GENERAL NOTICE NO. 12, 2017

PROPOSED DECISION IN TERMS OF SECTION 32 OF THE SWAZILAND COMMUNICATIONS COMMISSION ACT, 2013: RADIO FREQUENCY SPECTRUM PRICING MODEL FOR CONSULTATION

INVITATION FOR WRITTEN REPRESENTATIONS.

The Swaziland Communications Commission, hereinafter referred to as the Commission, has developed a Spectrum Pricing Model in accordance with Section 34 of the Electronic Communications Act,2013 and Regulation 16 of the Electronic Communications (Radio Communications and Frequency Spectrum) Regulations, 2016.

The Spectrum Pricing Model was developed according to the parameters stipulated in Regulation 17 of the Electronic Communications (Radio Communications and Frequency Spectrum) Regulations, 2016 which states that the Commission shall adopt a pricing formula that reflects the economic value of frequency spectrum in order to encourage efficient use of frequency spectrum and stimulate growth.

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 17th 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 Spectrum Pricing Model for Consultation

Version 1

4th October 2017

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1 Introduction

1.1 Background

The Commission intends to revise the **Schedule of Spectrum Fees** (The Electronic Communications Act 2013 [Act No. 09 of 2013) Electronic Communications [Radio Frequency Spectrum) Regulations 2016).

This is as per the following requirement stated in the Spectrum Regulations.

17. (1) The Commission shall adopt a pricing formula that reflects the economic value of frequency spectrum in order to encourage efficient use of frequency spectrum and stimulate growth.

(2) The pricing formula adopted under sub-regulation (1) shall take into account the-

(a) size of spectrum assigned;

(b) frequency band and level of congestion within the band;

(c) market demand;

(d) power output;

(e) geographical usage; and

(f) such other factors as the Commission may from time to time determine.

(3) The Commission shall review and publish the pricing formula for frequency spectrum at least once in every three (3) years.

The present fees are no longer in line with the regulations and a new schedule of fees needs to be created.

The Intentions of the Commission are summarised in Chapter 2 and the draft schedule of fees is in the appendix.

1.2 Invitation to comment

The Commission invites comments on the proposed schedule of spectrum fees.

2 The Intentions of the Commission - Summary

The intention of the Commission is to introduce a system of spectrum fees that are in line with Spectrum regulations and meet the following criteria:

- Promote efficient use of spectrum.
- Prevent stockpiling of spectrum.
- Provide incentives to move to less congested spectrum.
- Provide incentives to hand back spectrum that is not needed.
- Encourage users to switch to spectrally efficient technologies.
- Reflects the relative economic value of spectrum
- Be forward looking, technologically neutral and sustainable.
- Be user friendly and easy to implement.
- Be flexible and be tuneable to meet alternative spectrum fee revenue objectives.
- Stimulate economic growth.
- Be appropriate for Swaziland conditions and SCCOM resources.

The proposed model is an administrative pricing model with incentives to promote the efficient use of spectrum and national development. Moreover, it is a unified pricing model that reflects the relative value of different spectrum bands and can be calibrated to cover regulatory costs or any other revenue target that may be specified.

The model contains four formulae consisting of several factors as follows:

Point to Area Formula
Fee = (UNIT * FREQ * BW * HD * GEO * SHR * AF)

Point to Point Formula
Fee = (UNIT * FREQ * BW *HD * GEO * SHR * HOPMINI)

Hub Ground Station Satellite Formula
Hub ground station Fee = Max ($\$_{UL}$; UNIT * BW_{UL})

Non-hub VSAT Ground Station Satellite Formula
Non-hub VSAT Fee = (UNIT * BW_{UL})

The factors used in in the model are as follows:

UNIT	Unit Price per MHz of assigned spectrum
BW	Bandwidth in MHz being the total unpaired assigned bandwidth
FREQ	Frequency factor that is based on the propagation characteristics of the frequency locations meaning that higher frequencies cost less than lower frequencies.

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GEO	Geographic factor that gives a discount to any assignment that does not cover high density areas.
HD	High Demand Factor set by the Commission for spectrum in High Demand which may include spectrum subject to congestion
SHR	Sharing factor that gives a discount of 50% to licensees who are prepared to share spectrum
AF	Area Factor that reflects the land area covered by a point to area assignment based on the radial distance that corresponds to the area in square kilometres
HOPMINI	Minimum Hop Length, which will be applied to point to point links and penalises licensees who make undue use of low frequency bands for links with relatively short hop lengths
BW_{UL}	The bandwidth of the uplink connection
$\$_{UL}$	The current minimum fee for satellite uplink connections

The proposed model charges licensees for the spectrum they use, incentivises them to only use the spectrum they need and to use such spectrum efficiently. It is also intuitively fair to all users, especially as a uniform Unit Price is charged.

It is proposed that the HOPMINI factor is set at one (unity) until the three year review to allow the hop lengths to be calculated. In addition, it is proposed that the GEO factor is set to 1 pending the definition of high and low density population areas. The High Demand factor, imposes a premium on certain “High Demand” frequency bands, as designated by the Commission. This factor is used instead of a congestion factor. The frequency band to which the High Demand factor will be applied may be updated by the Commission during its triennial reviews.

The three year reviews will also assess the Unit Price in terms of prevailing inflation, any increase or decrease in the number of assignments

It is proposed to set the Unit Price at SZL 2,000 for the first three years.

3 Review of Laws & Regulations

3.1 Objective

The objective of this section is to review existing laws and regulations that govern the usage of radio spectrum and pricing thereof, in relation to the International Telecommunications Union and other international organisations.

3.2 ITU Guidelines

The radio frequency spectrum is a fundamentally scarce resource and accordingly it has to be managed effectively, a process in which pricing plays its part. There are almost as many perceptions of the role of pricing in spectrum management as there are countries.

The ITU can only issue guidelines on the matter of spectrum fees and over the years has prepared a series of such guidelines, the earliest one of relevance being its 1993 recommendations[1] for setting spectrum prices.

Recent reports have been made by two groups of the ITU.

ITU-R - Study Group 1 has been producing a report series on the Economic aspects of spectrum management since 1998, the latest version of which was produced in 2016[2].

ITU-D Study Group 2 has also produced, in 2016, Guidelines for the establishment of a coherent system of Radio Frequency Usage Fees[3] taking into account the aforementioned study on Economic aspects of spectrum management.

A further report 'Guidelines for the review of spectrum pricing methodologies and the preparation of spectrum fees schedules" was published in 2016, referencing the above reports.

The purpose of the ITU studies is to create awareness of the different spectrum pricing methodologies and to move to a greater consensus regarding how spectrum pricing is carried out. It must be emphasized that guidelines are not recommendations, there is no compulsion for ITU member states to follow any of the guidelines. Nevertheless, these guidelines are useful in showing the different approaches and permitting regulatory authorities to choose an appropriate approach for a given period of time.

'Guidelines for the review of spectrum pricing methodologies and the preparation of spectrum fees schedules" enunciated the following principles and objectives:

[1] ITU (1993): Spectrum Pricing Study, Commission Study Groups, ITU-R, SM.2012 – this is cited (with commentary) in Martin Cave, Chris Doyle and William Webb, "Essentials of Modern Spectrum Management", Cambridge University Press 2007.
[2] Report ITU-R SM.2012-5 (06/2016) Economic Aspects of Spectrum Management
[3] ITU-D Study Group 2, 4th Study Period (2006-2010) 'Guidelines for the establishment of a coherent system of Radio Frequency Usage Fees' (separate publication to Resolution 9 report). This document responds to the request contained in resolves 2 of Resolution 9 (Rev. Doha, 2006) "to continue the development of the SF Database and provide additional guidelines and case studies, based on the practical experiences of administrations

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Regarding spectrum price principles:

- Spectrum should be allocated to the highest value use or uses to ensure maximum benefits to society are realized.
- Mechanisms should be put in place to enable and encourage spectrum to move to its highest value use.
- Greater access to spectrum will be facilitated when the least cost and least restrictive approach is chosen in achieving spectrum management goals and objectives.
- To the extent possible, regulators and spectrum managers need to promote both regulatory certainty and flexibility in how spectrum is used.
- Balance should be achieved between the cost of interference and the benefits obtainable from greater spectrum utilization.
- Fairness and objectivity require that fees are based on objective factors and all licence holders in a given frequency band should be treated on an equitable basis. This would preclude, for example, different treatment of different users in a given frequency band.
- Transparency requires that the basis on which fees are calculated should be made clear in a published document resulting from consultation with stakeholders and that all fees should be set based on a published schedule.
- Administrative costs will be lower if the fee schedule is simple to administer. The simplest fee schedule would be one involving a flat fee payment; however this may not promote efficient spectrum use.
- Administrative simplicity needs to be balanced against the requirement to encourage efficiency of spectrum use if fees are set taking account of parameters such as bandwidth, frequency band or coverage.
- Spectrum fees should be reviewed at suitable intervals in order to cater for changes in economic KPIs (key performance indicators) or advancement in technologies resulting in increased demand of a particular band.
- Mechanisms should be in place to avoid, detect and where necessary prevent spectrum hoarding, which will deter competition.
- A balance should be established between financial approach and other key facets – regulatory (competition), social (universal service).

Regarding spectrum price objectives:

- Spectrum prices should promote efficient use of spectrum. As a vital natural resource, the price of spectrum should be sufficient to ensure that it is valued and used wisely. Use of spectrum provides considerable benefits to the economy and benefits from spectrum should be maximized.
- The costs associated with managing and regulating radio frequencies (including monitor and control) should be recovered from those who benefit from spectrum management activities. This should apply to all users of spectrum – both public and private.

- Important social and cultural objectives can be advanced by use of the spectrum and spectrum pricing should facilitate the achievement of government social and cultural objectives.

These recommendations are fairly broad, the intention of the ITU is to generate a certain level of consistency in spectrum pricing without being too prescriptive.

3.3 Swaziland Laws and Regulations

In this section on Swaziland regulations, the parts pertinent to radio frequency spectrum pricing are extracted and commented on.

3.3.1 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:

> (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;*
>
> *(e) in collaboration with the Minister, prescribe fees for the use of the radio frequency spectrum;*

Section 35. includes the following pertinent conditions regarding requirements for radio frequency spectrum licences.

> *(1) With the exception of broadcast receivers, a person shall not use a radio frequency spectrum that has not specifically been allocated to that person through a licence issued by the Commission in accordance with the national radio frequency plan.*
>
> *(5) The Commission may, for the purpose of assigning radio frequency spectrum, use competitive bidding procedures if the Commission determines that it would be in the public interest where -*
>
> > *(a) a licence is to be granted to a new applicant; or*
> >
> > *(b) competing and mutually exclusive applications have been filed by qualified applicants.*
>
> *(6) The Commission shall prescribe rules and procedures that shall ensure that only bona fide bidders participate in bidding.*

The above section establishes the right to conduct competitive bidding procedures at its discretion, competitive processes is usually taken to include the following: beauty contest

where the bidders are evaluated on their proposals but price is not necessarily a determining factor or an auction where the winning bidder is so selected based on price.

The obligation to pay spectrum fees is indicated in:

Section 36. (I) Every holder of a frequency licence shall·

(a) pay the fees specified by the Commission for the use of the radio frequency spectrum as stated in the licence;

3.3.2 The Swaziland Communications Commission Act, 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 -

(h) monitor authorisation conditions;

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

(l) on the approval by the Minister, process applications for the allocation of satellite orbital locations;

(m) establish and run frequency and other monitoring stations;

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

The section "*FINANCIAL PROVISIONS*" deals with "*Funds of Commission*" as follows:

49. (1) The funds of the Commission shall consist of -

(a) such monies as may be appropriated by Parliament for the purposes of the Commission;

(b) such fees as the Commission may impose for authorisations issued under this Act;

(9) The Minister may, on receipt of the business plan and budget of the Commission, by notice in the Gazette prescribe fees or levies and charges for authorisations, that are payable by a category of licensees or customers set out in the notice.

(10) Any funds or revenue of the Commission remaining unused at the end of the financial year of the Commission shall be remitted into the Universal Service or Access Programme

The Act permits the SCCOM to use licence fees to finance its activities and indicates that surplus funds from the exercise will go into promoting universal service / access.

3.3.3 Radio Communications and Frequency (Spectrum) Regulations, 2016

These regulations will be referred to as the 'Spectrum Regulations'.

PART III RADIO FREQUENCY LICENSING AND ASSIGNMENT

Radio Frequency Spectrum License Exemptions

7. (1) The designated apparatus and frequency spectrum bands that are exempted from frequency spectrum licensing in Swaziland are -

> *(a) the 2.400-2.483 GHz, 5.150-5.350 GHz and 5.470-5.725 GHz bands; and*
>
> *(b) short-range devices designed to operate at low power levels in accordance with ITU-R Recommendations and as well as other internationally recognized and industry- based standards; and*
>
> *(c) apparatus exempted from frequency spectrum licensing as set out in the schedule.*

(2) Other license exempt radio spectrum may be designated by the Commission and made known to the public.

The important issue regarding the licence exempt spectrum is that fees are not levied for the spectrum and apparatus so defined and this is accordingly not covered.

The following sections deal with assignment methods.

Application criteria for approval

…….

8. (3) The Commission shall issue spectrum based on a first come, first serve basis.

