 450-470MHz

The following two ITU notes complement the table above:

Note 1**:** The number of frequency arrangements given in Table 13 reflects the fact that administrations have had to accommodate incumbent operations, while, for example, maintaining a common uplink/downlink structure (uplink in the lower 10 MHz, downlink in the upper 10 MHz) for FDD arrangements; and

Note 2: Arrangements D7, D8 and D9 can be implemented by administrations that have the whole 450-470 MHz band available for IMT. Arrangement D8 can also be implemented by administrations having only a subset of the band available for IMT.

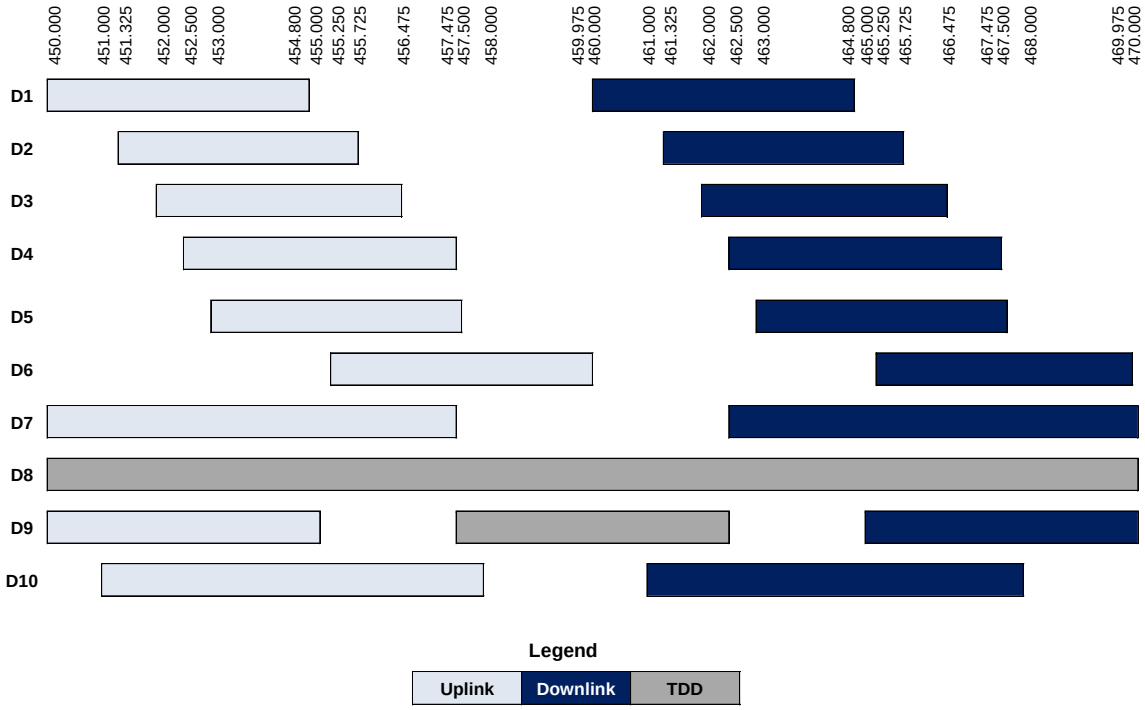


Figure 7: ITU-R recommendations for IMT450

5.3.3 SADC Frequency Allocation Plan for IMT450

The SADC FAP proposes the common utilisation of the 450-470 MHz band for IMT, Point to Point (PTP), PMR and/or PAMR.

Unique challenges exist for the in-band and adjacent-band co-existence between IMT450 and other services (e.g. broadcasting, trunked systems, radiolocation etc.). The ITU has

undertaken a feasibility study to assess these challenges, in the report titled "*ITU-R M.2110: Sharing studies between radiocommunication services and IMT systems operating in the 450-470 MHz.*"

A relevant extract from the SADC FAP is provided in the table below:

ITU Region 1 allocations and footnotes	SADC common allocation/s and relevant ITU footnotes	SADC proposed common sub-allocations / utilization	Additional information
450-455 MHz FIXED MOBILE 5.286AA 5.209 5.271 5.286 5.286A 5.286B 5.286C 5.286D 5.286E	**450-455 MHz** FIXED MOBILE 5.286AA 5.286 5.286A	Fixed links (PTP) IMT (450-470 MHz) , PMR and/or PAMR	This band is currently used for a variety of fixed and mobile systems in the various SADC. This band is also identified for IMT (Res. 224 applies)
455-456 MHz FIXED MOBILE 5.286AA 5.209 5.271 5.286A 5.286B 5.286C 5.286E	**455-456 MHz** FIXED MOBILE 5.286AA 5.209 5.286A		
456-459 MHz FIXED MOBILE 5.286AA 5.271 5.287 5.288	**456-459 MHz** FIXED MOBILE 5.286AA, 5.287		
459-460 MHz FIXED MOBILE 5.286AA, 5.209 5.271 5.286A, 5.286B 5.286C 5.286E	**459-460 MHz** FIXED MOBILE 5.286AA 5.209 5.286A		
460-470 MHz FIXED MOBILE 5.286AA Meteorological satellite (space to Earth) 5.287 5.288 5.289 5.290	**460-470 MHz** FIXED MOBILE 5.286AA Meteorological satellite (space to Earth) 5.287 5.289		

Table 14: 450-470MHz SADC Frequency Allocation Plan

5.3.4 Swaziland National Frequency Allocation Plan (NFAP) 2017

A relevant extract from the NFAP 2017 is provided in the table below:

ITU Region 1 allocations and footnotes	Swaziland allocation/s and relevant ITU footnotes	Utilization	Additional Information

450-455 MHz FIXED MOBILE 5.286AA 5.209 5.271 5.286 5.286A 5.286B 5.286C 5.286D 5.286E	450-455 MHz FIXED MOBILE 5.286AA 5.286 5.286A	PMR and/or PAMR PPDR PMR446 (446-446.1 MHz) FIXED (telemetry, dual frequency alarm systems)	The use of this band for PPDR to be studied. PMR446-ERC/DEC/(98)25
455-456 MHz FIXED MOBILE 5.286AA 5.209 5.271 5.286A 5.286B 5.286C 5.286E	455-456 MHz FIXED MOBILE 5.286AA 5.209 5.286A	Fixed links (PTP) IMT (450-470 MHz) PMR and/or PAMR	This band is currently used for a variety of fixed and mobile systems in the various SADC countries. This band is also identified for IMT (Res.224 applies).
456-459 MHz FIXED MOBILE 5.286AA 5.271 MOD5.287 5.288	456-459 MHz FIXED MOBILE 5.286AA MOD 5.287, 5.288		
459-460 MHz FIXED MOBILE 5.286AA 5.209 5.271 5.286A 5.286B 5.286C 5.286	459-460 MHz FIXED MOBILE 5.286AA 5.209 5.286A		
460-470 MHz FIXED MOBILE 5.286AA Meteorological-satellite (space-to-Earth) MOD 5.287 5.288 5.289 5.290	460-470 MHz FIXED MOBILE 5.286AA Meteorological-satellite (space-to-Earth) MOD 5.287 5.289		

Table 15: NFAP 450-470MHz

5.3.5 Options for Swaziland

In accordance with Article 5 of the Radio Regulations, the band 450-470 MHz has a primary mobile allocation and has been identified for IMT. Although this band has considerable advantages in terms of propagation, the ecosystem is nascent (i.e. relatively little equipment and terminals available). Moreover, there is no foreseeable demand for spectrum in the 450 – 470 MHz frequency range in the short term, as operators have the option of using either IMT700 or IMT800.

The bandwidth provided in 450-470 MHz is sufficient for services requiring low data rates and capacity. In terms of basic internet connectivity, the use of 450-470 MHz presents two distinct opportunities, namely rural broadband and deep-indoor data coverage. With either opportunity, IMT450 provides a cost efficient alternative compared to higher frequency bands:

Rural broadband in the 450-470 MHz is especially attractive for the following reasons: First, coverage using 450-470 MHz is a more cost-effective option when compared with using 700 MHz or higher frequencies. Therefore, the 450-470 MHz band provides a higher incentive for operators to offer services in rural areas where purchasing power is lower than in urban areas; Furthermore, the 20 MHz of bandwidth available in the 450-470 MHz is suitable for low-capacity demand profiles. Indeed, the low population density in rural areas results in low-capacity demand; services used in rural areas are not expected to be as data-intensive as those used in urban areas.

For deep-indoor coverage, the 450-470 MHz band is better suited to this use case when compared with higher frequency bands, which are costly to deploy. The 450-470 MHz therefore presents an attractive alternative to ensure that basic data coverage is available in deep, indoor environments.

The bandwidth offered by 2×5 MHz paired spectrum or 1×20 MHz[7] unpaired spectrum in IMT450 is limited compared with the IMT700 or IMT800, which offer 2×30 MHz or 2×45 MHz and 2×30 MHz, respectively. Therefore, basic services are in focus with reduced capacity and data rate requirements, but improved latency of LTE. Operational benefits are also expected due to harmonized and optimised core hierarchies.

The user penetration of IMT450 deployments could be significantly increased by Wi-Fi-offloading of mobile data traffic. In this regard, existing WiFi networks offering hotspot broadband internet connectivity could be leveraged. Potential Wi-Fi-offload-oriented areas should be implemented with a balanced or downlink- favoured TDD-scheme which would affect the coverage improvements.

In future, it is envisaged that both IMT450 and IMT700 will be employed in connected car solutions as backhaul technology to other Wi-Fi-capable devices. The potentially larger antenna sizes due to lower frequency operation will be easily accommodated within vehicle or home environments.

A full TDD configuration in the 450 – 470 MHz is attractive for 'uplink-heavy' services, with low data rates and the asymmetrical (or upload-dominated) nature of communications. Future uplink-oriented/focused services, like M2M, VoIP over IMS, and uplink use of broadcasting services may be implemented in 450 – 470 MHz. However, M2M and IoT or smart metering/grid services might require different network parameters optimized for uplink or for small data rate requirements. Any congestion due to millions of small-sized messages needs to be prevented. Therefore, an optimized network for M2M applications seems more cost-efficient.

The following options exist for the future use of the 450 MHz frequency band:

1. **Option 1**: Retain the band for use by PMR type systems – the current licensees are allowed to continue operations in the band and IMT is not implemented.
2. **Option 2**: Introduction of IMT systems into the band within a timeframe of the 5- 10 year timeframe – this will require the migration of existing users to alternative frequency locations.

[7] Maximum bandwidth to be considered is dependent on the potential interferences towards broadcast channel 21 from 470-478MHz; 1×15MHz seem realistic coupled with a 5MHz guard band seems realistic.

5.3.6 Initial Recommendations for Swaziland

Currently, 450-470MHz is widely used for PMR in Swaziland and requires careful consideration with regard to potential migration options. It is proposed that the Commission undertake a review of the costs and risks of maintaining legacy systems versus introducing new IMT systems. The Commission may use the consultation process on the IMT Roadmap in order to solicit views from relevant stakeholders.

In the event that the Commission decides to avail the frequency band for IMT, it is recommended that these systems are introduced within a timeframe of ~10 years, since it is envisaged that most PMR equipment would have reached end-of-life by that time. Moreover, it is recommended that existing PMR users are afforded sufficient time to migrate to alternative favourable frequency locations, where a period of ~5 years is deemed sufficient. With regard to the channelling arrangement, it is recommended the adoption of a TDD configuration D8 as per section 6.3.2. The unpaired TDD option offers more flexibility in light of the potential future IMT identification in digital dividend III bands and the ability to support either downlink or uplink centric traffic. Moreover, TDD in IMT450 could also be bundled with other TDD bands in higher frequencies to increase the flexibility of TDD applications and to build the TDD 'ecosystem' in Swaziland, which is currently well behind the FDD ecosystem.

5.4 694-960MHz (including the 700, 800, 850 and 900 bands)

5.4.1 Current Utilisation

In this section, all the IMT bands from 694-960MHz will be considered in order to give a holistic view and to propose the optimum utilization of spectrum for Swaziland.

The current usage of the aforementioned frequency bands in Swaziland is depicted in the following figure

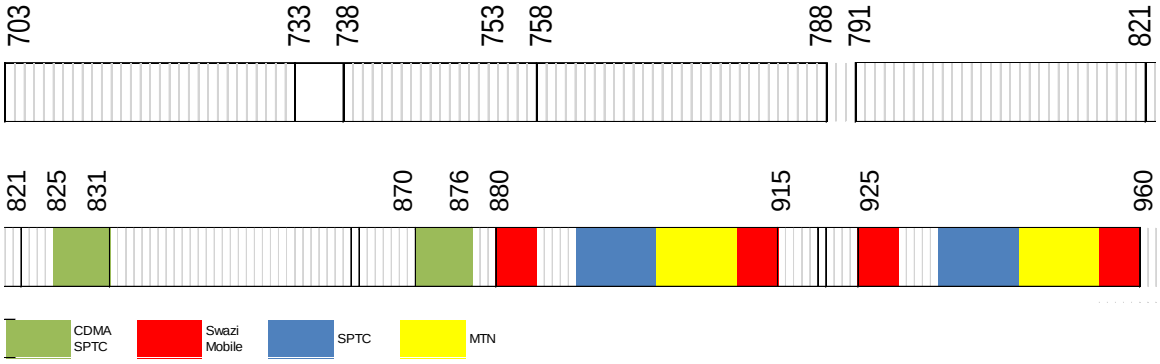


Figure 8: Current assignments in the 694-960MHz band Swaziland

The 700 MHz and 800 MHz bands are identified for IMT in the NFAP but the associated channelling arrangements have not been formally adopted. The 700MHz band is vacant and available for immediate assignment. However, the 800 MHz band contains broadcast studio links between approximately 846-860 MHz that need to be migrated out prior to assignment for IMT purposes. Moreover, SPTC is assigned spectrum for CDMA850 in 825-831//870-876MHz. In the event that SPTC deploys a network in this band, the CDMA uplink in 825-831 MHz may be subjected to harmful interference from the IMT800 downlink in 832-862 MHz.

Regarding IMT900 (i.e. GSM 900 band 8), the frequency range 885-890//930-935MHz is currently not assigned. In addition, SPTC is currently not utilising their assignment within IMT900.

With specific regard to the 876-880//921-925 MHz (GSM-R band), this is allocated for IMT in the NFAP but is not assigned as such. The SPTC CDMA assignments (825-831//870-876MHz) would cause harmful interference towards the GSM-R band if they were used.

5.4.2 ITU-R Recommendations

The ITU Recommendation, ITU-R M.1036-5 sets out the following channelling arrangements for the various IMT frequency bands within the frequency range 694 – 960 MHz:

Paired Frequency arrangements in the band 694-960 MHz

Frequency arrangements	Paired arrangements				Un-paired arrangements (e.g. for TDD) (MHz)
	Mobile station transmitter (MHz)	Centre gap (MHz)	Base station transmitter (MHz)	Duplex separation (MHz)	
A1	824-849	20	869-894	45	None
A2	880-915	10	925-960	45	None
A3	832-862	11	791-821	41	None
A4	698-716 776-793	12 13	728-746 746-763	30 30	716-728
A5	703-748	10	758-803	55	None
A6	None	None	None		698-806
A7	703-733	25	758-788	55	None
A8	698-703	50	753-758	55	None
A9	733-736	52	788-791	55	None
A10	External	–	738-758	–	None
A11 (harmonized with A7 and A10)	703-733 External	25 –	758-788 738-758	55 –	None

Table 9: ITU proposed frequency arrangements in 694-960

The interaction of the different relevant channelling options is demonstrated below:

FIGURES 3A1 and 3A2
(See notes to Table 3)

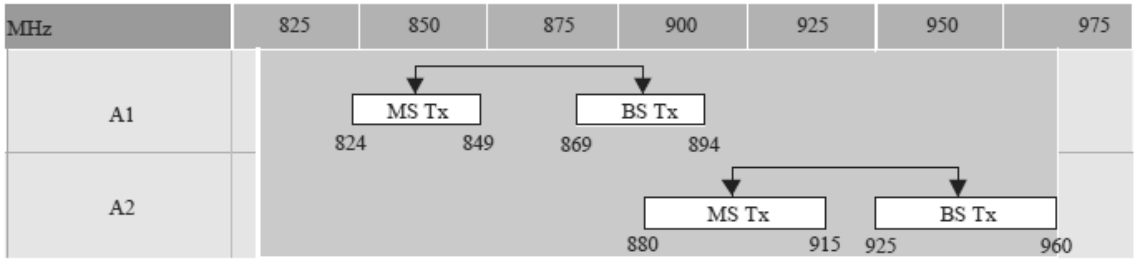


Figure 10: Option A1 (IMT850) in relation to option A2 (IMT900)

FIGURE 3A3

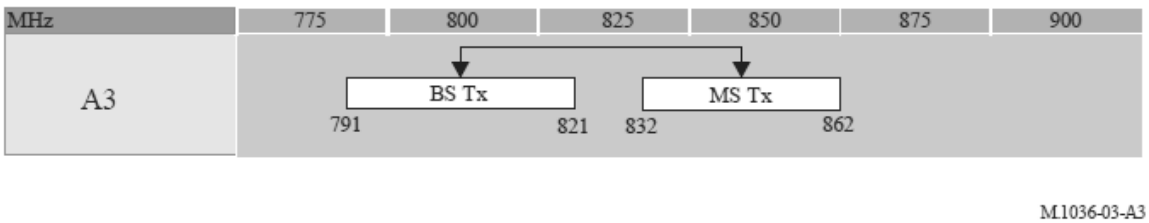
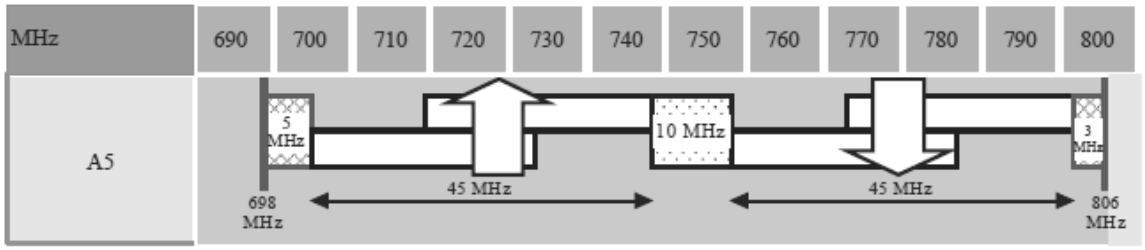


