Consultation Document

Consultation on Spectrum Management

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About this document

The Botswana Communications Regulatory Authority (BOCRA) is conducting a consultation exercise regarding its future spectrum management strategy. BOCRA has already concluded a consultation on a revised National Radio Frequency Plan (NRFP) and supporting footnotes. BOCRA has also requested initial stakeholder views on a wide range of spectrum management topics. BOCRA is now seeking stakeholder comments on a set of proposals for the future management of spectrum within Botswana. The issues addressed in this consultation potentially have relevance for a wide range of spectrum users, including:

- Fixed Wireless Access Systems;
- Mobile Services (voice and data);
- Mobile Radio Services;
- Radio Local Area Networks;
- Broadband Wireless Access Systems;
- Broadband Public Protection and Disaster Relief;
- Fixed Radio Services;
- Fixed Services
- Point-to-Point Radio Systems
- Point-to-Multi-Point Systems;
- Broadcasting Services;
- Public Mobile Access Radio (PAMR) and Private Mobile Radio (PMR);
- Satellite Communications; and
- Short Range Devices.

In this document, BOCRA's consultants, Coleago Consulting Ltd, discusses a range of spectrum management issues and provide proposals. BOCRA seeks stakeholder views on the relevance and suitability of these recommended approaches in Botswana. Input from stakeholders will inform BOCRA's future policy decisions.

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Section 1. Executive Summary

1.1 Introduction

1.1.1. The management of spectrum is one of the Botswana Communications Regulatory Authority's key roles and a successful spectrum management strategy can provide significant benefits to the people and economy of Botswana. In this consultation a range of spectrum management issues are discussed including spectrum assignment, renewal, trading as well as licensing and pricing. This consultation includes Coleago's proposals to BOCRA, upon which BOCRA now seeks stakeholder comments.

1.2 Legal context and statutory duties

1.2.1. The Botswana Communications Regulatory Authority (BOCRA) was established by the Communications Regulatory Authority Act, 2012 (CRA Act) and is responsible for managing radio frequency spectrum in the Republic of Botswana. BOCRA is required by the CRA Act to promote efficiency, investment, innovation and competition, including in relation to radio spectrum management.

1.2.2. BOCRA is responsible for formulating, periodically updating and implementing a Spectrum Management Strategy, which comprises the National Radio Frequency Plan, and the licensing frameworks and principles for spectrum management. BOCRA has the power to recover costs of spectrum management based on section 24(1)(c) of the CRA Act, which provides that BOCRA's funds shall consist, among other things, of "such fees as the Authority may impose for goods and services provided under this Act or any Act permitting the Authority to charge for such goods and services". BOCRA also has the power to impose prices for spectrum based on section 47(e) of the CRA Act which authorises it to "set the conditions and tariffs applicable in connection with the allocation of radio frequencies to the holders of telecommunications licence holders."

1.3 Strategic priorities

1.3.1. The proposals in this consultation are also influenced by "Vision 2036". The Vision is based on four pillars of which "sustainable economic development" and "human and social development" are most directly impacted by spectrum management decisions. In developing its proposals, Coleago has also considered the proposals of the National Broadband Strategy.

1.4 Spectrum management

1.4.1. Coleago has examined the following key spectrum management issues which it considers most relevant to achieving BOCRA's objectives:

a. spectrum assignment;
b. spectrum licence conditions to promote rural coverage and advance the National Broadband Strategy;
c. secondary markets and spectrum trading;
d. approaches to sharing;
e. licence renewal;
f. licence duration; and
g. public safety and emergency services.

Spectrum assignment

1.4.2. The main issues in the approach to spectrum assignment are as follows:

a. the use of auctions to award spectrum is regarded as best practice where there is excess demand for spectrum. Well-designed auctions with potentially spectrum caps, low reserve prices and coverage

obligations can deliver efficient, pro-competitive outcomes and should be capable of meeting a wide range of policy objectives. One important element is to set the reserve price appropriately as failure to do so has led to some failed auctions in the recent past. Spectrum auctions have been used successfully in several countries similar in size and average income to Botswana and in a few larger African countries. Hence the small size of the Botswanan market need not be an impediment to successful auctions;

b. comparative selection (or beauty contests) has been used in the past in a number of countries but is no longer regarded as best practice. Regulators may not achieve the best outcome for society because they are at an informational disadvantage to the market and a lack of transparency in the evaluation of criteria has led to court challenges in European jurisdictions and other areas. Though auctions are the preferred method of competitive award, beauty contests have been used in specific situations, e.g. in connection with re-farming mobile spectrum. In 2017 BOCRA used beauty contests to award fixed wireless access spectrum citing specific policy objectives as justification for this choice of approach; and

c. administered assignments are simple, low-cost mechanisms to assign spectrum. As such they may be appropriate if the supply of spectrum is certain to exceed demand. However, they may not necessarily promote efficient spectrum use as technology and markets change over time, especially given the ongoing rising demand for spectrum. Of the various methods for administered assignment, first-come-first-served (FCFS) may lead to competition problems, weaken technical efficiency and raise concerns over transparency. In contrast, BOCRA's historic approach in relation to mobile spectrum of "equal administered assignments" does reduce competition concerns and takes into account the sector's needs for spectrum.

Rural coverage

1.4.3. The key issues and challenges in extending rural coverage and advancing the NBS are as follows:

a. the award of new low frequency mobile spectrum is a great opportunity to advance the goals of the NBS since LTE and 5G will bring down the cost of broadband networks;

b. coverage obligations can encourage operators to roll-out mobile broadband services in a timely manner. If the obligations include areas that would not otherwise be commercially viable, the value of spectrum is reduced, and this should be taken into account in the design of award mechanisms, including auctions, and in setting licence fees and reserve prices. Subsidies may help to extend coverage into deeply rural areas, but this relies on competition in the tendering process for subsidy and an accurate estimation of the costs of rural coverage by the regulator; and

c. the societal impact of extended coverage will be limited unless broadband is affordable in rural areas. As a result, Coleago believes BOCRA should consider allowing operators to cooperate - by roaming or spectrum sharing in specified rural areas - alongside coverage obligations and subsidy programmes. This can reduce the cost of covering rural areas and increase affordability.

Spectrum trading

1.4.4. Establishing secondary markets for spectrum is an established part of spectrum management in many countries and is seen as best practice. In a well-functioning secondary market: spectrum trading provides incentives for efficient spectrum use; may deter inefficient spectrum hoarding; and promotes greater transparency over spectrum ownership.

1.4.5. Spectrum trading also complements other spectrum management mechanisms. Trading can improve efficiency under both administered and competitive spectrum assignments because it provides ongoing incentives for spectrum to move to its most economic use. Trading also complements incentive-based spectrum pricing by reinforcing incentives for efficient spectrum use and a faster route for recycling of spectrum within the market.

Sharing

1.4.6. Infrastructure sharing is common in many developed mobile markets because it reduces inefficient duplication of infrastructure and generates cost savings. It is also viewed as important in the context of new 5G architectures

which are expected to need many more cell sites than at present due to the use of much higher frequencies with shorter propagation characteristics.

1.4.7. Passive infrastructure sharing of towers, cabinets, power supplies etc. has been widely adopted and is regarded as best practice. Because operators are still able to differentiate their services and it does not require the sharing of strategic information, it raises few competition concerns.

1.4.8. Active infrastructure sharing of active elements in the radio access network, such as antennas and radio network controllers, is less common than passive sharing but many agreements have been signed. In the EU, for example, it is present in roughly half the Member States[1]. This is because active sharing offers greater scope for collaboration. If this is not appropriately managed it can create opportunities for collusion and distortions to competition. Regulators have to strike a balance between incentivising investment and promoting competition. This has led many countries to take a case-by-case approach to active network sharing in which each request is reviewed taking into account the operational framework for the shared network, the ownership structure and the potential impact on competition in the market. In a few countries, regulators have relied on ex-post competition law procedures to challenge sharing agreements once they have been put into operation.

1.4.9. Spectrum sharing is becoming increasingly important internationally. Although it may bring further cost reductions on top of infrastructure sharing, the growing interest is mainly driven by increasing demands for spectrum in areas such as mobile broadband and emergency service use. Sharing enables spectrum to be used more efficiently, helps to reduce spectrum scarcity, and may also lower barriers to accessing spectrum, enabling more innovation and niche-based competition.

1.4.10. There are several forms of spectrum sharing:

a. shared access targets spectrum that is under-utilised by incumbents while ensuring incumbents do not suffer harmful interference. Licenced approaches bring more certainty over rights to spectrum but impose costs on regulators and users. Unlicensed approaches rely on technology such as location databases or "spectrum sensing" to detect which frequency and / or time slot can be used without causing interference to nearby devices in the same band;

b. spectrum pooling may generate cost savings and enable higher quality services by enabling licensees to use their spectrum holdings jointly. It has not been widely used due to concerns it might reduce competition and service differentiation; and

c. national wholesale mobile networks may also generate cost savings. However, they also raise concerns over the potential for wholesale monopolies and the major disincentives to investment and innovation that may follow. Few wholesale networks have been deployed. Experiences in Rwanda and Mexico provided little evidence of benefits in terms of lower prices or increased broadband take-up.

Renewal

1.4.11. It is important to manage the process of licence renewal to avoid any disruption to investment or services arising from the expiry of a licence. Two approaches to spectrum licence renewal are accepted as best practice:

a. a hybrid approach of a presumption of renewal in favour of the incumbent but keeping open the possibility of a competitive process to re-assign the spectrum has been used in many countries. Several countries, such as Canada, New Zealand, Sweden (for some bands) and the US routinely apply this approach; and

b. competitive processes can be used to re-award spectrum. This is most relevant where there is likely to be competition for spectrum and uncertainty over the most efficient future use of the spectrum. Many EU countries such as France, Germany, Ireland and Spain have used auctions to re-assign rights to fixed term spectrum licences.

Licence duration

1.4.12. Licence duration is a key consideration for all stakeholders. The licence duration should be sufficiently long for spectrum users to be able to earn a reasonable return on their investment over the period of the licence.

1 See BEREC Report on Infrastructure Sharing, 2018 https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/8164-berec-report-on-infrastructure-sharing

However, the licence duration should also allow the regulator the opportunity to review whether spectrum continues to be used efficiently over time. Globally, there is pressure from spectrum users for longer licence durations. At a minimum, best practice is a 15-year licence term and in some cases longer terms of even 20 years or even indefinite licence terms may be justified.

Public safety and emergency services

1.4.13. Existing public safety and emergency service networks are not adequate for the changing requirements of security and emergency service users such as real-time video (e.g. body worn cameras) or near real-time transfer of pictures and other evidence in emergency scenarios.

1.4.14. Emergency service organisations globally want to move to broadband systems, but national administrations are divided over the use of dedicated or shared networks. Sharing with commercial networks should generate economies of scale and reduce costs for both emergency services and commercial users. However, the cost to commercial networks of delivering the required levels of resilience may be high. The US has leant towards a hybrid solution of dedicated networks but with shared capacity offered to commercial customers. Other countries such as the UK are considering shared network arrangements.

1.5 Results of the initial consultation

1.5.1. An initial consultation was held on general spectrum management issues. Eleven responses were received but only seven stakeholders commented on the spectrum management issues highlighted in the consultation. Hence, the number of respondents is too few to be taken as representative of the views of all stakeholders in Botswana, but they nonetheless provide useful insights.

1.5.2. Views on many issues were divided. On the approach to spectrum assignment, views were split between support for the use of auctions for high value spectrum uses such as mobile and support for the current system of managed equal assignments. The key issue was whether supply was likely to exceed the demand for spectrum. Responses were similarly split on the approach to the award of 800 MHz spectrum.

1.5.3. There was majority support, notwithstanding some objections, for the introduction of other market mechanisms including spectrum trading and spectrum sharing.

1.5.4. On licence duration and renewal, the consensus supported the proposals in the initial consultation for a licence duration of 15 years and for a presumption of renewal of spectrum in favour of the incumbents.

1.6 Spectrum management strategy proposals

1.6.1. Coleago makes 14 proposals for BOCRA's spectrum management strategy as listed below:

a. Coleago proposes that, for the award of exclusive spectrum licences and where the demand for spectrum is likely to exceed supply, auctions are used as the assignment mechanism. Spectrum caps and coverage obligations should apply where appropriate.

b. Coleago proposes that administrative assignment is used where the supply of spectrum is likely to exceed demand, including equal administered assignment where necessary to promote competition.

c. BOCRA should apply a demand assessment procedure for new spectrum and should award the spectrum by competitive process if there is evidence of excess demand.

d. BOCRA should consider introducing a licence condition in future mobile spectrum awards, including 800 MHz, to permit infrastructure and spectrum sharing between operators to meet coverage obligations. Sharing should be limited to specific rural areas.

e. BOCRA should consider reverse auctions for subsidies in relation to the rollout of coverage to areas that would be otherwise commercially unviable in order to meet the objectives of the NBS. BOCRA should permit operators to share infrastructure and spectrum in covering these areas.

f. BOCRA should include coverage obligations in future spectrum licences for services such as mobile and fixed wireless access, setting spectrum and technology agnostic targets for covering specific areas by specified dates and at designated service levels.

g. BOCRA should include conditions in spectrum licences to allow transfers of spectrum. BOCRA should create a framework to facilitate the development of a secondary market including a register of spectrum holdings and spectrum trades and a procedure to address competition concerns.

h. BOCRA should require any operators wanting to actively share networks to request prior approval from BOCRA. BOCRA should review each request on its merits taking into account competition concerns and the potential benefits for investment and should set out the criteria it would use in a set of guidelines.

i. BOCRA should consult on the need for and priority attached to introducing the shared access form of spectrum sharing. If BOCRA decides to proceed, it should initially address specific requests for shared access on a trial basis until developments have stabilised enough for a more general framework to be introduced. The general framework should apply to specific bands, such as 3.4 GHz where there is considerable momentum internationally.

j. BOCRA should permit spectrum pooling in new spectrum licences subject to approval by BOCRA on competition grounds. BOCRA should also issue guidelines setting out the issues it would take into account.

k. BOCRA should not mandate the establishment of a single wholesale network for mobile broadband at this time.

l. BOCRA should apply a presumption of renewal in favour of the incumbents, subject to any efficiency and competition concerns, for spectrum licences. The renewal fee should reflect the economic value of the spectrum.

m. BOCRA should set the duration of licences for spectrum associated with significant network investment at 15 years.

n. BOCRA should conduct a review into the options for providing mobile broadband capability for public safety and emergency services examining the costs and benefits of dedicated versus shared network solutions.

1.7 Migration strategy and plan

1.7.1. Migration of existing uses and users of certain spectrum bands may become necessary under the updated National Radio Frequency Plan (NRFP). The development of markets and technologies would be hampered if new uses of spectrum were confined to only the parts of the spectrum range which have not previously been used. Similarly, if new uses were kept out of a band until the existing use is entirely without value, the result could slow down the development of the telecommunications sector to the detriment of the economy as a whole.

1.7.2. However, forced migration from one frequency band to another should be limited to the maximum degree possible. There is always a cost involved and regulation should avoid imposing additional costs on stakeholders unless absolutely necessary.

1.7.3. The updated NRFP is in line with the latest WRC proposals. As a result, only a few spectrum bands are affected by a need for migration:

a. 450 - 470 MHz is currently used by private mobile radio services mainly in urban areas. A parallel use for rural mobile coverage may be feasible without a need for these services to move to other frequency bands.

b. 700 and 800 MHz "Digital Dividend" bands: Only a few TV transmitters are still active in the 700 MHz band and should be moved to other VHF channels to allow these bands to be used for Land Mobile services (i.e. terrestrial mobile communications services).

c. IMT Extension band 2500 - 2690 MHz: This band has already been re-assigned by BOCRA to accommodate both FDD and TDD technologies for mobile use. Since previous use has already been decommissioned no major issues are expected from completing this migration process.

1.7.4. In their consultation responses, two stakeholders addressed the use of mmWave spectrum for mobile services, namely the 26 GHz and 28 GHz bands. While the 26 GHz band is likely to be standardised by the upcoming

WRC-19 for mobile use, the 28 GHz is likely to remain reserved for satellite use (Europe already harmonized this band for satellite use).

1.8 Spectrum licensing

Best practice in spectrum licensing

1.8.1. Elements of best practice in spectrum licensing include:

a. regulators should support a "mixed market" in spectrum with a combination of licence-exempt spectrum and spectrum licensed for exclusive use;

b. spectrum licensed for exclusive use should be available for government and other users whose operation has been identified as vital to the security or social needs of the nation;

c. spectrum licensed for exclusive use to commercial providers should be assigned to market participants who value it most highly, subject to ensuring market competitiveness is maintained or enhanced;

d. forms of sharing, trading and assignment of spectrum should be permitted, subject to ensuring market competitiveness is maintained or enhanced;

e. all spectrum users, whether licence-exempt or licensed, must operate subject to conditions designed to limit the risk of interference with other national and international users;

f. conditions of operation applying to spectrum should be transparent and predictable and set out in spectrum licences or other regulation; and

g. to support investment, spectrum licences should be of relatively long duration accompanied by a presumption of renewal at the end of the licence term.

Spectrum licensing in a unified licensing environment

1.8.2. Botswana has recently adopted a Unified Licensing model for communications provision. The implications for spectrum licensing are that:

a. new spectrum licensed for exclusive use should be made available by means of a separate spectrum license or permission; and

b. this separate licence or permission should reflect historic regulatory practice in the Botswana national market, while taking into account good practice internationally.