> *(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.*

This reiterates the Commission's ability to use an auction, tender or beauty contest to assign spectrum.

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;

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The above section requires the licensees to give full information about their assignments and implicitly states that is the licence fee shave not been paid, the licence is not in force.

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.

Regarding **Frequency spectrum pricing** the following section lays down the

16. (1) The Commission may from time to time prescribe the methods of determining frequency spectrum pricing.

(*2) The Commission shall not avail frequency spectrum licences to a licensee unless the licensee has paid frequency spectrum licence fees and complied with the conditions imposed by the Commission.*

(3) The Commission may recall frequency assignments that have not been utilized within the period specified in the licence.

(4) Where a frequency assignment is recalled for non-utilization, the licence fee paid in accordance with sub-regulation (2) shall not be refunded.

The section on **Pricing parameters** is the most critical part of the regulations as they specify the basis if the pricing approach.

17. (1) The Commission shall adopt a pricing formula that reflects the economic value of frequency spectrum in order to encourage efficient use of frequency spectrum and stimulate growth.

(2) The pricing formula adopted under sub-regulation (1) shall take into account the-

(a) size of spectrum assigned;

(b) frequency band and level of congestion within the band;

(c) market demand;

(d) power output;

(e) geographical usage; and

(f) such other factors as the Commission may from time to time determine.

(3) The Commission shall review and publish the pricing formula for frequency spectrum at least once in every three (3) years.

The overall implications of the regulation is that there should be a consistent approach to spectrum pricing that encourages users to use the spectrum efficiently which amongst other things, means using a spectrum assignment that is most appropriate.

A pricing model should be applied to the entire spectrum band and by implication does not preclude any licence holders (including broadcast) from paying spectrum fees.

3.3.4 The Electronic Communications (Licensing) Regulations, 2016

These will be referred to as the 'Licensing Regulations'.

These regulations encompass radio frequency spectrum licences.

PART I - PRELIMINARY PROVISIONS – Application

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.

PART III – LICENCING PROCESS

Renewal of licence

11. (1) A licence may be renewed, upon application by the licensee.

(2) An application for a renewal of a licence shall be submitted at least twelve (12) months prior to the expiration of the licence, and the Commission shall make a decision relating to such renewal application by no later than three (3) months before the expiry date of the license.

The above clause appears to conflict with the duration of licence of one year as indicated in 15. (1) (2) of the spectrum regulations.

PART IV FEES – deals with the different types of fees.

Application fee

12. A person who applies for a licence under these Regulations shall pay an application fee as prescribed in the Schedule before the Commission may consider the application.

Initial licence fee

13. (I) A licensee shall pay an initial fee as prescribed in the Schedule.

(2) The Commission shall, before issuing of a licence for an application that it has been successful, issue an invoice to the applicant to pay an initial licence fees.

(3) Where, within one month from the date of issuance of the invoice, the applicant fails to pay the initial fee, the Commission may reject that application.

(4) The Commission may extend the period of payment of the initial fee for one month upon request by the applicant, and upon showing good cause for such extension, save that, the Commission shall not grant further extension.

Recurring licence fees

14. A licensee shall pay a recurring licence fee within one month of the date of issuance of the invoice by the Commission, such fees include-

(a) royalties as set out in the Schedule, which royalties shall be calculated based on the licensees annual financial statement results;

(b) annual licence fees as set out in the Schedule;

(c) renewal fees as set out in the Schedule; and

(d) any other licence fees as may be determined by the Commission from time to time.

Late payments and failure to pay

15. The Commission may -

(a) impose interest on all late payments in respect of the licence fees set out in these regulations at the applicable interest rate as published by the Ministry of Finance.

(b) suspend the licence of any licensee that fails to pay the annual licence fees until such time that the annual license fees and/or royalties are paid in full.

Schedules

Licence Fees – Individual Electronic Communications Network

Individual licences for Electronic Communications Networks are subject to annual licence fees equivalent to **'5%of Net operating Income'**. There are two implications:

- The main spectrum licensees are already paying licence fees in addition to spectrum fees.
- The Commission is already part funded by such individual licence fees and other fees so spectrum fees do not have to cover overall Commission costs.

The fees in the schedule attached to the regulations do not in general apply to use of the radio spectrum, however, the General and Individual Renewals and Transfers do not explicitly exclude spectrum licences.

General and Individual Renewals and Transfers

TYPE LICENCE	*Fee (Emalangeni)*
General Licence Renewal	*1,000 (one thousand)*
Individual Licence Renewal	*5,000 (five thousand)*
General Licence Transfer	*1,000 (one thousand)*
Individual Licence Transfer	*50,000 (five thousand)*

Renewals should not include spectrum licences for the following reasons for the reasons outlined above, that a renewal takes place on an annual basis.

Regarding the fees for transfers of spectrum, these should in principle be the same as for an application for spectrum.

3.4 Current Swaziland Spectrum Pricing Regulations

3.4.1 Current spectrum prices

The current pricing regulations that prescribe application and annual spectrum fees is set-out in the table below.

Description		***Fee (Emalangeni)***	
		Application	***Annual***
1	**Land Mobile Services (non-cellular)**		
1.1	Mobile two-way radio stations		
1.1.1	Network of up to 10 radios	SZL 1,000.00	SZL 1,500.00
1.1.2	Network of 11 – 30 radios	SZL 1,000.00	SZL 3,000.00
1.1.3	Network of 31 – 50 radios	SZL 1,000.00	SZL 6,000.00
1.1.4	Network of 51 – 100 radios	SZL 1,000.00	SZL 9,000.00
1.1.5	Network of above 100 radios	SZL 1,000.00	SZL 15,000.00
1.2	Cross Border		
1.2.1	Network of up to 10 radios	SZL 1000.00	SZL 2,500.00
1.2.2	Network of 11 – 30 radios	SZL 1000.00	SZL 4,000.00
1.2.3	Network of 31 – 50 radios	SZL 1000.00	SZL 7,000.00
1.2.4	Network of 51 – 100 radios	SZL 1000.00	SZL 10,000.00
1.2.5	Network of above 100 radios	SZL 1000.00	SZL 16,000.00
1.3	Alarm system including base station with remote stations	SZL 1000.00	SZL 5,000.00
1.4	Paging systems	SZL 1000.00	SZL 300.00
2	**Satellite Services**		
2.1	Earth station/ VSATs -Transmit/ Receive (TX/RX) - Corporate	SZL 20,000.00	SZL 15,000.00
2.2	Earth Station / VSATs – Transmit/Receive – Solar and Heliospheric Observatory (SOHO)	SZL 5,000.00	SZL 5,000.00
2.3	Amateur	SZL 1,000.00	SZL 1,200.00
2.4	Terminal for radio determination services	SZL 5,000.00	SZL 1,200.00
2.5	Landing rights:	SZL 8,200.00	SZL 10,000.00
3	**Radio-determination/Aeronautical Services**		
3.1	Aeronautical stations (per airport)	SZL 600.00	SZL 3,000.00
3.2	Aircraft Licence (per aircraft)	SZL 600.00	SZL 750.00
3.3	Radio - operators Certificate	Nil	Nil
3.4	Aeronautical earth station	SZL 600.00	SZL 1,000.00
3.5	Radiolocation stations e.g. Radar	SZL 600.00	SZL 575.00
4	**Fixed services**		**(per MHz)**
4.1	Point to Point Link	SZL 1,000.00	SZL 1,400.00
4.2	Point to Multi-Point Link	SZL 1,000.00	SZL 2,000.00
4.3	Amateur Radio	SZL 250.00	nil

5	**Telemetry/Tele-command: e.g. radio equipment for measuring seismic movements**	**SZL 1000.00**	**SZL 3,000.00**
6	**Broadcasting Services**		**per MHz**
6.1	Sound		
6.1.1	MF-AM	SZL 1,000.00	SZL 1,000.00
6.1.2	HF-AM	SZL 1,000.00	SZL 1,000.00
6.1.3	VHF-FM	SZL 1,000.00	
6.1.3.1	Up to 500W		SZL 1,000.00
6.1.3.2	Above 500W		SZL 2,000.00
6.2	Television		
6.2.1	VHF	SZL 1,000.00	SZL 1,000.00
6.2.2	UHF operating with an effective isotropic radiated power (e.i.r.p) of:		
6.2.2.1	up to 1Kw	SZL 1,000.00	SZL 1,000.00
6.2.2.2	Above 1Kw	SZL 1,000.00	SZL 2,000.00
7	**Land Mobile Services (Cellular)**		
7.1	Broadband General Bands (1MHz)	SZL 7,000.00	SZL 7,000.00
7.2	CDMA Bands (10 MHz paired)	SZL 1,500,000.00	SZL 1,500,000.00
7.3	3G/UMTS/WCDMA Bands (5 MHz paired)	SZL 1,800,000.00	SZL 1,800,000.00
7.4	Mobile Broadband (4G) Bands (1 MHz)	SZL 400,000.00	SZL 400,000.00
7.6	Cellular GSM Channel Pair (200 kHz)	SZL 20,000.00	SZL 20,000.00

Table 1: Swaziland Current Spectrum Fees

3.4.2 Commentary on the current pricing

The pricing schedule covers both application fees and annual fees.

Application Fees

The application fees for services, excluding land mobile services (cellular), range from SZL 250 for an amateur radio licence to SZL 20,000 for a satellite station with a mean value of SZL 1,000 (applied to PMR and point to point links). A premium is placed on land mobile (cellular) service applications, where potential licensees will incur costs ranging from SZL 7000 to SZL 1.8 million.

Annual Fees

The present annual fees are stated according to the service and based on various mixed criteria:

- Per station without reference to the bandwidth used:
    - For PMR – as per the number of radios used
- Per link and per bandwidth used in the case of Point to Point and Point to Multi point links. These would appear to be per link (without reuse), although the higher price for point to multipoint may indicate that this refers to all the links.
- Per station and per bandwidth used and AM sound radio and UHF Tv – assumed to be a de facto national assignment as there are no assignments for VHF Television.

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- Per station (assumed), per bandwidth used and per power output for FM Radio and UHF Television (assumed not to be a nationwide assignment because of the power output component).
- Per bandwidth for the cellular mobile service and in the absence of any other criteria, these can be assumed to be nationwide.

Present annual fees and spectrum regulations

Comparing the current annual spectrum fees with the requirements prescribed in the Spectrum Regulations, the following observations can be made.

Service	Size of spectrum assigned;	frequency band and	level of congestion within the band;	market demand;	power output;	geographical usage;
Land Mobile Services (non-cellular)						
Mobile two-way radio stations	No	No	No	No	No	No
Cross Border	No	No	No	No	No	No
Alarm system including base station with remote stations	No	No	No	No	No	No
Paging systems	No	No	No	No	No	No
Satellite Services						
Earth station/ VSATs - Transmit/ Receive (TX/RX) - Corporate	No	No	No	No	No	No
Earth Station / VSATs – Transmit/Receive – Solar and Heliospheric Observatory (SOHO)	No	No	No	Not explicitly	No	No
Amateur	Not explicitly	Not explicitly	No	No	Not explicitly	Not explicitly
Terminal for radio determination services	Not explicitly	Not explicitly	No	No	Not explicitly	Not explicitly
Landing rights:	Not explicitly	Not explicitly	No	No	Not explicitly	Not explicitly
Radio-determination/Aeronautical Services						
Aeronautical stations (per airport)	Not explicitly	Not explicitly	No	No	Not explicitly	Not explicitly
Aircraft Licence (per aircraft)	Not explicitly	Not explicitly	No	No	Not explicitly	Not explicitly
Radio - operators Certificate	Not explicitly	Not explicitly	No	No	Not explicitly	Not explicitly
Aeronautical earth station	Not explicitly	Not explicitly	No	No	Not explicitly	Not explicitly
Radiolocation stations e.g. Radar	Not explicitly	Not explicitly	No	No	Not explicitly	Not explicitly
Fixed services						

Point to Point Link	Yes	No	No	No	No	No
Point to Multi-Point Link	Yes	No	No	No	No	No
Amateur Radio	n/a	n/a	n/a	n/a	n/a	n/a
Telemetry/Tele-command: e.g. radio equipment for measuring seismic movements	No	No	No	No	No	No
Broadcasting Services						
Sound						
MF-AM	Yes	Not explicitly	No	No	Not explicitly	No
HF-AM	Yes	Not explicitly	No	No	Not explicitly	No
VHF-FM						
Up to 500W	Yes	Not explicitly	No	No	Yes	No
Above 500W					Yes	No
Television						
VHF	Yes	Not explicitly	No	No	Not explicitly	No
UHF operating with an effective isotropic radiated power (e.i.r.p) of:						
up to 1kW	Yes	Not explicitly	No	No	Yes	No
Above 1kW	Yes	Not explicitly	No	No	Yes	No
Land Mobile Services (Cellular)						
Broadband General Bands (1MHz)	Yes	No	No	No	No	No
CDMA Bands (10 MHz paired)	Yes	Yes for Swaziland[4]	No	No	Not explicitly	no
3G/UMTS/WCDMA Bands (5 MHz paired)	Yes	Yes – but not explicitly	No	No	Not explicitly	no
Mobile Broadband (4G) Bands (1 MHz)	Yes	No	No	No	No	No
Cellular GSM Channel Pair (200 kHz)	Yes	No	No	No	No	No

Table 2: Swaziland Current Spectrum Fees

By ‘Not explicitly’ is meant that while the criterion (such as frequency band) is not stated, it can be assumed, the frequency location of the 3G band for example is standard.