Figure 11: A3 (IMT800) as adopted for region1: 2x30MHz, overlaps with A1 (IMT850)

Proposed IMT roadmap for consultation

FIGURE 3A5



M.1036-03-A5

Figure 12: IMT700 option for region3 (A5 - APT band) of 2x45MHz

FIGURE 3A7

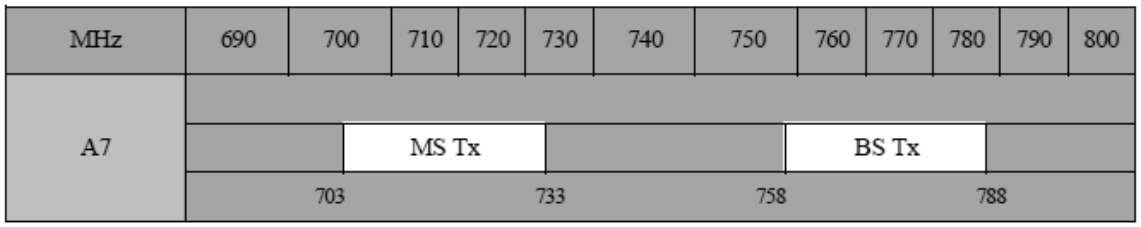


Figure 13: Option A7 (IMT700) as adopted in Region1: 2x30MHz

FIGURE 3A8

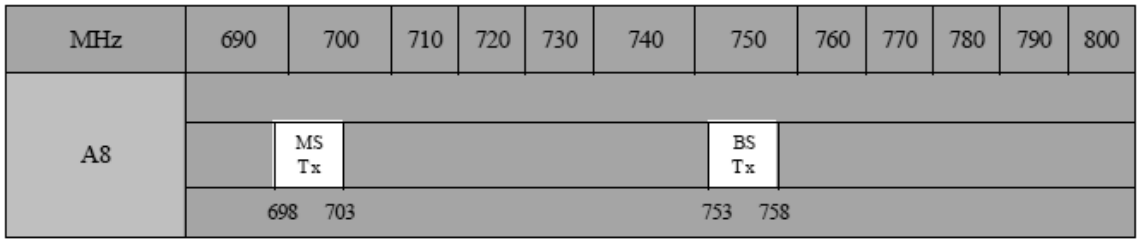


Figure 14: A8 - PPDR-option 1 for Region1

FIGURE 3A9

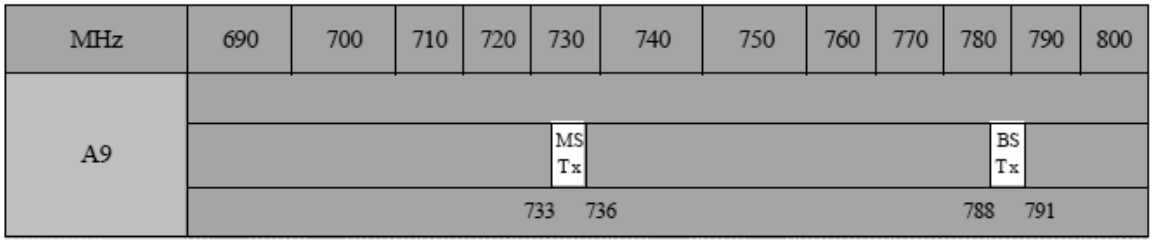


Figure 15: A9 - PPDR-option 2 for Region1

Proposed IMT roadmap for consultation

FIGURE 3A10

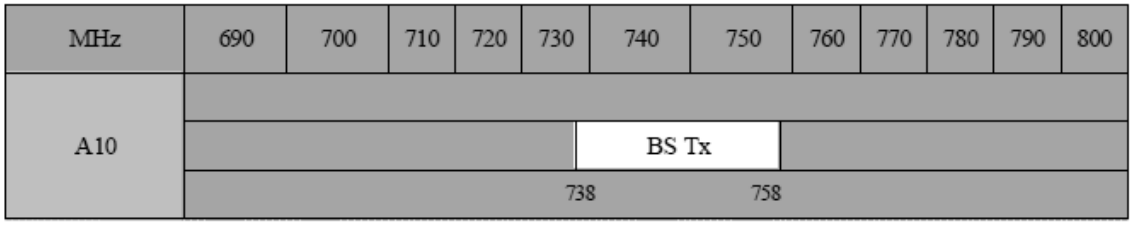


Figure 16: Option A10 IMT700 SDL suitable for Region1

FIGURE 3A11

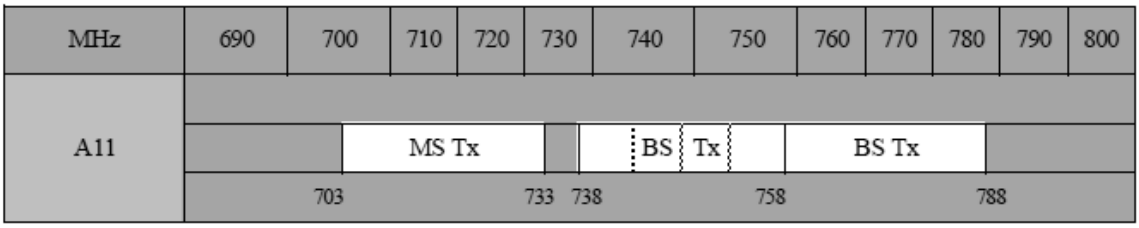


Figure 17: Option A11 for IMT700 band for Region 1 with 2x30MHz plus 20MHz SDL

Subsequent to WRC – 15, A7 has been widely adopted in Region 1 as the channelling plan for in the 700MHz band as it can be used together with A3 (a.k.a. EU 800 band 20).

A3 (3GPP band 20 a.k.a. EU 800) has been widely adopted in Region 1, including Western Europe and South Africa as the channelling plan for IMT in the 700 MHz band.

A2 (3GPP band 8 a.k.a. E-GSM) has been widely adopted in Region 1 as the channelling plan for IMT in the 900 MHz band.

5.4.3 **SADC Frequency Allocation Plan**

In the SADC frequency plan, the following is proposed.

ITU Region 1 allocations and footnotes	SADC common allocation/s and relevant ITU footnotes	SADC proposed common sub-allocations/utilization	Additional information
694-790 MHz MOBILE except aeronautical mobile MOD 5.312A 5.317A BROADCASTING MOD 5.300 5.311A 5.312	**694-790 MHz** MOBILE except aeronautical mobile MOD 5.312A 5.317A BROADCASTING MOD 5.300 5.311A MOD 5.312	IMT	
790-862 MHz FIXED MOBILE except aeronautical mobile 5.316B 5.317A BROADCASTING	**790-862 MHz** FIXED MOBILE except aeronautical mobile 5.316B 5.317A BROADCASTING 5.319 SADC13	IMT	Band IV/V analogue television to migrate to digital television according to SADC time lines. WRC-07, WRC-12and WRC-15 allocated this band to Mobile service except aeronautical mobile and identified it for IMT. This band should be

Proposed IMT band plan and Roadmap

			made available for IMT as soon as possible after the migration of analogue television to digital. Fixed links operating in this band will have to be migrated in order to accommodate IMT.
862-890 MHz FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 5.319 5.323	**862-890 MHz** MOBILE except aeronautical mobile 5.317A 5.322 SADC14	862-876 MHz, IMT	This band is paired with 824-849 MHz
		876-880 MHz, IMT PMR and/or PAMR	This band is paired with 921-925 MHz.
		880-915 MHz, IMT	Paired with 925-960 MHz.
890-942 MHz FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 Radiolocation 5.323	**890-942 MHz** MOBILE except aeronautical mobile5.317A	915-921 MHz PMR and/or PMR	
		921-925 MHz IMT PMR and/or PAMR	Paired with 876-880 MHz.
942-960 MHz FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 5.323	**942-960 MHz** MOBILE except aeronautical mobile 5.317A 5.322	925-960 MHz IMT	Paired with 880-915 MHz

The utilization proposals are also included in the Swaziland NAFP.

5.4.4 Swaziland National Frequency Allocation Plan (NFAP) 2017

The relevant extract from NFAP 2017, which is aligned with the SADC plan, is shown below

ITU Region 1 allocations and footnotes	Swaziland allocation/s and relevant ITU footnotes	Utilization	Additional information
694-790 MHz MOBILE except aeronautical mobile MOD 5.312A 5.317A BROADCASTING MOD 5.300 5.311A 5.312	**694-790 MHz** MOBILE except aeronautical mobile MOD 5.312A 5.317A BROADCASTING MOD 5.300 5.311A MOD 5.312	IMT	
790-862 MHz FIXED MOBILE except aeronautical mobile 5.316B 5.317A BROADCASTING 5.312 5.319	**790-862 MHz** FIXED MOBILE except aeronautical mobile 5.316B 5.317A BROADCASTING 5.319 SADC13	IMT	Band IV/V analogue television to migrate to digital television according to SADC time lines. WRC-07, WRC-12 and WRC-15 allocated this band to Mobile service except aeronautical mobile and identified it for IMT. This band should be made available for IMT as soon as possible after the migration of analogue television to digital. **Fixed links operating in this and will have to be**

Proposed IMT roadmap for consultation

			migrated in order to accommodate IMT.
862-890 MHz FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 5.319 5.323	**862-890 MHz** MOBILE except aeronautical mobile 5.317A 5.322	862-876 MHz IMT	This band is paired with 824-849 MHz
		876-880 MHz IMT PMR and/or PAMR	This band is paired with 921-925 MHz Paired with 921-925 MHz
		880-915 MHz IMT	Paired with 925-960 MHz
890-942 MHz FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 Radiolocation 5.323	**890-942 MHz** MOBILE except Aeronautical mobile 5.317A	915-921 MHz PMR and/or PMR	
		921-925 MHz IMT PMR and/or PAMR	Paired with 876-880 MHz
		925-960 MHz IMT	Paired with 880-915 MHz
942-960 MHz FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 5.323	**942-960 MHz** MOBILE except aeronautical mobile 5.317A 5.322	**942-960 MHz** MOBILE except aeronautical mobile 5.317A 5.322	

The utilization in the frequency range 862-890 MHz which is adopted from the SADC FAP is erroneous as the paired frequencies are of inconsistent sizes. This should be amended in line with Band 5 (IMT 850) specifications unless the decision is taken not to make an identification for IMT in the 850 band

5.4.5 **Options for Swaziland – 700 MHz, 750MHz and 800 MHz**

Spectrum bands below 1 GHz are best suited for both indoor and outdoor mobile coverage since lower frequencies have better propagation characteristics. The 'digital dividend' spectrum released in the 694–862 MHz range as a result of the digitisation of broadcasting is being adopted for mobile broadband globally. ITU Rec M.1036-5 proposes various options for structuring the 'digital dividend' for IMT services.

The principal debate has been how to structure the "digital dividend II" 700 MHz band in Region 1, with the alternatives being option A5 (the APT-700 MHz band adopted for ITU Region 3[8]) and option A7 (the partial implementation of A5 that is favoured in Europe by virtue of their decision to adopt option A3 for IMT800).

In 2014 prior to WRC-15, the following main options were proposed in the IMT-roadmap of South Africa:

[8] Although the USA (and Canada) adopted the North American channeling scheme for the 700 band, some countries within South America (including Mexico and Brazil) have already adopted the APT-700 band rather than the US-channeling scheme.

Proposed IMT roadmap for consultation

Alternative 1 based on A5 used in ITU Region 3 APT. This channelling option provides 2×45 MHz in the 700 MHz band (A5, Figure 12) and has the advantage of a potentially large ecosystem (network equipment and terminals) being driven by mobile markets in Asia-Pacific ITU Region 3 and large parts of Latin and South America. Assuming channelling arrangements A5 and A3 are adopted for IMT 700 and IMT 800, respectively, then only 2x18 MHz of bandwidth will be available in IMT800. This yields a total of 2×63 MHz of available spectrum across IMT700 and IMT800 bands[9].

Alternative 2 based on A7 used in European Countries within ITU Region 1. The majority of European countries have adopted A3 for IMT800. Due to the overlap between IMT 800 in A3 and IMT700 in A5, European countries have adopted channelling option A7 for IMT700. As a result, 2x63 MHz of bandwidth is made available, comprising 2x30 MHz and 2x33 MHz from IMT800 and IMT700, respectively.

With regard to IMT700, the first 30 MHz of bandwidth in both the uplink and the downlink forms part of the first duplexer of A5, so the user terminals of the Asia-Pacific ecosystem would also be usable in ITU Region 1 and vice versa. This 2x30 MHz will function as a global international roaming band which will boost the ecosystem significantly. Although there is an additional 2×3 MHz, this could only be used by terminals with a second duplexer, so it is appropriate to assume that only 2x30 MHz is effectively available in IMT700.

Therefore, Alternative 2 yields the same effective bandwidth as compared to Alternative 1. In addition, for both alternatives, 2×5 MHz of the IMT 850 band 5 can be deployed, subject to the outcome of adjacent band compatibility studies.

Alternative 2 offers the opportunity for between 15 and 25 MHz of TDD unpaired spectrum in the centre gap between the FDD blocks, whereas Alternative 1 does not permit the implementation of TDD in the centre gap. Alternative 2 is therefore more spectrum-efficient relative to Alternative 1, if the TDD band was implemented as well.

In 2014, South Africa adopted Alternative 2 (Figure 18):

Alternative 2 is best suited for countries with 3-4 licensed operators and also presents the opportunity for new entrants.

Potential assignment solutions:

2×30 MHz in IMT700 assigned as 2×2×15 MHz or 3×2×10 MHz;

2×30 MHz in IMT800 assigned as 2×2×15 MHz or 3×2×10 MHz;

2×3 MHz in IMT850 and 2×4 MHz GSM-R or 2×5MHz IMT850 and 2×2.4MHz GSM-R;

2×5 MHz in IMT900.

[9] However, the complexity of the APT 700 band capable terminals and equipment is high because they need two overlapping duplexers of 30 MHz bandwidth.

For an operator, it is better to deploy/utilize either the 700 MHz or the 800 MHz band or otherwise the investment in radio equipment would be significantly higher if both bands are used.

In Alternative 2, the 25 MHz centre gap in the IMT 700 band can also be used for a separate TDD assignment. With the required 2×5 MHz guard bands between TDD and FDD spectrum, 15MHz TDD would be available (738-753 MHz). In principle, the guard bands could also be used for an additional 5+5MHz TDD for indoor coverage only by the TDD assignee. Therefore, with this Option, 15-25 MHz TDD capacity would be possible for a TDD operator. It should be noted that the equipment is available for the TDD band as China has selected the unpaired TDD configuration in the whole 700 band.

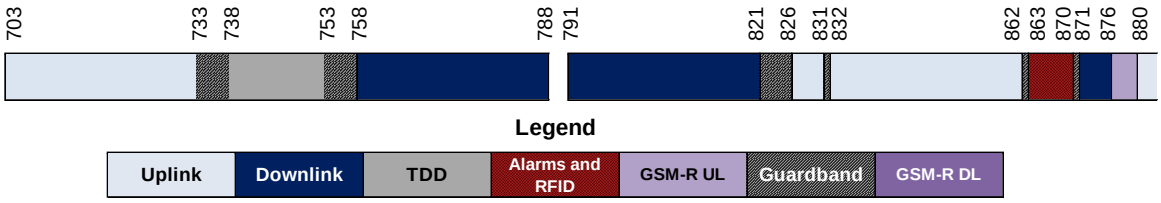


Figure 18: IMT recommendations of ICASA, South Africa (in 2014 before WRC-15)

Alternative 3: Following WRC-15, the option has emerged of deploying a **supplementary downlink of 20MHz (738-758MHz) in the centre gap (rather than the TDD-option)**. The SDL option is recommended for Swaziland, but needs alignment and amendment in South Africa and SADC in order to ensure harmonisation within the sub-region.

Based on experiences in South Africa, the interference between GSM-R and assignments in the IMT850 band is particularly problematic. Therefore, a possible option is to extend the GSM-R band width from 2x4MHz to 2x5MHz to be used for Future Railway Mobile Communication Systems (FRMCS) (Figure 19) and migrate CDMA systems from the 850 MHz band accordingly. It needs to be analysed, if an additional 2x2.4MHz spectrum could be made available for GSM-based voice and CS-based operational services in addition to enhanced mobile broadband services on the railways[10]. Potential RFID and alarm assignments within 863-860 MHz need to be considered in general, but these are not assigned in Swaziland at the moment.

The following is proposed for the future assignment of the IMT700:

1. **Option 1**: Assign IMT700 and IMT750 within a 5-10 year timeframe – noting that the availability of IMT750 will be determined by the IMT700 channelling arrangement that is adopted

[10] In Germany, this allocation has been extended by 3 MHz (873-876 MHz) to cater for the extensive and dense network of the railway company (Deutsche Bahn). It is important to note that the 873-876 MHz band was previously in use for trunking services.