1.8.3. Communications providers who secure new spectrum must also have an appropriate type (or types) of Unified Licence in order to operate infrastructure and / or provide services and that existing Unified Licences should continue without interruption until their expiry and presumed renewal.

1.8.4. This approach to the licensing of new spectrum should ensure the smooth introduction of new spectrum assignments while providing for continuity of operation of existing assignments.

Spectrum licensing proposals

1.8.5. Coleago makes seven specific proposals in relation to spectrum licensing:

a. BOCRA should continue to follow international developments in the identification of licenced and licence-exempt spectrum for high-value services, such as broadband, and its relevance to Botswana.

b. Coleago believes the optimal approach for Botswana should be for BOCRA to reflect international consensus and regional practice in the identification of spectrum for licence-exempt use and licenced use for high-value services and bring this spectrum into use in a timely manner.

c. Where BOCRA proposes to licence new spectrum for exclusive use, it should provide a separate spectrum licence for each band. Such a licence should include only rights and obligations relevant to the use of the spectrum.

d. Coleago believes it is in Botswana's interests for BOCRA to offer longer terms for new spectrum licences reflecting international practice. New spectrum licences should be offered for a minimum period of 15 years.
e. Coleago believes that coverage and service quality obligations in spectrum licences are appropriate to achieve relevant public policy objectives, including those set out in the National Broadband Strategy.
f. Coleago proposes that BOCRA applies a presumption of renewal in favour of spectrum holders, subject to progressively re-farming spectrum towards higher value use and overall spectrum assignments meeting efficiency and competition concerns.
g. Coleago believes that spectrum licences should be service and technology neutral and should allow operators to re-farm frequency assignments.

1.9 Television White Space

1.9.1. Another aspect under consideration by BOCRA is whether it would be beneficial for Botswana to permit Television White Space (TVWS) devices to operate on unused national television broadcasting spectrum. These spectrum bands have desirable propagation characteristics so that transmissions on frequencies in these bands can be made over a longer distance than existing unlicensed spectrum bands available for use in Botswana (2.4 GHz and 5.8 GHz). Bringing TVWS spectrum into use would increase spectrum efficiency which is a BOCRA statutory objective and provision of low frequency spectrum to improve communications access in remote and rural areas of Botswana supports the Government's National Broadband Plan.

1.9.2. A number of other countries, including the US, Canada, the UK and South Africa, have already decided to permit TVWS devices to operate within unused television spectrum below 694/698 MHz. TVWS trials have also taken place in African markets, including Botswana, where no formal decision has been taken to permit large-scale TVWS operation.

1.9.3. BOCRA welcomes all current and future users of spectrum as well as other stakeholders to contribute to this consultation on TVWS spectrum use in Botswana. An important factor in deciding BOCRA's TVWS policy and its implementation will be an assessment of the level of demand from trialists and other providers for TVWS devices, services and applications. This consultation therefore seeks input from stakeholders on their assessment of demand over the coming 10 years. Finally, if TVWS spectrum is to be brought into use, BOCRA welcomes the views of stakeholders on how this should be done.

About Television White Space

1.9.4. TV White Spaces refers to parts of the terrestrial national television broadcast spectrum left unused by national broadcasting services. The reasons for this spectrum remaining unused are:

a. the need to avoid interference between high-power broadcast transmitters serving adjacent geographical regions;
b. broadcast transmission services which only operate during certain hours of the day / days of the week; and
c. spectrum which is unassigned because of limited demand for terrestrial television broadcasting.

1.9.5. All these situations apply in the case of Botswana.

1.9.6. Where terrestrial television broadcast spectrum is unused it is possible to permit other devices and associated services and applications to operate within it. This type of secondary use is normally subject to conditions designed to prevent interference with primary uses, notably broadcast television itself, low-power radio devices such as wireless microphones, and radio-astronomy.

1.9.7. Regulators may permit TVWS devices, services and applications to operate on an unlicensed basis subject to using certain approaches to limit interference. These approaches include: spectrum use geolocation databases to ensure TVWS devices only use frequencies which will not cause interference to broadcast or other users, forms of spectrum use "sensing" by TVWS devices or hybrid approaches which combine both techniques.

Alternatively, regulators may require that devices, services and applications operate on a licenced basis using identified frequencies in specific geographic areas.

1.9.8. International debate on the use of TVWS spectrum anticipates that it will be used to improve internet and data connectivity, notably in the context of extending connectivity to rural and remote areas, where, in general, there is more unused television spectrum than in urban areas. However, there is no inherent reason for use of unused spectrum to focus on rural and remote areas and liberalization could also benefit urban and sub-urban areas of Botswana where unlicensed spectrum is subject to congestion.

1.9.9. The introduction of TVWS devices, services and applications has also been seen as an opportunity to experiment with forms of Dynamic Spectrum Sharing - an approach to spectrum management through forms of active spectrum sharing which BOCRA expects to become more widely used in future.

Conditions and limitations applying to TVWS use

1.9.10. Should BOCRA decide to permit the wider use of unused national television broadcasting spectrum in Botswana it faces a choice of national licensing mechanisms to bring such spectrum into use.

1.9.11. BOCRA could permit TVWS devices services and applications to operate on an unlicensed basis subject to the use of a national Botswanan location database, spectrum use "sensing" or a hybrid of these techniques to ensure TVWS devices do not interfere with existing users. While both technical approaches remain the subject of international trials, TVWS introductions which have taken place internationally in the US, Canada, the UK, and South Africa have required the introduction of one or more national device location databases.

1.9.12. Coleago has advised BOCRA that the use of an unlicensed approach or of LSA does not imply that one approach to spectrum use will be lower cost than another. While unlicensed use of spectrum is not inherently chargeable, establishing and operating a geolocation database to ensure unlicensed TVWS devices do not interfere with existing users, would be an additional activity with costs which may have to be recovered from national providers and, ultimately, users.

1.9.13. Regulators internationally have supported unlicensed TVWS approaches in conjunction with spectrum geo-location databases, however, Coleago understands that take-up remains modest. While unlicensed TVWS use is viable technically, current approaches may be considered as equivalent to expanded trials. In many situations, TVWS broadband use is static, operating consistently on the same frequency and this seems to be the case for most rural use. Dynamic spectrum usage, requiring an operational database, may only be needed in urban locations subject to peaks of demand for local wireless microphones or other devices.

1.9.14. Coleago notes that BOCRA could, alternatively, adopt a form of Licensed Shared Access (LSA) of TVWS frequencies in specific geographic regions. Such a licensing model might be suitable for the provision of broadband access services and has been used in Canada for some time to serve rural and remote areas. Licences to use spectrum could be provided by BOCRA on a geographic basis where:

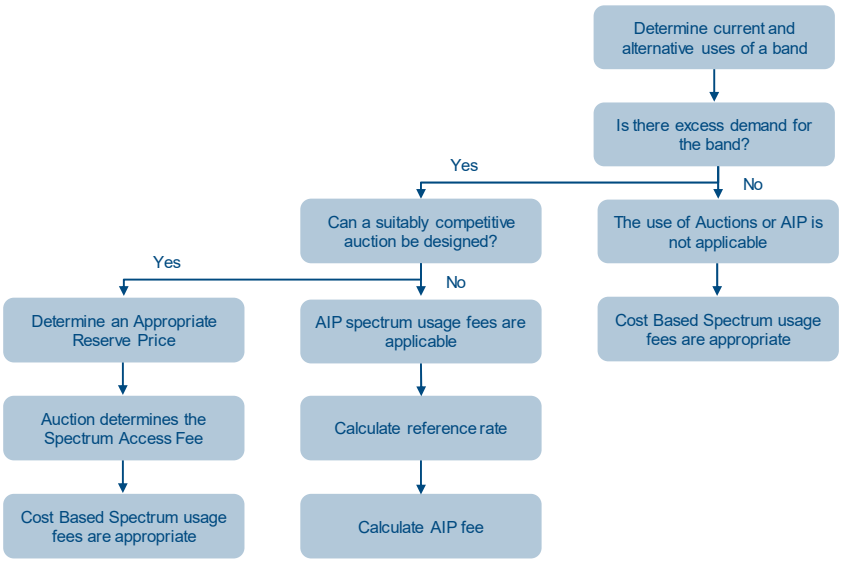
a. spectrum was not in use by Botswana TV (BTV);
b. the geographic location was sufficiently far from BTV's existing transmissions serving other locations; and
c. its use would not limit future plans for national TV broadcasting adoption or evolution.

1.9.15. Protection from interference would be through administrative spectrum management - that is by BOCRA identifying unused television spectrum available for use regionally and inviting proposals on the use of frequencies from communications providers. Coleago believes that a Licensed Shared Access model may be simpler overall and allow for unused frequencies to be brought more rapidly into use. Coleago therefore proposes this approach to TVWS.

1.10 Spectrum pricing

1.10.1. The principles of best practice spectrum pricing are reflected in the Exhibit below.

Exhibit 1: Best practice approach to spectrum pricing



Source: Coleago

1.10.2. The key elements of best practice are:

a. spectrum which is not congested or does not face excess demand should be subject to spectrum usage fees based on an allocation of spectrum management costs;

b. where appropriate, market-based mechanisms should be used to assign spectrum and to determine the spectrum access fee, subject to on-going cost-based spectrum usage fees;

c. spectrum trading should be facilitated to provide ongoing market-based incentives for spectrum to move to its most economic use;

d. where spectrum is congested or faces excess demand, but a suitable market-based mechanism cannot be utilised, then spectrum should be priced based on some form of Administered Incentive Pricing;

e. when implementing AIP:

i. regulators should select reference rates which are based on spectrum bands which are as similar as possible to the frequencies subject to the AIP algorithm;

ii. formulate an algorithm which is as simple as possible, and which best relates the reference rate to the spectrum subject to AIP (for example, avoid including multiple factors that seek to achieve the same objective);

iii. avoid algorithms that create significant variations in price between similar frequencies;

iv. set prices conservatively; and

v. subject prices to periodic review.

1.10.3. Coleago proposes adopting the principles of best practice described above. Coleago's specific proposals are:

a. the approach to assessing excess demand recommended in the 2008 Spectrum Management Report and developed further in this consultation should be implemented. The approach involves publicising a request for the assignment of additional spectrum and then assessing demand based on any received requests for similar assignments;

b. new spectrum assignments which face excess demand should be assigned through some form of appropriate market mechanism wherever possible. The market mechanism will determine the price for spectrum access. Holders of newly assigned spectrum will also be liable for annual spectrum usage fees based on BOCRA's costs of spectrum management;

c. in the absence of excess demand or congestion, spectrum prices should be based on an allocation of BOCRA's spectrum management costs. Spectrum prices should be set to fully recover the costs of spectrum management. The current fee levels should be maintained as they are reasonably well aligned

with cost recovery and provide for circa 80% recovery of BOCRA's spectrum management costs. Spectrum prices should be subject to annual inflation-based increases;

d. where it is not possible to design a suitable market-based mechanism or spectrum has already been assigned but faces congestion then spectrum should be priced based on the application of Administered Incentive Pricing. Prices should be set to reflect the opportunity cost of the use of the spectrum;

e. Administered Incentive Pricing (AIP) formulae should be as simple as possible and relate prices to a reference rate which reflects the opportunity cost of the spectrum. The reference rates for Botswana should be inferred from spectrum values observed in other markets in the absence of Botswana specific spectrum value estimates or recorded market transactions. Prices based on AIP should be subject to annual inflationary increases;

f. spectrum prices based on the application of AIP are proposed for frequencies assigned to mobile operators and FWA providers. In addition, AIP should be applied to fixed links and VHF frequencies which exhibit congestion;

g. the fees charged to communication providers for spectrum will increase significantly as a result of the proposed introduction of AIP for certain frequencies. These increases will allow BOCRA to re-balance the fees it charges away from turnover and towards spectrum.

h. Coleago proposes that the current turnover charge is reduced from 3% to 1%; and

i. the introduction of the new spectrum pricing regime should be phased over five years. During the first three years the new pricing regime will have been announced but will not be in effect. In the fourth year, the fees will increase, where appropriate, to 50% of their new levels and in the fifth year to 100% of their new levels.

1.11 Summary of proposals

1.11.1. In total Coleago makes 33 proposals in relation to spectrum management, spectrum licensing and spectrum pricing as set out below.

Spectrum management proposals

a. Proposal 1: Coleago proposes that, for the award of exclusive spectrum licences and where the demand for spectrum is likely to exceed supply, auctions are used as the assignment mechanism. Spectrum caps and coverage obligations should apply where appropriate.

b. Proposal 2: Coleago proposes that administrative assignment is used where the supply of spectrum is likely to exceed demand, including equal administered assignment where necessary to promote competition.

c. Proposal 3: BOCRA should apply its existing demand assessment procedure to 800 MHz spectrum and should award the spectrum by competitive process if there is evidence of excess demand.

d. Proposal 4: BOCRA should consider introducing a licence condition in future mobile spectrum awards, including 800 MHz, to permit infrastructure and spectrum sharing between operators to meet coverage obligations. Sharing should be limited to specific rural areas.

e. Proposal 5: BOCRA should consider reverse auctions for subsidies in relation to the rollout of coverage to areas that would be otherwise commercially unviable in order to meet the objectives of the NBS. BOCRA should permit operators to share infrastructure and spectrum in covering these areas.

f. Proposal 6: BOCRA should include coverage obligations in future spectrum licences for services such as mobile and fixed wireless access, setting spectrum and technology agnostic targets for covering specific areas by specified dates and at designated service levels.

g. Proposal 7: BOCRA should include conditions in spectrum licences to allow transfers of spectrum. BOCRA should create a framework to facilitate the development of a secondary market including a register of spectrum holdings and spectrum trades and a procedure to address competition concerns.

h. Proposal 8: BOCRA should require any operators wanting to actively share networks to request prior approval from BOCRA. BOCRA should review each request on its merits taking into account competition concerns and the potential benefits for investment and should set out the criteria it would use in a set of guidelines.

i. Proposal 9: BOCRA should consult on the need for and priority attached to introducing the shared access form of spectrum sharing. If BOCRA decides to proceed, it should initially address specific requests for shared access on a trial basis until developments have stabilised enough for a more general framework to be introduced. The general framework should apply to specific bands, such as 3.4 GHz where there is considerable momentum internationally.

j. Proposal 10: BOCRA should permit spectrum pooling in new spectrum licences subject to approval by BOCRA on competition grounds. BOCRA should also issue guidelines setting out the issues it would take into account.

k. Proposal 11: BOCRA should not mandate the establishment of a single wholesale network for mobile broadband at this time.

l. Proposal 12: BOCRA should apply a presumption of renewal in favour of the incumbents, subject to any efficiency and competition concerns, for spectrum licences. The renewal fee should reflect the economic value of the spectrum.

m. Proposal 13: BOCRA should set the duration of licences for spectrum associated with significant network investment at 15 years.

n. Proposal 14: BOCRA should conduct a review into the options for providing mobile broadband capability for public safety and emergency services examining the costs and benefits of dedicated versus shared network solutions.

Spectrum licensing proposals

o. Proposal 15: BOCRA should continue to follow international developments in the identification of licenced and licence-exempt spectrum for high-value services, such as broadband, and its relevance to Botswana.

p. Proposal 16: Coleago believes the optimal approach for Botswana should be for BOCRA to reflect international consensus and regional practice in the identification of spectrum for licence-exempt use and licenced use for high-value services and bring this spectrum into use in a timely manner.

q. Proposal17: Where BOCRA proposes to licence new spectrum for exclusive use, it should provide a separate spectrum licence for each band. Such a licence should include only rights and obligations relevant to the use of the spectrum.

r. Proposal 18: Coleago believes it is in Botswana's interests for BOCRA to offer longer terms for new spectrum licences reflecting international practice. New spectrum licences should be offered for a minimum period of 15 years.

s. Proposal 19: Coleago believes that coverage and service quality obligations in spectrum licences are appropriate to achieve relevant public policy objectives, including those set out in the National Broadband Strategy.

t. Proposal 20: Coleago proposes that BOCRA applies a presumption of renewal in favour of spectrum holders, subject to progressively re-farming spectrum towards higher value use and overall spectrum assignments meeting efficiency and competition concerns.

u. Proposal 21: Coleago believes that spectrum licences should be service and technology neutral and should allow operators to re-farm frequency assignments.

TV White space

v. Proposal 22: Coleago proposes that a Licensed Shared Access model be adopted for TVWS.