[4] CDMA is not assigned in the 450 band for Swaziland so it can be assumed to be 850.

3.4.3 Current prices and requirements of the Spectrum Regulations

The following observations should be made concerning some of the parameters to be considered under 17. (2) of the Spectrum Regulations:

- *Size of spectrum assigned* parameter is a critical factor but is not applied for all services.
- The *frequency band* parameter is not generally applied.
- The *level of congestion* parameter is not applied.
- The *market demand* parameter is not applied but the following should be noted:
    - In the case of administrative pricing – market demand is reflected through a congestion factor or high demand factor.
    - For bands that would be considered to be high value under clause 8. (4) of the spectrum regulations (see above) because of market demand, the option of carrying out an auction could be considered[5].
- The *power output parameter* is explicitly applied to UHF TV, FM radio, but not to Point to Point. (the power output overlaps with the geographical usage parameters to a certain extent as they take into account the area denied to other users.)
- The *geographical usage* factor in terms of urban / rural high density / low density is not applied. In terms of general coverage area it overlaps with the power output factor. The cellular assignments are assumed for national coverage as are the VHF and AM sound radio assignments. The geographical coverage is a significant issue for making efficient use of spectrum, especially for PMR and other services that might be assigned on a sub-national level.

5

4 Pricing Model Options

4.1 Objective

The objective of this section is assess the various spectrum pricing model options and propose a suitable approach for Swaziland.

4.2 Definitions

The field of spectrum or radio frequency licensing and pricing has many different definitions with each country adopting different policies.

Definitions used by ITU

Spectrum pricing: A generic term currently used to denote the use of pricing as a spectrum management tool. It covers both *administrative incentive pricing* and *auctions* of either *apparatus licences* or *spectrum rights*.

Administrative pricing: A form of *spectrum pricing* in which *equipment licence* fees or charges for *spectrum rights* are set by the spectrum manager. Administrative pricing may include such variants or elements as:

- *Shadow pricing* (A form of administrative pricing in which the price is set according to a predetermined formula intended to mimic the effect of market forces)
- *Incentive pricing*, where fees are set with the intention of promoting efficient spectrum use;
- *Regulatory pricing*, where fees are set unrelated to market considerations, for example, to recover spectrum management costs[6].

Auction: A form of *spectrum pricing* – as well as a spectrum assignment mechanism – in which *apparatus licences* or *spectrum rights* are assigned to the winner(s) of a competitive process selected on the basis of price.

Concerning the apparatus licences and spectrum rights, the Australian and (in particular) Malaysian frameworks make a useful distinction:

- An apparatus assignment is where the applicant applies to install and use radio equipment where the frequency to be used, type of apparatus to be used, power,

[6] It should be noted that the objective of *at least* covering costs can apply even when there is no legal requirement for the spectrum fees to cover the costs exactly.

coverage area, geographical location and type of service to be provided may be specified.

- A spectrum assignment is where a frequency band is assigned either nationwide or by state. This assignment is normally the subject of an invitation for competitive bidding, through the mechanism of a beauty contest or an auction or some combination of both.

4.3 Focus

The development of an administrative pricing framework for the whole frequency band from 8.3 kHz to 100 GHz.

4.4 Administrative Incentive Pricing

Administrative Pricing is to be applied for the whole frequency band from 8.3 kHz to 100 GHz.

The requirements in the spectrum regulations are to adopt a pricing formula that reflects the economic value of spectrum in order to encourage efficient use of the spectrum and use the parameters of the size of the spectrum assigned, the frequency band, congestion and market demand, power output and geographical factors.

This implies Administrative Incentive Pricing (AIP) is a spectrum management tool, which aims to reflect the relative value of spectrum bands and bring Demand in line with Supply. AIP can be tailored to achieve a myriad of objectives, such as, inter alia::

- Promote efficient use of spectrum.
- Prevent stockpiling of spectrum.
- Provide incentives to move to less congested spectrum.
- Provide incentives to hand back spectrum that is not needed.
- Encourage users to switch to spectrally efficient technologies.

In AIP the general method is to calculate the spectrum fee by taking into account a range of factors, including but not limited to:

Bandwidth used

- Charges vary according to bandwidth use, the more bandwidth used, the higher the price although it must be pointed out that international practice varies from increasing the price per KHz of bandwidth with the volume used, to applying an effective discount per KHz with the volume used.

Frequency Band

- Charges vary with frequency band (spectrum location).
- As AIP is intended to encourage efficient use of the spectrum, the relative pricing of frequency bands will encourage users to use the most cost efficient spectrum location.
    - All things being equal, the lower the frequency band, the higher the value due to better propagation and scarcity.

- In some methodologies, commercial frequency bands – especially those used for cellular type applications such as GSM and 3G - are priced higher than lower frequency bands due to their commercial value[7]. In particular, certain methodologies look to establish a "spectrum sweet spot" centred around the aforementioned commercial frequency bands.

Area Sterilised / Power Output

- Charges increase according to the area 'sterilised' (i.e. the geographical area denied to other users as a consequence of the assignment).
- It is frequently the practice to use the power output of the transmitter as a proxy for the area sterilised, but this is less efficient than using an area sterilized or area factor as it does not take into account topography.

Geographical Area

- There are different charges per Geographic Area – i.e. urban / rural or high density / low density.
  - In many countries, the spectrum is used more in the main urban areas than it is in the rural areas[8]. As a result, the spectrum charges may differ according to the geographical area covered.
  - For lower frequencies and national assignments, all classes of geographical area are covered in any case so therefore drawing a distinction between specific high and low density areas is not required.

Exclusive Rights or Sharing

- The spectrum charge varies according to whether the spectrum is used on an exclusive or shared basis.

Supply and Demand

- The spectrum charge reflects the demand for the frequency band. In administrative pricing, market demand is often reflected in a **congestion charge** which is applied when a spectrum band is fully assigned. Where it is known in advance that a radio frequency band will be in high demand, i.e. that demand will exceed supply, it is better to assign the band by a competitive process, which may be an auction or a beauty contest. Even in the case of a beauty contest, there may be a base price for the license[9].

[7] It is not the intention to do this in the proposed methodology IMT technologies make very efficient use of spectrum and this goes against principles of technological neutrality and .

[8] This equally applies to countries such as Swaziland where a small city like Mbabane will have a higher usage of radio spectrum than the rural areas.

[9] In Swaziland, there is little evidence of demand exceeding supply for spectrum except for the popular mobile bands.

Proposed spectrum pricing model for consultation

Duration

- The spectrum charge varies according to the length of time in which the licence is in force. In the case of annual spectrum fees, common practice is to give a discount where the annual fee is paid in advance.

Service Factor

- In some cases a service factor might be applied in order to:
    - Reflect the perceived value of the services that use the spectrum, i.e. for Cellular services. This is not recommended because it is difficult to objectively calculate the factor and in many countries (including Swaziland), the service licence fees are already levied based on net income.
    - Government usage, where the spectrum fee may be lower or waived altogether, although certain administrations such as the United Kingdom require that all spectrum users pay.
    - Broadcasting, especially non-commercial broadcasters.
    - Aeronautical and maritime and other exclusive international assignments are used only for specific applications and therefore pricing incentives, strictly speaking, have no role as there will be no changes in the frequency assignment.
- In some countries, rather than use a service factor, 'non-commercial' services are not required to pay spectrum fees.

4.5 Approaches to Spectrum Fees in Practice

The consistent pattern that has emerged over the years is that for spectrum where demand exceeds the supply (and where it is possible to make new assignments), competitive auctions are held in which the assignment is often based on the highest price offered. The price bid for spectrum can be taken as r the perceived value of the band at that point in time; while for the rest of the spectrum, the prices (i.e. spectrum fees) are applied administratively.

Although the spectrum bands that are subject to fees according to administrative pricing are usually based on the principle of cost recovery, this is not always the case in practice and some countries (apply fees on specific bands that lead to fee revenue that is higher than cost coverage, sometimes deliberately because the government would like to maximise revenue from administrative spectrum fees or simply because the number of fee paying licensees has risen (leading to higher revenues). In many countries, the administrative fee system has evolved over time and different methods have been applied to different bands such that it is difficult for the regulator to calibrate fees to match costs.

A few countries have started to update the spectrum fees system in order to ensure the fees are set on a more consistent basis. Usually these systems aim to encourage efficient spectrum use by giving a price incentive to users to migrate to spectrum that is less scarce / in demand (i.e. higher frequencies) and to use only the quantity of spectrum (in terms of bandwidth and coverage area) that is actually needed.

How this is done differs from country to country. The United Kingdom takes an ad hoc approach, the fees for most bands are still set according to cost, but from time to time the regulator determines that a frequency band should be subject to administrative incentive pricing and carries out over several months a feasibility study to try and determine 'value based' fees based on opportunity cost. Australia takes a similar approach, but with the added complication that the overall revenue from apparatus (i.e. administrative) fees should be cost covering, resulting in a formula whose parameters are always changing.

South Africa adopted a technology and service neutral system of administrative spectrum fees based on an incentive system in which the fee rises proportionally with bandwidth used and the radius of coverage, becomes progressively lower as the frequency band becomes higher and attracts a premium when the 'area sterilised' (i.e. coverage denied to other users) includes all part of a metropolitan urban area. The fees for Point to Point (i.e. microwave) do not reflect the area sterilised but do penalise using a frequency that is lower (and hence more valuable) than is required for the hop length. For both the Point to Area and Point to Point assignments, a factor value is applied to the variables described and multiplied by a single unit price per MHz. Consequently, a revenue target (i.e. cost coverage) can be achieved by raising (or lowering) the usage price. This uniform system had the advantages of being logical and systematic, encouraged efficient use of spectrum could be applied alongside Auctions and was seen to be intuitively fair. Importantly, there was no premium applied to GSM and 3G frequencies because it was inappropriate to penalise efficient use of the spectrum and also because this would jeopardise sustainable technology and service neutrality.

As a general principle these fees should be implemented in a transparent and fair manner without any complicated administrative mechanisms. Therefore the fees should be defined by some fixed (long-term constant) input parameter individually weighting the use of spectrum according to bandwidth, frequency band and target coverage area and one overall scaling unit factor for all weights taking the overall cost target into account. To be more flexible the scaling factor might be adapted on a regular basis to be flexible to include new influences and tendencies, but taking care not to increase administrative efforts.

For Bahrain, in view of the fast rate of technological evolution, it is clearly desirable to have a systematic and uniform system of administrative fees along the lines of the South African model and accordingly a model has been developed that evolves from the current practice. It must be emphasised that this model is for the administrative schedule of fees, where the spectrum is perceived to have a commercial value and is 'scarce' as supply exceeds demand, then a separate competitive auction process is applied.

4.6 Selected Benchmarks

Examples of spectrum fee pricing regimes for South Africa, Qatar, UAE, Singapore, Malta and Luxembourg, Nigeria and Malaysia are analysed.

The South African model is particularly important as it meets all the criteria and there is several years' of experience in implementation.

4.6.1 South Africa

The South African Model includes the following parameters

i. **UNIT** = the unit price per MHz paired is R2,226 (2017)
ii. **FREQ** = the frequency factor
iii. **BW** = a bandwidth factor directly proportionate to the amount of bandwidth
iv. **CG** = the congestion factor; based on the table in the annex
v. **GEO** = a factor accounting for different geographies; based on the table in the annex:
vi. **SHR** = the sharing factor; based on the table in the annex
vii. **HOPMINI =** minimum hop length; based on the table in the annex
viii. **UNIBI** = the rare case of unpaired frequency; based on the table in the annex
ix. **SEC =** Security Factor – that is applied to reflect the assignments made to security services[10]**.**

ICASA applies the following point-to-point formula for determination of the spectrum fee:

Spectrum Fee = (UNIT × FREQ × BW × CG × GEO ×SHR × HOPMINI × UNIBI × SEC)

ICASA applies the following point-to-area formula for determination of the annual spectrum fee. The minimum fee was originally set at R120.

Spectrum Fees = (UNIT × FREQ × BW × CG × GEO × SHR × ASTER × UNIBI × SEC)

The schedule of fees in South Africa is very transparent and well structured. All relevant factors are taken into account. The model also includes a multi-year assignment factor to reduce costs and administrative effort.

Recent modifications to the spectrum fees include:

- The Unit Price is now increased automatically by the Consumer Price Index every year.
- The SEC factor has been introduced (see above).
- Assignments above 50 GHz are charged at the minimum fee.

4.6.2 Qatar

ictQatar identified the following parameters to be taken into account for setting the fees for Radio Spectrum Licences:

- **Frequency band used:** taking into account supply and demand of the band. The regulator set high prices where demand exceeds supply relative to these frequency bands with low demand. ictQatar also took into consideration the high spectrum management costs associated with lower frequencies due to increase probability of interference and greater need for coordination between countries.
- **Amount of spectrum licensed:** the fee, for a given frequency band, be proportional to the amount of radio spectrum (bandwidth) assigned to the user.
- **Coverage area:** for larger coverage areas, the fee is set higher.

[10] The Security factor was introduced at a later stage into the formula in order to reduce the cost for public security services.