Proposed IMT roadmap for consultation

The following channelling options exist for the IMT700:

1. **Option 1**: Adopt the IMT700 channelling arrangement A5 – this reduces the available IMT800 bandwidth from 2x30 MHz to 2x18 MHz and also removes the possibility of implementing IMT750
2. **Option 2**: Adopt the IMT700 channelling arrangement A7 – this avails the full bandwidth of 2x30 MHz in IMT800 and also presents the opportunity for the implementation of IMT750

The following is proposed for the future assignment of the IMT750:

1. **Option 1**: Assign IMT750 within a 5-10 year timeframe – noting that the availability of IMT750 will be determined by the IMT700 channelling arrangement that is adopted

The following channelling options exist for the IMT750:

1. **Option 1**: Adopt a TDD channelling configuration – noting that the relevant guard bands will be taken from IMT750

2. **Option 2:** Adopt an SDL configuration for IMT750, in accordance with A10

The following is proposed for the future assignment of the IMT800:

1. **Option 1**: Assign IMT800 within the next 5 years – noting that the bandwidth available for assignment will be dependent on the future treatment of the CDMA 850 assignment. The remaining 2x10 MHz in IMT800 could be assigned within the 5-10 year timeframe, given that CDMA systems have been migrated out by then.

The following channelling option exists for the IMT800:

1. **Option 1**: Adopt the IMT800 channelling arrangement A3 – noting that this mandates the adoption of A7 for IMT700.

5.4.6 Options for Swaziland – 850 MHz

The IMT850 band suffers from worldwide loss of interest due to overlapping with IMT800 and IMT900 (and GSM-R) assignments. In the event that the CDMA assignment of SPTC is terminated, the available portion of IMT850 (band 5) can be deployed in one of two ways:

1. Deployment as a SDL: 821-826MHz (5MHz) which extends band 20[11] (Figure 19) in alignment with GSM-R extension; this SDL-assignment would give one operator 5MHz more DL-capacity, which needs to be reflected/balanced in the overall SDL-spectrum assignments, e.g. in 700MHz; or

[11] In general, this should not cause any equipment issues, since most radio unit support both bands.

2. IMT850 FDD with 2x5MHz e.g. usage for PPDR services in the 827-832MHz // 872-877MHz (Figure 20)[12]; this would limit the amount of spectrum available for the deployment of GSM-R due to the need to establish the necessary guard bands

In light of the abovementioned, the following options exist for the future use of the 850 MHz band:

2. **Option 1**: Retain CDMA 850 assignment – the current licensee is allowed to continue/commence operations in the band and IMT is not implemented. This option also prevents the implementation of the GSM-R extension proposal and will also impede the assignment of all available bandwidth in IMT800.
3. **Option 2**: Migrate the CDMA850 licensee to an alternative frequency location and introduce IMT in the frequency range 827-832MHz // 872-877MHz – this would limit the amount of spectrum available for the deployment of GSM-R.
4. **Option 3**: Migrate the CDMA850 licensee to an alternative frequency location, introduce SDL 821-826 MHz and extend GSM-R uplink by 1 MHz so that it spans the frequency range 875 – 880 MHz

5.4.7 Options for Swaziland – 900 MHz

The following options exist for the future use of IMT900:

1. **Option 1:** Refarming IMT900 for 3G depending within the next 5 years, depending on terminal penetration
2. **Option 2**: Refarming IMT900 for LTE within the 5 to 10 year timeframe, depending on terminal penetration

The following channelling option is proposed for IMT900:

1. **Option 1**: Adopt the IMT900 channelling arrangement A2 – current assignments are in accordance with this channelling arrangement.

The following is proposed for the future assignment of the IMT900:

1. **Option 1**: Assign remaining spectrum bandwidth in IMT800 within the next 5 years

5.4.8 Options for Swaziland – PPDR Implementation

Options for the PPDR implementations:

As noted above, in the 850 MHz band, PPDR services could be deployed in the 827-832MHz // 872-877MHz band.

[12] 826-831//871-876MHz might also be an option to balance interferences to IMT900 from 880MHz.
825-830//870-875MHz is also an option, but might cause interference to RFID-systems below 870MHz.

In addition, ITU-R M.1036-5 proposes two options for potential PPDR implementation in the 700MHz band:

1. A8 (Figure 14): 698-703//753-758MHz: 2x5MHz[13].
2. A9 (Figure 15): 733-736//788-791: 2x3MHz.

Together with the 827-832//872-877MHz (2x5MHz), 2x13MHz could be used for PPDR services in 700-900MHz band, but only separately, since no aggregation is possible.

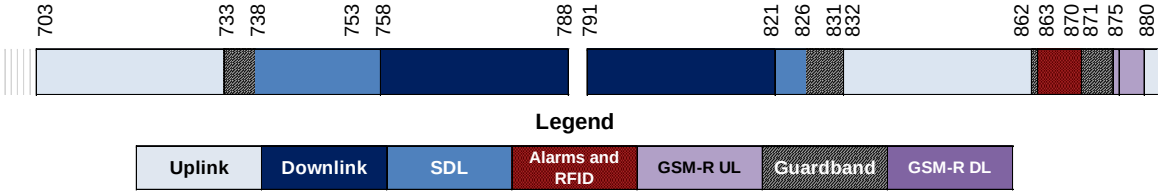


Figure 19: Alternative 1: SDL and GSM-R

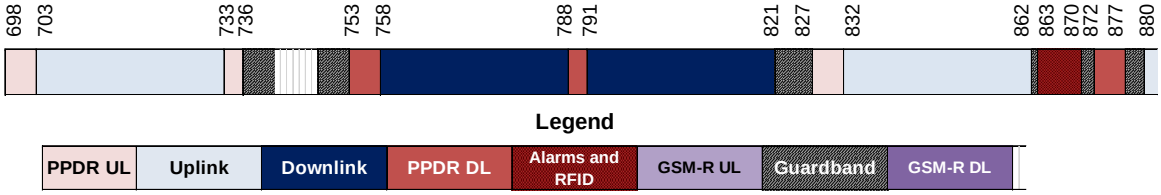


Figure 20: Alternative 2: PPDR networks in 700MHz and 800MHz bands

The PPDR bands in the 700 MHz band area have the disadvantage of a small ecosystem since 698-703MHz and 788-791MHz do not fall within the frame of the APT-700 band's potential for 2 duplexers of 30MHz and this situation is not expected to change in the short term. Only the IMT850-PPDR option would be of interest due to use of existing terminals. It is not expected to have one unified terminal for all 3 PPDR sub-bands in one unit, which would also not enable carrier aggregation (CA) of these sub-bands. CA to other IMT band would only be possible with the PPDR-Core network permission to assess these IMTs bands.

Consequently, focus should be placed on PPDR usage in the 850 MHz band and to share the network resources with critical infrastructure providers by one central mission critical network provider. Note that this proposal will negatively impact the spectrum available for GSM-R deployment.

The following options exist for the implementation of PPDR:

1. **Option 1**: 850 MHz PPDR deployment within 827-832MHz // 872-877MHz

2. **Option 2**: 700 MHz PPDR deployment within 698-703//753-758MHz: 2x5MHz[14], in accordance with A8
3. **Option 3**: 700 MHz PPDR deployment within 733-736//788-791: 2x3MHz, in accordance with A9

5.4.9 Initial Recommendations for Swaziland

1. IMT700 MHz – It is recommended that channelling configuration A7 is adopted to ensure compatibility with the preferred IMT800 channelling arrangement A3. IMT700 should be licensed within the 5-10 year timeframe as this will allow sufficient time for the ecosystem to mature.
2. IMT750 – It is recommended that the 20 MHz SDL option in accordance with channelling configuration A10 be adopted. This option makes efficient use of spectrum due to the fact that only one 5 MHz guardband is required. IMT750 should be licensed within the 5-10 year timeframe.
3. IMT800 - It is recommended that channelling configuration A3 is adopted as this is aligned with Commission's assignment plans. IMT800 should be assigned within the next 5 years due to the high demand for this band. The remaining 2x10 MHz in IMT800 could be assigned within the 5-10 year timeframe, given that CDMA systems have been migrated out by then.
4. 850 MHz – The following is recommended: migrate the CDMA 850 licensee migrate to an alternative frequency location, introduce SDL 821-826 MHz and extend GSM-R uplink by 1 MHz so that it spans the frequency range 875 – 880 MHz. The envisaged railway development in Swaziland justifies the preservation of spectrum for GSM-R applications.
5. IMT900 - It is recommended that channelling configuration A2 is adopted as this is aligned with Commission's current assignment of the band. The remaining bandwidth in IMT900 should be assigned within the next 5 years so that potential licensees can immediately benefit from its mature ecosystem. Moreover, it recommended that licensees refarm the band for LTE technology within the 5 to 10 year timeframe.
6. PPDR – The Commission is advised to undertake a study regarding national PPDR spectrum requirement prior to selecting a band for the deployment thereof. Nevertheless, PPDR deployment in 700 MHz is possible. Note that PPDR deployment in 450 MHz is not supported within the SADC spectrum planning framework and PPDR in 850 MHz will not be possible due to the envisaged deployment of GSM-R in this band.

[14] CEPT Report 53 confirmed that 698-703/753-758 MHz is a sub-band which could be made available for broadband PPDR at national level alongside MFCN SDL.

Proposed IMT roadmap for consultation

Note on GSM R

The use of GSM-R (or the Future Railway Mobile Communication Systems [FRMCS]) for Swaziland Railways including the Swaziland Rail Link Project needs to be established

5.5 L-band: 1427- 1518MHz

Resolution 223 (REV. WRC 15) identified the L band from 1427-1518MHz for IMT.

In many countries (but not Swaziland) is mainly used for fixed links (downlink) (Figure 21). In Swaziland, the entire spectrum 1350-1517MHz is currently unassigned. It is possible to assign the part from 1452-1492MHz directly to IMT-SDL, and decide in the long term to use the other parts either for long hop fixed links or for further IMT-FDD bands. Since the latter is not defined as IMT-spectrum yet, there is no current ecosystem, but the long term preference is for 2*20MHz IMT instead of fixed links in this band.

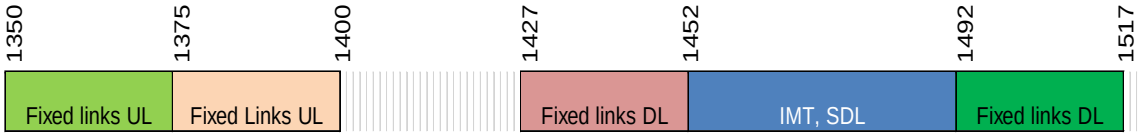


Figure 21: IMT1500, L-band usage in general

5.5.1 ITU-R Recommendations

WRC 15 has invited the ITU-R ….*to develop harmonized frequency arrangements to facilitate IMT deployment in the frequency band 1 427-1 518 MHz, taking into account the results of sharing and compatibility studies*

….that appropriate technical and regulatory criteria should be applied to future IMT deployments to ensure coexistence between MSS in the frequency band 1 518-1 525 MHz and IMT in the frequency band 1 492-1 518 MHz. . . . Resolution 223 (REV. WRC 15).

The channelling plans for IMT in the L band are currently being studied by ITU Working Party 5D, there are no ITU-R recommendations as of yet and the options should be available by WRC 19.

5.5.2 SADC Frequency Allocation Plan

SADC already reflects WRC-15 Resolution 223 to study the use 1452-1492MHz for IMT although the channelling arrangements (including potential SDL arrangements are not yet defined.

.

ITU Region 1 allocations and footnotes	SADC common allocation/s and relevant ITU footnotes	SADC proposed common sub-allocations/utilization	Additional information
1 350-1 400 MHz FIXED MOBILE RADIOLOCATION 5.1495.3385.338A 5.339	**1 350-1 400 MHz** FIXED RADIOLOCATION 5.1495.338A 5.339	1 350-1 375 MHz Fixed links (duplex)	Paired with 1492-1517 MHz; CEPT T/R 13-01 refers.
		1 375-1 400 MHz Fixed links (duplex)	Paired with 1427-1452 MHz; CEPT T/R 13-01 refers.
1 400-1 427 MHz EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY	**1 400-1 427 MHz** EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY		

SPACE RESEARCH (passive) 5.3405.341	SPACE RESEARCH (passive) 5.3405.341		
1 427-1 429 MHz SPACE OPERATION (Earth to-space) FIXED MOBILE except aeronautical mobile 5.341A 5.338A 5.341 5.342	**1 427-1 429 MHz** SPACE OPERATION (Earth-to space) FIXED MOBILE except aeronautical mobile5.341A 5.338A 5.341	1 427-1 452 MHz Fixed links (duplex)	Paired with 1375-1400 MHz; CEPT T/R 13-01 refers.
1 429-1 452 MHz FIXED MOBILE except aeronautical mobile5.341A 5.338A 5.341 5.342	**1 429-1 452 MHz** FIXED MOBILE except aeronautical mobile5.341A 5.338A5.341		
1 452-1 492 MHz FIXED MOBILE except aeronautical mobile 5.346 BROADCASTING BROADCASTING-SATELLITE 5.208B 5.341 5.342 5.345	**1 452-1 492 MHz** FIXED MOBILE except aeronautical mobile 5.346 BROADCASTING BROADCASTING-SATELLITE 5.208B 5.341 5.345	1 452-1 467 MHz Terrestrial Digital Audio Broadcasting (T-DAB) IMT Res. 223 (Rev.WRC-15)	
		1 467-1 492 MHz Satellite Digital Audio Broadcasting (S-DAB) IMT Res. 223 (Rev.WRC-15)	
1 492-1 518 MHz FIXED MOBILE except aeronautical mobile 5.341A 5.341 5.342	**1 492-1 518 MHz** FIXED MOBILE except aeronautical mobile 5.341A 5.341 SADC15	1 492-1 517 MHz Fixed links (dual frequency) IMT Res. 223 (Rev.WRC-15)	Paired with 1350-1375 MHz; CEPT T/R 13-01 refers.
		1 517-1 518 MHz Fixed links (single frequency) IMT Res. 223 (Rev.WRC-15)	

<u>The SADC proposed sub-allocations / utilizations reflect the fact that administrations are free to continue assigning fixed links or to utilise the band for IMT.</u>

5.5.3 Swaziland National Frequency Allocation Plan (NFAP) 2017

The NFAP of 2017 is aligned with the SADC plan.

ITU Region 1 allocations and footnotes	Swaziland allocation/s and relevant ITU footnotes	Utilization	Additional information
1 350-1 400 MHz FIXED MOBILE RADIOLOCATION	**1 350-1 400 MHz** FIXED RADIOLOCATION 5.149 5.338A 5.339	1 350-1 375 MHz Fixed links (duplex)	Paired with 1492-1517 MHz; CEPT T/R 13-01 refers.

Proposed IMT roadmap for consultation

5.149 5.338 5.338A 5.339		1 375-1 400 MHz Fixed links (duplex)	Paired with 1427-1452 MHz; CEPT T/R 13-01 refers.
1 400-1 427 MHz EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.341	**1 400-1 427 MHz** EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive) 5.340 5.341		
1 427-1 429 MHz SPACE OPERATION (Earth-to-space) FIXED MOBILE except aeronautical mobile 5.341A 5.338A 5.341 5.342	**1 427-1 429 MHz** SPACE OPERATION (Earth-to-space) FIXED MOBILE except Aeronautical mobile 5.341A 5.338A 5.341	1 427-1 452 MHz Fixed links (duplex)	Paired with 1375-1400 MHz; CEPT T/R 13-01 refers.
1 429-1 452 MHz FIXED MOBILE except aeronautical mobile 5.341A 5.338A 5.341 5.342	**1 429-1 452 MHz** FIXED MOBILE except Aeronautical mobile 5.341A 5.338A 5.341		
1 452-1 492 MHz FIXED MOBILE except aeronautical mobile 5.346 BROADCASTING BROADCASTING-SATELLITE 5.208B 5.341 5.342 5.345	**1 452-1 492 MHz** FIXED MOBILE except Aeronautical mobile 5.346 BROADCASTING BROADCASTING-SATELLITE 5.208B 5.341 5.345	1 452-1 467 MHz Terrestrial Digital Audio Broadcasting (T-DAB) IMT Res. 223 (Rev.WRC-15)	
		1 467-1 492 MHz Satellite Digital Audio Broadcasting (S-DAB) IMT Res. 223 (Rev.WRC-15)	
1 492-1 518 MHz FIXED MOBILE except aeronautical mobile 5.341A 5.341 5.342	**1 492-1 518 MHz** FIXED MOBILE except Aeronautical mobile 5.341A 5.341	1 492-1 517 MHz Fixed links (dual frequency) IMT Res. 223 (Rev.WRC-15)	Paired with 1350-1375 MHz; CEPT T/R 13-01 refers.
		1 517-1 518 MHz Fixed links (single frequency) IMT Res. 223 (Rev.WRC-15	

5.5.4 Options for Swaziland

WRC-15 proposes the opportunity to use the entire L-Band 1427-1518MHz for IMT[15]. ITU WP5D is working on a proper channelling plan.

[15] This conference has identified the frequency band 1 427-1 518 MHz for use by administrations wishing to implement terrestrial IMT systems.

Proposed IMT band plan and Roadmap

Swaziland might chose option 2 (Figure 23) which offers 2*20MHz FDD for IMT and 40MHz SDL as well, together with 5MHz guard band to protect 1518-1525MHz[16]. This option 2 would offer 2 operators each 2*10MHz in uplink and 2*20MHz in downlink. The SDL-band is also aligned with 3GPP-band 32.