Spectrum pricing proposals

w. Proposal 23: Coleago proposes that BOCRA adopts the decision tree approach to spectrum pricing decisions.

x. Proposal 24: Coleago proposes that BOCRA adopts a formal approach to assessing demand for new spectrum assignment.

y. Proposal 25: BOCRA should adopt a flexible and varied response to assessing congestion within assigned frequencies including reference to its spectrum assignment database as well as assessing reports of congestion from stakeholders

z. Proposal 26: When there is no spectrum scarcity the price of spectrum should reflect only the costs of spectrum management.

aa. Proposal 27: BOCRA should seek to recover both direct and indirect spectrum management costs.

bb. Proposal 28: BOCRA should seek to fully recover the costs of its spectrum management activities.

cc. Proposal 29: BOCRA should use relevant spectrum auction benchmarks with appropriate adjustments for setting Reference Prices where possible. The results of benchmarking should be discounted to reduce the risk of spectrum prices being set at too high a level. Where auction benchmarks are not available then benchmarks from other markets which have made explicit attempts to estimate the opportunity cost of spectrum should be used, subject to appropriate adjustments.

dd. Proposal 30: BOCRA should generally adopt the simplest possible algorithm for adjusting the Reference Rate to set specific spectrum usage fees.

ee. Proposal 31: BOCRA should continue to estimate the full direct and indirect costs associated with spectrum management activities on an ongoing and annual basis.

ff. Proposal 32: Coleago proposes leaving fees unchanged for frequencies which are not congested or face excess demand other than to apply an inflation-based increase for the coming year.

gg. Proposal 33: The turnover fee should be set at 1%.

hh. Proposal 34: The revised spectrum prices should be introduced on a phased basis over three years.

1.12 Structure of the document

1.12.1. This consultation begins in section 2 by setting out the legal context in which these proposals have been prepared. The remaining sections discuss Coleago's proposals in relation to spectrum management generally, spectrum licensing, the licensing of TW white space and spectrum pricing.

1.13 Consultation approach

1.13.1. BOCRA has already consulted on the updated National Radio Frequency Plan and Footnotes. BOCRA has also sought initial stakeholder input on a wide range of spectrum management issues.

1.13.2. All stakeholders are now invited to contribute to the consultation process by submitting their views on the proposals contained within this document by the closing date. Detailed instructions on how to respond are provided in Annex G including supporting forms and tables.

1.14 Next steps

1.14.1. Stakeholders are invited to provide input to BOCRA's by following the procedures explained in Annex D and making use of the templates provided alongside this consultation. The closing date for these is 5:00pm on 18 January 2018. Any responses received after this date will not be considered and will be returned to the sender unopened / unread.

1.14.2. BOCRA will review all stakeholder inputs and is targeting publication of its final spectrum management strategy by April 2018. BOCRA will inform stakeholders if there are changes to these dates.

Exhibit 2: Provisional key dates

Event	Date
Consultation closing date	5pm 18 January 2018
Publication of BOCRA's final spectrum management strategy	April 2018

Source: BOCRA

Section 2. Legal Context and Policy Objectives

2.1 Legal framework

2.1.1. The Botswana Communications Regulatory Authority (BOCRA) was established by the Communications Regulatory Authority Act, 2012 (CRA Act) and is responsible for managing radio frequency spectrum in the Republic of Botswana. BOCRA is required by the CRA Act to promote efficiency, investment, innovation and competition, including in relation to radio spectrum management.

2.1.2. BOCRA is responsible for formulating and implementing a Spectrum Management Strategy. The Strategy comprises the National Radio Frequency Plan and frameworks and principles related to spectrum management activities. The National Radio Frequency Plan identifies the use (allocation) of radio spectrum by different classes of user. The frameworks and principles relate to:

a. spectrum licensing (this consultation);
b. spectrum pricing;
c. spectrum assignment; and
d. other aspects of spectrum management.

2.2 BOCRA's statutory duties

2.2.1. BOCRA's statutory duties as defined by the CRA Act. The duties most relevant to spectrum licensing are:

a. protecting and promoting the interests of consumers;
b. facilitating and encouraging private sector investment and innovation;
c. ensuring that technology is aligned with recognised standards so that Botswana can benefit from economies of scale in equipment manufacture and inter-operability;
d. promoting efficiency and economic growth in the sector and ensuring rational use of radio spectrum; and
e. ensuring the availability of ICT services to low income groups, rural areas or otherwise disadvantaged groups of consumers.

2.3 BOCRA's values

2.3.1. BOCRA's values describe the manner in which BOCRA should make decisions and govern the conduct of this consultation process. BOCRA's values include:

a. openness;
b. transparency;
c. accountability;
d. innovation;
e. people centred;
f. consistency;
g. objectivity; and
h. (acting) without undue preference to any person or organisation.

2.4 Policy objectives

Botswana's "Vision 2036"

2.4.1. Botswana's "Vision 2036," first published in 2016, provides the overall context for the strategic objectives of BOCRA. Vision 2036 is based on four pillars:

a. sustainable economic development;
b. human and social development;
c. sustainable environment; and
d. governance, peace and security.

2.4.2. Vision 2036 is a wide-ranging programme that encompasses a great many industries, markets and consumer groups within Botswana. Increasing broadband access is an important enabler for many aspects of Vision 2036.

National Broadband Strategy

2.4.3. In May 2018 the Ministry and Transport and Communications published a National Broadband Strategy for Botswana. The National Broadband Strategy identifies two overall policy goals and a number of objectives which are relevant to BOCRA's approach to spectrum licensing.

2.4.4. The overall policy goals of the Strategy are to:

a. establish a coordinated approach to ensure that reliable high-speed networks are universally accessible throughout the country; and
b. ensure equitable and affordable access to broadband infrastructure and services by all people over time.

2.4.5. The Strategy also sets out a range of objectives of which the following are most relevant to policy decisions in relation to spectrum licensing:

a. create an enabling environment that:
    i. encourages and ensures increased uptake and usage of broadband services by all citizens; and
    ii. introduces and promotes flexibility in the use of scarce resources such as spectrum to ensure the broader availability of broadband services.

2.4.6. The Strategy makes 39 proposals. Although there are no specific proposals on spectrum licensing Coleago notes that:

a. Section 6.5 proposes the legal right on the part of BOCRA to repossess any unused spectrum in accordance with conditions under which it was allocated, and re-allocate it to operators prepared to meet Government's policy objectives of providing broadband services to all parts of the country; and
b. Section 6.8 proposes that holders of 4G / LTE spectrum should be required to provide coverage to towns and villages with more than 5,000 inhabitants. This coverage obligation would normally be applied though a condition in the relevant spectrum licence.

2.5 Summary

2.5.1. Spectrum is a valuable natural resource and BOCRA’s approach to spectrum management has a material impact on how spectrum can be used by providers. BOCRA’s statutory duties of promoting efficiency, encouraging investment and ensuring the affordability of telecommunication services must be taken into account when determining BOCRA’s spectrum management approach.

2.5.2. The regulator’s values of transparency, objectivity and consistency should be reflected in BOCRA’s spectrum policy choices. BOCRA’s spectrum management strategy should support and enable communications providers to contribute effectively to the goals and objectives of the Botswana National Broadband Strategy.

Section 3. Spectrum Management Strategy – Issues and Best Practice

3.1 Overview of the communications market in Botswana

3.1.1. Developments in Botswana's Information and Communication Technology (ICT) markets have been progressing at an increasing rate. Two of the major drivers have been the emergence of low-cost smartphones and the expansion of the networks to which they connect. These offer an ever-wider proportion of the population access to the Internet and a range of new applications and services. Maintaining and accelerating the rate of growth will depend on:

a. the availability of increasingly affordable devices;
b. extending mobile broadband access to increasingly rural areas;
c. data packages at affordable prices;
d. increasing adoption of mobile financial services and mobile commerce;
e. locally relevant content, applications and social media platforms and messaging services; and
f. the development of general commerce and industry requiring automation.

3.1.2. In the next three to five years the two most likely trends to feature in Botswana will be:

a. mobile networks will become the dominant access provider of public data services;
b. the roll-out of the NBS will expand the availability of high-speed data services to a wider geographic area.

3.1.3. Botswana has experienced remarkable growth in mobile telephony subscriptions with numbers more than doubling since 2009. Penetration was 157% in March 2018, equivalent to 3,181,591 subscriptions, and is high by international standards[2]. In recent years growth in mobile telephony subscribers has flattened out as to be expected with such high levels of penetration. However, part of the slowdown is also due to reduced consumer reliance on owning multiple SIM-cards from different operators.

3.1.4. Mobile broadband penetration is still increasing and reached 75% (1,523,545 subscriptions) in FY 2017/18, an 8.5% increase. Subscribers throughout Botswana have access to mobile Internet services. 3G and 4G are available mostly in urban areas and coverage in March 2018 reached 67% and 55% respectively. In more rural areas, consumers rely on GPRS and EDGE for mobile data which is widely deployed throughout the country. BOCRA has given subsidies to upgrade 2G base stations to 3G or better in 68 villages in the regions of Mabutsane, Kgalagadi and Ghanzi under the Universal Access and Service Fund to improve rural broadband coverage.

3.1.5. Fixed telephony subscriptions have grown much more slowly over the past decade. A significant decrease of 13% was even registered between March 2016 and March 2017 although this was due to disconnections of some customers for non-payment of bills and migration of customers to mobile telephony.

3.1.6. In contrast, fixed broadband subscriptions – wireline and wireless – are growing strongly though absolute numbers are still low compared to mobile broadband. BOCRA believes that high reliability and price competitiveness compared to mobile broadband is driving the rapid uptake. BTCL's Asymmetric Digital Subscriber Line (ADSL) increased 68.4% from 35,394 to 59,590 subscriptions in FY 2016/17, while Orange Botswana's fixed wireless broadband service, Konnecta, increased 183%, from 3,180 to 8,997 subscribers.

3.1.7. In 2017 BOCRA released Fixed Wireless Access (FWA) spectrum in the 2300-2400 MHz and 3400-3600 MHz bands to increase fixed broadband coverage, increase speeds and complement ADSL availability in line with the National Broadband Strategy. The additional spectrum particularly helped to address rising demand for data in urban areas.

3.1.8. Increasing access to mobile broadband is likely to see social media become the dominant medium by which family and other social groups communicate. Currently the single largest data application within the mobile network is "Facebook" which is setting the standard for market penetration and expansion of services including messaging. This will make customers more confident in using data services on mobile devices and so they will then start using an increasing array of applications within their normal working lives. Ubiquitous broadband

2 See BOCRA Annual Report 2018, https://www.bocra.org.bw/bocra-annual-report-2018u

access will change the way individuals and businesses interact and applications such as email, messaging, banking / commerce, eHealth, location services and eGovernment will become increasingly pervasive.

3.1.9. The National Broadband Strategy and the consolidation of high-speed fibre deployment under Bofinet will greatly increase public access to high-speed data services. This in turn allows a greater number of customers to use the Internet and associated data services; the experience will also be enhanced by faster data-rates (10Mbps+ download). Increased local access to national broadband services using a combination of fibre (Bofinet) with wireless (LTE/UMTS) will further increase broadband availability in rural and deep rural areas. This will greatly improve the ability of schools, hospitals and social support organisations to use the latest information to serve the local population.

3.1.10. Three mobile networks operate in Botswana which compares reasonably with other countries in terms of the pure number of MNOs. Mascom Wireless was the leader at 55%, followed by Orange at 30% and BTCL (beMOBILE) at 15% (March 2017). Although Mascom commands a majority of subscribers, the other operators are sustainable and appear to constrain Mascom's ability to raise prices above competitive levels. From an economic standpoint four MNOs might improve competition; however, in a relatively small economy such as Botswana, it is not clear whether more MNOs would be sustainable. The prevalence of multiple SIM ownership may also heighten competition between operators in those areas where multiple networks are available.

3.1.11. The financial performance of the telecoms sector as a whole (Mascom, Orange, BTCL and Bofinet) is stable with total profits of P890 Million in 2016/17. This represents 20% of total industry revenues which grew by 5% during the financial year[3].

3.1.12. Botswana has concluded the countrywide deployment of a Digital Terrestrial Television (DTT) transmission network and Botswana TV, the national broadcaster, has launched DTT service. Analogue TV transmission continues but the analogue signal has been switched off in some areas, e.g. Ghanzi. Competition also increased with the recent licensing of new broadcasters over satellite and IP platforms.

3.1.13. These trends indicate that mobile and fixed wireless broadband services, which can be important components of the National Broadband Strategy, are likely to be the priorities for new spectrum in coming years.

3.2 Spectrum management issues

3.2.1. This section discusses the elements of spectrum management which Coleago believes are most important for responding to the changing market, technology and social trends in the communications market and for meeting the goals of the National Broadband Strategy. The issues considered are as follows:

a. options for spectrum assignment;
b. rural coverage and advancing the National Broadband Strategy;
c. secondary markets and spectrum trading;
d. approaches to sharing spectrum;
e. licence renewal;
f. licence duration; and
g. public safety and emergency services.

3.3 Options for spectrum assignment

Overview

3.3.1. There are three main approaches to assigning spectrum:

a. administered;
b. comparative assessments; and
c. market based.

3 https://www.bocra.org.bw/bocra-annual-report-2017

3.3.2. Where the supply of spectrum exceeds demand, administered procedures are most commonly used to assign spectrum. However, where demand for spectrum exceeds supply, there has been a trend towards competitive spectrum assignment approaches – comparative assessment and auctions. This is typically the case for spectrum that generates the highest benefits for society such as mobile communications. The use of auctions emerged in developed nations of North America, Australasia and Europe, but in the last decade a wider variety of countries, including some in Africa, have used competitive methods, particularly auctions to assign spectrum.

3.3.3. Within these three main categories, a wide range of alternative options can be adopted. The following discussion highlights some of the most commonly used, exploring the advantages and disadvantages of each in light of BOCRA's policy objectives, and giving further details on international trends in their use.

Administered procedures

3.3.4. Administered approaches that have been adopted for the assignment of spectrum include:

a. lotteries;
b. first come, first served; and
c. administered assignments.

Lotteries

3.3.5. Lotteries involve assigning spectrum at random amongst those that submitted applications for spectrum. The only real advantages of the approach are that it is quick and low cost to implement. The approach makes no attempt to achieve any policy objectives and the outcome is likely to be highly inefficient. Lotteries are not best practice and are seldom if ever used today for the assignment of spectrum.

First come, first served

3.3.6. Under the "first come, first served" (FCFS) approach, the first to request additional spectrum is assigned some or all of the spectrum. When there is a large supply of spectrum and it is sufficient to meet all the demands of potential users, the FCFS approach can be an easy way of assigning spectrum very quickly.

3.3.7. However, when demand exceeds supply, FCFS may not lead to an efficient assignment of frequencies. In the mobile industry, many countries have found that high data growth and competition has led to demand for spectrum exceeding supply. This has been an important factor in leading regulators around the world to use competitive methods for assigning mobile spectrum.

3.3.8. Whilst some arguments have been made to suggest that FCFS could deliver economic efficiency, they are tenuous at best. For example, some may argue that the operator with the greatest need for spectrum will be the first to demand it. However, the order of requests for spectrum does not necessarily relate to who can use it best and may reflect short term investment decisions rather than long term needs.

3.3.9. The FCFS approach could deliver economic efficiency if it is accompanied by an effective secondary market enabling spectrum trading so that eventually spectrum is allocated to those that value it most highly. However, this is akin to the use of lotteries by the FCC at the dawn of the mobile market in the US. Spectrum was acquired by those who might not have been the ultimate users of the spectrum and was then sold on creating personal fortunes for the lucky few who 'won' the lottery, and the actual use of spectrum was delayed. BOCRA will want to see spectrum deployed as quickly as possible. Furthermore, any value associated with the sale of a valuable, finite natural resource is probably best appropriated by the government on behalf of society as a whole.

3.3.10. The acquisition of spectrum as a financial asset may also be encouraged by FCFS with detrimental effects on the value created by spectrum for society. Speculators may seek to hoard spectrum to create private gains through reselling spectrum to operators. This could result in spectrum being left idle or delay its deployment. In the absence of stringent licence conditions and their enforcement regarding roll-out and coverage, policy objectives relating to expanding coverage may also not be met.

3.3.11. A further potential problem with the FCFS approach is that spectrum may not be allocated efficiently from a technical perspective. Contiguous, wide blocks of spectrum are optimal for a cost-effective deployment and to harness the spectral efficiencies of technologies such as LTE. The risk with FCFS is that spectrum becomes fragmented, damaging the technical efficiency with which it can be deployed. Hence the use of FCFS provides no assurance that spectrum will be used efficiently especially when there is no secondary market.

3.3.12. The relative level of spectrum holdings by operators can play a very significant role in determining the level of competition between them. To ensure a level playing field between operators and competition, the regulator will wish to ensure that all operators have an appropriate and well-balanced portfolio of spectrum assets. The use of the FCFS approach may result in the concentration of spectrum in the hands of a small number of operators thus reducing competition and the welfare of consumers.

3.3.13. FCFS may also deter investment through its impact on regulatory uncertainty. The more certain businesses are about the future the more encouraged they are to invest. This is particularly true of mobile operators where investment decisions involve significant amounts of cash and long pay-back periods. The use of the FCFS creates a very high degree of uncertainty for operators as to when spectrum will be available and whether they will be able to acquire it when it is released. This lack of regulatory uncertainty will deter investment.

3.3.14. Finally, another major criticism of the FCFS approach is its lack of transparency. The experience of India is a good example. In 2008, the then telecom minister A. Raja decided to give away 122 licences on a first come, first served basis at low prices to a few players despite having as many as 40 players waiting in line. These allocations were later cancelled by the Supreme Court on grounds of impropriety and damaged the credibility and investment in the Indian telecoms market for a number of years. The key challenge of the FCFS approach is that the risk of corruption or impropriety is extremely high. The spectrum will be allocated to those who have the best information as to the timing of the spectrum award and as that information is extremely valuable the risk of a leak or worse is extremely high. A lack of transparency undermines confidence in the regulatory regime and increases uncertainty. As argued above, where there is a high degree of regulatory uncertainty this will deter investment.