- **Duration of license:** the longer the duration of use, the higher the fee should be as it restricts other users from accessing the band.

Like the South Africa model, the charge on a paired spectrum base and introduce a unidirectional factor in case only one link is used.

4.6.3 Luxembourg

The following are the annual area assignment fees for Luxembourg:

	Fees	
Frequency Band	**EUR/MHz**	**SZL /MHz**
791-821 MHz paired with 832-862 MHz 880-915 MHz paired with 925-960 MHz	18,750	9,455
1710-1785 MHz paired with 1805-1880 MHz	18,750	9,455
1920-1980 MHz paired with 2110-2170 MHz	12,000	6,051
2500-2690 MHz	4,000	6,051
3400-3800 MHz	6,000	3,026

Table 3: Annual area assignment fees for Luxembourg

For the point to point fixed link fees a comparable approach like in South Africa is used.

The point to point formula is

B*Fb*Fm*Rb

Where:

B = Bandwidth size

Fb = Band Factor

Fm = Modulation Factor

Rb = Base price in in Euros per MHZ and is currently EUR 40 per MHz.

The fee for a paired frequency is double a single frequency.

The Fb band factor is 1 for all bands up to 4.2 GHz and then drops thereafter, clearly giving an incentive to move to higher frequency bands.

In addition, modulation is charged to incentive higher modulation (=higher capacity).

However, also other models include this indirectly by offering the possibility to reduce the needed bandwidth in case of higher modulation.

The schedule of fees in Luxembourg is well structured. Major relevant factors are taken into account.

4.6.4 UAE

The UAE model in general uses a model proportional to frequency and bandwidth. Some fees do not include the frequency factor.

Most area assignments use number of channels with various bandwidths and costs.

In general the schedule of fees is quite complex and non-transparent. Each assignment is service dependent with different fees. This results in complex administrative process and costs.

4.6.5 Singapore

iDA Singapore defined a well-structured set of services, but finally charge all of them with quite similar fees, in general depending on bandwidth, but no frequency factor or congestion factor is included.

Therefore it was not recommended to evaluate it more in detail compared to the more promising models of Qatar and South Africa.

4.6.6 Malta

In Malta, there are two license categories for all radio related links:

- Links below 1GHz: further categorized into those being used for services ancillary to broadcasting and those used for other services
- Links above 1 GHz: the operator may apply for the type for a 'per link' licence or a 'national coverage' licence

'Per link' license gives the operator the right to deploy a link between two specific points. The 'national coverage' gives the operator the right to deploy any number of links with the channel spacing less than or equal to the assigned frequency channel.

The regulator provides a reduction in fees for additional links depending on the type of licences, type of link and number of links the operator is requesting.

MCA structures the fees based on bandwidth below or above 1 GHz which is a quite simple FREQ-factor approach. It also incentivizes the operators to apply for more than one link in a channel by providing a 50% discount for additional link.

4.6.7 United Kingdom[11]

The United Kingdom is included in this benchmark because it in the context of Administrative Pricing it has over the years applied a system of Administrative Assignment Pricing to a progressive set of services, commencing with 1997 for Fixed Services (point-to-point links); Private Business Radio (including CBS use), and Public Mobile Communications (Cellular).

Ofcom's AIP methodology uses the marginal value of spectrum to the user taking into consideration the amount of congestion in a given band and attempts to set fees at "market-clearing" rates that balance spectrum supply and demand. Ofcom has said that one way to evaluate the marginal value to the user is on the basis of the "additional costs of the least-cost practicable alternative" – another way of stating opportunity cost. For example, for a user of a point-to-point fixed service band, the most cost-effective alternative to using the band

[11] Paraphrased from the ITU Regulation Toolkit (ITU)

would be either deploying more spectrally efficient systems or relocating to higher frequencies. The relative costs of these alternatives reflect the marginal value.

Therefore, most valuation models involve a calculation of marginal costs associated with network infrastructure, including equipment and construction costs, as well as cost of capital or labour. Some of these costs can be known or at least well estimated, through benchmarking and survey of existing equipment markets.

The key criteria for setting a more incentive based pricing regime are that:

- Prices should be based on the estimated marginal value of spectrum;
- Marginal spectrum values should be calculated by costing the alternatives faced by potential users denied access to the spectrum and then taking the difference between the costs of providing the service at current levels and the minimum cost of those alternatives initially prices less than marginal values should be set, because the current allocation and assignment of spectrum was not an equilibrium position;
- Initial prices should be set at a fraction of the estimated marginal values, but probably at several times the then current fee levels;
- Prices should then be increased over, say, a five year timescale, depending on users' reactions.

OfCom has continued to deploy this system of AIP fees to different services,

4.6.8 Australia

In Australia, there are two mechanisms for assigning and pricing spectrum:

Spectrum Assignments – where the prices are typically set through auctions.

Apparatus assignments – where the prices are set by the a formulaic methodology.

This analysis is concerned primarily with apparatus assignments-

4.6.9 Australian Apparatus fees methodology

ACMA which determines spectrum fees in Australia has operated a system of spectrum pricing which in part utilizes opportunity costs. ACMA employs the following principles in developing spectrum fees to encourage the efficient use of spectrum based on an equitable and consistent spectrum fee regime:

Spectrum fees, however based, should cover the costs of authorizing spectrum;

Taxes from spectrum licensees should recover the indirect costs of managing spectrum;

Taxes should be based on the amount of spectrum denied to others;

Spectrum fees should be based on their opportunity cost that is the best alternative use;

If the opportunity cost is less than costs of managing spectrum, taxes should then make up the difference but not exceed these costs.

Adjustment factors will be used by ACMA to take special situations into account.

The principle in Australia is that prices should not exceed the costs to manage the spectrum, this differs from the UK where the prices may exceed costs. The principle in South Africa is more open in that the prices should at least cover the costs of spectrum management.

4.6.10 Malaysia

Malaysia's system of spectrum [pricing has been in place for many years and the prices are rarely changed.

4.6.10.1 Overall Licensing Approach

Malaysia has a distinctive approach to telecommunications licensing and spectrum licensing which stems from the convergent Communications and Multimedia Act 1998. The regulator is a converged telecommunications and broadcasting agency – the Malaysian Communications and Multimedia Commission (MCMC).

Although the Malaysian telecommunication market is liberalized but a company may only enter the market by obtaining a license. There is a stepped licence structure that aims to be technology and service neutral and aims to allow a licensee to undertake activities that are market specific in order to create opportunities for industry expansion in the area of Applications Service Providers and provide for a more effective utilisation of Network Infrastructure.

There are four categories of licensable activities:

Network Facilities Providers

> These are owners of facilities such as satellite earth stations, broadband fibre optic cables, telecommunications lines and exchanges, radio communications transmission equipment, mobile communications base stations, and broadcasting transmission towers and equipment. They are the fundamental building block of the convergence model upon which network, applications and content services are provided.

Network Services Providers

> These are providers of basic connectivity and bandwidth to support a variety of applications. Network services enable connectivity or transport between different networks. A network service provider is typically also the owner of the network facilities. However, a connectivity service may be provided by a person using network facilities owned by another.

Applications Service Providers

> ASPs are providers of particular functions such as voice services, data services, content-based services, electronic commerce and other transmission services. Applications services are essentially the functions or capabilities, which are delivered to end-users

Content Applications Service Providers

> These providers represent a special subset of applications service providers including traditional broadcast services and newer services such as online publishing and information services.

Within the four categories listed, there are two types of licences provided for – Individual Licence and Class Licence are granted for activities where a high degree of regulatory control is required. Class Licences are annually renewable.

4.6.10.2 Malaysian Spectrum Assignments

The licencing – or rather assignment – of Radio Frequency Spectrum is carried out on a separate basis to the licencing of networks and services. In many cases it is necessary to have a Network Facilities Providers Licence before applying for frequency.

Malaysian Spectrum use is based

Under the 1998 Act Malaysia distinguishes between two types of radio frequency assignments:

Spectrum Assignments where a frequency is assigned over the whole country or by State or groups of States.

- Although in principle it is possible under the law that the assignment is technology neutral and the spectrum can be traded, this has not been done up to now.
- The Spectrum assignment approach has so far only been undertaken for 3G and 2.4 GHz WiMAX – GSM operators for example still operate under an Apparatus Assignment.
- The Spectrum Assignments have all been awarded on the basis of a competitive tender in the form of a 'Beauty Contest' at a fixed price. The government has not so far favoured priced based competition in the form of Auctions as it does not want a high entrance fee to militate against universal coverage.

Apparatus Assignments where the assignment is based on the location of transmitter equipment.

- Most assignments are apparatus assignments.

4.6.10.3 Apparatus Assignment Fees

The Apparatus Assignment Fees have two components:

Fixed Fees which are essentially applied per station differentiated on the basis of service.

Variable Fees which are based on the bandwidth used in two dimensions:.

- Three main bands
    - Less than 30 MHz
    - 30 MHz to 3GHz
    - More than 3 GHz
- The amount of bandwidth used
    - A characteristic of the system is that the greater the bandwidth occupied, the lower the cost per kHz.

Proposed spectrum pricing model for consultation

The total fees payable for an apparatus assignment is the aggregate total of the individual fee calculated using the fixed fee plus the variable fees for an assignment. An apparatus assignment may have fixed fees charged for the existence of the apparatus only or plus the variable fees for the various frequencies employed depending on the nature of the service being provided.

- For fixed apparatus communicating with other fixed apparatus or space apparatus, as in the case of point-to-point systems, the fee is calculated relative to the number of transmit and receive frequencies and the bandwidth for each frequency.
- For any fixed apparatus communicating with mobile apparatus such as an aircraft, ship and land mobile, the fee is calculated relative to the number of transmit and receive frequencies employed.
- For fixed apparatus communicating with other fixed apparatus or mobile apparatus on the same frequency, for example, an automatic repeater, one fee will be charged for communications with the fixed apparatus and one fee with the mobile apparatus as in the case of a leased channel radio base station and trunked radio base station;
- For communications via a fixed apparatus with other apparatus, whether fixed or mobile on the same paired or single frequency, for example, via a repeater or fixed base station, the fee will be charged on a single repeater or base station basis and for the channel bandwidth occupied for each distinct channel.
- For fixed apparatus using only one frequency to communicate with any number of mobiles applications, whether aircraft, ship or land mobiles, the fee shall be based on the single use of that frequency.

The Malaysian tables for the Fixed and Variable Fees are given below. The Malaysian Ringgit is currently worth SZL 3.16.

Malaysian Fees for Apparatus Assignment[12]

Fixed Fees

Nature of Service as Per Spectrum Plan	*Type of Apparatus*	*Annual Fees (RM)*
FIXED		
	Earth Station (less than 2.4 meters)	120.00
	Earth Station (2.4 meters and above)	1,200.00
	Land Station (less than 30 MHz)	60.00
	Land Station (30 MHz up to 3 GHz)	120.00
	Land Station (more than 3 GHz)	240.00
	Experimental Station	60.00
	Press Receiving Station	360.00

[12] P.U. (A) 128/2000 – Communications and Multimedia (Spectrum) Regulations 2000

	Fixed Station	120.00
RADIODETERMINATION	Radiolocation Station	120.00
	Radio-navigation Station	120.00
	Radio-determination Station	1,200.00
SPACE	Space Station	120.00
	Amateur-Satellite Station	120.00
	Broadcasting Satellite Station	1,200.00
	Fixed-Satellite Station	1,200.00
MOBILE	Mobile Station	60.00
	Land Mobile Station	60.00
	Aeronautical Mobile Station	60.00
	Mobile Earth Station	60.00
	Maritime Mobile Earth Station	60.00
	Aeronautical Mobile Earth Station	60.00
	Experimental Station	60.00
	Ship Station	60.00
	Remote Controlled Station	60.00
	Private Use Station	240.00
	Paging Base Station	120.00
	Cellular Radio Base Station	120.00
	Leased Channel Radio Base Station	120.00
	Trunked Radio Base Station	120.00
	Cordless Base Station	120.00
	Coast Station	120.00
	Wireless Alarm Station	60.00
	Aircraft Station	60.00
	Aeronautical Fixed Station	120.00
BROADCASTING	Broadcasting Transmitter Station	1200.00
	Broadcasting Repeater Station	120.00
AMATEUR	Amateur Station (Class A)	36.00
	Amateur Station (Class B)	24.00
	Amateur Repeater Station	60.00

Table 4: Malaysian Fixed Fees for Apparatus Assignment

Variable Fees

	Annual fees with respect to bands per Apparatus (RM)		
Bandwidth (per channel) (kHz)	*less than 30 MHz*	*30 MHz up to 3 GHz*	*More than 3 GHz*
0 - 5	42	90	60
5 - 12	52	110	70
12 - 25	62	130	90
25 - 100	113	230	130
100 - 200	186	380	200
200 - 1,000	264	520	280
1,000 – 3,500	342	680	360
3,500 – 7,000	420	840	440
7,000 – 14,000	498	1,000	510
14,000 – 28,000	576	1,160	590
28,000 – 60,000	654	1,300	670
36,000 – 54,000	732	1,470	750
54,000 or greater	810	1,620	830

Table 5: Malaysian Variable Fees

4.6.11 Nigeria

4.6.11.1 The general framework and methodology

Nigeria adopted a pricing formula which reflects the economic value of frequency spectrum in order to encourage the efficient usage of frequency spectrum and stimulate growth of the telecommunication market in Nigeria. The price is directly proportional to the size of frequency spectrum assigned and can be adjusted depending on the frequency band reflecting the level of congestion, market demand and the relative cost of deploying network infrastructures. The frequency spectrum fees and pricing regulations provide general pricing rules and a methodology for calculation of frequency fees for licensed digital mobile operators in Nigeria.