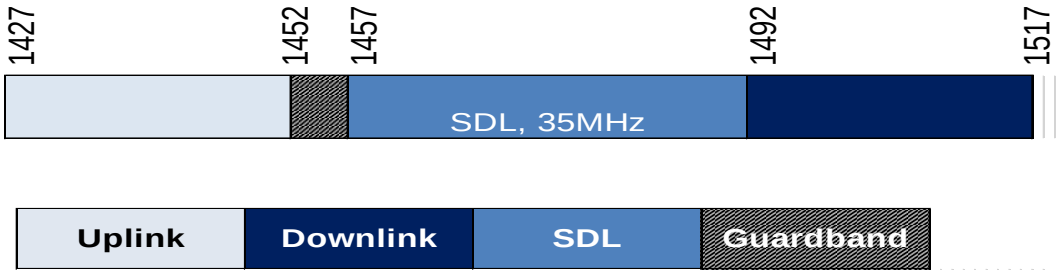


Figure 22: Option1: 2*25MHz plus 35MHz SDL

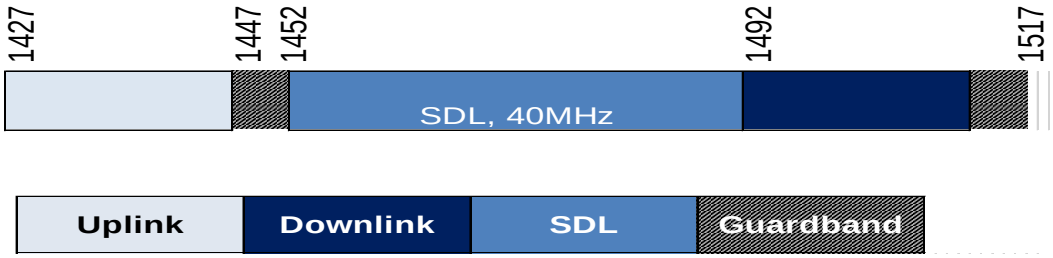


Figure 23: Recommended option 2 for Swaziland: 2*20MHz FDD plus 40MHz SDL[17]

The following is proposed for the future assignment of the IMT1500:

1. **Option 1**: Assign remaining spectrum bandwidth in IMT800 within the 10-15 year timeframe – This will allow sufficient time for the development of standardised channelling arrangements and the requisite ecosystem.

The following channelling options exist for IMT1500:

1. **Option 1**: A 2x25 MHz FDD arrangement spanning 1427-1452//1492-1517 MHz and an SDL configuration spanning 1457-1492 MHz.
2. **Option 2**: A 2x20 MHz FDD arrangement spanning1427-1447//1492-1512 MHz and an SDL configuration spanning 1452-1492 MHz.

5.5.5 Initial Recommendations for Swaziland

The 2x20 MHz FDD arrangement spanning1427-1447//1492-1512 MHz and an SDL configuration spanning 1452-1492 MHz is tentatively recommended, as this may afford

[16] appropriate technical measures to facilitate adjacent band compatibility between MSS in the frequency band 1 518-1 525 MHz and IMT in the frequency band 1 492-1 518 MHz need to be studied.
[17] The band 1518-1525MHz is protected from interference due to guard band 1512-1517MHz.

the required protection to MSS operating in the adjacent bands. The Commission should review this recommendation based on the developments at ITU WP5D.

IMT1500 should be licensed within the 10-15 year timeframe – This will allow sufficient time for the development of standardised channelling arrangements and the requisite ecosystem.

The above recommended options are pending on the outcome of studies being conducted in WP5D. Swaziland should also be aligned with other SADC members on this issue to ensure regional harmonisation.

5.6 1700-2200MHz

The 1700 – 2200 range includes the IMT1800 (3GPP-band 3), the IMT2100 3G band (3GPP-band 1) and the associated TDD bands (3GPP-band 33 and 34).

The key proposals in this band include an extension of the IMT-2100 band, the potential migration of fixed links into parts of the band and the introduction of fixed broadband where feasible.

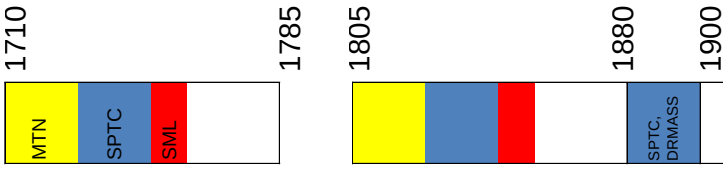


Figure 24: IMT1800 current usage: 20MHz, 20MHz and 10MHz: 25MHz not assigned[18]

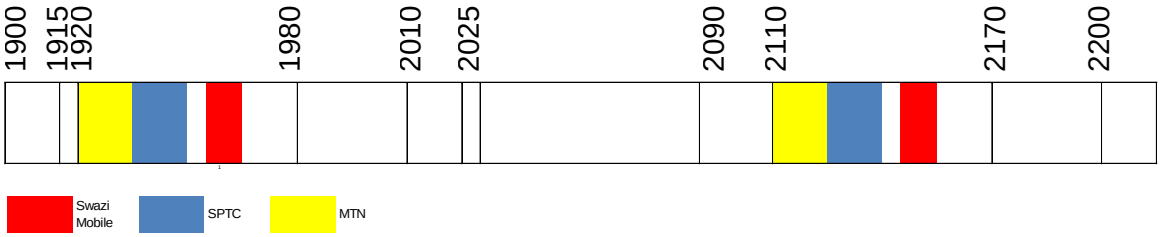


Figure 25: IMT2100 current usage: 15MHz, 15MHz and 10MHz: 20MHz not assigned

5.6.1 ITU-R Recommendations

The ITU Recommendation ITU-R M.1036-5 (10/2015) states the following: The recommended frequency arrangements for implementation of IMT in the band 1710-2200 MHz are summarized in Table 16.

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)	
B1	1 920-1 980	130	2 110-2 170	190	1 880-1 920; 2 010-2 025
B2	1 710-1 785	20	1 805-1 880	95	None
B3	1 850-1 910	20	1 930-1 990	80	1 910-1 930
B4 harmonized with B1 and B2)	1 710-1 785 1 920-1 980	20 130	1 805-1 880 2 110-2 170	95 190	1 880-1 920; 2 010-2 025

[18] In case DRMASS is in operation, 1880-1885MHz needs to be used as guard band or low power indoor only to prevent interference to FDD-part.

B5 (harmonized with B3 and parts of B1 and B2)	1 850-1 910 1 710-1 770	20 340	1 930-1 990 2 110-2 170	80 400	1 910-1 930

Table 16: Frequency arrangements in the band 1710-2290 MHz

NOTE 1 – In the band 1 710-2 025 MHz and 2 110-2 200 MHz three basic frequency arrangements (B1, B2 and B3) are already in use by public mobile cellular systems including IMT. Based on these three arrangements, different combinations of arrangements are recommended as described in B4 and B5. The B1 arrangement and the B2 arrangement are fully complementary, whereas the B3 arrangement partly overlaps with the B1 and B2 arrangements.

For administrations having implemented the B1 arrangement, B4 enables optimisation of the use of spectrum for paired IMT operation.

For administrations having implemented the B3 arrangement, the B1 arrangement can be combined with the B2 arrangement. B5 is therefore recommended to optimise the use of the spectrum: B5 enables the use of spectrum to be maximised for IMT in administrations where B3 is implemented and where the band 1 770-1 850 MHz is not available in the initial phase of deployment of IMT in this frequency band.

NOTE 2 – TDD may be introduced in unpaired bands and also under certain conditions in the uplink bands of paired frequency arrangements and/or in the centre gap between paired bands.

NOTE 3 – If selectable/variable duplex technology is implemented within terminals as the most efficient way to manage different frequency arrangements, the fact that neighbouring administrations could select B5 will have no impact on the complexity of the terminal. Further studies are necessary.

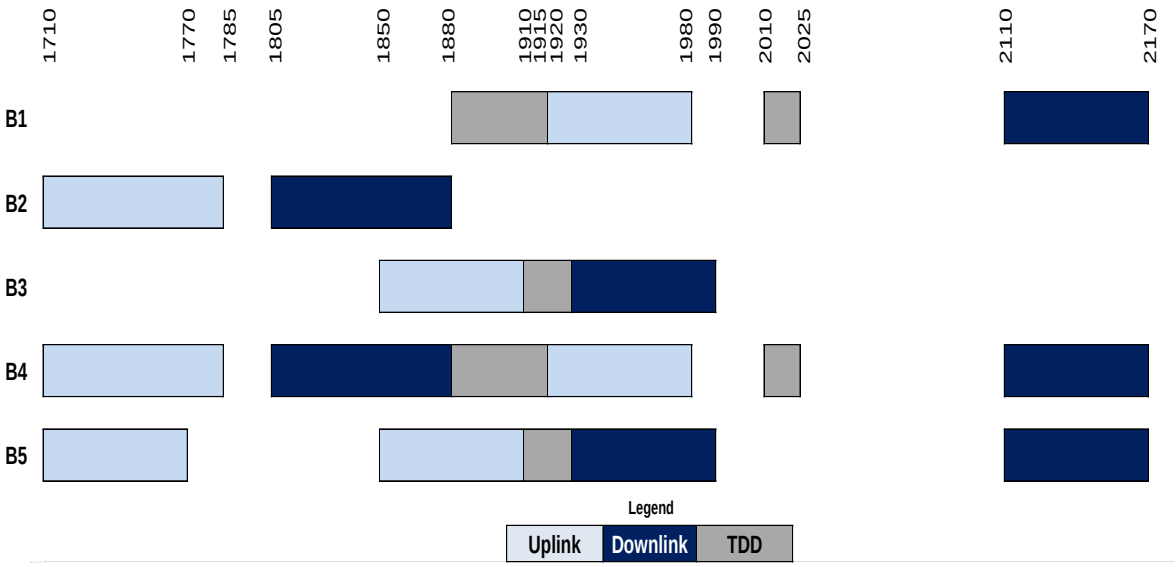


Figure 26: ITU-R options for IMT1800 and IMT2100 bands: B4 is recommended

5.6.2 SADC Frequency Allocation Plan

The SADC Frequency Allocation Plan proposes that common utilisation of the1700-2290 MHz fora myriad of applications such as Fixed Links (single frequency), IMT, IMT (Terrestrial), IMT (Satellite), FWA and BFWA.

Proposed IMT roadmap for consultation

The 1700-2290 MHz band is currently used for a fixed, mobile, mobile-satellite, meteorological-satellite and space operation systems in various SADC countries.

The SADC FAP recognizes that frequency channelization of several key frequency bands must be developed and preferably harmonized throughout SADC. The frequency bands used for IMT, Broadband Fixed Wireless Access (BFWA), PTP microwave systems, etc. will be considered. Channelling plans will be added to the SADC band plan in future, as required.

ITU Region 1 allocations and footnotes	SADC common allocation/s and relevant ITU footnotes	SADC proposed common sub-allocations/utilization	Additional information
1 700-1 710 MHz FIXED METEOROLOGICAL–SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.289 5.341	**1 700-1 710 MHz** FIXED METEOROLOGICAL–SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.289 5.341	Fixed links (single frequency)	
1 710-1 930 MHz FIXED MOBILE 5.384A 5.388A 5.388B 5.149 5.341 5.385 5.386 5.387 5.388	**1710 – 1930 MHz** FIXED MOBILE 5.384A 5.388A 5.388B 5.149 5.341 5.385 5.388	1 710-1 785 MHz IMT	Paired with 1805-1880 MHz.
		1785-1805 MHz BFWA	
		1 805-1 880 MHz IMT	Paired with 1710-1785 MHz.
		1 880-1 900 MHz FWA Cordless telephone	
		1 900-1 920 MHz FWA IMT (terrestrial)	
1930 – 1979 MHz FIXED MOBILE 5.388A 5.388B 5.388	**1930 – 1979 MHz** FIXED MOBILE 5.388A 5.388B 5.388	1920-1980 MHz IMT (terrestrial)	Paired with 2110 – 2170MHz
1970 – 1980 MHz FIXED MOBILE 5.388A 5.388B 5.388	**1970 – 1980 MHz** FIXED MOBILE 5.388A 5.388B 5.388		
1 980-2 010 MHz FIXED MOBILE MOBILE-SATELLITE (Earth to-space) 5.351A 5.3885.389A5.389B5.389F	**1 980-2 010 MHz** MOBILE MOBILE-SATELLITE (Earth-to space) 5.351A 5.3885.389A5.389B	IMT (satellite) (1980-2010 MHz)	Paired with 2170 - 2200 MHz. The development of satellites for IMT services to be monitored.
2 010-2 025 MHz FIXED MOBILE 5.388A 5.388B 5.388	**2 010-2 025 MHz** FIXED MOBILE 5.388A 5.388B 5.388	IMT terrestrial (2010 – 2025 MHz)	TDD
2 025-2 110 MHz SPACE OPERATION (Earth to-space) (space-to space)	**2 025-2 110 MHz** SPACE OPERATION (Earth-to space) (space-to-space)	Fixed links (2025-2110 MHz paired with 2200-2285MHz)	Radio Frequency channel arrangement according to ITUR F.1098.

Proposed IMT band plan and Roadmap

EARTH EXPLORATIONSATELLITE (Earth-to space) (space-to-space) FIXED MOBILE 5.391 SPACE RESEARCH (Earth-to space) (space-to-space) 5.392	EARTH EXPLORATIONSATELLITE (Earth-to-space) (space-to-space) FIXED SPACE RESEARCH (Earth-to space) (space-to-space) 5.392		
2110 – 2120 MHz FIXED MOBILE 5.388A5.388B SPACE RESEARCH (deep space) (Earth-to-space) 5.388	**2110 – 2120 MHz** MOBILE 5.388A5.388B SPACE RESEARCH (deep space) (Earth-to-space) 5.388	IMT (terrestrial) (2110-2170 MHz)	Paired with 1920-1980 MHz
2120 – 2160 MHz FIXED MOBILE 5.388A 5.388B 5.388	**2120 – 2160 MHz** MOBILE 5.388A 5.388B 5.388		
2160 – 2170 MHz FIXED MOBILE 5.388A 5.388B 5.388	**2160 – 2170 MHz** MOBILE 5.388A 5.388B 5.388		
2 170-2 200 MHz FIXED MOBILE MOBILE-SATELLITE (space-to-Earth) 5.351A 5.388 5.389A 5.389F	**2 170-2 200 MHz** MOBILE MOBILE-SATELLITE (space-to-Earth) 5.351A 5.388 5.389A 5.389F	IMT (satellite) (2170-2200 MHz)	Paired with 1980-2010 MHz. The development of satellites for IMT services to be monitored.
2 200-2 290 MHz SPACE OPERATION (space-to-Earth) (space-to-space) EARTH EXPLORATION – SATELLITE (space-to-Earth) (space-to-space) FIXED MOBILE 5.391 SPACE RESEARCH (space-to-Earth) (space-to-space) 5.392	**2 200-2 290 MHz** SPACE OPERATION (space-to-Earth) (space-to-space) EARTH EXPLORATION – SATELLITE (space-to-Earth) (space-to-space) FIXED SPACE RESEARCH (space-to-Earth) (space-to-space) 5.392	Fixed links (2025-2110 MHz paired with 2200-2285 MHz)	Radio Frequency channel arrangement according to ITU-RF. 1098.
		BFWA (2 285-2 300 MHz)	
2 290-2 300 MHz FIXED MOBILE except aeronautical mobile SPACE RESEARCH (deep space) (space-to-Earth)	**2 290-2 300 MHz** FIXED MOBILE except aeronautical mobile SPACE RESEARCH (deep space) (space-to-Earth)	BFWA (2 285-2 300 MHz)	

Table 17: SADC Frequency Allocation Plan 1700-2300 MHz

Proposed IMT roadmap for consultation

Footnotes:

5.384 Additional allocation: in India, Indonesia and Japan, the band 1 700-1 710 MHz is also allocated to the space research service (space to Earth) on a primary basis. (WRC-97).

5.384A The bands, or portions of the bands, 1710-1885 MHz, 2300-2400 MHz and 2500-2690 MHz, are identified for use by administrations wishing to implement International Mobile Telecommunications (IMT) in accordance with Resolution 223 (Rev.WRC-07). This identification does not preclude the use of these bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC-07)

5.385 Additional allocation: the band 1718.8-1722.2 MHz is also allocated to the radio astronomy service on a secondary basis for spectral line observations. (WRC-2000)

5.386 Additional allocation: the band 1750-1850 MHz is also allocated to the space operation (Earth-to-space) and space research (Earth-to-space) services in Region 2, in Australia, Guam, India, Indonesia and Japan on a primary basis, subject to agreement obtained under No.9.21, having particular regard to troposcatter systems. (WRC-03)

5.387 Additional allocation: in Belarus, Georgia, Kazakhstan, Kyrgyzstan, Romania, Tajikistan and Turkmenistan, the band 1770-1790 MHz is also allocated to the meteorological-satellite service on a primary basis, subject to agreement obtained under No.9.21. (WRC-12)

5.388A In Regions 1 and 3, the bands 1885-1980 MHz, 2010-2025 MHz and 2110-2 170 MHz and in Region 2, the bands 1885-1980 MHz and 2110-2160 MHz may be used by high altitude platform stations as base stations to provide International Mobile Telecommunications (IMT), in accordance with Resolution 221 (Rev.WRC-07). Their use by IMT applications using high altitude platform stations as base stations does not preclude the use of these bands by any station in the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC-12)

5.388B In Algeria, Saudi Arabia, Bahrain, Benin, Burkina Faso, Cameroon, Comoros, Côte d'Ivoire, China, Cuba, Djibouti, Egypt, United Arab Emirates, Eritrea, Ethiopia, Gabon, Ghana, India, Iran (Islamic Republic of), Israel, Jordan, Kenya, Kuwait, Libya, Mali, Morocco, Mauritania, Nigeria, Oman, Uganda, Pakistan, Qatar, the Syrian Arab Republic, Senegal, Singapore, Sudan, South Sudan, Tanzania, Chad, Togo, Tunisia, Yemen, Zambia and Zimbabwe, for the purpose of protecting fixed and mobile services, including IMT mobile stations, in their territories from co-channel interference, a high altitude platform station (HAPS) operating as an IMT base station in neighbouring countries, in the bands referred to in No. 5.388A, shall not exceed a co-channel power flux-density of −127 dB(W/(m^2 · MHz)) at the Earth's surface outside a country's borders unless explicit agreement of the affected administration is provided at the time of the notification of HAPS.(WRC-12)

5.389A The use of the bands 1 980-2 010 MHz and 2 170-2 200 MHz by the mobile-satellite service is subject to coordination under No. 9.11A and to the provisions of Resolution 716 (Rev.WRC-2000)×.(WRC-07)

5.389B The use of the band 1 980-1 990 MHz by the mobile-satellite service shall not cause harmful interference to or constrain the development of the fixed and mobile services in Argentina, Brazil, Canada,

Chile, Ecuador, the United States, Honduras, Jamaica, Mexico, Peru, Suriname, Trinidad and Tobago, Uruguay and Venezuela.