3.3.15. In summary, the FCFS approach to spectrum assignment can be an easy way of assigning spectrum when demand is unlikely to exceed supply and an efficient assignment can be achieved if it is accompanied by effective spectrum trading. However, demand may exceed supply for certain spectrum assignments and spectrum trading may not be fully effective, particularly where firms can get a competitive advantage by hoarding spectrum to deny access to competitors. Consequently, the FCFS approach suffers from the following disadvantages:

a. the allocation of spectrum is likely to be economically and technically inefficient;
b. if trading is present then the value of spectrum is appropriated by private individuals rather than society as a whole;
c. the approach creates regulatory uncertainty which does not encourage investment; and
d. the process is very susceptible to corruption which also tends to discourage investment.

Administered assignments

3.3.16. In this type of process, the awarding body determines, through discussions with stakeholders, and its own analysis of the market and technology, the award of the spectrum to those parties which it believes would most appropriately meet the needs of the economy and consumers in accordance with its objectives.

3.3.17. A managed licensing and spectrum assignment process could have an advantage over other processes in that it could theoretically be completed relatively quickly, if all parties agreed to the assignment. However, a significant disadvantage of a managed assignment process is that it is unlikely to lead to an efficient allocation of spectrum, particularly if spectrum demand may exceed supply.

3.3.18. Achieving an efficient assignment of spectrum through a managed licensing and spectrum assignment process would require the regulator, rather than the market, to identify that efficient assignment. This would require the regulator to have a perfect understanding of the potential value of the usage rights to each individual mobile operator or new entrant: for example, it would require the regulator to understand the potential revenues, costs

and risks associated with all possible services which could be supplied using the spectrum. As the regulator faces an insurmountable asymmetry of information regarding the value of spectrum versus the operators there is a very high chance that the resulting spectrum assignment would not be efficient. This challenge is compounded by the possibility that operators may have an incentive to mis-represent the value of spectrum in order to influence the assignment and price.

3.3.19. In addition to a potential lack of efficiency, the approach also lacks transparency and could potentially be subject to corruptive practices. Administered approaches for new spectrum awards are therefore not usually considered consistent with international best practice.

3.3.20. BOCRA has historically used a form of this approach - equal administered assignments - to assign spectrum to mobile operators. It has ensured spectrum is assigned on an equal (or close to equal) basis to active operators in the market. The approach has the advantage of being quick, low cost and simple to implement. The approach also ensures that there is not an excessive concentration of spectrum with one or more operators and therefore may help maintain existing levels of competition.

3.3.21. This approach suffers from the same information asymmetry problems discussed above which will lead to inefficient outcomes when spectrum demand exceeds supply. In addition, equal administered assignment may not be efficient if there are substantial differences in operators' customer bases. Competition can be protected by ensuring that all operators have at least the minimum amount of spectrum necessary to compete effectively in the market. Beyond that, it may serve the interests of consumers better if operators have sufficient spectrum to meet their capacity needs which will vary according to their subscriber numbers, mix of services and commercial strategies.

Comparative assessments

3.3.22. Comparative assessments involve the regulator determining a set of criteria against which applications for spectrum are evaluated. The applicants which best meet the criteria are awarded the spectrum. Comparative assessments are often referred to as “beauty contests” or “beauty parades”.

3.3.23. In a beauty contest, the regulator develops a set of criteria against which it would judge competing bids for the spectrum. In a well-run beauty contest, it would publish these criteria in advance, together with a ‘scoring scheme’ describing how the regulator would select winning bids. It would invite interested parties to submit bids for the spectrum, describing how their bids would meet the criteria. Such criteria could cover both technical and financial components, including the amount a party is prepared to pay for the spectrum. In practice, the criteria and scoring mechanism are often either, not communicated or communicated poorly.

3.3.24. The main advantage of a comparative assessment is that in establishing the criteria the regulator can take into account a broader range of public policy objectives which may not be fully reflected in the private values placed on spectrum by bidders in an auction.

3.3.25. BOCRA used a form of beauty contest approach – a competitive tendering process – in 2017 for the award of fixed wireless access spectrum in the 2300-2400 and 3400-3600 MHz bands. BOCRA justified the use of a beauty contest on the grounds that there were “there are specific policies to be considered” such as meeting coverage commitments, citizen participation, social responsibility and service innovation.

3.3.26. However, the regulator faces a significant asymmetry of information when reviewing the bid books and may not be able to identify which operator will best meet the public policy objectives. As a result, beauty contests may not necessarily result in an economically efficient allocation of spectrum. Processes may also lack transparency and can result in legal challenges that delay putting the spectrum into productive use[4]. Furthermore, they can be costly and time consuming to complete both for the regulator and the applicants. As a result, the use of beauty parades is no longer considered international best practice.

3.3.27. However, hybrids between comparative selection and market-based procedures have nevertheless been used in a limited number of cases in recent years. They have usually taken place under specific conditions. For example, comparative selection processes with high weights for financial bid components were used to re-award

4 For example the US switched from beauty contests eventually to auctions because of legal challenges. The French and Swedish beauty contests for 3G were challenged.

rights to 2G / 3G spectrum in Spain in 2011; however, one of the goals of the process was to even up the distribution of spectrum in the industry. In contrast, auctions were used to awards new 4G spectrum in Spain shortly after.

Market based procedures

3.3.28. One of BOCRA's key policy objectives with regard to spectrum assignment is to ensure the economically efficient use of spectrum. Ensuring the most economically efficient use of spectrum means allocating the spectrum to those users that will generate the greatest economic value from it[5]. A well-designed and competitive auction ensures that spectrum is allocated on an efficient basis since those who value spectrum most highly will outbid their weaker competitors and win the spectrum.

3.3.29. Achieving an efficient allocation of spectrum, however, may not be the only public policy objective. For Botswana, meeting the objectives of the National Broadband Strategy is also highly important, in particular ensuring affordable access to broadband and universal accessibility. Promoting downstream (post auction) competition maximises consumer choice and welfare, therefore it is also an important policy consideration. Spectrum auction design has progressed significantly over the course of time and modern spectrum auction design is capable of addressing multiple policy objectives simultaneously such as coverage, downstream competition and economic efficiency.

3.3.30. Furthermore, whilst maximising economic efficiency and maximising auction revenues are not necessarily aligned in the context of a competitive auction, it is reasonable to presume that if the spectrum is awarded to those that value it most highly then, in doing so, the regulator is also maximising government revenues.

3.3.31. The benefits to the public purse from auctioning spectrum are not limited to the revenues generated at auction. As an auction ensures the spectrum is allocated to the operators which will generate the greatest value or profit from the spectrum, an auction therefore also ensures that the government will maximise tax receipts down the line.

3.3.32. The amount paid at auction by a mobile operator for spectrum is often referred to as a "sunk cost". A sunk cost is a cost that has already been incurred and which is non-recoverable. Economists argue that sunk costs are irrelevant for future decision making such as setting prices. As the sunk cost has already been incurred it does not matter at what level prices are set as it will have no bearing on the money that has already been spent. Economists argue that in a competitive market what determines price is the marginal cost of providing the incremental unit of the item being sold and so auction prices should not impact end-user prices.

3.3.33. The same sunk cost argument can also be made for the impact of spectrum auction prices on future investment. Network investment decisions depend only on the future revenues and costs associated with that investment. The economic assumption of perfect capital markets further supports the view that auction revenues do not impact future investment decisions by reducing the amount of capital available for future investment. The recent history of the financial markets has strongly challenged the efficient capital markets hypothesis. However, if there are concerns about future investment, a deferred payment scheme is entirely compatible with auctions and can alleviate budgetary concerns.

3.3.34. The sunk cost arguments presented above have been challenged in recent years by both economists and empirical research. A detailed discussion of recent developments in behavioural economics related to sunk costs and empirical research is discussed in detail in section 13.11 on spectrum pricing.

3.3.35. Auctions are completely transparent, objective and significantly less prone to corruption. A well-designed auction will increase investors' confidence in BOCRA and the government and will help reduce regulatory uncertainty. By reducing uncertainty BOCRA can de-risk the market and encourage inward investment. An auction will also significantly reduce the risk of legal challenge particularly when demand is high, and spectrum is scarce.

3.3.36. A well-designed auction can be executed quickly which reduces risk and uncertainty leading to potentially greater auction revenues. The process of conducting an auction can also be considerably less expensive that the use of a lengthy beauty parade, depending on the nature of the auction. Furthermore, the benefits of the

5 Regulators typically assume that the company that can generate the greatest private value from the spectrum, subject to competition considerations, will also be the company that generates the greatest societal value from the spectrum.

additional revenues raised are likely to more than offset any incremental costs associated with the administration of an auction.

3.3.37. In order for an auction to be effective it needs to be well designed and competitive. A competitive auction requires scarcity such that there is excess demand for the lots being auctioned. If an auction is not sufficiently competitive then it may fail to deliver economically efficient outcomes. Indeed if prior to the start of the auction demand equals or is less than supply then the auction will conclude after the first round of bidding and lots will be sold at their reserve prices. The auction effectively becomes an administered approach and the determination of the appropriate reserve prices becomes critical.

3.3.38. Coleago notes that there may be uncertainty over whether there is excess demand for spectrum because of uncertainty over the future growth of demand for end-user services and technology developments. A formal assessment of spectrum demand, as discussed in section 13.6 on spectrum pricing, can be incorporated in to the process for an auction and if excess demand is not found an alternative award process can be specified. Coleago notes that BTA adopted a proposal similar to this in its 2008 Spectrum Management Strategy Position Paper although the process has not been applied in practice.

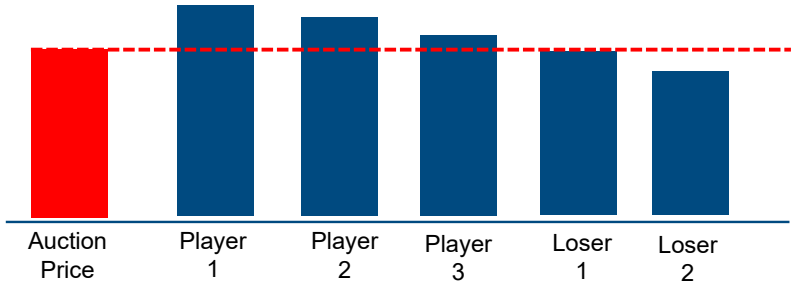
3.3.39. In practice therefore, auctions can be used where:

a. an appropriate auction design can be formulated that incorporates public policy objectives;
b. there is excess demand for the lots to be awarded;
c. the monetary value of the license is relatively high, justifying what can be a complex assignment procedure; or
d. where there is a need to adopt a process, which is highly transparent, to avoid potential legal challenges and increase confidence in the regulatory body.

Challenges for spectrum assignment in promoting competition

3.3.40. In competitive mobile markets with four or more operators of comparable size and similar spectrum valuations, an auction is likely to represent best practice for assigning spectrum when demand exceeds supply. The exhibit below shows the expected outcome from a competitive auction process where three identical spectrum Lots are auctioned. Competitive bidding will continue until the auction price reaches the value of the spectrum to Loser 1. At this point, Loser 1 will withdraw from the auction, demand will equal supply and the auction will end. The outcome will be efficient as the three operators who value the spectrum most highly will be assigned the spectrum. The red block indicates the auction price and the blue blocks show the players' valuations.

Exhibit 3: Auction outcome in a competitive market



Source: Coleago

3.3.41. Telecoms markets, however, are not always characterised by four or more operators of similar size. Many telecoms markets are characterised by relatively few operators and often by market structures that are asymmetric with significant differences between the strong and weak players. This is more representative of the situation in Botswana. Under these conditions, it is reasonable to ask whether the accepted best practice of market-based assignment when demand exceeds supply still holds or whether administered assignment might be a better alternative.

3.3.42. Low, but excess, demand for spectrum does not invalidate the case for market-based processes and in fact increases the need for good auction design. For example, excess demand for spectrum can be low in total, but there may still be competition for spectrum between the operators in the market. Hence, the distribution of spectrum between operators will affect efficiency and operators' ability to deliver greater service quality, higher data speeds and lower prices. In Botswana these issues are important, particularly for the National Broadband Strategy.

3.3.43. The alternative of an administrative assignment will not necessarily deliver the most efficient allocation of spectrum given the information asymmetry of the regulator. Regulators would also have to decide on the appropriate level of spectrum fees. Setting the level of fees too low may result in an inefficient allocation in the absence of spectrum trading. Setting fees too high may result in spectrum lying idle and not contributing to economic welfare.

3.3.44. The second issue for spectrum assignment in markets with limited competition is the risk that that spectrum becomes concentrated in the hands of one or two operators. This can result in undue competitive advantage and weakening overall competition in the market. This is a particular risk for low frequency spectrum such as 800 MHz, which has superior reach and indoor penetration and could enable significant differentiation between operators.

3.3.45. The approach of equal assignment of spectrum to competing operators, as followed in Botswana, is one way of easing competition concerns under administrative assignment. However, as discussed above this may have negative implications for spectrum efficiency.

3.3.46. In contrast, tried and tested mechanisms for avoiding competition problems have been developed in auctions. Limits can be set for the proportion of spectrum that any one operator can acquire in the auction, as a proportion of one or several bands, e.g. holdings of sub 1 GHz spectrum are often targeted. Such spectrum acquisition limits are also referred to as "spectrum caps". Typically, regulators seek to impose the least onerous restrictions necessary to safeguard competition. BTA in its 2008 Spectrum Management Strategy Position Paper supported the use of spectrum caps to protect against concentration of licences.

Examples of auctions in similar countries to Botswana

3.3.47. A number of African have begun to auction spectrum in recent years and others are considering using auctions to assign spectrum.

3.3.48. Tanzania conducted a 700 MHz auction in 2018 that was widely considered as successful, resulting in an efficient, pro-competitive outcome, meeting industry needs, enabling widespread network coverage, and raising a reasonable return for the state.

3.3.49. Auctions were also held in Ghana (800 MHz), Nigeria (2.6 GHz), Mozambique (800 MHz), and Senegal (800 MHz). These auctions were not regarded as successful. This lack of success, however, was not down to the complexity of the auction or local market conditions but the decision to set Reserve Prices at unrealistically high levels. Indeed, experience in Kenya and Tanzania shows that simple auction formats and low but non-trivial reserve prices can be used successfully in Africa.

3.3.50. More countries in Africa are considering auctions for mobile spectrum. For example, South Africa is planning to auction 700, 800 MHz and 2.6 GHz spectrum in April 2019 and 5G spectrum in 2020. Although the South African regulator had to postpone spectrum auctions in the past, the industry is optimistic that these problems will not recur this time. The Communications Regulatory Authority of Namibia has also stated that it is considering the use of alternatives to FCFS for spectrum assignment going forward and that it considers that auctions are best practice for high value spectrum, provided that local market conditions permit competitive bidding.

3.3.51. Nearly all the countries discussed above have much larger populations and markets than Botswana, so it could be argued whether their precedents are applicable to Botswana. However, countries similar in size and income to Botswana, in other regions of the world, have held auctions for high value mobile spectrum in recent years. The Exhibit below lists a number of countries which have similar populations and / or GDP per Capita levels to Botswana that have successfully auctioned spectrum. Hence, Coleago considers that the nature and size of the

mobile market in Botswana is unlikely to be a barrier to the successful use of auctions when demand for spectrum exceeds supply.

Exhibit 4: Auctions in countries of similar size and national income to Botswana[6]

Country	GDP/capita, US$ PPP rates	Population	Spectrum auctioned
Botswana	17,354	2,291,661	n/a
Albania	12,021	2,873,457	1800 MHz: 2015 2100 MHz: 2016
Costa Rica	17,044	4,905,769	1800, 2100 MHz: 2017
Georgia	10,699	3,717,100	800 MHz: 2015 2100 MHz: 2017
Macedonia, FYR	15,231	2,083,160	800, 1800 MHz: 2013
Moldova	5,698	3,549,750	2600 MHz: 2012
Montenegro	18,765	622,471	900, 1800 MHz: 2016

Source: Coleago

Proposal 1: Coleago proposes that, for the award of exclusive spectrum licences and where the demand for spectrum is likely to exceed supply, auctions are used as the assignment mechanism. Spectrum caps and coverage obligations should apply where appropriate.

Proposal 2: Coleago proposes that administrative assignment is used where the supply of spectrum is likely to exceed demand, including equal administered assignment where necessary to promote competition.

Proposal 3: BOCRA should apply its existing demand assessment procedure to 800 MHz spectrum, and should award the spectrum by competitive process if there is evidence of excess demand.

3.4 Rural coverage and advancing the National Broadband Strategy

3.4.1. Upcoming awards of spectrum suitable for LTE (and other services) represent a significant opportunity for BOCRA to advance the NBS and meet its goal of ensuring affordable access to high-speed services across the whole country.

3.4.2. LTE, and subsequently 5G, raise the prospect of providing high speed, high capacity broadband services more cheaply than existing technologies, particularly 3G. Coverage obligations can be used to encourage operators to rollout mobile broadband services in a timely manner to the extent that it is commercially viable. In a well-functioning market, operators, without compulsion, would continue to expand coverage to all areas where it was profitable to do so, i.e. as long as the marginal benefits exceed the marginal costs. Coverage obligations may seek to compel operators to achieve this level more quickly than they otherwise might and/or to roll out beyond this level. This will have an impact on operator return on investment. Regulators should seek to allow the operator to earn a reasonable return on investment, taking into account licence fees. If this is not the case, there is a risk that operators decide not to apply for licences or that investment is undermined in other areas of the network. These issues are discussed in more detail in section 3.4 on coverage.