Frequency spectrum are issued according to licensing areas that corresponds to the states of the Federal Republic of Nigeria and the Federal Capital Territory. For this purpose the entire geographic area of Nigeria is classified into five licensing areas (tier 1-5).

There are two main pricing Formulas, Point to Area and Microwave.

Pricing Formula for Point to Area

Applying the formula for frequency fee calculation laid down in the frequency regulations, the price of spectrum for a licensing region will be calculated as follows:

Spectrum fee = (Unit Price) (B) (K_1) (K_2) per state

Where B = assigned bandwidth in MHz or spectrum size in MHz

K1 = Band factor:

1 for 3.5GHz Band

1.6 for 1.8/1.9GHz Band

1.4 for 800/900 MHz Band

1.2 for 2.0-2.5 GHz Band

0.8 for 10.5GHz Band

For Bands lower than 800 MHz or higher than 10.5GHz, the factor, K1, will be determined as the bands are allocated.

K2 = Tenure Duration Factor

0.3 for 3 months

1 for 1 year license

4 for 5-year license (standard)

7.2 for 10 year license

10.4 for 15-year license.

This giving an incentive to commit to a frequency.

Duplex/Simplex: For simplex channel, unit price per state will be half of equivalent duplex channel.

Unit price per MHz for each Licensing Region

Tier Structure	**Unit Price per MHZ per annum**
Tier 1 (Lagos)	₦ 3 million
Tier 2 (5 States)	₦ 1.5 million
Tier 3 (5 States)	₦ 1.2 million
Tier 4 (14 states)	₦ 600,000
Tier 5 (12 states)	₦ 300,000

PRICING FORMULA FOR MICROWAVE FREQUENCIES

Price per hop = Unit Price (F1) (F2) (N) per annum

Where unit price = ₦18,000

FI = Band Factor

12 = 1-4 GHz band

1 = 6/7/8 GHz band

0.8 = 13 GHz band

0.7 = 15-18 GHz band

0.5 = 19-25 GHz band

F2 = Bandwidth Factor

1 = 3.5 MHz

2 = 7 MHz

4 = 14 MHz

8 = 28 MHz

16 = 56 MHz

N = Total Number of RF Channels (for N + 1 Systems)

4.7 Recommended Administrative Pricing Model or Swaziland

4.7.1 Criteria

As can be seen from the benchmarks, there are a range of available options. Selection of the correct approach will depend on an evaluation according to the following specific criteria:

i. Requirements of the regulations
ii. The characteristics of Swaziland
iii. The objectives to be achieved through spectrum pricing
iv. The resources available to SCCOM.
v. Future proofing.

The aforementioned criteria will be discussed in detail below.

4.7.1.1 Requirements of the regulations

The regulations state that the model should include the following criteria:

(a) size of spectrum assigned;

(b) frequency band and level of congestion within the band;

(c) market demand;

(d) power output;

(e) geographical usage; and,

(f) other factors that the Commission may determine.

4.7.1.2 The characteristics of Swaziland

Swaziland is small, does not have extensive urban areas and does not have intensive use of the radio frequency spectrum. Shortage of spectrum might be experienced in developed countries such as the UK, however this is not apparent at the moment in Swaziland. Therefore, the complex opportunity cost approach to spectrum pricing of the UK and Australia is not appropriate. Nevertheless, it is necessary to make the most effective and efficient use of spectrum, therefore an approach that incentivises users to move to higher bands and only apply for the spectrum that they actually use is be recommended.

4.7.1.3 The objectives to be achieved through spectrum pricing

The primary role in spectrum pricing, as evidenced from the regulations, is to cover the costs of managing the spectrum with the rider that any spectrum fee revenues that exceed cost coverage can be used for universal service funding.

With respect to the spectrum prices, all spectrum users should, in principle, pay spectrum fees, this includes the broadcasters and government users. With respect to broadcasters, this is already reflected in the current pricing schedule.

4.7.1.4 The resources available to SCCOM and Stakeholders

The Commission is a small agency which is in the process of bolstering its skill and expertise. In the initial period, a spectrum pricing model that is simple to operate is a priority. At the same time, the model must be readily understandable and implementable by local operators who may not necessarily have the resources to establish specialist expertise to manage spectrum pricing.

4.7.1.5 Future proofing.

The spectrum model must be robust and sustainable, this means that it should be technologically neutral and be able to accommodate future technological developments. It should also be able to accommodate changes in assignment.

4.7.2 Proposed Approach to annual administrative fees

A well-structured system of administrative incentive pricing will meet the requirements of the regulations, namely:

i. The size of the bandwidth,
ii. The frequency band,
iii. The level of congestion which also caters for market demand
iv. The area sterilized in the case of point to area assignments, which not only reflects the power output of an individual transmitter, but also caters for the situation where there is more than one transmitter within an assignment.
v. The Geographical usage, to reflect the higher market demand for spectrum in high density areas.

In addition, the following are proposed for consideration

i. A sharing factor which will cater for the shared use of assignments
ii. A factor to improve efficiency of point to point microwave assignments.

The fees will be determined by applying a unit price to the above factors through separate formulas for Point to Area assignments, Point to Point assignments and satellite assignments. The principle of a minimum fee will be applied for certain services or assignments, including those where the formula is below the minimum fee.

The proposed pricing regime is similar to that of South Africa although there are modifications reflecting the unique operating environment of Swaziland, i.e.:

- The Area factor is scaled to reflect the geographic area of Swaziland.
- The Frequency factor has been reworked to ensure that a single assignment is contained within a single defined frequency range.
- The Geo factor will be redefined to reflect the population distribution in Swaziland

- The BW factor is represented as total unpaired bandwidth, whereas South Africa opted for paired bandwidth.
- The High Demand Factor is introduced in order to reflect the high value placed on certain IMT frequency bands and where there is considered to be congestion.
- Broadcasters are, in principle, covered by the fee system.
- Public security services are also covered by the fees.

4.7.3 Application Fees.

Regarding application fees, it is proposed to standardise the application fees to reflect the cost of application.

4.8 Role of Auctions

For spectrum bands that are in high demand, auctions play two roles:

- They are the means of awarding spectrum to the highest bidder, who in theory is the bidder that values the spectrum the most and can therefore be expected to make the most efficient use of the spectrum.
- They provide an indication of the spectrum value since the bidding price for a particular spectrum band is analogous to the spectrum value.

The bidding price from auctions can be a substitute for the administrative spectrum fees or the annual administrative fees can be levied in addition. If the annual administrative fees are to be levied as well, two conditions must apply; firstly, the fact that annual fees will be applied must be made clear at the start of the auction process; secondly the administrative fees should be stable and predictable.

5 Proposed Spectrum Pricing Framework

5.1 Objective

The objective of this section is to present the proposed spectrum pricing framework, which will be used to provide clarity to current and prospective licensees on associated spectrum usage fees based on the value assigned to the spectrum. The proposed spectrum pricing framework takes into account, the size of the assigned spectrum, the frequency band and the level of congestion within the band, market demand, power output, geographical usage and other factors.

5.2 Criteria

The administrative spectrum pricing model for annual spectrum fees applies to the entire radio frequency spectrum and meets the following criteria:

- Be forward looking.
- Be consistent.
- Be flexible.
- Be within the capability of SCCOM resources to administer.
- Provide incentives for spectrum users to migrate from high demand frequency bands to lower demand frequency demands, usually at higher frequencies where spectrum is less scarce.
- Meet financial objectives set by the government – normally they should at least cover the costs of spectrum management.

Regarding application fees, a standard fee that is consistent with the costs to process an application will be charged. However, exceptions may be prescribed, such as the fees associated with land mobile (cellular) application.

5.3 Outline of the Proposed System

The **application fees** are calibrated based on the work involved to process and issue the assignments, it is proposed that they are standardised at SZL 1,000. As a special case, the application fees for cellular services will be set when an invitation to apply for cellular frequency bands is issued.

The **annual Spectrum Fees** will move to a system centred around the extent of spectrum denied to others by a given licensee.

While most of the radio frequency spectrum will be priced according to the formulae, some licences will be charged the minimum fee. The new system also intends that all users of spectrum should in principle pay for spectrum on an equitable basis and should essentially pay for what they use. The new pricing process will mean that some licensees will pay more for their use of spectrum while some will pay less, but the basic principle is that spectrum users should pay their ‘fair’ share

5.4 Factors

The following factors have been identified for inclusion in the model and are used to calculate the annual radio frequency spectrum licence fees to be levied:

- Bandwidth (BW)
- Frequency factor (FREQ)
- Area Factor (AF)
- Geographic factor (GEO)
- High Demand Factor (HD)
- Sharing Factor (SHR)
- Minimum Hop Length (HOPMINI)

In addition, there will be a minimum fee applied to instances where the results of the formula are below the prescribed threshold minimum fee.

5.4.1 Unit Price (UNIT)

The Unit Price is the price per MHz of spectrum. This factor is the starting point for spectrum fee computation and will subsequently be scaled based on the various factors in the pricing formulae. A single unit price is proposed for all frequency bands or services.

5.4.2 Bandwidth (BW)

While a radio signal is said to be transmitted at a given frequency, the information carried spreads around that frequency. Bandwidth is a measure of the band over which the information spreads around a given carrier frequency. The lesser the spread is, the smaller the bandwidth occupied and denied to others.

Hence, the scarcity of radio resources in a frequency band is a direct consequence of more bandwidth being used, whether it is a large band spread around one frequency or spaced-out frequencies with contiguous band spreads. In either case, the more the bandwidth assigned to licensees in a frequency band, the less there is available for new assignments.

Of the many conceivable ways of factoring bandwidth into the price of spectrum, regulators usually adopt one of the following:

- A linear approach: all else being equal, spectrum price is proportionate to amount of bandwidth used.
- A discount for large bandwidth approach: the more the bandwidth, the less the price per unit: this approach does little to encourage spectrum efficiency, especially in conditions of scarcity.
- A premium for large bandwidth approach: licensees requesting large bandwidths pay a premium. This approach discourages licensees to hoard spectrum, but may raise transparency and objectivity questions as to the amount of the appropriate premium

The **linear approach** is proposed, with the clear advantage of fairness. Spectrum hoarding can be avoided by setting appropriate price levels or by implementing market competition rules when demand rises dramatically.

In the proposed pricing regime, BW is defined as the total unpaired bandwidth assigned to a licensee. Note that in the case of paired FDD assignments, for example, 2x5 MHz, BW will be set at 10 MHz.

5.4.3 Frequency factor (FREQ)

How far a signal propagates is determined by several factors, the most universal of which are the frequency, transmit power and propagation environment. All other things being equal, the higher the frequency, the shorter the wave length and the more difficult it is at the receiving end to pick the signal up, due to the smaller aperture area.

At low frequencies, larger areas can be covered (longer ranges can be achieved for fixed links) than at high frequencies. As a consequence, deploying a system at a low frequency requires less infrastructure as compared to higher frequency deployments. This property makes the low frequencies (such as sub 1 GHz) more attractive for cost-effective network deployments.

Since range is the advantage here, quantifying the frequency factor requires knowledge of what affects range and how. For universality and simplicity, free space propagation is assumed. Therefore path loss is defined as:

Path Loss = Constant + 20*Log (Distance) +20*Log (Frequency).

The frequency factor can then be assumed to be a normalized version of the receive power. Note that the decibel function is chosen here rather than the linear formula to smooth out the effect of signal variation at high frequencies.