5.389C The use of the bands 2010-2025 MHz and 2160-2170 MHz in Region 2 by the mobile-satellite service is subject to co-ordination under No.9.11A and to the provisions of Resolution 716 (Rev.WRC-2000)×.(WRC-07)

5.389E The use of the bands 2 010-2 025 MHz and 2 160-2 170 MHz by the mobile-satellite service in Region 2 shall not cause harmful interference to or constrain the development of the fixed and mobile services in Regions 1 and 3.

5.389F In Algeria, Benin, Cape Verde, Egypt, Iran (Islamic Republic of), Mali, Syrian Arab Republic and Tunisia, the use of the bands 1 980-2 010 MHz and 2 170-2 200 MHz by the mobile-satellite service shall neither cause harmful interference to the fixed and mobile services, nor hamper the development of those services prior to 1 January 2005, nor shall the former service request protection from the latter services. (WRC-2000)

5.391 In making assignments to the mobile service in the bands 2 025-2 110 MHz and 2 200-2 290 MHz, administrations shall not introduce high-density mobile systems, as described in Recommendation ITU-R SA.1154, and shall take that Recommendation into account for the introduction of any other type of mobile system. (WRC-97)

5.392 Administrations are urged to take all practicable measures to ensure that space-to-space transmissions between two or more non-geostationary satellites, in the space research, space operations and Earth exploration-satellite services in the bands 2 025-2 110 MHz and 2 200-2 290 MHz, shall not impose any constraints on Earth-to-space, space-to-Earth and other space-to-space transmissions of those services and in those bands between geostationary and non-geostationary satellites.

5.6.3 Swaziland National Frequency Allocation Plan (NFAP) 2017

The NFAP of 2017 is aligned with the SADC plan.

ITU Region 1 allocations and footnotes	Swaziland allocation/s and relevant ITU footnotes	Utilization	Additional information
1 700-1 710 MHz FIXED METEOROLOGICAL SATELLITE (space-to- Earth) MOBILE except aeronautical mobile 5.289 5.341	**1 700-1 710 MHz** FIXED METEOROLOGICAL SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.289 5.341	Fixed links (single frequency)	
1 710-1 930 MHz FIXED MOBILE 5.384A 5.388A 5.388B 5.149 5.341 5.385 5.386 5.387 5.388	**1 710-1 930 MHz** FIXED MOBILE 5.384A 5.388A 5.388B 5.149 5.341 5.385 5.388	1 710-1 785 MHz IMT	Paired with 1805-1880 MHz
		1785-1805 MHz BFWA	
		1 805-1 880 MHz IMT	Paired with 1710-1785 MHz
		1 880-1 900 MHz FWA Cordless telephone	
		FWA IMT (terrestrial)	
		1 920-1 980 MHz IMT (terrestrial)	Paired with 2110-2170 MHz
1 930-1 970 MHz FIXED	**1 930-1 970 MHz** MOBILE 5.388A 5.388B		

Proposed IMT roadmap for consultation

MOBILE 5.388A 5.388B 5.388	5.388		
1 970-1 980 MHz FIXED MOBILE 5.388A 5.388B 5.388	**1 970-1 980 MHz** MOBILE 5.388A 5.388B 5.388		
1 980-2 010 MHz FIXED MOBILE MOBILE-SATELLITE(Earth-to-space) 5.351A 5.388 5.389A 5.389B 5.389F	**1 980-2 010 MHz** MOBILE MOBILE-SATELLITE (Earth-to-space) 5.351A 5.388 5.389A 5.389B	IMT (satellite) (1980-2010 MHz)	Paired with 2170 - 2200 MHz. The development of satellites for IMT services to be monitored.
2 010-2 025 MHz FIXED MOBILE 5.388A 5.388B 5.388	**2 010-2 025 MHz** MOBILE 5.388A 5.388B 5.388	IMT (terrestrial) (2010-2025 MHz)	TDD
2 025-2 110 MHz SPACE OPERATION (Earth-to-space) (space-to-space) EARTH EXPLORATION SATELLITE (Earth-to-space) (space-to-space) FIXED MOBILE 5.391 SPACE RESEARCH (Earth-to- space) (space-to-space) 5.392	**2 025-2 110 MHz** SPACE OPERATION (Earth-to-space) (space-to-space) EARTH EXPLORATION SATELLITE (Earth-to-space) (space-to-space) FIXED SPACE RESEARCH (Earth-to-space) (space-to-space) 5.392	Fixed links (2025-2110 MHz paired with 2200-2285 MHz)	Radio Frequency channel arrangement according to ITUR F.1098.
2 110-2 120 MHz FIXED MOBILE 5.388A5.388B SPACE RESEARCH (deep space) (Earth-to-space) 5.388	**2 110-2 120 MHz** MOBILE 5.388A 5.388B SPACE RESEARCH (deep space) (Earth-to-space) 5.388	IMT (terrestrial) (2110-2170 MHz)	Paired with 1920-1980 MHz
2 120-2 160 MHz FIXED MOBILE 5.388A 5.388B 5.388	**2 120-2 170 MHz** MOBILE 5.388A 5.388B 5.388		
2 160-2 170 MHz FIXED MOBILE 5.388A 5.388B 5.388	**2 160-2 170 MHz** MOBILE 5.388A 5.388B 5.388		
2 170-2 200 MHz FIXED MOBILE MOBILE-SATELLITE (space-to-Earth) 5.351A 5.388 5.389A 5.389F	**2 170-2 200 MHz** MOBILE MOBILE-SATELLITE (space-to-Earth) 5.351A 5.388 5.389A 5.389F	IMT (satellite) (2170-2200 MHz)	Paired with 1980-2010 MHz. The development of satellites for IMT services to be monitored.

2 200-2 290 MHz SPACE OPERATION (space-to-Earth) (space-to-space) EARTH EXPLORATION SATELLITE (space-to-Earth) (space-to-space) FIXED MOBILE 5.391 SPACE RESEARCH (space-to-Earth) (space-to-space) 5.392	**2 200-2 290 MHz** SPACE OPERATION (space-to-Earth) (space-to-space) EARTH EXPLORATION SATELLITE (space-to-Earth) (space-to-space) FIXED SPACE RESEARCH (space-to-Earth) (space-to-space) 5.392	Fixed links (2025-2110 MHz paired with 2200-2285 MHz)	Radio Frequency channel Arrangement according to ITUR F.1098.
		BFWA (2 285-2 300 MHz)	
2 290-2 300 MHz FIXED MOBILE except aeronautical mobile SPACE RESEARCH (deep space) (space-to-Earth)	**2 290-2 300 MHz** FIXED MOBILE except aeronautical mobile SPACE RESEARCH (deep space) (space-to-Earth)	BFWA (2 285-2 300 MHz)	

5.6.4 Options for Swaziland – 1800 MHz

The IMT 1800 band, (1710-1785 // 1805-1880 MHz which is band 3 (a.k.a. DCS) is already assigned to MTN, SPTC and Swazi Mobile.

The 1760-1785 // 1855-1880 MHz is not assigned for IMT purposes due to the assignment of microwave links and DRMASS in this frequency range. It is recommended that the microwave links be migrated out and the DRMASS service switched off and the users migrated out. This will allow the full band to be assigned, thus facilitating the deployment of the band for 4G.The following option exists for the future use of IMT1800:

1. **Option 1**: Migrate legacy DRMASS and point-to-point links from 1800 MHz within the next 5 years.

The following channelling option is proposed for IMT1800:

1. **Option 1**: Adopt the IMT1800 channelling arrangement B2 – current assignments are in accordance with this channelling arrangement.

The following is proposed for the future assignment of the IMT1800:

1. **Option 1**: Assign remaining spectrum bandwidth in IMT1800 within the next 5 years

5.6.5 Options for Swaziland – 2100 MHz

The IMT 2100 FDD band (1920-1980 // 2110-2170 MHz which is band 1 is already assigned to MTN, SPTC and Swazi Mobile for 3G.

The frequency ranges 1965-1980 // 21655-2170MHz and 1950-1955 // 2140-2145MHz are not assigned for 3G and contain microwave assignments. It is recommended that the microwave links be migrated out.

Proposed IMT roadmap for consultation

The identified IMT2100 band 1 currently consists of 2×60 MHz of spectrum in 1920-1980 MHz paired with 2110-2170 MHz. Resolution 21 (REV WRC-15), indicates the possibility to extend this band by 2×30 MHz at the upper part of the current IMT2100 band (utilising the IMT for satellite band where these are not used and where there is no danger of interference)[19]. The consolidated IMT2100 band would therefore be 1920-2010 MHz paired with 2110-2200 MHz (band 65, see Figure 27 below).As noted, an analysis needs to be carried out per geographical area, as to whether current and planned IMT-satellite systems would be subjected to harmful interference from terrestrial IMT. If so, terrestrial IMT may not be possible (although indoor only use might be feasible).

This extension of the IMT2100 band would extend the paired portion of IMT2100 right up to the unpaired portion of the band that extends from 2010 MHz to 2025 MHz (band 34 – a.k.a. IMT 2100 TDD). In this case a guard band of 5 MHz is typically required between adjacent paired and unpaired IMT bands.

With the guard band above 2010MHz, the 2015-2025 MHz remains usable for IMT TDD. These new TDD bands from 1885-1915 MHz plus guard bands and 2015-2025 MHz might be assigned for new 5G-TDD-based services.

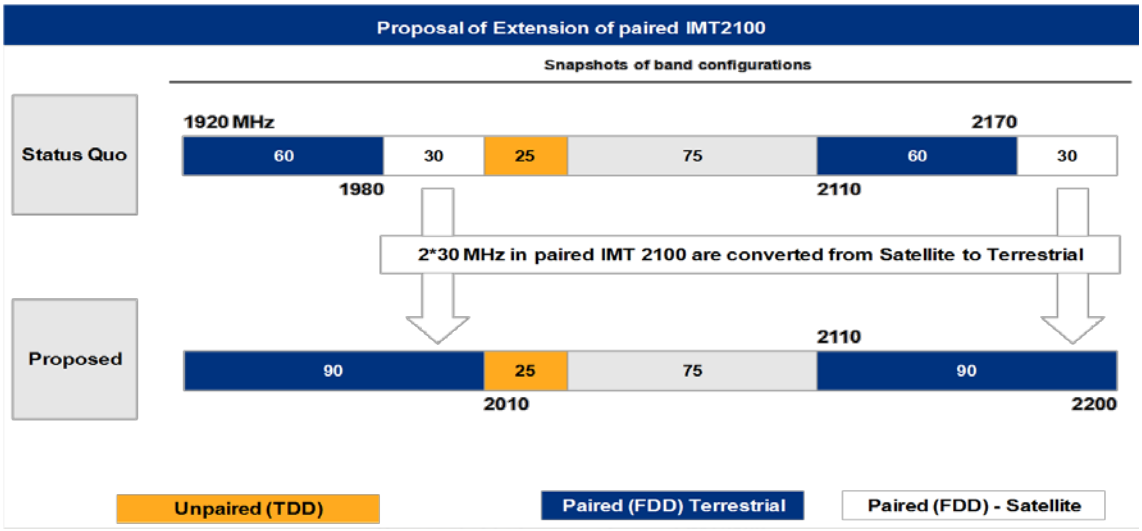


Figure 27: Proposal of Extension of paired IMT2100

This potential usage of bands, also depicted in Figure 29, encompasses the existing FDD-band 1, the TDD-bands 33 and 34 and the satellite extension of IMT; in total 2*90MHz

[19] WARC-92: 230 MHz of spectrum was identified for IMT-2000 in the frequency bands 1 885-2 025 MHz and 2 110-2 200 MHz, *including the frequency bands 1 980-2 010 MHz and 2 170-2 200 MHz for the satellite component of IMT-2000*, in No. 5.388 and under the provisions of Resolution 212 (Rev.WRC-15). ITU-R has recognized that space techniques are an integral part of IMT. The availability of the satellite component of IMT in the frequency bands 1980-2010 MHz and 2170-2200 MHz simultaneously with the terrestrial component of IMT in the frequency bands identified in No. 5.388 would improve the overall implementation and the attractiveness of IMT. When the satellite and terrestrial components of IMT are deployed in the frequency bands 1980-2010 MHz and 2170-2200 MHz in adjacent geographical areas, technical or operational measures may need to be implemented to avoid harmful interference, and further studies by ITU-R are required, results expected in WRC-19.

FDD plus 25MHz TDD[20]. In general, the potential interference mitigation measures, between point to point and IMT-TDD at 2025 MHz and at 2285 MHz and to IMT FDD at 2110 MHz, have to be considered.

Since the 2025-2110//2200-2290 MHz band parts is not considered to be usable for (high-density) IMT-services[21], SADC proposes to use this band used for P2P link destination band migrated from lower bands, also depicted in Figure 29.

In the *long term*, next generation IMT systems might also find proper co-existence (e.g. LSA, at least indoor) of these band parts as well: 60MHz SDL in 2030-2090MHz and 70MHz in 2215-2285MHz. In addition, the former TDD-bands could be then used as UL-parts combined with the new DL-parts. Figure 30 shows the long term solution:

1. Band 1: 1920-1980 // 2110-2170MHz with 1980-2010//2170-2200MHz (Extended IMT band 65)
2. Band 33: 1900-1920 *// 2090-2110MHz*: 2*20MHz
3. Band 34: 2010-2025 *// 2200-2215MHz*: 2*15MHz
4. And additional 60MHz and 70MHz SDL (at least indoor or with LSA assignment)

leads in total to 125MHz uplink and 255MHz downlink for the extended IMT2100, but also parts 1 - 3 could be realized independently from SDL solution (4) which might be used indoor only or on a local service area basis. These long term suggestions are not yet defined for IMT, therefore the ecosystems are not prepared and these bands might be available in a second step.

The current usage for DECT might still remain between 1880-1900MHz. Potential limitations need to be analysed and prioritized.

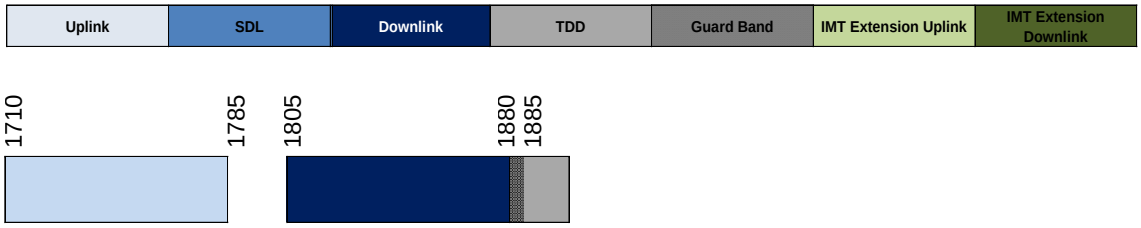


Figure 28: IMT1800: no changes

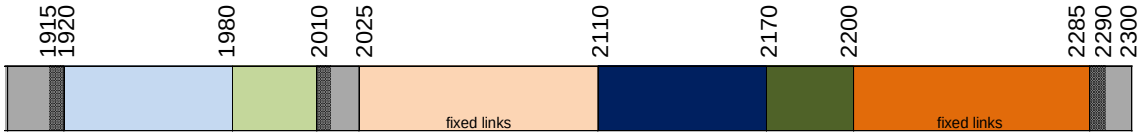


Figure 29: IMT2100: co-existence use of terrestrial and satellite IMT bands (3GPP-band 65)

[20] This takes also 2 times 5MHz guard band into account. In addition, 20MHz to be used for DECT indoor.
[21] Recommendation ITU-R SA.1154

Figure 30: long term IMT2100 *option* with use of currently protected band for SDL (e.g. indoor only)

The 2290-2300 MHz band is currently not used in Swaziland, neither in South Africa. The possibility exists that IMT-TDD equipment could be developed or tuned to extend IMT-2300 downwards to start at 2290-, giving a TDD band from 2290-2400MHz. However, this is a long term perspective as this is not currently on the agenda at the ITU.

The following option exists for the future use of IMT2100:

1. **Option 1**: Migrate out point-to-point links within the 5-10 year timeframe
2. **Option 2**: Leverage the adjacent IMT satellite frequency band for the extension of IMT2100 by up to 2x30 MHz – potential consolidated IMT2100 band would therefore be 1920-2010 MHz // 2110-2200 MHz, however the implementation of this option will be subject to the outcome of technical studies

The following channelling arrangement option is proposed for IMT2100 and IMT2100 TDD:

1. **Option 1**: Adopt channelling arrangement B4 for the IMT 2100 FDD and IMT2100 TDD, which span respective frequency ranges 1920-1980 // 2110-2170 MHz and 2010 – 2025 MHz - current assignments are in accordance with this channelling arrangement.
2. **Option 2:** Given that the option to extend IMT2100 by 2x30 MHz in the frequency range 1980-2010//2170-2200MHz is adopted, a consolidated channelling arrangement spanning 1920-2010 MHz // 2110-2200 MHz is proposed – the implementation of the IMT2100 extension band will be subject to the outcome of a technical compatibility study

The following is proposed for the future assignment of the IMT2100 and IMT2100 TDD:

1. **Option 1**: Assign the remaining spectrum bandwidth in IMT2100 within the 5-10 year timeframe – This will allow sufficient time for the migration of point-to-point links to alternative frequency locations.