3.4.3. Direct subsidies or public private partnerships (PPP) are two options for extending broadband coverage beyond the commercially viable level, thereby helping meet NBS objectives. There are ample precedents for this approach from a number of European countries. For example, the UK's Broadband Delivery UK programme used direct subsidy to extend fixed broadband coverage. Italy's rollout of superfast broadband in commercially unviable areas was delivered through PPPs between regional governments and the Italy's telecoms operators[7].

3.4.4. However, the success of the subsidy approach depends on governments accurately estimating how far operators would rollout without subsidy, i.e. the extent of commercially viable coverage. Furthermore, if tenders

6 Population and GDP per capita data is for 2017, source World Bank
7 In 2016, the Italian government allocated €3.5 billion of national funding for this purpose.

are used to award contracts for deploying networks in unprofitable areas, there has to be sufficient competition to secure network deployment at the minimum possible cost to the government.

3.4.5. The award of licences for new high-speed mobile networks could be used as an efficient quasi-subsidy mechanism. Demanding coverage conditions could be included in spectrum licences and, by giving up a portion of licence revenues in return for operator meeting those conditions, the extension of coverage beyond commercially viable areas could be subsidised. This option carries a risk however; if coverage conditions are too stringent, the licence fee (or reserve price in an auction) could exceed than the value of the licence.

3.4.6. Another way to facilitate commercially non-viable coverage in rural areas is to mandate cooperation between the operators to reduce the costs of extending rural coverage. Once again, the regulator faces the challenge of assessing how much additional rural coverage might be possible as a result. However, it does not necessarily imply any sacrifice of licence fees. There are several alternatives:

a. roaming;
b. spectrum sharing; and
c. shared wholesale networks (limited to rural areas).

3.4.7. France led the way in Europe by mandating cooperation to extend rural coverage. The regulator ARCEP proposed a collaborative, time-limited approach, to facilitate mobile broadband rollout in rural areas. In the 2011 auction of 800 MHz spectrum, ARCEP imposed conditions in all of the licences, mandating either spectrum sharing or roaming in the most rural areas (and permitting sharing in certain less rural areas). Rollout obligations were also imposed. In 2015, similar licence conditions were included for the auction of 700 MHz spectrum. In 2015, the Hungarian regulator approved an application from Magyar Telekom and Telenor Magyarország to share 800 MHz spectrum principally to reduce the costs of providing rural mobile broadband coverage.

3.4.8. Elsewhere in Europe, Germany's regulator BNetzA has proposed that operators voluntarily agree roaming in rural areas for 5G, in the context of its forthcoming 2019 auction of 2 GHz and 3.6 GHz spectrum. While it is not legally possible in Germany to mandate this kind of sharing, BNetzA has stated very clearly its wish that companies should negotiate.

3.4.9. Regulators should weigh carefully the advantages and disadvantages of rural spectrum sharing or roaming. Much depends on the details of the sharing arrangements. For example, the risks to competition will be lower if the network is either owned or operated[8] by a third party or a ring-fenced joint venture. This reduces the extent to which information is exchanged between operators and usually limits it to technical rather than strategic information. Another issue is whether all operators have access to sharing agreements. If one operator is unable to benefit, competition may be distorted.

3.4.10. Competition risks will be mitigated if the requirement to share networks is limited to specific geographic areas, which is consistent with the intention to extend rural coverage. However, consumers in rural areas might suffer as a result of the lower network competition in their area. For example, quality of service and innovation may be lower than the national average.

3.4.11. Competition risks could also be mitigated by making the requirement for spectrum sharing or roaming time limited. This may be appropriate if the main economic barrier in rural areas is the initial capital outlay. However, if affordability is also a barrier, it will be important to minimise the ongoing operating costs of the service. Hence, a time-limited sharing agreement may have some disadvantages. Some recent developments in rural roaming in Africa, discussed in the next section, suggest that affordability is important.

Recent developments in roaming and spectrum sharing in Africa

3.4.12. Spectrum sharing and roaming in rural areas appear to be moving up the agenda in several African markets. Some regulators and operators have found that, if services are not affordable, promoting rural coverage does little for the communities it seeks to help. Hence, ways to reduce ongoing operating costs as well as initial capital

8 e.g. in the UK, EE and Three have a RAN sharing agreement, but the shared network – MBNL – is managed by Ericsson.

costs have an important role to play in bringing affordable services to rural areas. A few examples of regulatory and commercial approaches are set out below.

a. In Tanzania in 2017, Airtel, Tigo and Vodacom trialled a three-way roaming service, for a 3G low cost solution to provide mobile broadband services to rural and remote populations. The service was trialled in six pilot sites across Tanzania with assistance from the GSMA[9]. In the initial seven months of the trial, the operators found they were able to cut their costs sufficiently so that the pilot sites would be financially viable, based on projected full year operating costs and revenues. Service take-up was boosted by the increased choice from multiple retailers and distribution channels. However, it was also found that capital expenses could not be covered and alternative solutions such as tax relief or government subsidy would be needed to cover up-front costs.

b. In South Africa, commercial roaming agreements have or are being negotiated to improve rural coverage and affordability. MTN and Cell C agreed a 3G/4G roaming deal in small cities and rural areas in May 2018 for this purpose. Although the major drivers of the deal were MTN's spare network capacity and Cell C's desire to reduce its costs for extending 4G coverage, the deal also allows both MTN and Cell C to improve rural affordability and drive take-up. Vodacom approached Telkom in September 2018 for a network sharing deal in response to the MTN Cell C agreement. [10]

c. The Nigerian Communications Commission (NCC), said in April 2018[11] that national roaming and active Infrastructure Sharing in Nigeria could help end the rural-urban digital divide. The regulator is developing a framework which it helps will reduce costs and increase take-up as services become more affordable for rural users.

Promoting coverage through new spectrum awards

3.4.13. The above discussion suggests that there are a number of alternatives open to BOCRA in terms of using the awards of LTE and 5G spectrum to promote extensive broadband coverage.

a. Option 1 - in a new spectrum award, include licence conditions for extensive coverage and permit operators to share spectrum or allow roaming. Coleago believes that including a requirement for operators to cooperate in extending rural coverage is likely to bring positive benefits in terms of lower costs and wider coverage. Competition risks can be managed by a process of regulatory approval to ensure agreements are appropriately structured.

b. Option 2 - in a new spectrum award, include licence conditions for extensive coverage and mandatory roaming in only one licence and apply less restrictive licence conditions to the others. The licence with the more stringent coverage conditions would probably need to be allocated more spectrum than the others in view of the roaming condition. The extra spectrum could be limited to the areas where the roaming obligation applied, though this would introduce more complexity. This option reduces risk that a regulatory error in setting the extent of the demand coverage conditions disrupts the entire market. Moreover, competition may lead the other licensees to match the coverage of the licensee with the most extensive obligations over the course of time.

c. Option 3 - in a new spectrum award, include licence conditions for extensive coverage and require operators to set up a neutral host network to serve specified rural areas. This is similar to option 1 however spectrum sharing agreements would be formalised into the creation of an independent wholesale network alongside the MNOs. This option should be considered if competition concerns from spectrum sharing are particularly high. However, the disadvantages of creating a monopoly wholesale operator would also need to be considered.

3.4.14. Coleago believes that an auction would be the best method to implement options 1 to 3 provided there is likely to be excess demand for spectrum. However, Coleago also recognises that this might add complexity and should be considered carefully in a country such as Botswana where auctions have not previously been held. However, partners / owners of Orange and Mascom do have experience of auctions in a wide range of other markets.

9 https://www.gsma.com/mobilefordevelopment/programme/connected-society/tanzania-rural-coverage-pilots-performance-report-2/

10 https://www.telegeography.com/products/commsupdate/articles/2018/09/03/vodacom-negotiating-a-roaming-deal-with-telkom/

11 https://allafrica.com/stories/201804260671.htm

3.4.15. Each of these three options would also require BOCRA to estimate the level of commercially viable coverage and the costs of extending coverage beyond this level in order to identify the areas where sharing would be permitted. This is the case whether spectrum was assigned by auction or administratively. Coleago has also identified a fourth option.

a. Option 4 - hold a separate reverse auction for the right to supply specific areas. This option is similar to the approach used in the UK to subsidise rural fixed broadband coverage. A list of specific areas to cover would be drawn up by BOCRA and bids taken for the minimum amount of subsidy needed to provide service to those areas - the price would go down as the auction progressed hence it is termed a reverse auction. Option 4 has the advantage that BOCRA does not have to estimate the cost of serving uneconomic rural areas. Instead the cost is determined by the market in the reverse auction.

3.4.16. Coleago believes that Option 4 also carries some risk. In particular, smaller players may be discouraged from bidding because they lack the economies of scale of larger competitors. Furthermore, if the level of competition for the subsidy is limited, the process may not reveal the lowest subsidy which operators are willing to accept. However, on balance, Coleago considers that Option 4 can play a useful role in delivering universal broadband access in Botswana and the achievement of NBS objectives. It can also work in concert with Options 1 to 3.

3.4.17. Coleago considers that if BOCRA agrees with the proposal that 800 MHz should be awarded by auction, then Option 1 is best on the basis that it limits the additional complexity for the spectrum auction and carries the least risks for competition.

Proposal 4: BOCRA should consider introducing a licence condition in future mobile spectrum awards, including 800 MHz, to permit sharing between operators to meet coverage obligations. Sharing should be limited to specific rural areas.

Proposal 5: BOCRA should consider reverse auctions for subsidies in relation to the rollout of coverage to areas that would be otherwise commercially unviable in order to meet the objectives of the NBS.

Coverage obligations

3.4.18. Coverage obligations are an important tool for encouraging rural coverage. They can be used with both comparative selection and auctions, though auctions have been more common. Coverage obligations are now standard for many mobile spectrum auctions, where spectrum is expected to be used to provide network coverage.

3.4.19. Coleago believes that coverage obligations should be seen as complementary to the other options discussed in this section. In particular, coverage obligations have to balance delivering the widest feasible service availability with financial sustainability. If obligations are not financially sustainable, service providers may launch legal challenges to coverage obligations, hand back licences, or reduce investment in other areas resulting in lower service quality and innovation.

3.4.20. Coverage obligations should be set such that:

a. they are meaningful in terms of promoting the provision of good-quality services on a wide area basis; and

b. they are measurable in terms of the regulator being objectively able to determine when and whether obligations have been met.

3.4.21. Coverage is most commonly expressed in terms of the proportion of population or geographical land area covered. Occasionally, for example for the French 800 MHz award, specific towns or zones are specified, alongside percentage coverage targets.

3.4.22. Cost is an important consideration in the choice between the two because providing extensive geographic coverage is substantially more expensive than providing a similar proportion of population coverage. The nature of economic activity in rural areas is another important consideration. In some countries, economic activity in many rural areas is concentrated in villages and along road links and most of the wider economic benefits of mobile can be delivered by covering these focal points. In other countries, economic activity is more widely dispersed and there are greater economic benefits to extending coverage beyond the areas where these focal points.

3.4.23. There are four separate issues that can be considered in setting coverage obligation:

a. the frequencies used to meet the obligation - should obligations attach to one specific band, e.g. that with the best characteristics for coverage, or should operators be given the freedom to meet obligations whatever combination of spectrum they wish, as long as the required service quality is provided?
b. the extent of the population to be covered and/or specific areas to be covered. It has been more common to specify percentage of population covered rather than individual zone or percentage of geographic area covered;
c. the time by which population coverage must be achieved. This could be specified as one final date to meet the full obligations or interim targets and dates could be added; and
d. the service quality to be provided. This varies by country and over time and will depend on local market conditions. The level of coverage that is commercially viable will depend on the quality of service chosen. The regulator will have to make a trade-off therefore between quality of coverage and its extent.

3.4.24. If all the above are taken into account, together with the impact on operator investment and profitability, so that a balance is achieved between securing the roll out of coverage as widely as possible, on a timely basis, while providing operators a reasonable return on investment, significant benefits can be generated for Botswana.

Proposal 6: BOCRA should include coverage obligations in future spectrum licences for services such as mobile and fixed wireless access setting spectrum and technology agnostic targets for covering specific areas by specified dates and at designated service levels.

3.5 Spectrum Trading

3.5.1. Spectrum trading establishes a secondary market for spectrum. This means that it would provide a secondary means to access spectrum alongside the primary means of assigning spectrum through an auction or administrative assignment. Spectrum trading can thus promote efficient spectrum use by creating market incentives for spectrum to flow into the most profitable uses.

3.5.2. Spectrum trading was first introduced in the late 1980s in the US and New Zealand and has since been introduced in many countries around the world. In Europe, spectrum trading is widespread, having been pioneered in Denmark in 1997. Subsequently, many other European Union Member States introduced trading, particularly after the European Commission actively encouraged spectrum trading in the Revised Framework Directive of 2009[12] (which covered the regulation of communications services more generally).

3.5.3. A spectrum trade is a transfer of the rights to use a specified set of frequencies from one person to another. It can be the transfer of all the frequencies associated with a licence or it can be a partial transfer in terms of frequency, geography and even by time. Time limited spectrum trades are sometimes leasing, but they are effectively the same type of spectrum transfer. However, spectrum leasing usually takes place under a less formal framework, with fewer regulatory requirements including the possibility of not issuing new licences, than under trading.

3.5.4. Typically, regulators have introduced spectrum trading in phases, focusing first on the bands which were most congested and where excess demand for spectrum was likely to be greatest such as PMR, public mobile, fixed wireless access and fixed links.

12 Directive 2009/140/EC, https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0140

3.5.5. Publicly available evidence on the effectiveness of trading is limited. That which is available, such as the ECC Report on Spectrum Trading[13], suggests that the number and rate of spectrum trades vary. The report found that trading occurred regularly in some countries, including Austria, France and Norway. For example, France reported significant activity in fixed wireless access- 45 transactions from a pool of 45 licences. However, other countries reported that trading seldom occurred such as Spain and Switzerland.

Advantages and disadvantages

3.5.6. The advantage of a secondary spectrum market is that, if it is well functioning, like any market it should lead to spectrum flowing towards those who value it the most. A well-functioning market should have a degree of competition for buyers and sellers and a degree of transparency over the ownership, quality and legal rights or obligations associated with the goods or services. Current and potential spectrum users should also be able to access information on existing spectrum assignments which should be kept up-to-date.

3.5.7. Hence, spectrum trading incentivises efficient spectrum use for spectrum that is already in the market, including any that was previously awarded on a FCFS basis. Spectrum trading provides on-going incentives for efficient spectrum use in response to changing market conditions. Trading may accomplish this faster than the regulator having to revoke and re-assign a licence. The market can also evaluate the need for short-term re-distribution of spectrum amongst the industry players much better than the regulator. Furthermore, the regulator would need strong evidence to intervene where a licence has been awarded for a fixed term, even if it suspects that an imbalance has arisen. Spectrum trading suffers no such drawback.

3.5.8. Trading helps to deter the inefficient hoarding of spectrum. Users which no longer need spectrum will have an incentive to release rather than hoard it because they can realise value from the trade. In economic terms, the holder has an opportunity cost and should sell the licence if the value it can generate from using it falls below the value it could receive by selling it.

3.5.9. Similarly, trading can also facilitate acquisitions of failing companies which, as a result, are not using their spectrum effectively. Where trading is not allowed, creative solutions have sometimes been used to get around restrictions such as side-agreements for the use of the spectrum between companies without an actual transfer of the licence. However, side-agreements like this are not transparent and they may distort fair competition and other regulatory objectives.

3.5.10. Finally, and importantly, the ability to trade spectrum is also likely to increase spectrum value with the aforementioned benefits for investment, particularly in the context of a fixed term licence where the incumbent is given an expectation of renewal.

3.5.11. The potential downsides to trading also have to be considered. Spectrum transfers could lead to concentration of spectrum holdings, resulting in a distortion of competition. Regulators in other jurisdictions have addressed this in a number of ways, e.g. a full competition assessment on a case by case basis, a two-stage process where trades are only reviewed if pre-published conditions are met, and spectrum caps.

3.5.12. Spectrum trading on its own may be insufficient to secure that spectrum is used efficiently. The secondary market may not function as well as desired because:

a. demand and competition for spectrum may be low;
b. there may be significant transactions costs in trading spectrum which prevents trades that would be efficient from happening e.g. it may be costly for buyers to get all the necessary information on spectrum availability and quality to properly value spectrum if spectrum information is not published or available from the regulator; and
c. a licensee holding spectrum that is idle or inefficiently used may prefer to continue to hoard it to maintain its market share, rather than allow a competitor to use the spectrum to compete successfully against the original licensee.

3.5.13. In other words, regulators need other mechanisms to promote efficient spectrum use in the long term by having the option to re-assign the spectrum at the end of a fixed duration licence or when the need arises due to concerns about efficiency. Setting annual fees based on economic value for spectrum that has become scarce

13 ECC Report 169, https://www.ecodocdb.dk/document/277

or congested, but has been awarded by administered processes - i.e. administered incentive pricing or AIP - can also complement spectrum trading in promoting efficient spectrum use.