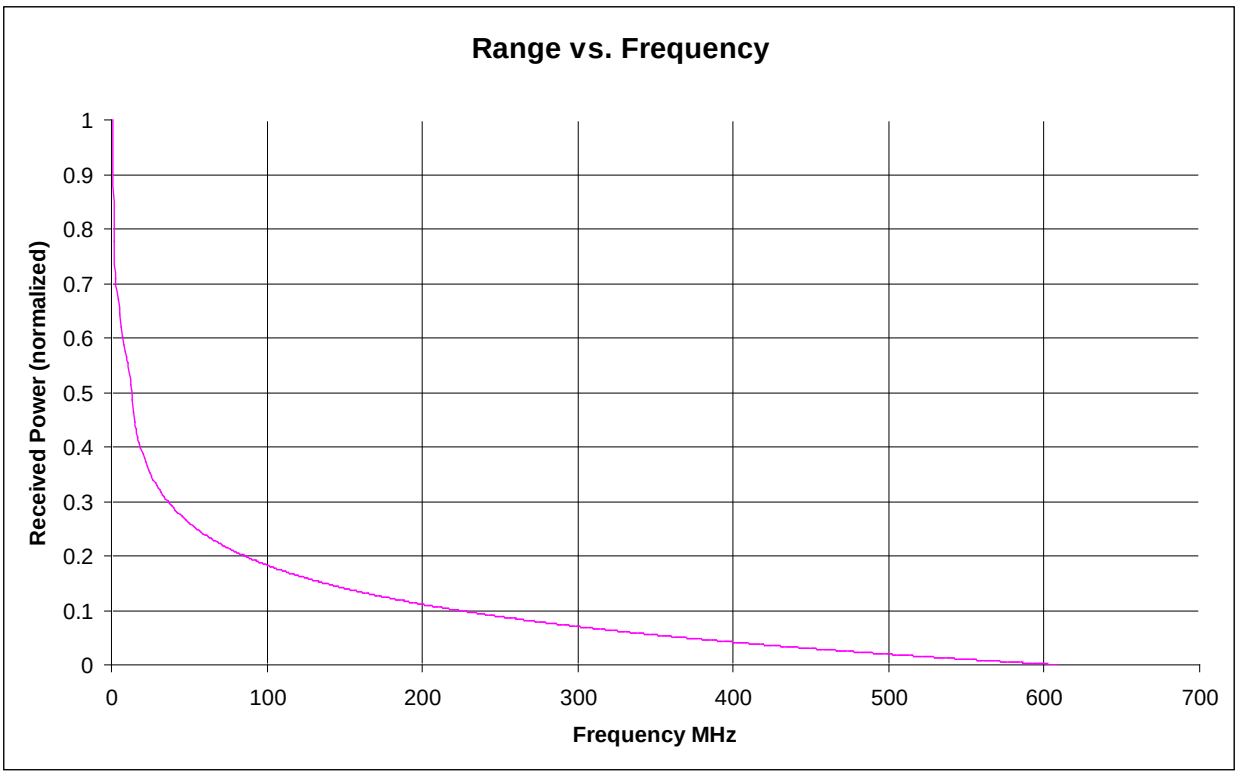

Figure 1: Frequency Factor

Proposed spectrum pricing model for consultation

Assuming a transmit power reference and a static distance, different frequencies will result in different path losses from which the received signal power levels can be derived. Figure 1 above shows how the receive signal power decreases based on increasing frequencies.

It is possible to obtain an FREQ value for each discrete frequency under consideration, however, for convenience of use, ranges have been defined. The main challenge is to select the ranges so as to contain bands allocated for the same purpose. By doing so, there will be only minimal disparity between licensees using different frequency bands to deliver the same services. However, when the difference in frequency band locations is significant (e.g. PMR in the UHF band and also in VHF), the frequency factor should not be used as a levelling tool and different FREQ factor values may need to be applied.

The FREQ ranges are according to the standard band classifications (VLF, LF, MF, HF, VHF, UHF, SHF and EHF) as these are commonly accepted. However, the UHF band is an exception and has been subdivided into two parts, sub 1GHz and above 1 GHz.

By applying an appropriate scaling factor to the result obtained in Figure 1, the following ranges for the frequency band factor can be defined:

Frequency Band	Centre Frequency	FREQ Factor
VLF	3-30 kHz	1.2
LF	30-300 kHz	1
MF	0.3-3 MHz	0.87
HF	3 - 30 MHz	0.7
VHF	30 - 300 MHz	0.54
UHF	0.3 - 1 GHz	0.38
UHF	1 - 3 GHz	0.29
SHF	3 - 30 GHz	0.21
EHF	above 30 GHz	0.05

Table 6: Proposed FREQ Factor

Note that the factor is calculated based on the lower bound of each designated frequency range, for example, in the case of frequency range 3-30 kHz, the FREQ will be computed based on 3kHz.

5.4.4 Geographic factor (GEO)

The GEO factor is intended to both reflect the more intensive use of radio frequency spectrum in higher density (urban) areas and also to provide incentives for the provision of services to rural areas.

Radio waves do not respect boundaries and for some low frequencies a GEO factor is of little relevance. However, for higher frequencies, it is possible to have an assignment that covers a low density (rural) areas only.

Swaziland has the following characteristics

- Two significant urban areas, Mbabane and Manzini- Matshapa.
- Other district centres and other small towns (such as Malkerns).
- Settled rural areas with a moderate to high population density.
- Areas with very low population such as the forestry areas,
- The most intense use of radio based communications is in the main cities, whereas the use is less intense elsewhere.

The objective of government is to foster economic activity and the use of technology in the poorer rural areas. The GEO factor facilitates the attainment of this objective by stimulating rural-only network deployments through a lower spectrum fee structure.

The following is a table of envisaged GEO factors applied to spectrum assignments that cover high density areas and those that cover low density areas only.

Area Type	GEO
High Density	1
Low Density	0.5

Table 7: Proposed GEO Factor

Due to the need to adopt formal definitions for high and low density population areas, it is proposed that the application of the GEO factor will be deferred for the first three years and set to a default value of 1 for all assignments. Where an assignment covers more than one type of area, the GEO factor will reflect the higher value area; this ruling also applies to nationwide assignments. Therefore, where the coverage area (i.e. AF see below) spans both high density area and a low density areas, the high density factor applies.

5.4.5 High Demand Factor

In some areas (irrespective of the geographic dimension), radio frequency spectrum could become scarce or unavailable. Demand exceeding supply is an indication of value of an item on the market. In the case of spectrum, both current and prospective licensees should be aware of its value and must be prepared to pay for it.

This also applies to bands such as the IMT bands where demand is higher than supply, even though applications are restricted.

A band that is not in High Demand is unity (i.e. 1). For bands where the Commission has determined that the spectrum is High Demand, the factor is higher than 1. Besides the application to intrinsically high demand spectrum such as IMT spectrum, this could be determined when there is no longer any spectrum available for assignment within a spectrum band. When such congestion exists, prices are proposed to be 2x higher than the base price.

The following is a table of suggested factors:

HIGH DEMAND	HD Factor Value
High Demand	2
Not in High Demand	1

Table 8: Proposed High Demand Factor

The bands subject to the High Demand factor will be determined by the Commission every three years[13].

[13] The application of the congestion factor that changes every year introduces an element of unpredictability into the spectrum fees that is largely absent from the rest of the model. This is because the fees may increase by 50% from one review period to another. Consequently, a High Demand factor is applied at three year intervals rather than an annual congestion factor.

5.4.6 Sharing Factor (SHR)

The exclusive use of radio frequency spectrum across a geographical area refers to the impossibility to assign a given frequency to more than one user. By their nature, some radio services tolerate frequency sharing in the sense that more than one licensee can use the spectrum for communications in the same geographical area without undue interference to concurrent licensees. Some services lend themselves naturally to such uses because of the traffic load on the systems or the very short range of the equipment. The extent to which this is possible is usually a function of the load pattern of the system, the degree to which the exchanged signals are scattered and the localised nature of the communications. In systems where communications are intermittent or are relatively distributed in geographical silos rather than flowing to and from a central point, it is possible for several licensees to operate equipment on the same frequency.

Whenever shared usage is possible, spectrum is used efficiently as a direct result of not having to assign different frequencies to different licensees, but effectively sharing one frequency between different licensees. In line with its policy of giving an incentive for efficiency and sparing use of spectrum, the Commission proposes to implement a price discount policy when two or more licensees opt to share spectrum.

However, if the fee per user-as a result of sharing discount is a direct division of the overall fee for the shared channel by the number of sharing licensees, administration would become over-complicated with wide price variations from area to area depending on the sharing dynamics. Therefore, the Commission proposes to set the sharing discount to 50%. This value is the sharing coefficient when two licensees share spectrum and still offers a significant discount to the full price when more than two licensees are involved.

Sharing	Value of sharing factor
Exclusive	1
Shared	0.5

Table 9: Proposed Sharing Factor

Sharing is considered to exist in instances where 2 or more licensees share a common frequency assignment within a common geographical area.

5.4.7 Area Factor (AF)

The Area Factor AF refers to the area sterilized (area denied to other users). In radio, the idea of area sterilized refers to the area over which a given transmitting station radiates. A wireless communication between radio apparatus, whether fixed or mobile, requires a link between both. When the receiving apparatus are mobile or when their number is large, it is more cost-effective for the transmitting station to cover an entire area rather than maintain several physical links. In practice, most point-to-area systems are built to radiate all around the base stations (omni-coverage) or in partitions (sectors around the base station).

This suggests that pricing should reflect the extent of the area over which the Commission is bound to monitor and guarantee minimum interference levels.

Furthermore, the use of a frequency across a geographical area makes it difficult or simply impossible in some cases to have another licensee use the same frequency in the same area. In other words, the use of spectrum usually carries the notion of exclusivity over a given area. As a consequence, spectrum pricing should be a function of the area over which each specific chunk of spectrum is denied to all other licensees (i.e. -the area sterilized).

One of the reasons for congestion is the expanse of the area sterilized. The larger the area sterilized, the more difficult it is to re-use frequencies. In order to promote spectrum efficiency and sparing use of limited spectrum, the area sterilized should be factored into the price of spectrum. For convenience and implementation simplicity, the area factor ranges are intended to allow easy application at the local, provincial and even national level.

The prospective licensee shall submit their system description including the location of their radio base stations as well as transmit power figures. The Commission shall estimate the area covered by the transmitters and feed this value into the price algorithm.

To make the pricing process understandable and convenient, ranges are used rather than absolute values. In the proposed pricing model, the area factors are based on radius ranges associated with the area sterilized as follows:

Area (sq km)	AF
0-1	0.6
1-10	1.8
10-100	5.6
100-1000	17.8
1000-5000	39.9
5000-10,000	56.4
10,000 above	73.6

Table 10: Proposed Area Factor

The first column reflects the geographical area coverage area of a particular service or application and is intended to cater for a myriad of long and short range applications that are deployed in low and high frequencies and will be able to cater for all future developments in technology.

5.4.8 Minimum hop length (HOPMINI)

The HOPMINI factor is applied to fixed links to ensure that appropriate frequencies are used for particular hop lengths

In the case of fixed links, the footprint of the link is narrow and can be seen as an ellipsoid between the two ends of the link. A network of fixed links is not geographically continuous in nature but rather like a web with gaps in between. In addition, the usefulness of a fixed link is not a function of how many randomly located receivers it can cover but how well it can link two fixed points. The resource denial here is not necessarily related to geographical overlapping in the sense of area sterilized. Rather, it is an expression of the excessive

interference that would be imposed on other links at the same frequency and installed along the path of a given link. In this case, the length of the link and the bandwidth used are indicative of the constraints it poses on other links in the area.

The frequency factor showed that how well a frequency can be picked up by an antenna depends on its wavelength, hence the dependence on the frequency. Standard maximum transmit power levels and antenna gains for most radio equipment and for fixed links exist and these limits give an indication of typical ranges of fixed links. Therefore, the length of a link could not be varied indefinitely while using type-approved equipment.

Fixed links are operated at frequencies varying from a few hundreds of megahertz to several tens of gigahertz. In order to ensure an efficient utilization of spectrum, it is helpful to add a dimension other than the frequency factor to pricing. For short links, both lower and higher frequencies could be used. But more radio frequency spectrum is available at high frequencies and long links can only operate at low frequencies. As a result, ensuring that short links do not unnecessarily clutter low frequencies is necessary to help avoid artificial congestions. The minimum path length idea associates a minimum length to fixed links at different frequencies. While licensees could require low frequencies for short links, this is not encouraged and would therefore cost a premium to the licensee. The premium percentage to be paid is computed as follows:

$$HOPMINI = \sqrt{\frac{Minimum\ Path\ Length}{Length\ of\ requested\ link}}$$

Where Minimum Path Length is defined in the table below and $HOPMINI = 1$ for $\sqrt{\frac{Minimum\ Path\ Length}{Length\ of\ requested\ link}} < 1.$

The square root function has been chosen since the receive signal power is proportional to the inverse square of the distance. The receive signal power is what matters when picking up a signal so in order to have proportions based on signal power, the square roots of distances need to be taken.

The minimum path lengths are the results of an analysis of the trends in equipment manufacturers and technologies as well as the current installed base of transmission equipment. Aspects such as transmit power, modulation and usual bandwidths have been considered to produce the table[14] 11 below.

The following is a table of minimum path lengths by frequency. Frequencies not appearing specifically in this table shall be rounded to the next highest value in the table.

[14] The calculations were based on values calculated by the British regulator OfCom who did estimations based on the most common transmission equipment (power, antenna types).

Frequency Band	Min Path Length (Km)
400 MHz	100
800 MHz	60
1.4/1.6/2 GHz	30
4 and 5 GHz	16
7.5 GHz	14
10 and 11 GHz	10
13/14/15 GHz	9
17/18 GHz	4
22/23 GHz	3
25/26 GHz	3
28 GHz	2
31 and 32 GHz	1.5
38 GHz	1
Higher	0

Table 11: Minimum path lengths by frequency

The minimum hop length is introduced to encourage licensees to use high frequencies for short links. If a licensee wishes nonetheless to apply for a license at a lower frequency a premium shall be paid.

The premium shall be the square root of the ratio between the minimum path length for the frequency requested and the actual path length of the licensee's link. This is understood as a premium on the price of the actual frequency requested.

Example: A licensee requests a 5GHz link for a hop length of 9 Km.

1. The minimum hop length at 5GHz is 16 Km
2. 9 Km hop lengths are normally assigned at frequencies starting from 13 GHz upward
3. the licensee may take the next available spectrum from 13 GHz on or insist on an assignment in the 5 GHz band but at a premium
4. For the calculation of the premium,
    a. the minimum length at the requested premium frequency is required. Here the requested premium frequency is 5GHz and the minimum length at 5 GHz is 16 km.
    b. the premium fee would then be **SQRT(16/9)=1.33** times the normal fee for the 5 GHz band.