   Assign all available spectrum in the IMT2100 TDD and IMT2100 extension bands (1980-2010//2170-2200MHz) within the 5-10 year timeframe

5.6.6 Initial Recommendations for Swaziland

1. IMT1800– It is recommended that channelling arrangement B4 is adopted for the frequency range spanning (1710-1785MHz // 1805-1880 MHz). The Commission has already licensed users in accordance with the abovementioned frequency

arrangement. DRMASS and point to point links to be migrated out of IMT800 to allow full assignment of the band within the next 5 years.

2. IMT2100 – It is recommended to adopt channelling arrangement B4 for the IMT 2100 FDD and IMT2100 TDD, which spans respective frequency ranges 1920-1980 // 2110-2170 MHz and 2010 – 2025 MHz. The current IMT2100 assignments are in accordance with this channelling arrangement.
3. Point-to-point links contained in IMT2100 must be migrated out to allow full assignment of the band within the 5-10 year timeframe.
4. Leverage the adjacent IMT satellite frequency band for the extension of IMT2100 by up to 2x30 MHz – potential consolidated IMT2100 band would therefore be 1920-2010 MHz // 2110-2200 MHz.
5. Assign all available spectrum in the IMT2100 extension band and IMT2100 TDD within the 5-10 year timeframe.
6. The IMT2100 SDL usage (Figure 30) with former TDD bands as new FDD band is also seen in the long term, especially for indoor usage.

5.7 2300-2400MHz

Currently SPTC is using the spectrum from 2300-2480MHz for DRMASS System as point-to-multi-point links (PMP fixed links with FDD usage), despite the full band 2400-2500MHz (not only 2400-2483MHz) being reserved for ISM (=WiFi purpose) in Swaziland. *The current DRMASS deployment effectively blocks the future implementation of IMT2300 Swaziland.* Moreover, DECT systems have also been deployed within this band.

5.7.1 ITU Radio Recommendations

ITU Recommendation ITU-R M.1036-5 states that the recommended frequency arrangements for implementation of IMT in the band 2300-2400 MHz are summarized in Table 18.

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)	
E1					2 300-2 400 TDD

Table 18: Frequency arrangements in the band 2300-2400 MHz

Figure 31: Frequency arrangements in the band 2300 – 2400 MHz: 100MHz (unpaired)

5.7.2 SADC Frequency Allocation Plan

The SADC Frequency Allocation Plan proposes the common utilisation of 2300-2400 MHz for Fixed Links, IMT (TDD), PTP/PTMP and Broadband Fixed Wireless Access (BFWA).

The 2300-2400 MHz band is currently used for fixed and mobile systems in various SADC countries.

The SADC FAP recognizes that frequency channelization of several key frequency bands must be developed and preferably harmonized throughout SADC. The frequency bands used for IMT, BFWA, PTP microwave systems, etc. will be considered. Channelling plans will be added to the SADC Band Plan in future, as required.

ITU Region 1 allocations and footnotes	SADC common allocation/s and relevant ITU footnotes	SADC proposed common sub-allocations/utilization	Additional information
2300-2450 FIXED MOBILE 5.384A Amateur Radiolocation 5.150 5.282 5.395	**2300-2450** FIXED MOBILE 5.384A Amateur Radiolocation 5.150 5.282	2300-2400 MHz Fixed links PTP/PTMP IMT (TDD) BFWA	Fixed paired with 2400-2500 MHz. This band has been identified for IMT.
2 450-2 483.5 MHz FIXED MOBILE Radiolocation 5.150 5.397	**2 450-2 483.5 MHz** FIXED MOBILE Radiolocation 5.150 5.397	2400-2500 MHz Fixed links PTP/PTMP **The band 2 400-2 500 MHz is designated for ISM applications (5.150).** SRD applications (2 400-2 483.5 MHz)	FS paired with 2300-2400 MHz. The band 2483.5-2500 MHz is identified for satellite component of IMT; Res.225 applies. Common international SRD band; see ITU-R Rec.SM.[SRD]
2 483.5-2 500 MHz FIXED MOBILE MOBILE-SATELLITE (space to- Earth) 5.351A RADIODETERMINATIONSATELLITE (space-to-Earth) 5.398 Radiolocation 5.398A 5.150 5.399 5.401 5.402	**2 483.5-2 500 MHz** FIXED MOBILE MOBILE-SATELLITE (space-to- Earth) 5.351A RADIODETERMINATIONSATELLITE (space-to-Earth) 5.398 Radiolocation 5.398A 5.150 5.399 5.401 5.402		

Table 19: SADC Frequency Allocation Plan 2300-2500 MHz

5.7.3 Swaziland National Frequency Allocation Plan (NFAP) 2017

The NFAP of 2017 is aligned with the SADC plan.

ITU Region 1 allocations and footnotes	Swaziland allocation/s and relevant ITU footnotes	Utilization	Additional information
2 300-2 450 MHz FIXED MOBILE 5.384A Amateur Radiolocation 5.150 5.282 5.395	**2 300-2 450 MHz** FIXED MOBILE 5.384A Amateur Radiolocation 5.150 5.282	2300-2400 MHz Fixed links PTP/PTMP IMT (TDD) BFWA	Fixed paired with 2400-2500 MHz This band has been identified for IMT.
2 450-2 483.5 MHz	**2 450-2 483.5 MHz**	2400-2500 MHz	

Proposed IMT roadmap for consultation

FIXED MOBILE Radiolocation 5.150 5.397	FIXED MOBILE Radiolocation 5.150 5.397	Fixed links PTP/PTMP **The band 2 400-2 500 MHz is designated for ISM applications (5.150).** SRD applications (2 400-2 483.5 MHz)	FS paired with 2300-2400 MHz. The band 2483.5-2500 MHz is identified for satellite component of IMT; Res.225 applies. Common international SRD band; see ITU-R Rec.SM.[SRD]
2 483.5-2 500 MHz FIXED MOBILE MOBILE-SATELLITE (space-to-Earth) 5.351A RADIODETERMINATION SATELLITE (space-to-Earth) 5.398 Radiolocation 5.398A 5.150 5.399 5.401 5.402	**2 483.5-2 500 MHz** FIXED MOBILE MOBILE-SATELLITE (space-to-Earth) 5.351A RADIODETERMINATION SATELLITE (space-to-Earth) 5.398 Radiolocation 5.398A 5.150 5.399 5.401 5.402		

Resolution 223 (REV. WRC 15) states:

1. the frequency band 2 300-2 400 MHz is allocated to the mobile service on a co-primary basis in the three ITU Regions
2. the frequency band 2 300-2 400 MHz, or portions thereof, is used extensively in a number of administrations by other services including the aeronautical mobile service for telemetry in accordance with the relevant provisions in the Radio Regulations
3. in the frequency band 2 300-2 400 MHz, or portions thereof, there are services such as fixed, mobile, amateur and radiolocation which are currently in operation or planned to be in operation in the future

5.7.4 Options for Swaziland

The band currently contains non-IMT assignments. However, these assignments are used for Fixed Wireless Access services (DRMASS and DECT). It is recommended that when end of life of DRMASS and DECT equipment is reached, to implement a IMT band plan 2300-2400MHz with TDD.

Any remaining users could be migrated out to another frequency band and/or catered for by an alternative technology. I the case that the technology to be deployed is LTE using the IMT TDD band, the migration could be done in a step wise manner by proper refarming of used frequencies (FDD fixed links) to some parts of the spectrum and to introduce the new IMT equipment in the other spectrum parts to migrate current users from old systems to newer alternatives.

The remaining 2400-2480MHz links might be scrutinised to ensure that they operate within the transmit power restriction applicable in the ISM frequency band. In the long term it is expected, that the FDD fixed links would migrate to 2025-2110//2200-2285MHz band.

The following option exists for the future use of IMT2300:

Proposed IMT roadmap for consultation

1. **Option 1**: Migrate legacy DRMASS and DECT systems from the 2300 MHz frequency band within the 5-10 year timeframe.

The following channelling option is proposed for IMT2300:

1. **Option 1**: Adopt the IMT2300 channelling arrangement E1

The following is proposed for the future assignment of the IMT2300:

1. **Option 1**: Assign all spectrum bandwidth in IMT2300 within the 5-10 year timeframe – noting that the migration DRMASS and DECT are prerequisites spectrum assignment.

5.7.5 Initial Recommendations for Swaziland

1. Adopt the IMT2300 channelling arrangement E1. Migrate out legacy DRMASS and DECT systems and assign all IMT2300 spectrum within the 5-10 year timeframe.

5.8 2500-2690MHz

Currently, the spectrum from 2490-2540MHz is assigned for WiMAX (TDD) by SPTC. SwaziMobile has an assignment for Microwave links - 2550-2555//2680-2685MHz.

These assignments block the proper introduction of IMT within the bands and therefore these assignments need to be terminated / migrated out.

5.8.1 ITU Radio Recommendations

ITU Recommendation ITU-R M.1036-5 10/2015 states the following. The recommended frequency arrangements for implementation of IMT in the band 2500-2690 MHz are summarized in Table 20.

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)	Centre gap usage	
C1	2 500-2 570	50	2 620-2 690	120	TDD	2 570-2 620 TDD
C2	2 500-2 570	50	2 620-2 690	120	FDD	2 570-2 620 FDD DL external
C3	Flexible FDD/TDD					

Table 20: Frequency arrangements in the band 2500-2690 MHz

NOTE 1 – In C1, in order to facilitate deployment of FDD equipment, any guard bands required to ensure adjacent band compatibility at the 2 570 MHz and 2 620 MHz boundaries will be decided on a national basis and will be taken within the band 2 570-2 620 MHz and should be kept to the minimum necessary, based on Report ITU-R M.2045.

NOTE 2 – In C3, administrations can use the band solely for FDD or TDD or some combination of TDD and FDD. Administrations can use any FDD duplex spacing or FDD duplex direction. However, when administrations choose to deploy mixed FDD/TDD channels with a fixed duplex separation for FDD, the duplex separation and duplex direction as shown in C1 are preferred.

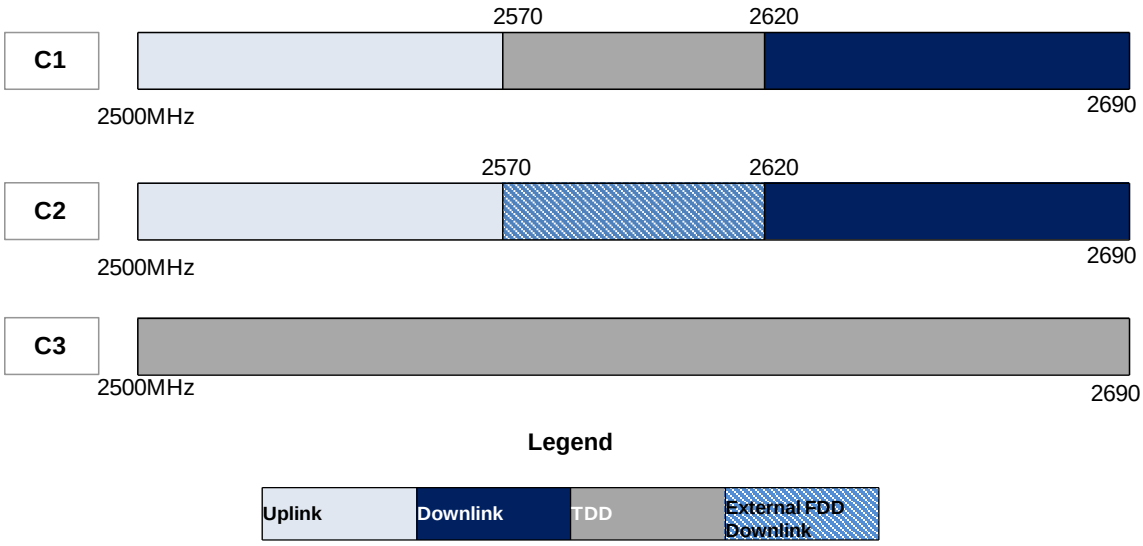


Figure 32: Frequency arrangements in the band 2500 – 2690 MHz

5.8.2 SADC Frequency Allocation Plan

The SADC Frequency Allocation Plan (Table 21) proposes that the 2500-2690 MHz be utilised for IMT and BFWA. The 2500-2690 MHz band is currently used for mainly BFWA systems in various SADC countries and is also allocated to mobile services, identified for IMT.

The SADC FAP recognizes that frequency channelization of several key frequency bands must be developed and preferably harmonized throughout SADC. The frequency bands used for IMT, Broadband Fixed Wireless Access (BFWA), PTP microwave systems, etc. will be considered. Channelling plans will be added to the SADC Band Plan in future, as required.

ITU Region 1 allocations and footnotes	SADC common allocation/s and relevant ITU footnotes	SADC proposed common sub-allocations / utilization	Additional information
2 500-2 520 MHz FIXED 5.410 MOBILE except aeronautical mobile 5.384A 5.4055.412	**2 500-2 520 MHz** FIXED MOBILE except aeronautical mobile 5.384A	BFWA (2500-2690 MHz) IMT (2500-2690 MHz)	The band 2 500-2 690 MHz is also used for BFWA in some SADC countries.
2 520-2 655 MHz FIXED 5.410 MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLITE 5.4135.416 5.3395.4055.412 5.418B 5.418C	**2 520-2 655 MHz** FIXED MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLITE 5.413 5.416 5.339 5.405 5.412 5.418B 5.418C		
2 655-2 670 MHz FIXED 5.410 MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLITE 5.208B5.4135.416 Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.1495.412	FIXED MOBILE except aeronautical mobile 5.384A 5.1495.412		
2 670-2 690 MHz FIXED 5.410 MOBILE except aeronautical mobile 5.384A Earth exploration-satellite (passive)	**2 670-2 690 MHz** FIXED MOBILE except aeronautical mobile 5.384A 5.1495.412		

Radio astronomy Space research (passive) 5.1495.412			

Table 21: SADC Frequency Allocation Plan

5.8.3 Swaziland National Frequency Allocation Plan (NFAP) 2017

The NFAP of 2017 is aligned with the SADC plan.

ITU Region 1 allocations and footnotes	Swaziland allocation/s and relevant ITU footnotes	Utilization	Additional information
2 500-2 520 MHz FIXED 5.410 MOBILE except aeronautical mobile 5.384A 5.405 5.412	**2 500-2 520 MHz** FIXED MOBILE except aeronautical mobile 5.384A	BFWA (2500-2690 MHz) IMT (2500-2690 MHz)	The band 2 500-2 690 MHz is also used for BFWA in some SADC countries.
2 520-2 655 MHz FIXED 5.410 MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLIT 5.413 5.416 5.339 5.405 5.412 5.418B 5.418C	**2 520-2 655 MHz** FIXED MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLITE 5.413 5.416 5.405 5.412 5.418B 5.418C 5.339		
2 655-2 670 MHz FIXED 5.410 MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLITE 5.208B 5.413 5.416 Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149 5.412	**2 655-2 670 MHz** FIXED MOBILE except aeronautical mobile 5.384A 5.149 5.412		
670-2 690 MHz FIXED 5.410 MOBILE except aeronautical mobile 5.384A Earth exploration-satellite (passive) Radio astronomy Space research (passive) 5.149 5.412	**2 670-2 690 MHz** FIXED MOBILE except Aeronautical mobile 5.384A 5.149 5.412		

5.8.4 Options for Swaziland

The existing assignments should be migrated out to allow full utilisation of this band.

Options for channelization based on M. 1036/5 are:

Proposed IMT roadmap for consultation

1. Option C1 (2500-2570//2620-2690 MHz) used most widely worldwide (it is 3GPP-band 7).

   (a) IMT-FDD 2500-2570//2620-2690 MHz offers 2×70 MHz that can be assigned for;

      (i) 7×2×10 MHz for max 7 operators; or

      (ii) 2×2×20 MHz and 3×2×10 MHz for 5 operators; or

      (iii) 2×2×20 MHz and 2×2×15 MHz for 4 operators, or

      (iv) 2×2×20 MHz and 1×2×30 MHz for 3 operators, or

      (v) 1×2×40MHz and 1×2×30MHz for 2 operators

   (b) Guard bands of less prioritized usage from 2570-2575 MHz and 2615-2620 MHz in TDD band due to improved spectrum efficiency compared to guard bands in FDD band;

   (c) The centre gap of C1 2570-2620 (3GPP-band 38) can be deployed as follows:

      (i) 2575-2615 MHz TDD – offering 40 MHz TDD for outdoor macro cell coverage with 2 times 5MHz guard bands or

      (ii) 2570-2620 MHz TDD - offering 50MHz for indoor cells only

      The TDD-band should be assigned to <u>one</u> operator or at least with the obligation <u>to all licensees to use the same TDD downlink scheme to minimize guard band need</u>.

      (iii) There might arise a third option as a Supplementary Downlink

2. Migration Options

As an interim measure to release the IMT 2600 FDD band:

   (a) The existing SPTC WiMAX assignment could be migrate to the centre gap.

   (b) The fixed link assignments of SwaziMobile could move to 2025-2090//2200-2285MHz, at least for the short term.

The following option exists for the future use of IMT2600:

1. **Option 1**: Migrate WiMAX systems from the 2600 MHz frequency band within the 5-10 year timeframe – this will enable the full use of IMT2600 FDD
2. **Option 2**: Retain WiMAX systems in the 2600 MHz frequency band and introduce IMT2600 in available bandwidth – this will enable the partial use of IMT2600 FDD

The following channelling option is proposed for IMT2600 FDD and IMT2600 TDD:

1. **Option 1**: Adopt channelling arrangement B4 for the IMT 2600 FDD and IMT2600 TDD, which span respective frequency ranges 2500-2570//2620-2690 MHz and 2570 – 2620 MHz - this is a popular configuration in ITU Region 1

Proposed IMT roadmap for consultation

The following is proposed for the future assignment of the IMT2600:

1. **Option 1**: Assign all available spectrum bandwidth in IMT2600 FDD and IMT2600 TDD within the 5-10 year timeframe – noting that the amount of bandwidth available for IMT2600 will be dependent on the future treatment of WiMAX systems.