3.5.14. Currently in Botswana, there is no legal framework in place to promote a well-functioning secondary market in spectrum, but there is no there is no general prohibition on spectrum trading either. Individual licences contain provisions prohibiting licensees from transferring rights, interests, or obligations to another person without the prior written consent of the Authority.

Proposal 7: BOCRA should include conditions in licences to allow transfers of spectrum. BOCRA should create a framework to facilitate the development of a secondary market including a register of spectrum holdings and spectrum trades and a procedure to address competition concerns.

3.6 Sharing

Infrastructure sharing

3.6.1. Infrastructure sharing is common in many developed mobile markets because it reduces inefficient duplication of infrastructure and generates cost savings. It is also viewed as important in the context of new 5G architectures which are expected to need many more cell sites than at present due to the use of much higher frequencies with shorter propagation characteristics.

3.6.2. Passive infrastructure sharing of towers, cabinets, power supplies etc. has been widely adopted and is regarded as best practice. Because operators are still able to differentiate their services and because it does not require the sharing of strategic information, it raises few competition concerns. There may be less competition in terms of network coverage, but operators can cover a wide area and the benefits for society are considered to significantly outweigh the costs.

3.6.3. Active infrastructure sharing of active elements in the radio access network such as antennas and radio network controllers is less common than passive sharing, but many agreements have been signed - in the EU for example, it is present in roughly half the Member States[14]. This is because active sharing offers greater scope for collaboration. If this is not appropriately managed, it can create opportunities for collusion and distortions to competition. Regulators have to strike a balance between incentivising investment and promoting competition.

3.6.4. This has led many countries, such as Greece, Sweden and the UK, to take a case by case approach to active network sharing in which each request is reviewed taking into account the operational framework for the shared network, the ownership structure and the potential impact on competition in the market. In a few countries, such as France and the Netherlands a different approach has been followed whereby regulators have relied on ex post competition law procedures to challenge sharing agreements once they have been put into operation.

3.6.5. Passive network sharing is currently permitted in Botswana, and guidelines have been published by BOCRA in collaboration with the Department for Environmental Affairs and the public telecommunications operators to that effect[15]. Coleago believes that no further action is necessary in this area. However, active network sharing is not permitted and Coleago believes that BOCRA should ensure that there are no unnecessary restrictions to active network sharing, where it may benefit the economy and society, while giving full consideration to the potential downsides for competition.

Proposal 8: BOCRA should require any operators wanting to actively share networks to request prior approval. BOCRA should review each request on its merits taking into account competition concerns and the potential benefits for investment and should set out the criteria it would use in a set of guidelines.

14 See BEREC Report on Infrastructure Sharing, 2018 https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/8164-berec-report-on-infrastructure-sharing

15 See https://www.bocra.org.bw/guidelines-sharing-passive-communications-infrastructure

Spectrum sharing

3.6.6. As the demand for mobile broadband capacity and other spectrum uses grows in the future, particularly with the advent of 5G and M2M technologies, sharing spectrum may become increasingly important, both as a way of using scarce spectrum resources more efficiently and a way of enabling greater access to spectrum resources thus facilitating innovation. Spectrum sharing may also drive further cost savings in addition to infrastructure sharing which could give a further boost to making services more affordable, particularly in rural areas.

3.6.7. The discussion of spectrum sharing is increasingly spreading into other spectrum management areas underlining its potential importance. For example, spectrum sharing could be important for helping to improve rural coverage and affordability as discussed above. There is also a significant debate over shared spectrum approaches for public safety and emergency services as discussed later on in this chapter.

3.6.8. Broadly speaking, there are two distinct types of sharing: shared access and spectrum pooling. Both lead to more efficient spectrum use, but they are likely to be applied in different circumstances and different areas of the spectrum. They may also have very different implications for market dynamics and regulation. Specifically, shared access should raise fewer competition concerns than spectrum pooling. This is because the sharers are very likely to be independent under shared access arrangements whereas they would be competing very closely in the same market and sharing information over network matters under spectrum pooling.

Shared access

3.6.9. As new competing demands for spectrum emerge, new types of shared access are emerging due to advances in technology. These have the potential to enable effective interference management between incumbents and new sharers. Where re-purposing of spectrum is not feasible, e.g. because of a need to protect the incumbents' rights, sharing may still offer opportunities to utilise spectrum more intensively and efficiently. Promoting increased access to spectrum in this way has been acknowledged by the European Commission as supporting innovation and market entry[16].

3.6.10. A specific way of providing shared access – the use of "TV white space" frequencies – has received much attention recently. For this reason, it has been considered separately in Section 12 of this consultation.

3.6.11. Shared access might be used by new entrants, innovators and niche players to get access to scarce spectrum. They might otherwise find it difficult to access spectrum which may be packaged in ways that do not suit their requirements. For example, frequency blocks may be too big in terms of bandwidth or geography, putting them at a disadvantage to other users. Hence, shared access could lower barriers to entry and stimulate more competition in networks and services. This could be used, not only for mobile data services, but also for fixed wireless access, community-based services, Programme Making and Special Events (PMSE) and other uses. Innovation could also be promoted, especially if niche operators are less bound by legacy issues and can act faster than larger nationally focussed operators.

3.6.12. Shared access could also be used to enable end-users to self-provide infrastructure in areas where it may cost less for the user to rollout than the MNO. This might apply to an indoor IoT network in a factory campus or warehousing facility that is not in a residential population area, or a roadside network that is similarly far from residential properties. Some commentators believe 5G will increase the demand for shared access of this type because of 5G's increased focus on industrial or "vertical" applications and with MNOs likely to focus in the early years of 5G on high population density areas with the greatest potential return on investment.

3.6.13. Finally, many regulators view shared access as a way to make more spectrum available for new or established mobile operators. It is seen as an important part of a portfolio of responses to making more spectrum available particularly for 5G services.

3.6.14. LSA enables shared access through an administered approach to interference management. The regulator has to specify when, how, where and what portion of an incumbent’s frequencies can be shared without causing harmful interference to the incumbent. The advantage of LSA are that it gives potentially greater certainty to the

16 EC, “Connectivity for a Competitive Digital Single Market: Towards a European Gigabit Society”, 2016, https://ec.europa.eu/digital-single-market/en/news/communication-connectivity-competitive-digital-single-market-towards-european-gigabit-society

incumbent and the sharer. The incumbent has more certainty that it will not suffer harmful interference; assuming that the LSA framework is properly set up. The sharer has certainty over its ability to access either specific frequencies in a specific geographic area. This could be important to stimulate network investment or for applications with requirements for high reliability.

3.6.15. The main disadvantages of LSA are the costs of setting up the LSA framework compared to an unlicensed approach. Much of the cost is likely to occur in interference management. As LSA approaches mature in other jurisdictions, evidence should become available that may reduce these costs. Regulators can also consider defraying some of the costs by requiring stakeholders requesting LSA to carry out initial technical studies of interference impacts as a first step in the assessment process.

3.6.16. LSA has generated much interest around the world. From 2015 17, a number of trials took place within the EU in France, Finland, Italy and Spain on LSA for wireless broadband access to the 2.3 to 2.4 GHz band. Here the incumbent user was often PMSE[17]. Public sector spectrum is also seen as a good candidate for an LSA and the UK is one of the countries investigating the feasibility of releasing additional wireless broadband spectrum this way. Finally, in June 2018, the Hong Kong Communications Authority allocated 580 MHz of spectrum in the 5 GHz band for a form of licensed shared access to support higher speed mobile data services.

3.6.17. In addition to LSA, other forms of shared access are being developed aiming to enable unlicensed access to spectrum and avoid harmful interference to incumbents by technological means. Dynamic Spectrum Access (DSA) technologies enable devices to select a frequency and/or time slot dynamically to avoid causing interference to nearby devices in the same spectrum band. Location-aware wireless devices assisted by "geo-location" databases, providing information on spectrum availability with regard to other licensed uses offer another new way of sharing spectrum.

3.6.18. More generally, further technology advances could open up future opportunities for more sophisticated forms of sharing across a wide set of applications. These include:

a. improvements in robust transmission and reception protocols that would enable wireless devices accessing shared spectrum resources to tolerate greater interference;
b. the evolution of radio frequency components capable of operating over wider frequency bands. As components become less frequency-specific, devices would be able to exploit underutilised spectrum available over a wider set of frequency ranges;
c. the emergence of smart antennas and the evolution of "beam forming" techniques that could allow devices to better manage interference by focusing the spatial distribution of wireless transmissions;
d. the growing use of software defined radios, software solutions and general-purpose computing processors to implement radio transmissions functions traditionally associated with specific hardware components. Software-defined radios can provide significant cost advantages in the production of low power devices by replicating transmission techniques that are normally associated with higher cost and higher power devices;
e. the development of carrier aggregation techniques, through which devices can dynamically combine small bands of spectrum into a single, virtual broadband pipe;
f. the increasing sophistication of white-space devices and geo-location databases in terms of interference management and spectrum access. For example, it will be possible to reflect devices' quality of service requirements through tailored assignment and management approaches. This could facilitate a tiered approach to sharing, with access to spectrum and protection from interference optimised for each device or user type; and
g. the development of sensing techniques, through which devices can independently detect and access available unused spectrum without the need to communicate with a database. Technical barriers to implementing cost-effective spectrum sensing in consumer equipment may mean that sensing can only become viable in the longer term.

3.6.19. Regulators have typically approached shared access by first conducting trials because of the need to assess new and innovative sharing techniques and dynamic access technologies. However, where technologies have been proven, it may not be necessary to hold trials before proceeding with a full implementation.

17 https://www.cept.org/ecc/topics/lsa-implementation

3.6.20. Where regulators decide to promote shared access to spectrum, the following factors need to be considered to determine in which bands shared access should be permitted:

a. the scale of the unmet demand for spectrum access from established national operators, niche players and potential entrants;

b. the extent of un- or under-utilised spectrum available in bands which could be used for other services than the incumbent, including public sector spectrum usage, in Botswana;

c. international momentum for the use of shared access in particular spectrum bands and the availability of equipment able to use those frequencies;

d. the resources that BOCRA would need to manage a shared access regime, particularly in terms of interference management;

e. whether it would be appropriate to accept or require initial studies on potential interference effects from stakeholders requesting shared access in a specific band, as inputs into an assessment of shared access in the band; and

f. the development and maturity of technologies for coordinating shared access.

3.6.21. In conclusion, Coleago believes that shared access may be beneficial in Botswana through promoting greater access to spectrum, efficiency, innovation and competition. However, the demand for shared access is uncertain. Moreover, frameworks for shared access are still evolving in many developed countries. Hence, at this time BOCRA should only proceed on a case by case basis as demand arises.

Proposal 9: BOCRA should consult on the need for and priority attached to introducing the shared access form of spectrum sharing. If BOCRA decides to proceed, it should initially address specific requests for shared access on a trial basis until developments have stabilised enough for a more general framework to be introduced. The general framework should apply to specific bands, such as 3.4 GHz where there is considerable momentum internationally.

Cooperative or collaborative sharing

3.6.22. Collaborative sharing by pooling spectrum has not been widespread up to now and has been much less common than network sharing. Although spectrum pooling could generate significant cost savings and economies of scale for operators, on top of network sharing (which would be passed onto consumers in a competitive market), the potential downsides for competition may explain its limited uptake. For example, some operators have been reluctant to pool spectrum because it limits their ability to differentiate themselves from their competitors.

3.6.23. The potential for competitors to cooperate even more closely than with network sharing has also been a concern for regulators. In some countries such as Germany, spectrum pooling has been specifically prohibited. In other countries, such as the UK, guidance was given to industry that spectrum pooling would face substantial hurdles for approval on competition grounds, and this may have acted as a substantial deterrent.

3.6.24. However, spectrum pooling has taken place in several countries including:

a. Hungary - two MNOs, Telenor and Magyar Telekom, have a sharing arrangement whereby one provides the mobile sites and infrastructure for the west of the country and the other one for the east (excluding Budapest). A leasing arrangement for 800 MHz spectrum is in place between the two and this is thought to have benefitted Hungary and led to a high level of LTE coverage nationally;

b. Sweden (3G/4G all Sweden) - two operators, Telenor Sweden and Tele2 Sweden, jointly bid for and won 4G spectrum under the net4mobility joint venture. Two competitors challenged the decision of PTS, the regulator, to allow the transfer of spectrum to the joint venture, but the decision was upheld by the Swedish competition authority and appeal court; and

c. France - the regulator allowed spectrum pooling in specified rural zones in the licence conditions for 800 MHz spectrum and mandated spectrum pooling or roaming in the least densely populated zones in order to achieve its objectives for a timely and sustainable rollout of 4G coverage in these areas.

3.6.25. The 3GPP standards accommodate the ability for operators to share spectrum. The standards provide the necessary functionality options for network infrastructure and user devices to operate in a way that partitions the network traffic, quality of service and core network routing, but share radio spectrum and radio access network resources.

3.6.26. An example of this type of sharing is Multi-Operator Core Network Sharing (MOCN) which was developed in the context of 3G and 4G networks. MOCN functionality allows several operators to jointly operate some elements of the radio access network. Unlike the basic level of active sharing, known as Multi-Operator Radio Access Network (MORAN) sharing, with MOCN the operators will be using shared spectrum, as opposed to using only their own separate licenced spectrum.

3.6.27. One of key benefits of MOCN is that operators can jointly use part of their bandwidth to create a much wider overall bandwidth, making it possible to offer much higher data rates for individual users. Additionally, trunking gain can be achieved as the usage of a single larger band is more effective in terms of throughput. Signalling overheads can also be less onerous with wider bandwidth allocations. MOCN can also be an enabler for operators to provide a better quality of coverage to the widest possible service footprint due to economies of scale and cost sharing achieved through combining spectrum and network resources.

3.6.28. The 5G ecosystem should involve a more diverse range of infrastructure and service providers and Coleago expects that further models will be developed within 3GPP to enable spectrum pooling. E.g. alternative infrastructure providers with access to facilities that MNOs cannot easily or economically replicate, may become useful partners for MNOs and spectrum pooling may be an option that they wish to explore. Furthermore, competition concerns might be reduced in this situation if the alternative infrastructure provider is a wholesale only operator or retail services to a niche that the national MNO does not target.

3.6.29. In summary, there may be real benefits for operators and consumers from allowing spectrum pooling, however BOCRA should ensure it has the power to review any arrangements in order to prevent a significant distortion of competition.

Proposal 10: BOCRA should permit spectrum pooling in new spectrum licence subject to approval by BOCRA on competition grounds. BOCRA should also issue guidelines setting out the issues it would take into account.

National wholesale networks

3.6.30. Increasing debate has surrounded the introduction of Single Wholesale Access Networks although there is considerable scepticism from many parties. Such networks were launched in Rwanda in 2015 and Mexico, after much planning, in 2018. However. any conclusions that could be drawn from either country at this stage are still very tentative.

3.6.31. In Rwanda, the national wholesale network – a joint venture between Korea Telecom and the government – is the sole provider of 4G wholesale connectivity. The existing MNOs retail 4G services alongside their own vertically integrated 2G and 3G services. The wholesale network reached 96.6% population coverage in June 2018. However, the number of 4G subscribers is still a small fraction of the total number of mobile data customers at 0.6%[18] and the expected reduction in retail prices for mobile data have not occurred.

3.6.32. The 4G wholesale price appears to have been too high, despite several large reductions that have taken place since 2015. Given the high wholesale prices, margins for the MNOs to retail 4G services have been low. As a result, the MNOs have had little incentive to market 4G services and have focused on their own 3G services instead.

3.6.33. The Rwandan experience highlights the importance of getting the regulatory framework right, promoting competition, and sustainable cost-oriented pricing for the wholesale network.

18 Rwanda Utilities Regulatory Authority, Second quarter statistics, 2018, http://www.rura.rw/uploads/media/Second_Quarter_for_Telecom_Statistics_report_as_of_June_2018.pdf

3.6.34. In Mexico, the national wholesale network (Red Compartida) has been allocated the available spectrum in the 700 MHz band. However, the existing MNOs are not compelled to use the wholesale network, in contrast to Rwanda. Instead the Mexican MNOs can provide 4G services using their own spectrum. One of the wholesale network's objectives is to cover the (mainly rural) areas of Mexico that are not covered by the country's existing MNOs. The wholesale network was launched with 32% coverage in March 2018 and aims to reach 92.5% coverage by 2024. Another key objective is to combat the unusually high concentration of the mobile market by opening access to new operators – the dominant operator, America Móvil, has a market share of 70%.

3.6.35. In October 2018, the operator of the wholesale network announced that it had signed contracts with sixteen clients who would retail services to the public. The MNO, Telefonica Movistar also announced that it had signed a reference offer with the wholesale network as a way potentially to extend in coverage in Mexico. These signs are encouraging, but they have yet to be translate into real improvements for the Mexican mobile.

3.6.36. South Africa is currently contemplating a national wholesale network. After significant opposition from stakeholders, the South African government now appears to be proposing a model in which both the national wholesale network and existing operators would have access to spectrum rather than vesting all mobile spectrum in the national wholesale network. However, the current MNOs would have to retail services from the national wholesale network in order to gain access to new 4G spectrum.