Where the actual path length is greater than or equal to the minimum path length for the frequency spectrum, or the length is not known, the value of the HOPMINI factor in the point to area formula will be 1.

It is proposed that the HOPMINI factor is set at 1 for the first three years to allow path lengths to be properly calculated.

5.5 Minimum price ($\$_0$)

For smaller assignments it is likely that the formula derived fee could be low. In order to avoid complicated formulas, reduce administrative burden and to ensure cost recovery, a minimum fee is proposed. Licensees will pay whichever is higher between the calculated fee and the minimum price.

The proposed minimum fee is SZL 150 (one hundred and fifty Emalangeni).

Whenever the application of the appropriate algorithm results in a license fee lower than SZL 150, the minimum fee of SZL 150 will be charged.

This minimum fee will be the fee applied to pre-assigned frequencies, such as all categories of Amateur Radio, Aeronautical as defined in the current regulations as well as certain land mobile stations.

5.6 Alternative Options

With respect to the proposed model, there are alternative options within the model that can be highlighted here.

a) Annual Congestion Factor instead of High Demand Factor

   The Congestion factor as applied in South Africa comes into use when there is no more spectrum that can be assigned. This can be can be problematic to implement as a band may be fully occupied but not congested (at least until another application is made for an assignment in that band). Therefore, the alternative approach has been adopted where the Commission designates bands as being High Demand bands. This does not just apply to the IMT frequency bands but also bands where the Commission believes that demand is higher than supply or is expected to be in the near future To introduce stability into the administrative pricing model, the designation would take place as part of the three year review of the spectrum pricing model.

b) Unit price and BW are applied to paired bandwidth.

   In the current proposal, the unit price and BW are reflected in terms of the total unpaired bandwidth of the spectrum assigned. An alternative would be to represent the unit price and BW in terms of paired spectrum (because most assignments are paired), this however, would require the introduction of an additional factor to cater for the instances where the assignment is unidirectional / for one link only. This is done in South Africa (where a UNIBI factor is applied) but additional level of undue complexity is not proposed in Swaziland.

c) Greater granularity in the FREQ factor.

   The proposed FREQ factors are based on the standard frequency band designations. Introducing greater granularity is an option, but this is not proposed because of the danger that a paired assignment would span two bands, thereby introducing a level of complexity and ambiguity that is not needed.

d) Technological efficiency factor.

Some models introduce a technological efficiency factor to reward the use of more efficient equipment etc. by licensees. This was not done in the proposed model because of three reasons: Firstly, the application of such factors is subjective, secondly, the formula already incentivises the efficient use of bandwidth and thus encourages technological efficiency and thirdly, such factors go against the principle of technological neutrality and the long term stability of the model.

5.7 Unit prices, Formulae and Derived Charges

The formulae are based on the multiplication of a unit price by a number of factors.

5.7.1 Unit Price

The Unit Price[15] is a reference amount which is scaled by various factors to result in the actual price for the spectrum used by the licensee. The unit price is analogous to being the base price per MHz of assigned spectrum.

This unit price is uniformly applied to all services and having a single Unit price ensures that all radio frequency spectrum bands and services are treated equally. For the purposes of the proposed pricing regime, the Unit Price for all services subject to the following formulae is set at **SZL 2,000** for the current period.

5.7.2 Point-to- Area Formula

The following is the formula for point-to-area type services. We recommend applying this formula for all point-to-area services except of aeronautical and maritime with exclusive band allocations. *Note there are exceptions where the point-to-area formula can be applied to point-to-point type services (see section 5.7.3), however this will be at the discretion of a particular licensee.*

Fee = (UNIT * FREQ * BW * HD * GEO * SHR * AF)

The fee is the multiplication of the unit price (UNIT) by the frequency factor (FREQ), the bandwidth in MHz, the high demand factor (HD), the geographic factor (GEO) the sharing factor (SHR), and the area factor (AF).

Worked Example:

A licensee deploys point-to-area system (repeater, tracking, alarm…) in Mbabane at 150 MHz. The requested bandwidth is 25 kHz= 0.025 MHz. Assuming that this particular band is designated as being high demand and that the requested coverage

[15] In some models, such as that deployed in Australia, the Unit price is referred to as the constant K

area is 1,256 km² (or alternatively a radius of 20 Km), on an exclusive basis, the following applies using the factors as taken from the respective look up tables:

- Unit Price = SZL 2,000
- Frequency factor FREQ = 0.54
- Bandwidth factor BW: 0.025MHz
- High Demand factor HD = 2
- Geographical factor GEO = 1 (GEO set to 1 for the initial implementation of the pricing model)
- Sharing Factor SHR = 1 as the operator requires exclusive use of that frequency band in that area.
- ASTER = 39.9 for the applicable area in km² or radius.

- The annual fee would then be: SZL2000*0.54*0.025*2*1*1*39.9 = SZL 2,154.60

Should in any calculation the fee be less than the minimum fee of SZL 150, then the minimum fee of SZL 150 shall be paid.

5.7.3 Point-to- Point Formula

The point-to-point algorithm is to be applied to all fixed links whether below or above 1GHz. *In the event that a particular licensee makes extensive use of a particular frequency range for the deployment of fixed links, it may be more cost effective to apply the point-to-area formula for the exclusive of that particular range over a geographical area that encompasses all current and planned fixed link deployments.*

The formula is as follows:

Fee = (UNIT * FREQ * BW * HD * GEO *SHR * HOPMINI)

The fee is the multiplication of the unit price (UNIT) by the frequency factor (FREQ), the bandwidth (BW) in MHz, the high demand factor (CG), the geographic factor (GEO), the sharing factor (SHR) and the minimum hop length (HOPMINI) when deemed to be appropriate.

Worked Example

A licensee operates a hop length of 8 km using 28 MHz of bandwidth in the 5GHz band in a low density area. The frequency band used has not been designated as high demand. The following applies using the factors as taken from the respective look up tables:

- Unit Price = SZL 2,000
- Frequency factor - FREQ = 0.21

- Bandwidth factor BW = 28MHz
- High Demand factor HD = 1.0 (no high demand designation)
- Geographical factor GEO = 1.0 (GEO set to 1 for the initial implementation of the pricing model)
- Sharing Factor SHR = 1.0
- HOPMINI = 1.414 - this is because the minimum hop length at 5 GHz is 16 km but the deployed hop length is 8 km therefore the premium is calculated as SQRT(16/8)=1.414 times the normal fee for the 5 GHz band. *However, HOPMINI will be set to 1 for the initial implementation of the pricing model.*
- The annual fee = SZL 2000 * 0.213 * 28 * 1 * 1* 1 * 1 * 1 = SZL 11,928[16]

Should in any calculation the fee be less than the minimum fee of SZL 150, then the minimum fee of SZL 150 shall be paid.

5.7.4 Hub Ground Station Satellite Formula

Hub ground station Fee = Max ($\$_{UL}$; UNIT * BW_{UL})

The fee is the multiplication of the unit price (UNIT) by the uplink bandwidth (BW_{UL}) in MHz, and **$\$_{UL}$** is the current minimum fee for satellite uplink connections (SZL 15000).

5.7.5 Non-hub VSAT Ground Station Satellite Formula

Non-hub VSAT Fee = (UNIT * BW_{UL})

For VSAT's which are a subordinate part of a system controlled by a hub station, the fee shall be determined as the multiplication of the unit price (UNIT) by the uplink bandwidth (**BW_{UL}**) in MHz – the standard rule regarding the Minimum fee applies.

5.8 Notes on Implementation

5.8.1 Fee Reviews

The radio frequency licence fees will be reviewed from time to time and it is expected that they will be raised in line with inflation. Such a review should be made at least every 3 years. Any adjustment to the fees will be made to the unit price, the definition the geographic factor, the designation of high demand frequency bands and the minimum fees.

5.8.2 Calculation and Payment

In order to simplify the fee calculation process, all fees other than the fees for temporary usage will be calculated as for one year from the time of first payment and will be renewable

[16] If HOPMINI is applied it would deploy a factor of 1.414 which would result in a fees of SZl 16,866

on the applicable anniversary, either the first anniversary for a single year licence or (for example) the fifth anniversary for a five year multi-year licence.

5.8.3 Minimum Fees

The fees for pre-assigned frequencies, i.e. Amateur, Aeronautical and Maritime Ship Stations will be set at the minimum fee of SZL 150.

5.8.4 Area Factor

For the point to area methodology, the key consideration is the area sterilized, i.e. denied to other users of the same spectrum.

Licensees may choose to request a change to their assignment upon renewal of their licence.

5.8.5 Minimum Hop Links

The Minimum hop length factor is deployed to ensure that licensees utilize the optimum frequency for their hop length by imposing penalties. It is suggested that the HOPMINI factor be deferred to the first review and until that time, the HOPMINI factor will be set at 1.

5.8.6 Broadcast

The methodologies can be applied to broadcast services as well.

5.8.7 Information

Licensees will however be obliged to fulfil all requirements including the provision of all necessary information regarding the stations to the Commission and comply with any regulations or guidelines regarding the maximum number of stations in any given system.

5.9 Assignments

The new pricing system does not necessarily cause the radio frequency spectrum to become more expensive, but it remains a scarce resource. Assignment of radio frequency spectrum remains at the discretion of the Commission and applicants for an assignment of radio frequency spectrum (including additional spectrum) should furnish all the information required by the Commission to support their application.

6 Future Methodology

6.1 Objective

Suggested future methodology to be used in reviewing the spectrum pricing as indicated in the regulations.

6.2 Methodology

The spectrum regulations stipulate that “The Commission shall review and publish the pricing formula for frequency spectrum at least one in every three years”.

An important and valuable feature of the proposed model is that it does not necessarily require frequent reviews and adjustment and accordingly brings stability to the sector.

However, the following issues should be reviewed on a three year basis:

Adjustments to the unit price to reflect:

- The effects of inflation and corresponding changes to the unit price. Inflation can be measured in terms of the Consumer Price Index (CPI).
- Changes in the number of licensees.

The designation of bands as being subject to congestion (or High Demand) can be reviewed at three year intervals and the application of the Congestion Factor (or High Demand factor) can be determined. Moreover, the Commission may opt to review the review the definition of high and low density areas, in line with the growth of the population.

For the first triennial review of spectrum fees, the following should be implemented:

- The HOPMINI factor for fixed links, it is proposed that this is not implemented until the first review in 3 years in order to allow the path lengths to be calculated properly and for licensees to consider alternatives,
- The GEO factor, it is proposed that a definition of high and low density population areas be formulated.
- The HD factor, it is proposed that the list of high demand frequency bands be reviewed.
- It is also suggested that the Area Factor be reviewed for some sub-national assignments (especially PMR) when it has become clear what the actual area of coverage is.

7 Implementation

7.1 Time frame for implementation

It is recommended that the administrative annual spectrum fees model be introduced at the start of the next financial year.

Step 1: Consultation process to be concluded by the end of October 2017.

Step 2: Revised spectrum fees schedule to be published by end of November 2017.

Step 3: New fees to be implemented in 2018.

The review of the spectrum fees should take place in the last quarter of 2020.

7.2 Procedures for the first three year cycle

In general, the model can be implemented in full immediately where there is full information about the assignments.

In certain instances it may be necessary to implement standardised assumptions regarding the application of the factors in the first three year cycle:

- The HOPMINI to be set at 1 for the first three years.
- The AF factor to be standardised for similar assignments (such as PMR) for the first 3 years.
- The GEO factor to be set at 1 for the first three years.
- The application of the minimum fee for aeronautical services for the first three years.