5.8.5 Initial Recommendations for Swaziland

1. It is recommended that channelling arrangement C1 for the IMT 2600 FDD and IMT2600 TDD, which span respective frequency ranges 2500-2570//2620-2690 MHz and 2570 – 2620 MHz be adopted. WiMAX systems must be migrated to enable the assignment of IMT200 FDD in the 5-10 year time frame. Moreover, IMT2600 TDD must be assigned in the 5-10 year timeframe.

5.9 3300-4990MHz

The applicable range for the present moment is 3300 – 3600 MHz. The frequency range 4 800-4 990 MHz has a mobile allocation and IMT identification for ITU regions 2 and 3 only and is not currently applicable to African countries, but may be in the future.

5.9.1 ITU Radio Recommendations

ITU Recommendation ITU-R M.1036-5 (10/2015) indicates that the recommended frequency arrangements for IMT in the band 3400-3600 MHz are summarized below:

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)	
F1					3 400-3 600
F2	3 410-3 490	20	3 510-3 590	100	None

Table 22: Frequency arrangements in the band 3400-3600 MHz

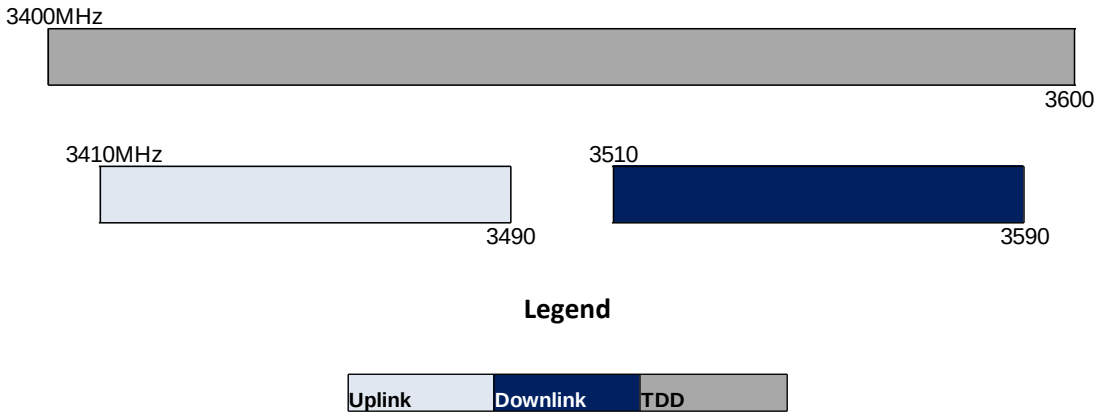


Figure 33: Frequency arrangements for 3400–3600MHz

The channelling arrangements for 3300 – 3400 MHz are currently under study in ITU WP 5D. The main issue here is ensuring that radiolocation services, which operate in the same band, are not subjected to harmful interference.

5.9.2 SADC Frequency Allocation Plan

The SADC Frequency Allocation Plan proposes that the 3400-3600 MHz be utilised for IMT and BFWA.

Proposed IMT roadmap for consultation

The 3400-3600 MHz band is currently used for mainly BFWA systems in various SADC countries and, as from 17 November 2010, is also allocated to mobile services identified for IMT.

The SADC FAP recognizes that frequency channelization of several key frequency bands must be developed and preferably harmonized throughout SADC. The frequency bands used for IMT, BFWA, PTP microwave systems, etc. will be considered. Channelling plans will be added to the SADC Band Plan in future, as required.

ITU Region 1 allocations and footnotes	SADC common allocation/s and relevant ITU footnotes	SADC proposed common sub-allocations/utilization	Additional information
3 300-3 400 MHz RADIOLOCATION 5.149 5.429 5.429A 5.429B 5.430	**3 300-3 400 MHz** RADIOLOCATION 5.149 5.429 5.429B 5.429A	IMT Res. 223 (Rev.WRC-15)	
3 400-3 600 MHz FIXED FIXED-SATELLITE (space to-Earth) MOBILE except aeronautical mobile 5.430A Radiolocation 5.431	**3 400-3 600 MHz** FIXED MOBILE except aeronautical mobile 5.430A SADC16 Radiolocation	BFWA IMT (3400-3600 MHz)	The band 3400 -3600 MHz is also used for BFWA in some SADC countries
3 600-4 200 MHz FIXED FIXED-SATELLITE (space to-Earth) Mobile	**3 600-4 200 MHz** FIXED FIXED-SATELLITE (space-to- Earth) SADC17	Fixed services (PTP) (3600-4200 MHz) Fixed-satellite (space-to-Earth) (PTP/VSAT/SNG) (3600-4200 MHz) **Broadband Fixed Wireless Access (BFWA) (3600-3800 MHz)**	**The sub-band 3 600-3 800 MHz could be used for BFWA where frequency sharing with FS PTP and/or FSS is feasible**. The channelling arrangement for PTP links in this band is based on ITU-R Recommendation F.635 Annex 1. The sub-band 3 600-4 200 MHz is used for medium and high capacity PTP links and FSS. In the band 3 600-3 800 MHz, BFWA, FS PTP and FSS applications will have to operate on coordinated basis. **However, considering the difficulty in coordinating ubiquitous user terminals used for BFWA and VSAT, it is proposed that VSAT systems be migrated to the Ku-band.**
4 400-4 500 MHz FIXED MOBILE 5.440A	**4 400-4 500 MHz** FIXED MOBILE	Government use	

Proposed IMT roadmap for consultation

4 500-4 800 MHz FIXED FIXED-SATELLITE (space-to-Earth) 5.441 MOBILE 5.440A	**4 500-4 800 MHz** FIXED FIXED-SATELLITE (space-Earth) 5.441 MOBILE	Government use	The band 4500-4800 MHz is part of the APP30B Plan (FSS space-to-Earth). Refer to Annex B.
4 800-4 990 MHz FIXED MOBILE 5.440A 5.441A 5.441B 5.442 Radio astronomy 5.1495.3395.443	**4 800-4 990 MHz** FIXED MOBILE5.442 Radio Astronomy 5.149 5.339	Government use	
4 990-5 000 MHz FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY Space research (passive) 5.149	**4 990-5 000 MHz** FIXED MOBILE except Aeronautical Mobile RADIO ASTRONOMY Space Research (passive) 5.149	Government use	

5.9.3 Swaziland National Frequency Allocation Plan (NFAP) 2017

The NFAP of 2017 is aligned with the SADC plan.

ITU Region 1 allocations and footnotes	Swaziland allocation/s and relevant ITU footnotes	Utilization	Additional information
3 300-3 400 MHz RADIOLOCATION 5.149 5.429 5.429A 5.429B 5.430	**3 300-3 400 MHz** RADIOLOCATION 5.149 5.429 5.429B 5.429A	IMT Res. 223 (Rev.WRC-15)	
3 400 - 3 600 MHz FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile 5.430A Radiolocation 5.431	**3 400 -3 600 MHz** FIXED MOBILE except aeronautical mobile 5.430A Radiolocation	BFWA IMT (3400-3600 MHz)	The band 3 400-3 600 MHz is used for BFWA in some SADC countries,
3 600 - 4 200 MHz FIXED FIXED-SATELLITE (space-to-Earth) Mobile	**3 600 - 4 200 MHz** FIXED FIXED-SATELLITE (space-to-Earth)	Fixed services (PTP) (3600-4200 MHz) Fixed-satellite (space-to-Earth) (PTP/VSAT/SNG) (3600-4200 MHz) **Broadband Fixed Wireless Access (BFWA) (3600-3800 MHz)**	**The sub-band 3 600-3 800 MHz could be used for BFWA where frequency sharing with FS PTP and/or FSS is feasible**. The channelling arrangement for PTP links in this band is based on ITU-R Recommendation F.635 Annex 1. The sub-band 3600-4 200 MHz is used for medium and high capacity PTP links and FSS. In the band 3 600-3 800 MHz, BFWA, FS PTP and FSS applications will have to operate on coordinated basis. **However, considering the difficulty in coordinating**

Proposed IMT roadmap for consultation

			ubiquitous user terminals used for BFWA and VSAT, it is proposed that VSAT systems be migrated to the Ku-band.
4 400 -4 500 MHz FIXED MOBILE 5.440A	**4 400 - 4 500 MHz** FIXED MOBILE	Government use	
4 500 - 4 800 MHz FIXED FIXED-SATELLITE (space-to-Earth) 5.441 MOBILE 5.440A	**4 500 - 4 800 MHz** FIXED FIXED-SATELLITE (space-to-Earth) 5.441 MOBILE	Government use	The band 4 500 – 4 800 MHz is part of the APP30B Plan (FSS space-to-Earth). Refer to Annex B.
4 800 - 4 990 MHz FIXED MOBILE 5.440A 5.441A 5.441B 5.442 Radio astronomy 5.149 5.339 5.443	**4 800 - 4 990 MHz** FIXED MOBILE 5.442 Radio Astronomy 5.149 5.339	Government use	
4 990 - 5 000 MHz FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY Space research (passive) 5.149	**4 990 - 5 000 MHz** FIXED MOBILE except Aeronautical Mobile RADIO ASTRONOMY Space Research (passive) 5.149	Government use	

Resolution 223 (REV. WRC 15) states:

4. *this conference has identified the frequency band 3300-3400 MHz for use by administrations wishing to implement terrestrial IMT systems*
5. *the frequency band 3 300-3 400 MHz is allocated worldwide on a primary basis to the radiolocation service*
6. *a number of administrations use the frequency band 3300-3400 MHz, or portions thereof, which is allocated to the fixed and mobile services on a primary basis*
7. *the frequency band 4800-4990 MHz is allocated worldwide to the mobile service on a primary basis*
8. *this conference has identified the frequency band 4800-4990 MHz for use by administrations wishing to implement terrestrial IMT systems; appropriate technical measures may be considered by administrations at a national level to facilitate adjacent band compatibility between radio astronomy receivers in the frequency band 4990-5000 MHz and IMT systems in the frequency band 4800-4990 MHz*

and invites ITU-R

9. *to further study operational measures to enable the coexistence of IMT and radiolocation service in the frequency band 3300-3400 MHz*
10. *to develop harmonized frequency arrangements for the frequency bands 3300-3400 MHz and 4800-4990 MHz for operation of the terrestrial component of IMT, taking into account the results of the sharing studies;*

Other Resolutions

11. *Resolution 154 (REV.WRC-15) the frequency band 3400-4200 MHz is allocated worldwide to the fixed-satellite service (FSS) in the space-to-Earth direction and to*

the fixed service on a primary basis; the frequency band 3 400-3 600 MHz is allocated on a primary basis to the mobile, except aeronautical mobile, service and identified for International Mobile Telecommunications (IMT) in Region 1 countries as specified in Article 5 of the Radio Regulations; in Region 1, the allocation to the mobile, except aeronautical mobile, service in the frequency band 3 400-3 600 MHz is subject to technical and regulatory conditions aimed at ensuring compatibility with co-primary services of neighbouring countries;

12. *Reference may also be made to Resolution 157 (WRC-15) Study of technical and operational issues and regulatory provisions for new non-geostationary-satellite orbit systems in the 3700-4200 MHz, 4500-4800 MHz, 5925-6425 MHz and 6725-7025 MHz frequency bands allocated to the fixed-satellite service.*

5.9.4 Options for Swaziland

The 3400-3600MHz band is unoccupied and could be deployed immediately.

The band has a very large bandwidth, but high propagation loss and penetration loss; making is less useful in the short term.

There is a worldwide trend to use higher bands for TDD to encourage more flexible uplink or downlink schemes. For the IMT 3400-3600 band there would be more capacity available with TDD with 200 MHz permitted as opposed to 2×80 MHz in FDD. In addition, IMT3500 is frequently used for WIMAX-TDD so far, many of whom migrate to LTE, so the ecosystem is favourable for TDD.

TDD-bands 42 (3400-3600 MHz) and 43 (3600-3800MHz) are used for WiMAX in many countries, but with a general worldwide move to LTE. Trials demonstrated a seamless TDD-LTE option over existing WiMAX infrastructure, offering a smooth migration path from WiMAX to TDD-LTE;

Potential arrangements in Swaziland for 3300-3600MHz. *Extension to 3800 will depend if this being adopted by the African countries in the longer term.*

1. Full IMT-TDD usage with larger TDD downlink schemes in the lower part of the band and reduced smaller part with TDD uplink schemes in the higher part due to coverage degradation of uplink schemes, therefore almost comparable coverage areas;
    (a) It could be decided based on traffic and asymmetry requirements which option might be chosen finally;
    (b) Between TDD downlink and TDD uplink schemes at least 5 MHz are needed;
2. In the long term, 3300-3800 would be the next 5G band with at least small coverage (compared to 5GHz-WiFi-usage). However, considerations for 3300-3800 MHz is dependent on outcome of studies being conducted in ITU-R working party 5D.
3. Higher bands are expected to be very short range hotspot coverages for high capacities. Hotspots as are understood globally are not present in the Swazi

landscape as even Mbabane and Manzini – Matshapa do not really have the sort of intense concentrations of demand that require a high capacity low coverage band, the lower bands will provide plenty of capacity, even for these.

The following option exists for the future use of IMT3500:

1. **Option 1**: : Combine the IMT frequency range 3400 – 3600 MHz with the recently identified IMT frequency range 3300 – 3400 MHz to potentially form a 300 MHz contiguous IMT frequency band –the implementation of this option will be subject to the outcome of technical studies underway at ITU-R Working Party 5D

The following channelling option is proposed for IMT3500:

1. **Option 1**: Adopt channelling arrangement F1 for IMT3500 and also adopt a full TDD channelling arrangement for IMT3350, which spans the frequency range 3300 – 3400 MHz.- the implementation of a full TDD channelling configuration in 3300 – 3400 MHz is dependent on the outcome of studies being conducted in ITU Working Party 5D

The following is proposed for the future assignment of the IMT3500:

1. **Option 1**: Assign all available spectrum bandwidth in IMT3500 TDD and IMT3350 TDD within the next 10 – 15 year timeframe – This will allow sufficient time for the conclusion of studies and for ecosystem development.

5.9.5 Initial Recommendations for Swaziland

1. It is recommended that channelling arrangement F1 be adopted for the frequency range 3400 – 3600 MHz. It is preferred that a full TDD implementation in 3300 – 3400 MHz is adopted, however this is dependent on the outcome of studies at ITU Working Party 5D. IMT3500 TDD to be assigned within the 10 – 15 year timeframe.
2. Higher bands up to 4990MHz need to be officially identified first as IMT bands for Region 1 and endorsed at regional level. An ecosystem needs to evolve before deployment in Swaziland can be considered

5.10 Overview of Higher Bands

With respect to the search for new spectrum bands (either for 4G or 5G), the anticipated demand (globally) for more bandwidth requires spectrum beyond 10GHz with the attendant disadvantages of reduced coverage or indoor only usage. Larger bandwidths require higher throughputs which can only be enabled by deploying fibre for backhauling. Consequently, deployment of IMT in higher bands results in higher costs due to:

1. Higher site density due to reduced coverage; even if no homogeneous area coverage is expected for all higher bands, it is not expected to have fixed wireless backhaul access by microwave, so
2. Expensive fibre access per site (access point) are assumed or
3. Other massive MIMO technology based point-to-multi-point backhauling in higher bandwidths could be used.

All these issues need to be considered when designing a mobile wireless access system

5.10.1 ITU Resolution 238

The use of higher bands is reflected in RESOLUTION 238 (WRC-15) - Studies on frequency-related matters for International Mobile Telecommunications identification including possible additional allocations to the mobile services on a primary basis in portion(s)of the frequency range between 24.25 and 86 GHz for the future development of International Mobile Telecommunications for 2020 and beyond, with the following actions:

resolves to invite ITU-R

1 to conduct and complete in time for WRC-19 the appropriate studies to determine the spectrum needs for the terrestrial component of IMT in the frequency range between 24.25 GHz and 86 GHz, taking into account:

- *technical and operational characteristics of terrestrial IMT systems that would operate in this frequency range, including the evolution of IMT through advances in technology and spectrally efficient techniques;*
- *the deployment scenarios envisaged for IMT-2020 systems and the related requirements of high data traffic such as in dense urban areas and/or in peak times;*
- *the needs of developing countries;*
- *the time-frame in which spectrum would be needed;*

2 to conduct and complete in time for WRC-19 the appropriate sharing and compatibility studies1, taking into account the protection of services to which the band is allocated on a primary basis, for the frequency bands:

- *24.25-27.5 GHz, 37-40.5 GHz, 42.5-43.5 GHz, 45.5-47 GHz, 47.2-50.2 GHz, 50.4-52.6 GHz, 66-76 GHz and 81-86 GHz, which have allocations to the mobile service on a primary basis; and*
- *31.8-33.4 GHz, 40.5-42.5 GHz and 47-47.2 GHz, which may require additional allocations to the mobile service on a primary basis,*

5.10.2 Options for Swaziland

Some of the bands cited in Resolution 238 may eventually be considered for 5G, Swaziland, like other African countries may choose to deploy 5G in lower frequencies rather than high frequencies because of considerations of coverage.

5.10.3 Initial Recommendations for Swaziland

These are pending the outcome of the studies and WRC 19.

5.11 Considerations of 5G

The IMT road map is focussed on making spectrum available for IMT in general in which 5G (IMT 2020) is included. 5G is in the process of development, but consideration can be given to the use case for 5G.

Three principal use cases have been defined for 5G, namely:

1. Enhanced mobile broadband;
2. ultra-reliable low-latency communications and
3. massive machine type communications.

Each use imposes a particular spectrum requirement, for example an appropriate blend of sub 1 GHz and high frequency spectrum will be needed for enhanced mobile broadband, whereas ultra-reliable low-latency and massive machine type communications will typically be deployed in sub 1 GHz frequency bands. Therefore, it is imperative that sufficient spectrum bandwidth is available. For example, the use of IMT700, IMT 2300 and IMT3500 for early 5G deployments in Africa has been speculated but no formal arrangements have yet been made. Furthermore, the 36 GHz, 32 GHz and 42 GHz frequency bands may be eventually deployed for 5G, pending the conclusion of WRC-19.