3.6.37. This type of approach addresses one of the concerns over the neutral host approach -the potential dulling of competition and the lack of long-term incentives for investment in the wholesale network - since other companies would able to deploy competing networks integrated with their retail services. However, doubts about the model remain. It is not clear what benefits the national wholesale network would bring to consumers compared to the commercial networks. It will also be difficult for the government to ensure that the MNOs do not effectively side-line the national wholesale network in preference to their own networks.

3.6.38. As discussed under spectrum pooling, operators may become more open to such discussions in the future due to the more varied ecosystem of 5G and the barriers to deploying multiple small cell networks in urban areas[19]. However, spectrum pooling in 5G may be driven more by alternative operators being able to bring other facilities into play such as low-cost access to municipal infrastructure for cell sites, or dark fibre. It may also be limited to specific areas where niche networks, possibly using LSA, operate.

Proposal 11: BOCRA should not mandate the establishment of a single wholesale network for mobile broadband at this time.

3.7 Licence renewal

3.7.1. Licence renewal is important because a poorly managed process can have adverse impacts for consumers and investment. Spectrum users who have to make long term network investments, such as mobile operators and broadcasters, need certainty from regulators over both the process for renewal and the timing of the renewal process in order to make efficient investment decisions. The earlier that companies have clarity, the better business decisions they will take. A lack of clarity over the renewal process could chill ongoing network investment, particularly near the end of an existing licence period. Furthermore, significant disruptions to service continuity and consumer harm could result if the renewal process does not give spectrum users sufficient time to adjust in the event that some (or all) spectrum changes hands.

3.7.2. Today in Botswana, for example, mobile and fixed wireless access spectrum licences may be renewed if requested up to 12 months before the expiry date. BOCRA has the right to refuse renewal for non-payment of fees or if it determines renewal would not be in the best interests of Botswana. In this section the range of potential approaches to renewal are discussed along with the approaches that have been adopted in other markets.

19 Due to the large number of cell sites expected for 5G networks in urban areas, it may be difficult and costly for each operator to access to the number of small cell sites they want.

Approaches

3.7.3. In the case of renewal, regulators have the following choices:

a. administered renewal to existing holders;
b. administered re-assignment (some or all) to new users;
c. competitive re-assignment on expiry of licences to existing or new users; and
d. hybrid combinations of the above approaches.

3.7.4. The choice of approach may vary depending on circumstances as illustrated below.

Exhibit 5: Factors affecting the appropriate choice of licence renewal mechanism

	Administered re-assignment to existing holders	Administered re-assignment	Competitive re-assignment	Hybrid e.g. renewal to incumbents subject to conditions
High spectrum utilisation and deployment	Yes	No	No	Yes
Risk of distortion of competition from spectrum imbalances	No	Yes	Yes	No
New entry is sustainable and may increase competition	No	Yes	Yes	Yes
Fast growing spectrum demand from existing users	No	Yes	Yes	Yes
Uncertainty over most efficient use of spectrum	No	No	Yes	Yes
Major customer disruption if licensee changes	Yes	No	No	No
Spectrum can be divided and distributed effectively	n/a	Yes	n/a	n/a

Source: Coleago

3.7.5. Administered renewal to existing holders may be preferred when:

a. there are no problematic imbalances in spectrum holdings or other competition reasons to allow others to use the spectrum;
b. spectrum is deployed and intensely utilised and there are clearly only poor alternative uses;
c. the incumbent licensee has invested substantially in new technology that relies specifically on the licensed bands; or
d. customer disruption is likely.

3.7.6. Belgium is an example of automatic renewal in favour of existing holders in the case of 900 and 1800 MHz spectrum. These licences can be revoked for spectrum management reasons, however. Their initial term was 15 years and they are currently being renewed on a five-yearly basis subject to payment of a renewal fee calculated by the regulator, based on the economic value of the licence.

3.7.7. The UK approach to mobile spectrum and other high demand spectrum is similar. Licences are auctioned with an initial fixed term, usually of 20 years. Thereafter they are renewed every year subject to payment of a fee reflecting economic value. Licences cannot be revoked during the initial fixed term, but can be revoked afterwards, for spectrum management reasons, e.g. if a major re-planning of the spectrum band becomes justified. However, there is an understanding that revocation would need to pass significant hurdles and the licences are considered to be effectively perpetual. The provisions on licence revocation for spectrum management reasons also apply to spectrum assigned on a first come first served basis.

3.7.8. The main disadvantage of this approach is that the existing holder of the spectrum might not be the best user of the spectrum as markets and technology change over the course of time. For example, if the operator is struggling financially, it may be more efficient for the spectrum to go to another player who could use it more profitably. The problem might be resolved downstream by a takeover of the struggling spectrum user. However, this depends on financial markets working efficiently. Another possibility is that the distribution of the spectrum amongst the users in a band may become inefficient over time as the fortunes of companies diverge.

3.7.9. Administered re-assignment may also raise concerns over transparency and whether the regulator has properly considered competing demands for the spectrum.

3.7.10. Administered re-assignment (partial or total) to new users may be preferred when:

a. it is necessary to address imbalances in spectrum holdings (where the imbalance cannot be addressed through other spectrum bands) that are weakening competition;
b. the regulator wants to introduce a competitive new entrant;
c. spectrum is not deployed or is under-utilised; or
d. spectrum can be divided and distributed effectively.

3.7.11. The main disadvantage of this approach is similar to that of the previous approach. I.e. the spectrum may not go to those who could use it best because the regulator may not be best placed to identify the most efficient users of the re-assigned spectrum. However, it does give the regulator more flexibility to respond to obvious imbalances in the distribution of spectrum amongst market players. If demand for the spectrum is low, this will be less of a concern. There may also be problems over the lack of transparency in the choice of the beneficiaries of the spectrum re-assignment. Finally, the success of a re-assignment to new users may depend on it taking appropriate measures to avoid or manage any customer disruption.

3.7.12. The re-auctioning of rights to use spectrum on expiry of the licence term may be preferred when:

a. spectrum is not deployed or is under-utilised;
b. there has been no or limited recent investment in new technology on which users have not had sufficient time in which to earn a reasonable return on that investment;
c. there is uncertainty over demand or the most efficient use of the spectrum; or
d. there is a desire to avoid making subjective judgements which may be criticised as "arbitrary".

3.7.13. Economic theory supports the use of competitive processes to re-award spectrum, where there is likely to be competition for spectrum (either between incumbents or from entrants) because it is most likely to secure the optimal use of spectrum, assuming such processes are well designed. Many EU countries such as France, Germany, Ireland and Spain commonly set fixed terms for licences and use competitive award processes to re-assign rights to the spectrum.

3.7.14. In most cases, auctions have been used to competitively re-assign spectrum. For example, In Ireland 900 and 1800 MHz spectrum was auctioned along with 4G frequencies in a multiband spectrum auction. In Germany, 1800 MHz and UMTS (2100 MHz) spectrum was re-auctioned alongside new 4G frequencies in 2010. There is a rationale for such multi-band auctions when the timing of new awards of spectrum and renewal of existing spectrum coincides. Including existing and new spectrum in this type of auction allows MNOs to make the widest choice between spectrum bands that are substitutes or complements and leads to the most efficient outcome.

3.7.15. In a few cases, comparative selection has been used, e.g. in France, Italy and Spain. For example, In Spain in 2011, the regulator wanted to re-distribute existing 2G/3G spectrum in the 900 and 1800 MHz bands ahead of an auction for new 4G spectrum in the 800 and 2600 MHz bands. In order to promote competition, the two leading operators were barred from re-acquiring the 2G/3G spectrum. The regulator did not want to administratively re-assign the spectrum because of efficiency concerns. However, given the limited demand for the spectrum, it was considered unnecessary to incur the costs of an auction to get an efficient outcome and comparative selection was used.

3.7.16. There is a risk of uncertainty over continued access to spectrum as described above, however, these risks can be mitigated to some extent by holding auctions well in advance of licence expiry. It is not clear whether re-

auctioning spectrum is better in achieving a fair return for society than renewing licences in favour of the incumbent. If spectrum is re-assigned to incumbents as described above, and if annual spectrum usage fees are based on the economic value of the spectrum, then the total fees paid may end up being similar.

3.7.17. Hybrid approaches seek to combine the benefits of several of the above. The most common hybrid approach is to keep open the possibility of competitive re-assignment of the spectrum together with a presumption of renewal in favour of the incumbent. In other words, renewal to the existing users is presumed but not guaranteed, subject to the regulator testing for evidence of efficiency or competition problems. Such hybrids may be preferred when:

a. at the time of the initial award, problematic imbalances in spectrum holdings or other competition reasons to allow others to use the spectrum are not expected;
b. spectrum is deployed and intensely utilised and there is uncertainty over alternative uses; and
c. the possibility that more efficient users or uses of the spectrum may arise over time cannot be discounted.

3.7.18. Several countries, such as Canada, New Zealand, Sweden (for some bands) and the US routinely apply this approach. Typically, the rights of existing holders have tended to be renewed under this system. Proponents of this approach say that it reduces uncertainty and avoids the cost of unnecessary auctions, while retaining the ability to use the market when there are clear uncertainties over future spectrum demand.

3.7.19. The main disadvantage of this approach is the risk that the regulator fails to identify when re-auctioning the spectrum is justified. A well-functioning market should be able to determine the most efficient use of spectrum better than a regulator due to the fact that regulators suffer an informational disadvantage compared to the market. It also places more weight on capturing the economic value of spectrum in the licence fee, if the state is to continue to get a fair return on the use of valuable spectrum.

Proposal 12: BOCRA should apply a presumption of renewal in favour of the incumbents, subject to any efficiency and competition concerns, for spectrum licences. The renewal fee should reflect the economic value of the spectrum.

3.8 Licence duration

3.8.1. Licence duration is a key consideration for all stakeholders. The licence duration should be long enough for spectrum users to be able to earn a reasonable return on their investment over the period of the licence.

3.8.2. Some empirical evidence[20] suggests that licence duration does affect the success of network providers with longer licence durations providing a more secure basis for investment. For this reason, international practice is tending towards offering longer licence terms to mobile operators. The same arguments would apply to licence duration for any network operator where substantial investments are required in order to provide wide-area services.

3.8.3. On the other hand, there is a risk of inefficiency if licence terms are set too long. Markets and technologies change over time and new more efficient uses of the spectrum may emerge. Furthermore, the longer the licence term, over and above say 20 years, the more difficult it is for regulators and spectrum users to calculate accurately the value of the spectrum. Retaining the option to re-assess the efficient use of spectrum at suitable intervals of time, either through competitive or administrative processes, promotes the efficient use of spectrum so long as a balance is struck with encouraging investment and service provision throughout Botswana.

3.8.4. Spectrum trading can also help provide incentives for efficient spectrum use over the course of a licence term. However, secondary markets may not function well enough to allow regulators to rely on them exclusively for optimal spectrum use, particularly in sectors such as mobile where the number of spectrum users is limited.

3.8.5. In Botswana, mobile operators are currently using a mix of 2G, 3G and 4G radio access network technologies. Within the likely life-span of the current National Radio Frequency Plan, it is envisaged that operators will deploy 4G radio access network technology on new IMT spectrum assigned and will progressively upgrade 2G and 3G

20 Study on Spectrum Assignment in the European Union, 2017, https://publications.europa.eu/en/publication-detail/-/publication/2388b227-a978-11e7-837e-01aa75ed71a1/language-en

technology across existing frequencies where supported by their business plans. Towards the end of the period, operators may also begin to deploy 5G technology.

3.8.6. Currently, Botswana ICT licences have been offered with a 15-year term. Spectrum Licences for use with Long Term Evolution (LTE) technology in the 1800 MHz spectrum band were assigned in 2015 and for Fixed Wireless Access Spectrum in the 2300-2400 MHz and 3500-3600 MHz band in 2017 for 10-year terms.

3.8.7. The median duration for spectrum awards in the past decade has been about 20 years, e.g. as in Canada, France and the UK. This is in line with the GSMA's claim that the minimum operational term to earn an appropriate return on new investment is at least 20 years[21]. A few have been longer still, e.g. Denmark (22 years) and Sweden (24 years), while some have been shorter e.g. 15 years in Australia, Germany and Portugal. International practice is also increasingly to use generally applicable conditions of authorisation rather than individual operating licences. In some countries, particularly the UK and Belgium, the renewal process for certain bands (discussed above) makes the licences effectively perpetual, with regulators reserving certain rights of revocation.

3.8.8. As a result, Coleago also believes that spectrum licences, new or renewed, should have at least a 15-year licence term irrespective of services or technology, and in some circumstances, it may be possible to justify licence terms of up to 20 years. Coleago also proposes this in conjunction with the proposal to grant spectrum licence holders a presumption of renewal as discussed in the previous sub-section.

Proposal 13: BOCRA should set the duration of licences for spectrum associated with significant network investment at 15 years.

3.9 Public safety and emergency services

Overview

3.9.1. The requirements of emergency services and other government agencies responsible for providing public safety and disaster relief / recovery (Public Protection and Disaster Recovery – PPDR) are changing rapidly. Previous systems such as TETRA are dedicated voice centric networks, data is only available at slow speeds (10's of Kbps) which was added to provided limited telemetry and alarm options. Such narrow channel band systems cannot support high density, multi-agency traffic (voice and data) and cannot be upgraded to provide essential services such as real-time video (e.g. body worn cameras) or near real-time transfer of pictures and other evidential files to officers within an emergency scenario.

3.9.2. WRC-15, in light of the limitations of existing solutions, encouraged regulatory provision for PPDR networks in various sub-bands including 380 MHz to 470 MHz and 694 MHz to 894 MHz. However, administrations worldwide are still debating the various merits of standardised systems for the next generation of emergency service networks and also the licencing regime for these networks (dedicated versus shared). Due to their scope and complexity, dedicated PPDR networks are an ever-increasing cost to public budgets which can be difficult to justify given the low utilisation during non-emergency conditions.

3.9.3. Both the ITU and 3GPP have produced standardised network specifications which administrations can consider for national networks. Both sets of standards can be deployed as dedicated / stand-alone networks for emergency services only, but only the 3GPP standards can be applied to a shared public / private arrangement due to the legacy requirements and scale of existing public network operators.

3.9.4. National administrations are divided regarding the optimal arrangement of dedicated versus shared next generation emergency service networks. The USA has leant towards a hybrid solution of dedicated networks but with shared capacity offered to commercial customers. The UK, on the other hand, released tenders for a contract for a completely shared arrangement.

21 Best Practice in Spectrum Renewals, GSMA, 2015, https://www.gsma.com/spectrum/best-practice-in-license-renewals/

Impact of new BPPDR services

3.9.5. The impact of new services brought by Broadband Public Protection and Disaster Recovery (BPPDR) in security and emergency services will likely significantly improve efficiency and safety across all operating outcomes.

3.9.6. A key feature required by all emergency services is the ability to maintain basic voice communication in the event of a total network failure, or service outage – direct handset to handset operation (walkie-talkie) on-demand is required in this event. This key feature of TETRA type networks has been replicated by 3GPP in Release 14 with the ProSe (proximity) feature. This allows handsets to use common spectrum for direct device-to-device voice communication including talk-groups and high-level privacy. There is strong debate about whether this feature should be available to all customers or only to the emergency services based on SIM profile or another activation feature.

3.9.7. A wide range of new services and applications could be provided through the broadband capability of new networks. The take-up of these services will be determined by the cost-benefit assessment for each emergency service and/or government. Typical examples of emergency service features for BPPDR are:

a. real-time video from body-worn cameras;
b. event commanders receiving video feeds from multiple sources during the event;
c. automatic vehicle and face recognition in near real-time with officer alert based on location;
d. direct telemetry and video feeds from ambulances to their hospital base of patients in-transit with treatment instructions given to the ambulance crew;
e. event information including building pictures, diagrams and special instructions sent to fire appliances and fire-commanders in real time in-transit to the fire event;
f. safety of life telemetry from fire service crew available to both the local fire-ground commander and base operations in real-time;
g. automatic escalation of safety procedures based on trigger events within emergency scenarios e.g. dispatching additional ambulances in the event that life affecting telemetry is received; and
h. multiple agency and event monitoring, control from central or devolved locations.

Issues in shared PPDR - commercial networks

3.9.8. Shared PPDR / commercial networks promise several benefits:

a. reduced the "cost to serve" of the operator and these savings will be passed on to both sets of users (emergency service users and commercial users);
b. reduced cost to government of upgrading, maintaining and supervising a dedicated PPDR network through outsourcing to a specialist telecommunications provider; and
c. customers in lower population density areas may receive mobile service where previously this was only available to the emergency services due to the economies of the shared network.

3.9.9. Against these benefits should be set the point that there is no real precedent for meeting emergency service requirements through a public network in other similar areas. Hence, many consider the shared model for providing emergency service capacity as quite radical.

3.9.10. The most critical area of concern is strengthening the reliability of a commercial network to enable it to provide a “Safety of Life” service. All commercial networks specifically exclude safety of life resilience within their terms and conditions of sale and all IP based services specifically exclude services such as 999 / 911 / 112 calling. For example, hardening network infrastructure to support life support type services will require all traffic paths and RF units to be duplicated, including ring-connectivity where this is relevant. All traffic nodes will need a “DC no-break” power supply with a battery / generator standby time from four hours to continuous depending on the node.

3.9.11. One mitigating factor is that under a total network failure scenario, handsets would automatically revert to a ProSe mode of handset-to-handset communication. BPPDR would also enable fast establishment (within two

hours) of a local control point (so called network in a box) allowing voice and data communications between handsets in the immediate vicinity to regain connectivity without ProSe.