7.3 Application of pricing model to present schedule of fees.

• **Description**			
		Application Fee	***Formula***
1	**Land Mobile Services (non-cellular)**		
1.1	Mobile two-way radio stations		
1.1.1	Network of up to 10 radios	SZL 1,000.00	Point to Area formula
1.1.2	Network of 11 – 30 radios	SZL 1,000.00	Point to Area formula
1.1.3	Network of 31 – 50 radios	SZL 1,000.00	Point to Area formula
1.1.4	Network of 51 – 100 radios	SZL 1,000.00	Point to Area formula
1.1.5	Network of above 100 radios	SZL 1,000.00	Point to Area formula
1.2	Cross Border		
1.2.1	Network of up to 10 radios	SZL 1,000.00	Point to Area formula
1.2.2	Network of 11 – 30 radios	SZL 1,000.00	Point to Area formula
1.2.3	Network of 31 – 50 radios	SZL 1,000.00	Point to Area formula
1.2.4	Network of 51 – 100 radios	SZL 1,000.00	Point to Area formula
1.2.5	Network of above 100 radios	SZL 1,000.00	Point to Area formula
1.3	Alarm system including base station with remote stations	SZL 1,000.00	Point to Area formula
1.4	Paging systems	SZL 1,000.00	Point to Area formula

Proposed spectrum pricing model for consultation

2	**Satellite Services**		
2.1	Earth station/ VSATs -Transmit/ Receive (TX/RX) - Corporate	SZL 1,000.00	Satellite or VSAT formula
2.2	Earth Station / VSATs – Transmit/Receive – Solar and Heliospheric Observatory (SOHO)	SZL 1,000.00	Satellite or VSAT formula
2.3	Amateur	SZL 1,000.00	Minimum Price
2.4	Terminal for radio determination services	SZL 1,000.00	Point to Area formula
2.5	Landing rights:	SZL 1,000.00	Point to Area formula
3	**Radio-determination/Aeronautical Services**		
3.1	Aeronautical stations (per airport)	SZL 1,000.00	Minimum Price
3.2	Aircraft Licence (per aircraft)	SZL 1,000.0	Minimum Price
3.3	Radio - operators Certificate	Nil	Nil
3.4	Aeronautical earth station	SZL 1,000.0	Minimum Price
3.5	Radiolocation stations e.g. Radar	SZL 1,000.0	Minimum Price
4	**Fixed services**		
4.1	Point to Point Link	SZL 1,000.00	Point to Point formula
4.2	Point to Multi-Point Link	SZL 1,000.00	Point to Area formula
4.3	Amateur Radio	SZL 1,000.0	Minimum Price
5	**Telemetry/Tele-command: e.g. radio equipment for measuring seismic movements**	**SZL 1000.00**	Point to Area formula
6	**Broadcasting Services**		
6.1	Sound		
6.1.1	MF-AM	SZL 1,000.00	Point to Area formula
6.1.2	HF-AM	SZL 1,000.00	Point to Area formula
6.1.3	VHF-FM	SZL 1,000.00	
6.1.3.1	Up to 500W		Point to Area formula
6.1.3.2	Above 500W		Point to Area formula
6.2	Television		
6.2.1	VHF	SZL 1,000.00	Point to Area formula
6.2.2	UHF operating with an effective isotropic radiated power (e.i.r.p) of:		
6.2.2.1	up to 1kW	SZL 1,000.00	Point to Area formula
6.2.2.2	Above 1kW	SZL 1,000.00	Point to Area formula
7	**Land Mobile Services (Cellular)**		
7.1	Broadband General Bands (1MHz)	Application Fees will be specified in the invitation to apply.	Point to Area (max AF)
7.2	CDMA Bands (10 MHz paired)		Point to Area (max AF)
7.3	3G/UMTS/WCDMA Bands (5 MHz paired)		Point to Area (max AF)
7.4	Mobile Broadband (4G) Bands (1 MHz)		Point to Area (max AF)
7.6	Cellular GSM Channel Pair (200 kHz)		Point to Area (max AF)

Table 12: Application of pricing model to present categories

Proposed spectrum pricing model for consultation

As noted, application fees are in general standardised and the application fees for cellular bands will be prescribed when an invitation to apply for cellular frequencies is issued by the Commission.

Appendix A Draft Schedule

1. The Commission intends to revise the **Schedule of Spectrum Fees** as per *17. (1)* of Electronic Communications (Radio Frequency Spectrum) Regulations 2016.
2. Pricing Approach
   (a) The Commission shall adopt a pricing formula that reflects the relative economic value of radio frequency spectrum in order to encourage the efficient usage of radio frequency spectrum and stimulate growth.
   (b) The price of radio frequency spectrum shall be directly proportional to the size of radio frequency spectrum assigned.
   (c) The price of radio frequency spectrum shall vary depending on the frequency band.
   (d) The price of the radio frequency spectrum may also reflect all or some of the following factors, the geographic location, the area sterilised (denied to other users), whether the band in question is determined to be in high demand or not, the degree of sharing, the minimum hop length of an assignment of a single link.
   (e) The Fees payable for radio frequency spectrum shall be at least sufficient to cover the costs of radio frequency spectrum management and monitoring.
3. Application Fees
   (a) The standard application fees are stated in the annex,
   (b) Application Fees for cellular bands and any other bands identified by the Commission will be specified in the invitation to apply or otherwise separately.
4. Annual Fee Determination
   (c) The annual fees payable for each category of radio frequency spectrum shall either be as determined by a pricing formula as described in these Regulations or by application of the minimum fee.
   (d) The unit price per MHz of Frequency Spectrum is as stated in the Annex to these regulations and may be reviewed from time to time as directed by the Spectrum Regulations.
   (e) The minimum fee is as stated in these regulations and may be reviewed from time to time as directed by the Spectrum Regulations.
5. Exceptions
   (a) Equipment that is licence-exempt is not subject to a radio frequency spectrum licence fee.
6. Formulae

   The following formulae shall be used as indicated in the price schedules.

   (a) Point-to-area formula

Applied to all point to area services except for amateur and aeronautical with exclusive band allocations.

Fee = (UNIT * FREQ * BW * HD * GEO * SHR * AF)

The fee is the multiplication of the unit price (UNIT) by the frequency factor (FREQ), the bandwidth (BW) in MHz, the high demand factor (HD), the geographic factor (GEO) the sharing factor (SHR) and the area factor (AF).

(b) Point-to-point formula

Applied to all fixed links whether below or above 1GHz. The formula is as follows:

Fee = (UNIT * FREQ * BW *HD * GEO * SHR * HOPMINI)

The fee is the multiplication of the unit price (UNIT) by the frequency factor (FREQ), the bandwidth (BW) in MHz, the high demand factor (HD), the geographic factor (GEO), the sharing factor (SHR) and the minimum hop length (HOPMINI)

(c) Hub Ground Station Satellite Formula

The fee for a principle hub station for uplink is determined by the following fee

Hub ground station Fee = Max ($$_{UL}$; UNIT * BW$_{UL}$)

The fee is the multiplication of the unit price (UNIT) by the bandwidth (BW) in MHz, and **$$_{UL}$** is the minimum fee for satellite uplink connections.

(d) Non-hub VSAT Ground Station Satellite Formula

The fee for a non-hub Very Small Aperture Station for uplink is determined by the following fee

Non-hub VSAT Fee = (UNIT * BW$_{UL}$)

The fee is the multiplication of the unit price (UNIT) by the uplink bandwidth (BW) in MHz.

7. Unit Price – the Unit Price (UNIT) is applied per MHz paired of bandwidth. UNIT is as stated in the Annex.
8. Factors and Look Up Tables

(a) Bandwidth (BW)

The Bandwidth factor is expressed per MHz.

(b) Frequency factor (FREQ)

(i) The following are the ranges and the relevant frequency band factor:

(ii) Frequency Band	Centre Frequency	FREQ Factor
VLF	3-30 kHz	1.2
LF	30-300 kHz	1
MF	0.3-3 MHz	0.87
HF	3 - 30 MHz	0.7
VHF	30 - 300 MHz	0.54
UHF	0.3 - 1 GHz	0.38
UHF	1 - 3 GHz	0.29
SHF	3 - 30 GHz	0.21
EHF	above 30 GHz	0.05

(iii) The factor is calculated based on the lower bound of each designated frequency range, for example, in the case of frequency range 3-30 kHz, the FREQ will be computed based on 3kHz.

(c) Geographic factor (GEO)

(i) The following is the table of geographic factors:

Area Type	GEO
High Density	1
Low Density	0.5

(ii) The definition of high and low density is stated in the Annex to this regulation.

(iii) Where the geographic area that is covered by a licence includes more than one GEO area, the highest GEO factor will be applied.

(d) High Demand Factor (HD)

(i) The following is the table of High Demand Factors:

HIGH DEMAND	HD Factor Value
High Demand	2
Not in High Demand	1

(ii) High demand is as determined by the Commission.

(e) Degree of sharing (SHR)

(i) The following is the table of Share factors

Sharing	Value of sharing factor
Exclusive	1
Shared	0.5

(ii) 'Sharing is considered to exist in instances where 2 or more licensees share a common frequency assignment within a common geographical area

(f) Area Factor (AF)

(i) The following is the table of AF factors

Area (sq km)	AF
0-1	0.6
1-10	1.8
10-100	5.6
100-1000	17.8
1000-5000	39.9
5000-10,000	56.4
10,000 above	73.6

(g) Minimum hop length (HOPMINI)

(i) The following is a table of minimum path lengths by frequency. Frequencies not appearing specifically in this table shall be rounded to the next highest value in the table.

Frequency Band	Min Path Length (Km)
400 MHz	100
800 MHz	60
1.4/1.6/2 GHz	30
4 and 5 GHz	16
7.5 GHz	14
10 and 11 GHz	10
13/14/15 GHz	9
17/18 GHz	4
22/23 GHz	3
25/26 GHz	3
28 GHz	2
31 and 32 GHz	1.5
38 GHz	1
Higher	0

(ii) Where the actual path length of the licensee's link is shorter than the minimum path length for the frequency, the HOPMINI factor in the formula shall be calculated as the square root of the ratio between the minimum path length for the frequency requested and the actual path length of the licensee's link SQRT(Minimum Path Length for the Frequency / Actual Path Length)**.**

(iii) Where the actual path length is equal to the minimum path length for frequency spectrum or the length is not known, the value of HOPMINI in the formula will be 1.

9. Minimum Fees

(a) The Minimum Fees are as stated in the Annex.

(b) The Minimum fees are applicable to the services as defined in the Table of Fees by Type of Radio Communications Service.

(c) Where the Radio Frequency Spectrum Licence fee is defined by formula and the result is lower than the minimum fee, then the minimum fee shall apply.

(d) For satellite hub uplink stations, the minimum fee for satellite hub uplink stations shall apply.

(e) Table of Fees

• **Description**			
		Application Fee	***Formula***
1	**Land Mobile Services (non-cellular)**		
1.1	Mobile two-way radio stations	SZL 1,000.00	Point to Area formula
1.2	Cross Border	SZL 1,000.00	Point to Area formula (land area within Swaziland)
1.3	Alarm system including base station with remote stations	SZL 1,000.00	Point to Area formula
1.4	Paging systems	SZL 1,000.00	Point to Area formula
2	**Satellite Services**		
2.1	Earth station/ VSATs -Transmit/ Receive (TX/RX) - Corporate	SZL 1,000.00	Satellite or VSAT formula
2.2	Earth Station / VSATs – Transmit/Receive – Solar and Heliospheric Observatory (SOHO)	SZL 1,000.00	Satellite or VSAT formula
2.3	Amateur	SZL 1,000.00	Minimum Price
2.4	Terminal for radio determination services	SZL 1,000.00	Point to Area formula
2.5	Landing rights:	SZL 1,000.00	Point to Area formula
3	**Radio-determination/Aeronautical Services**		
3.1	Aeronautical stations (per airport)	SZL 1,000.00	Minimum Price
3.2	Aircraft Licence (per aircraft)	SZL 1,000.0	Minimum Price
3.3	Radio - operators Certificate	Nil	Nil
3.4	Aeronautical earth station	SZL 1,000.0	Minimum Price
3.5	Radiolocation stations e.g. Radar	SZL 1,000.0	Minimum Price
4	**Fixed services**		
4.1	Point to Point Link	SZL 1,000.00	Point to Point formula
4.2	Point to Multi-Point Link	SZL 1,000.00	Point to Area formula
4.3	Amateur Radio	SZL 1,000.0	Minimum Price
5	**Telemetry/Tele-command: e.g. radio equipment for measuring seismic movements**	**SZL 1000.00**	Point to Area formula
6	**Broadcasting Services**		
6.1	Sound		
6.1.1	MF-AM	SZL 1,000.00	Point to Area formula
6.1.2	HF-AM	SZL 1,000.00	Point to Area formula
6.1.3	VHF-FM	SZL 1,000.00	Point to Area formula

6.2	Television		
6.2.1	VHF	SZL 1,000.00	Point to Area formula
6.2.2	UHF	SZL 1,000.00	Point to Area formula
7	**Land Mobile Services (Cellular)**	Application Fees will be specified in the invitation to apply.	Point to Area (max AF) and max HD Factor

Annex

A. The Unit Price per MHz paired is SZL 2,000

B The Minimum Fee is SZL 150

C The Minimum fee for a Satellite Hub Station is R 50,000

D The GEO Factor will be 1 for all assignments until high density and low density areas are determined by the Commission.

E The HOPMINI Factor will be 1 for all point to point assignments until otherwise determined by the Commission

F The High Demand Factor of 2 is applied to Land Mobile Cellular Services.

Appendix B 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;
AF	means Area Factor
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 Commission 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;
Assignment	means the authorisation given by the Commission 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
BTS	means Base Station
BTX	means Base Transceiver;
BW	Means Bandwidth factor
CA	means Carrier Aggregation

CDMA	means Code Division Multiplex Access
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
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
EHF	means Extremely High Frequency
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
FWA	means Fixed Wireless Access
FWBA	means Fixed Wireless Broadband Access
Gbps	means Gigabits per second
GEO	Means Geographical Factor
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
HF	means High Frequency
HOPMINI	Means minimum hop length factor applied to microwave links.
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
LF	means Low Frequency
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
MF	means Medium Frequency
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%)
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
ZAR or R	Means South African Rand
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
SCCOM	means the Swaziland Communications Commission

SDL	means Supplementary Downlink
SEC	means Security Factor
SF	means Single Frequency
SHF	means Super High Frequency
Ship station	means a mobile station in the maritime mobile service that has been erected
SHR	means Charing Factor
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
SZL or E	means Swazi Lilangeni
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.
THF	means Tremendously High Frequency
UNIBI	means unidirectional/bidirectional factor
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
VLF	Very Low Frequency
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