For Swaziland, the critical elements are widespread adoption of the band for IMT 2020 (5G), which implies harmonized channelling arrangements and the existence of a robust ecosystem.

As noted above, Swaziland may choose to deploy 5G in lower frequencies rather than high frequencies because of considerations of coverage.

5.12 Time Frame

The time frame is driven by the following considerations:

1. To ensure maximal use of established bands (900, 1800 and 2100) with an established ecosystem allowing immediate implementation.
2. To focus on lower bands given the need for coverage in consideration of Swaziland population densities, i.e. a lack of dense urban areas.
3. To ensure that the frequencies available are used optimally to ensure maximum data speeds, but at the same time to reserve spectrum for 5G.

Appendix A Glossary

2G, GSM	Means 2G Mobile Technology including GSM
3G	means 3G or 3rd generation mobile telecommunications is a generation of standards for mobile phones and mobile telecommunication services fulfilling the International Mobile Telecommunications-2000 (IMT-2000) specifications by the ITU
3GPP	means the 3rd Generation Partnership Project (3GPP) which consists of six telecommunications standard development organisations
4G, LTE	4G Mobile Technology including LTE and LTE-A
5G	means 5th Generation technology – currently under development
Act	means the Electronic Communications Act, 2013;
Amateur	means a person who is interested in the radio technique solely for a private reason and not for financial gain and to whom the Authority has granted an amateur radio station licence and shall mean a natural person and shall not include a juristic person or an association: provided that an amateur radio station licence may be issued to a licensed radio amateur acting on behalf of a duly founded amateur radio association;
APT	means Asia-Pacific Telecommunity which is the focal organisation for ICT in the Asia-Pacific region. The APT has 38 member countries, 4 associate members and 131 affiliate members.
ATU	African Telecommunications Union
Assignment	means the authorisation given by the authority to a licensee to use a radio frequency or radio frequency channel under specified conditions;
Base station	means a land radio station in the land mobile service for a service with land mobile stations;
BFWA	means Broadband Fixed Wireless Access
BS	means Broadcast Service or Base Station
BTX	means Base Transceiver;
CA	means Carrier Aggregation
CDMA	means Code Division Multiplex Access
CEPT	means Conference of European Posts and Telecommunications Authorities;
CoMP	means Co-ordinated Multi Point

DAB	means Digital Audio Broadcasting which is a digital radio technology for broadcasting radio stations
DECT	means Digital Enhanced Cordless Telecommunications 1880 - 1900MHz which is a digital communication standard, primarily used for creating cordless phone systems
DF	means Dual Frequency
DRMASS	means Digital Radio Multiple Access Subscriber System
DTT	means Digital Terrestrial Television
DTT Mobile	means Digital Terrestrial Television for Mobile services
EIRP	means effective isotopically radiated power;
ERP	means effective radiated power, which is the product of the power supplied to an antenna and its gain relative to a half wave dipole in a given direction;
ECA	means the Electronic Communications ACT of Swaziland
EDGE	means Enhanced Data rates for GSM Evolution and is a digital mobile phone technology that allows improved data transmission rates as a backward-compatible extension of GSM
eMTC	Enhanced Machine Type Communication, used for all devices and communications with at least one part is a machine, see also IoT.
ETSI	means European Telecommunications Standards Institute
eUTRAN	means 4G, LTE network
FDD	means Frequency Division Duplex
FMP	means Frequency Migration Plan
FTBFP 2008	means Final Terrestrial Broadcast Frequency Plan of 2008
FWA	means Fixed Wireless Access
FWBA	means Fixed Wireless Broadband Access
Gbps	means Gigabits per second
GHz	means Gigahertz of Radio Frequency Spectrum;
GSM	means Global System for Mobile Communications,(originally Groupe Spécial Mobile), and is a standard set developed by the European Telecommunications Standards Institute (ETSI) to describe technologies for second generation (2G) digital cellular networks
GSM-R	means GSM for Railways
IEEE	means the Institute of Electrical and Electronics Engineers
IMT	means International Mobile Telecommunications

INMARSAT	means International Maritime Satellite
IoT	means Internet of Things connectivity between machine type devices without human interaction, mainly to ease consumers` life in monitoring and controlling systems, triggering alarms and actions, etc
ISM	means Industrial, Scientific and Medical
ITU	means International Telecommunication Union
ITU RR	means International Telecommunication Union Radio Regulations
kHz	means Kilohertz of Radio Frequency Spectrum
Ku	"Unteres K-Band" = lower part of K-band used from 10.7 to 12.75 GHz
Land mobile service	means a mobile radio-communication service between fixed stations and mobile land stations, or between land mobile stations
LMR	means Land Mobile Radio
LTE	means Long Term Evolution and 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
M2M	means Machine to Machine
MFN	means Multiple Frequency Networks
MHz	means Megahertz of Radio Frequency Spectrum;
MIMO	means Multiple-Input and Multiple-Output and is the use of multiple antennas at both the transmitter and receiver to improve communication performance
Mobile station	means a radio station that is intended to be operated while it is in motion or while it is stationary at an unspecified place
NFAP	Means National Frequency Allocation Plan
Non-specific Short Range Devices	means radio apparatus used for general telemetry, telecommand, alarms and data applications with a pre-set duty cycle (0.1%: S duty cycle< 100%)
OB	means Outside Broadcast
PAMR	means Public Access Mobile Radio
PLMN ID	Public Land Mobile Network Identification
PMR	means Public Mobile Radio and is radio apparatus used for short range two-way voice communications;
PPDR	means Public Protection and Disaster Relief as defined in ITU-R Report M.2033.
PtM	means Point to Multipoint

PtP	means Point to Point
RATG	means Radio Access Technology Group
Radio trunking	means a technique by means of which free channels out of a group of radio frequency channels allocated to a base station are automatically made available for the establishment of a connection between the stations of a user
Radio-communication	means all electronic communication by means of radio waves;
Relay or repeater station	means a land station in the land mobile service;
RFID	means Radio Frequency IDentification and is a wireless system that uses radio frequency communication to automatically identify, track and manage objects, people or animals. It consist of two main components viz, a tag and a reader which are tuned to the same frequency
RLAN	means Radio Local Access Network and is the high data rate two-way (duplex) wireless data communications network
SADC	means Southern African Development Community
SADC FAP	means Southern African Development Community Frequency Allocation Plan 2016
SDL	Means Supplementary Downlink
SF	means Single Frequency
Ship station	means a mobile station in the maritime mobile service that has been erected
SNG	means Satellite News Gathering
Spread spectrum	means a form of wireless communications in which the frequency of the transmitted signal is deliberately varied, resulting in a much greater bandwidth than the signal would have if its frequency were not varied
SRD	means Short Range Device and is a piece of apparatus which includes a transmitter, and/or a receiver and or parts thereof, used in alarm, telecommand telemetry applications, etc., operating with analogue speech/music or data (analogue and/or digital) or with combined analogue speech/music and data, using any modulation type intended to operate over short distances;
STL or Studio Links	means point to point links in the broadcasting frequency bands used to connect studios to transmitters
T-DAB	means Terrestrial Digital Audio Broadcasting
TDD	means Time Division Duplex
Telemetry	means the transmission of remotely measured data
TETRA	means Terrestrial Trunked Radio and is a professional mobile radio [2] and two-way transceiver specification. TETRA was specifically designed for use by

	government agencies, emergency services, (police forces, fire departments, ambulance) for public safety networks, rail transportation staff for train radios, transport services and the military. TETRA is an ETSI standard.
UE	means user equipment
UHF	means Ultra High Frequency
UL	Uplink
UMTS	means Universal Mobile Telecommunications System is a third generation mobile cellular technology for networks based on the GSM standard
VHF	means Very High Frequency
Video Surveillance Equipment	means radio apparatus used for security camera purposes to replace the cable between a camera and a monitor
VSAT	means Very Small Aperture Terminal and is a two-way satellite ground station that is smaller than 3 metres in diameter
Wideband Wireless Systems	means radio apparatus that uses spread spectrum techniques and has a high bit rate;
WiMAX	means Worldwide Interoperability for Microwave Access, also known as WirelessMAN which is a wireless broadband standard
WP 5D	means ITU-R Working Party 5D - IMT Systems
WRC 07	means World Radio Conference 2007 held in Geneva
WRC 12	means World Radio Conference 2012 held in Geneva
WRC 15	means the World Radio Conference 2015 held in Geneva
WRC-19	means the World Radio Conference planned to held in 2019

Appendix B Current use of Potential IMT Bands

IMT 450

.450-455 MHz		APPLICATION	FREQUENCIES ASSIGNED	
	Royal Swaziland Police Service	Analog Radio System	450	460
	Royal Swaziland Police Service	Analog Radio System	450.025	460.025
	Royal Swaziland Police Service	Analog Radio System	450.05	460.05
	Royal Swaziland Police Service	Analog Radio System	450.075	450.075
	Swaziland Railway	Private Radio System & PTP links	451.1	461.1
	His Majesty's Correctional Services	PMR	451	461
	Umbuto Swaziland Defence Force	PMR	452.0157	463.0581
	His Majesty's Correctional Services	PMR	452.025	462.025
	His Majesty's Correctional Services	PMR	452.1	462.1
	His Majesty's Correctional Services	PMR	452.125	462.165
	Umbuto Swaziland Defence Force	PMR	452.5981	463.5481
	Umbuto Swaziland Defence Force	PMR	453.0748	464.0973
	Umbuto Swaziland Defence Force	PMR	453.5732	464.5904
	Umbuto Swaziland Defence Force	PMR	454.0839	465.0386
	Umbuto Swaziland Defence Force	PMR	454.5163	465.5259
455-456 MHz				
	Umbuto Swaziland Defence Force	PMR	455.0361	466.0481
	Umbuto Swaziland Defence Force	PMR	455.5591	466.548
	Swaziland Railway	Private Radio System	455.625	465.625
	Swaziland Railway	Private Radio System	455.975	465.975
	Swaziland Railway	Private Radio System	455.9875	465.9875
	Swaziland Railway	Private Radio System	456.0875	466.0875
	Swaziland Railway	Private Radio System	456.125	466.125
	Swaziland Railway	Private Radio System	456.25	466.25
	Swaziland Railway	Private Radio System	456.6	466.6
	Swaziland Railway	Shunting	455.7875	455.7875
	Swaziland Railway	Shunting	455.825	455.825
	Swaziland Railway	Shunting	465.7875	465.7875
	Swaziland Railway	Shunting	465.825	465.825
456-459 MHz				
	Umbuto Swaziland Defence Force	PMR	456.0185	467.0157
	Umbuto Swaziland Defence Force	PMR	456.5274	467.5195
	Umbuto Swaziland Defence Force	PMR	457.0259	468.0369
	Umbuto Swaziland Defence Force	PMR	457.5892	468.5471
	Umbuto Swaziland Defence Force	PMR	458.0274	469.0175
	Umbuto Swaziland Defence Force	PMR	458.5038	469.5083

Proposed IMT roadmap for consultation

459-460 MHz				
	Umbuto Swaziland Defence Force	PMR	459.0471	470.0013
	Umbuto Swaziland Defence Force	PMR	459.5694	470.5012
460-470				

Proposed IMT roadmap for consultation

IMT 800

790-862 MHz	APPLICATION	FREQUENCIES ASSIGNED	
Swaziland Broadcasting and Information Service	SBIS links to Tx	851.1	846.1
Swaziland Broadcasting and Information Service	SBIS links to Tx	851.1	856.1
Swaziland Broadcasting and Information Service	SBIS links to Tx	856.1	861.1
Swaziland Broadcasting and Information Service	SBIS links to Tx	856.95	857.95
Swaziland Broadcasting and Information Service	SBIS links to Tx	859.95	858.95
Swaziland Broadcasting and Information Service	SBIS links to Tx		859.95

IMT 850 and IMT 900

790-862 MHz	APPLICATION	FREQUENCIES ASSIGNED	
Swaziland Post and Telecoms (SPTC)	CDMA	870.495-871.725	825.495-836.725
Swaziland Post and Telecoms (SPTC)	CDMA	871.725-874.185	826.725-829.185
Swaziland Post and Telecoms (SPTC)	CDMA	874.185-875.415	829.185-830.415
Swazi Mobile	GSM (2G)	882.5	927.5
Swaziland Post and Telecomms (SPTC)	GSM (2G)	892.5	937.5
Swaziland Post and Telecomms (SPTC)	GSM (2G)	897.5	942.5
MTN Swaziland	GSM (2G)	902.5	947.5
MTN Swaziland	GSM (2G)	907.5	952.5
Swazi Mobile	GSM (2G)	912.5	957.5

IMT 1800

790-862 MHz	APPLICATION	FREQUENCIES ASSIGNED	
MTN Swaziland	GSM (2G/4G)	1712.5	1807.5
MTN Swaziland	GSM (2G/4G)	1717.5	1812.5
MTN Swaziland	GSM (2G/4G)	1722.5	1817.5
MTN Swaziland	GSM (2G/4G)	1727.5	1822.5
Swaziland Post and Telecoms (SPTC)	GSM (2G/4G)	1732.5	1827.5
Swaziland Post and Telecoms (SPTC)	GSM (2G/4G)	1737.5	1832.5
Swaziland Post and Telecoms (SPTC)	GSM (2G/4G)	1742.5	1837.5
Swaziland Post and Telecoms (SPTC)	GSM (2G/4G)	1747.5	1842.5
Swazi Mobile	GSM (2G/4G)	1752.5	1847.5
Swazi Mobile	GSM (2G/4G)	1757.5	1852.5
Swaziland Post and Telecoms (SPTC)	Microwave	1846.5	1727.5
Swaziland Post and Telecoms (SPTC)	Microwave	1871	1752
Swaziland Post and Telecoms (SPTC)	DRMASS	1880	1900

Proposed IMT roadmap for consultation

IMT 2100

1 930-1 970 MHz		APPLICATION	FREQUENCIES ASSIGNED	
	MTN Swaziland	GSM (2G/4G)	1712.5	1807.5
	MTN Swaziland	GSM (2G/4G)	1717.5	1812.5
	MTN Swaziland	GSM (2G/4G)	1722.5	1817.5
	MTN Swaziland	GSM (2G/4G)	1727.5	1822.5
	Swaziland Post and Telecoms (SPTC)	GSM (2G/4G)	1732.5	1827.5
	Swaziland Post and Telecoms (SPTC)	GSM (2G/4G)	1737.5	1832.5
	Swaziland Post and Telecoms (SPTC)	GSM (2G/4G)	1742.5	1837.5
	Swaziland Post and Telecoms (SPTC)	GSM (2G/4G)	1747.5	1842.5
	Swazi Mobile	GSM (2G/4G)	1752.5	1847.5
	Swazi Mobile	GSM (2G/4G)	1757.5	1852.5
	Swaziland Post and Telecoms (SPTC)	Microwave	1846.5	1727.5
	Swaziland Post and Telecoms (SPTC)	Microwave	1871	1752
	Swaziland Post and Telecoms (SPTC)	DRMASS	1880	1900

IMT 2100

1 710-1 930 MHz		APPLICATION	FREQUENCIES ASSIGNED	
	MTN Swaziland	GSM (3G)	1922.5	2112.5
	MTN Swaziland	GSM (3G)	1927.5	2117.5
	MTN Swaziland	GSM (3G)	1932.5	2122.5
	Swaziland Post and Telecoms (SPTC)	GSM (3G)	1937.5	2127.5
	Swaziland Post and Telecoms (SPTC)	GSM (3G)	1942.5	2132.5
	Swaziland Post and Telecoms (SPTC)	GSM (3G)	1947.5	2137.5
	Swazi Mobile	GSM (3G)	1957.5	2147.5
	Swazi Mobile	GSM (3G)	1962.5	2152.5
	Swaziland Post and Telecoms (SPTC)	Microwave	1951	2164

IMT 2300

2 300-2 450 MHz		APPLICATION	FREQUENCIES ASSIGNED	
	Swaziland Post and Telecoms (SPTC)	DRMASS	2308	2402
	Swaziland Post and Telecoms (SPTC)	DRMASS	2316	2410
	Swaziland Post and Telecoms (SPTC)	DRMASS	2320	2414
	Swaziland Post and Telecoms (SPTC)	DRMASS	2324	2418
	Swaziland Post and Telecoms (SPTC)	DRMASS	2328	2422
	Swaziland Post and Telecoms (SPTC)	DRMASS	2332	2426
	Swaziland Post and Telecoms (SPTC)	DRMASS	2356	2450
	Swaziland Post and Telecoms (SPTC)	DRMASS	2364	2458
	Swaziland Post and Telecoms (SPTC)	DRMASS	2380	2474
	Swaziland Post and Telecoms (SPTC)	DRMASS	2384	2478
	Swaziland Post and Telecoms (SPTC)	DRMASS	2402	2430

Proposed IMT roadmap for consultation

	Swaziland Post and Telecoms (SPTC)	DRMASS	2406	2312
	Swaziland Post and Telecoms (SPTC)	DRMASS	2430	2336
	Swaziland Post and Telecoms (SPTC)	DRMASS	2438	2344
2 450-2 483.5 MHz				
	Swaziland Post and Telecoms (SPTC)	DRMASS	2466	2372
	Swaziland Post and Telecoms (SPTC)	DRMASS	2470	2376

IMT 2600

2 483.5-2 500 MHz	**APPLICATION**	**FREQUENCIES ASSIGNED**	
Swaziland Post and Telecoms (SPTC)	WiMax	2490-2540	
2 520-2 655 MHz			
Swazi Mobile	Microwave	2550	2680
Swazi Mobile	Microwave	2555	2685