3.9.12. However, connection from the control point to the broadband approach links would not be restored. All advanced data services be unavailable, leaving the emergency services with local voice only services. Where this total network failure is the result of inadequate hardening then these losses will be the direct result of poor administration and governance of the emergency service network.

Proposal 14: BOCRA should conduct a review into the options for providing mobile broadband capability for public safety and emergency services examining the costs and benefits of dedicated versus shared network solutions.

Section 4. Spectrum Management Strategy – Results of Initial Consultation

4.1 Introduction

4.1.1. The number of stakeholders who responded to spectrum management strategy issues in the consultation was limited. Therefore, while they provide some insights into stakeholder views, they are not necessarily representative of all views. This should be taken into consideration when considering the summary of the key issues from the Initial Consultation below.

4.2 Review of stakeholder consultation responses

Spectrum assignment

4.2.1. In summary, the views of the respondents on the preferred approach to spectrum assignment are mixed. There appears to be broad acceptance that competitive assignment, particularly auctions, should be used when there is excess demand for spectrum. However, the key area of contention is whether auctions are appropriate given the small size of the market in Botswana and whether or not the supply of spectrum for high value uses like mobile is likely to exceed demand. Some respondents prefer that the current system of equal administered assignment and others, prefer auctions. A few respondents believe there is a role for comparative selection and FCFS, but the level of support is limited.

Coverage and service obligations

4.2.2. Respondents supported the use of reasonable coverage and service obligations regardless of the preferred manner of assignment. Some were keen to emphasise obligations should be set carefully to minimise any unintended impacts on the industry.

Spectrum trading

4.2.3. Most respondents were positive about the introduction of spectrum trading.

Sharing of spectrum and networks

4.2.4. There is considerable support for allowing greater sharing, with a few specific concerns over potential impacts on competition.

4.2.5. Support for active network sharing is less clear with some respondents in favour and others against.

Licence renewal

4.2.6. Views on renewal were mixed. Some support a presumption of renewal in favour of incumbents. Others supported administered renewal. Two responses were against using auctions to re-assign spectrum because of the small size of the market in Botswana and the costs and complexity of auctions. Additional comments included the believe that renewal fees should be low to encourage investment and that renewal decisions should be taken five years before licence expiry. Some also called for harmonisation of licence expiry dates for those with spectrum in multiple bands.

Licence duration

4.2.7. A number of respondents agree with the principle that licence durations should be set to allow recovery of investment. The consensus for licence duration where significant network investment is involved appears to be 15 years. It was proposed that durations of at least 10 years apply for government departments. One respondent considers a licence duration of 15 years as the minimum and prefers 25 years, for mobile and fixed links.

Migration issues

4.2.8. The initial consultation process included three questions regarding spectrum migrations:

a. which spectrum bands do you consider to be most affected by a need for migration to new uses and new users?

b. which mechanisms should BOCRA apply to migrate existing spectrum to new uses and / or users?

c. do you have any suggestions regarding the time frames for migration?

4.2.9. Of the consultation responses received, eight stakeholders commented on migration related issues. Most responses pointed out the need to vacate the 700 / 800 MHz band for mobile services.

4.2.10. Two further important issues were raised:

a. Parallel use of frequency bands in geographic areas not covered by commercial operators (in particular, use of 700 / 800 MHz which mobile operators may choose to not roll-out in the areas of mines).

b. Access to spectrum bands in specific geographic areas before a national-wide clearance of these bands (again, referring in particular to the 700 / 800 MHz band).

4.2.11. Coleago broadly agrees with both comments, if a consensual and coordinated agreement can be reached between all stakeholders affected. In the case that a consensual agreement cannot be reached, BOCRA will need to make a judgement on the best use of the spectrum band in question.

4.2.12. Regarding the time frame for migration, those respondents who provided a specific answer mentioned a period of 2 to 5 years. Only one suggested a full migration of all relevant spectrum bands by the year 2019.

4.3 Summary of key issues arising in the Initial Consultation

4.3.1. The key issues arising from the Initial Consultation are set out below:

- **Spectrum assignment**: The key issue is whether the supply of spectrum for high value services such as mobile is likely to be sufficient to meet demand in Botswana, given that low population density is low and markets are small. If supply exceeds demand, the clear preference is to continue with the current approach of equal administered assignment. If the opposite is true, the majority view is for auctions. Establishing the potential level of demand and supply for 800 MHz and for bands that are likely to be released for mobile spectrum over the next five years or so is a logical next step for BOCRA.

- **Coverage and service obligations**: There is support for imposing coverage and service obligations. However, stakeholders have said clearly that obligations should be realistic, i.e. commercially viable, and that coverage obligations need to be used together with other policies to meet all the challenges of providing rural coverage and to support use of mobile broadband in these areas.

- **Spectrum trading**: All but one respondent supported the introduction of a framework for a secondary market in Botswana, hence there is strong support if this is considered appropriate for Botswana.

- **Spectrum sharing**: Shared access is widely accepted in principle. The key issue for BOCRA is whether incumbent licensees can be protected from harmful interference under licensed or dynamic shared access, given BOCRA's technical resources, and the maturity of regulatory and technological approaches to

shared access. In addition, there is stakeholder support for spectrum pooling, passive network sharing and to a lesser extent active network sharing.

- **Licence renewal**: The responses broadly agree with BOCRA's proposal in the Initial Consultation for a presumption of renewal of licences in favour of the incumbent, subject to specified conditions being met.

- **Licence duration**: There is consensus around the principle that the licence duration should allow recovery of costs, and on 15 years as a reasonable duration for spectrum associated with significant network investment. This is in accordance with the proposals set out in the initial Consultation.

- **Spectrum migration**: Most respondents stressed the need to vacate the 700 / 800 MHz band and make these available for Land Mobile use. While this spectrum may not yet be fully available on a nation-wide scale, BOCRA may consider making parts of the spectrum available in certain geographic areas, while the process of migrating TV transmitters to other spectrum bands is still in progress.

4.3.2. Only two respondents addressed the use of mmWave spectrum for mobile services, namely the 26 GHz and 28 GHz bands. While the 26 GHz band is likely to be standardized by the upcoming WRC-19 for mobile use, the 28 GHz is likely to remain reserved for satellite use.

Section 5. Spectrum Management Strategy – Current Situation

5.1.1. In this section, the current position in Botswana on each of the issues set out in the section on challenges for spectrum management in Botswana is summarised.

5.1.2. **Spectrum assignment**: BOCRA current spectrum management strategy is to carry out a simple demand assessment procedure, then if demand exceeds supply a competitive process should be used to assign spectrum (comparative selection or auction). If demand does not exceed supply First Come First Served should be used. The demand assessment process was applied to fixed wireless access spectrum in 2017, resulting in the use of a beauty contest. For mobile spectrum, equal administered assignment has historically been used, i.e. giving equal shares to the operators in the industry to avoid distortions of competition.

5.1.3. **Coverage obligations**: Apart from the fixed wireless access licences awarded in 2017, spectrum licences in Botswana have historically not included formal coverage and service obligations. However, licence applicants have had to set out the network facilities they plan to install and commit to them, which may approximate to a coverage obligation.

5.1.4. **Spectrum trading**: Transfers of spectrum are currently prohibited by licence terms and conditions. BOCRA could permit trading by consenting to such transfers and amending the licences. However, this is administratively burdensome, and there is no legal framework for such process or criteria for the decision-making required.

5.1.5. **Spectrum sharing**: Currently, there are no frameworks in Botswana for shared access, spectrum pooling nor active network sharing. However, BOCRA has issued guidelines for passive network sharing along with the Department for Environmental Affairs.

5.1.6. **Licence duration**: ICT licences have been offered with a 15-year term, whereas Spectrum Licences have recently been assigned for 10-year terms: LTE in 1800 MHz (2015) and Fixed Wireless Access in 2300-2400 MHz and 3500-3600 MHz (2017). However, Coleago proposed in the Consultation on the NRFP to offer new Spectrum Licences also with a 15-year term irrespective of services or technology in principle.

5.1.7. **Licence renewal**: Mobile and fixed wireless access spectrum licences may be renewed if requested up to 12 months before the expiry date. BOCRA has the right to refuse renewal for non-payment of fees or if it determines renewal would not be in the best interests of Botswana. However, BOCRA stated in the Consultation on the NRFP its intention to provide incumbent spectrum licence holders with a presumption of renewal.

5.1.8. **Public safety and emergency services**: Coleago assumes that the policy is unchanged from the previous spectrum management strategy when BTA agreed that there should be no specific assignment procedure for public safety, emergency and safety of life services that are established and operated by the government itself. However, BTA encouraged infrastructure sharing and stated endorsed the commercial sale of spare capacity to accommodate civilian users without compromising the integrity of the network or the availability of the services to the main users.

Section 6. Spectrum Management Strategy – Proposals

6.1 Introduction

6.1.1. In this section, Coleago sets out its proposals for the spectrum management strategy based on its assessment of the spectrum management challenges facing Botswana, international best practice and stakeholder feedback from the initial Consultation on the revised NRFP, spectrum management, licensing and pricing principles.

6.2 BOCRA spectrum management strategy summary

6.2.1. Proposal 1: Coleago proposes that, for the award of exclusive spectrum licences and where the demand for spectrum is likely to exceed supply, auctions are used as the assignment mechanism. Spectrum caps and coverage obligations should apply where appropriate.

6.2.2. Proposal 2: Coleago proposes that administrative assignment is used where the supply of spectrum is likely to exceed demand, including equal administered assignment where necessary to promote competition.

6.2.3. Proposal 3: BOCRA should apply its existing demand assessment procedure to 800 MHz spectrum, and should award the spectrum by competitive process if there is evidence of excess demand.

6.2.4. Proposal 4: BOCRA should consider introducing a licence condition in future mobile spectrum awards, including 800 MHz, to permit infrastructure and spectrum sharing between operators to meet coverage obligations. Sharing should be limited to specific rural areas.

6.2.5. Proposal 5: BOCRA should consider reverse auctions for subsidies in relation to the rollout of coverage to areas that would be otherwise commercially unviable in order to meet the objectives of the NBS. BOCRA should permit operators to share infrastructure and spectrum in covering these areas.

6.2.6. Proposal 6: BOCRA should include coverage obligations in future spectrum licences for services such as mobile and fixed wireless access, setting spectrum and technology agnostic targets for covering specific areas by specified dates and at designated service levels.

6.2.7. Proposal 7: BOCRA should include conditions in spectrum licences to allow transfers of spectrum. BOCRA should create a framework to facilitate the development of a secondary market including a register of spectrum holdings and spectrum trades and a procedure to address competition concerns.

6.2.8. Proposal 8: BOCRA should require any operators wanting to actively share networks to request prior approval from BOCRA. BOCRA should review each request on its merits taking into account competition concerns and the potential benefits for investment and should set out the criteria it would use in a set of guidelines.

6.2.9. Proposal 9: BOCRA should consult on the need for and priority attached to introducing the shared access form of spectrum sharing. If BOCRA decides to proceed, it should initially address specific requests for shared access on a trial basis until developments have stabilised enough for a more general framework to be introduced. The general framework should apply to specific bands, such as 3.4 GHz where there is considerable momentum internationally.

6.2.10. Proposal 10: BOCRA should permit spectrum pooling in new spectrum licences subject to approval by BOCRA on competition grounds. BOCRA should also issue guidelines setting out the issues it would take into account.

6.2.11. Proposal 11: BOCRA should not mandate the establishment of a single wholesale network for mobile broadband at this time.

6.2.12. Proposal 12: BOCRA should apply a presumption of renewal in favour of the incumbents, subject to any efficiency and competition concerns, for spectrum licences. The renewal fee should reflect the economic value of the spectrum.

6.2.13. Proposal 13: BOCRA should set the duration of licences for spectrum associated with significant network investment at 15 years.

6.2.14. Proposal 14: BOCRA should conduct a review into the options for providing mobile broadband capability for public safety and emergency services examining the costs and benefits of dedicated versus shared network solutions.

Section 7. Migration Strategy and Plan

7.1 The need for migration

7.1.1. Migration of existing uses and users of certain spectrum bands may become necessary under the updated National Radio Frequency Plan (NRFP). The development of markets and technologies would be hampered if new uses of spectrum were confined to only the parts of the spectrum range which have not previously been used. Similarly, if new uses were kept out of a band until the existing use is entirely without value, the result could slow the development of the telecommunications sector with implications for the overall economy.

7.1.2. Enabling new uses of occupied spectrum (e.g. through migration and re-farming) poses two fundamental questions:

a. How to measure whether new uses are better than old ones?

b. How to ensure that new uses replace old ones when the (net present) benefit of new uses is larger than the (net present) cost of terminating the old use?

7.1.3. Value comparisons between old and new uses are often uncertain because users have incentives to misrepresent their valuations and existing users may resist migration because they do not get a share of the gains of spectrum re-assignments. In most cases, those who have to migrate must bear the full costs, while others may reap the benefits of migrated spectrum assignments.

7.1.4. The benefits from re-farming may only become apparent, when sufficient time has passed, and the benefits of migration are higher than estimates of costs. Migration can produce net gains even if some gain and others lose as a result of it. In particular where the costs accrue to government agencies or state-owned firms, they should be expected to take the potential for overall net benefits into account.

7.1.5. Apart from these economic considerations, other factors may trigger a need for spectrum migration, such as:

a. ITU radio regulations and / or decisions of a World Radio Conference (WRC) require a change in national spectrum allocations;

b. Regional Radio Conferences require a change in national allocations; and

c. Decisions taken on a national level to change the use of specific frequency bands (e.g. as mandated by the NRFP)

7.1.6. Whenever possible, the change process should aim at minimizing potential service disruptions for end users (e.g. by securing a timely availability of updated end-user equipment) as well as for operators (e.g. by scheduling migration processes towards the end-of-life of affected equipment).

7.1.7. In some cases, the user of a radio frequency may require a change of assignment within the same band to allow for greater efficiency (e.g. to obtain a contiguous assignment of one spectrum block, or to move to the upper or lower limit of a spectrum band in case of interference). This particular process is sometimes referred to as "in-band migration".

7.2 Re-farming

7.2.1. Re-farming is a specific case of spectrum migration which may not necessarily require that an existing licenced user needs to vacate the allocated spectrum band. According to the ICT Regulatory Toolkit (as published by Info Dev and ITU), describes re-farming as follows:

7.2.2. Generally speaking, re-farming may be seen as process constituting any basic change in conditions of frequency usage in a given part of radio spectrum.

7.2.3. Such basic changes might be:

a. Change of technical conditions for frequency assignments;

b. Change of application (particular Radiocommunication system using the band);
c. Change of allocation to a different Radiocommunication service

7.2.4. In case of technology-neutral licences, an operator is generally free to decide on an optimum choice of transmission standard: this has typically been the case, when operators have migrated their users from GSM or 3G to 4G/LTE. This process may still require some changes in spectrum allocations, as LTE requires multiples of 2 x 5 MHz blocks for optimum use.

7.3 Migration plan for high-demand spectrum bands

7.3.1. The following sections describe changes required in specific high-demand spectrum bands of the NRFP. Appendix A: includes tables with an overview of these high-demand bands, including the current and (potentially) changed uses. The following sections discuss in more detail, which spectrum bands will be affected by a need for migration.

Spectrum band: 450 - 470 MHz

7.3.2. The NPRF identifies the frequency band 450 - 470 MHz as suitable for rural area coverage (NTELETSA) and as a standardized band for LTE use (band 72) by 3GPP.

7.3.3. Currently, this band is mainly used for duplex services by various private mobile radio (PMR) operators. Since these licences are for the most part confined to urban areas, this band could also be assigned to rural area usage, e.g. with one LTE assignment in band 72 (Uplink frequency 451 - 456 MHz, Downlink 461 - 466 MHz).

Digital Dividend band 2: 694 - 790 MHz

7.3.4. This band has been allocated for IMT for Region 1 countries at WRC-15 and is often termed as Digital Dividend 2. Currently, only a few TV broadcasters are actively transmitting programs in this band. These will need to be reassigned to other broadcasting frequencies in the 470 - 694 range to allow for use by mobile services.

7.3.5. Mobile assignments are possible for 2 x 30 MHz (703 - 733 MHz UL, 758 - 788 MHz DL).

Digital Dividend band 1: 790 - 862 MHz

7.3.6. This band has been allocated for IMT for Region 1 countries at WRC-07 and is often termed as Digital Dividend 1. This band is mostly cleared, with the exception of few government links (825 - 835MHz), which will need to migrate to other frequencies, once this band get allocated for mobile use.

7.3.7. Mobile assignments are possible for 2 x 30 MHz (791 - 821 MHz DL, 832 - 862 MHz UL).

GSM band: 890 - 915 MHz, 935 - 960 MHz

7.3.8. According to the NRFP and the detailed table shown in Appendix A: there are currently three spectrum assignments to mobile operators in the GSM 900 band.

7.3.9. BTC has total allocation of 2 x 6 MHz bandwidth in this band which, however, is not contiguous. The guard band within the BTC allocations can be removed simply by shifting the allocation up.

IMT Extension band: 2500 - 2690 MHz

7.3.10. The 2.5 GHz IMT Extension band (also known as band 7) has been re-planned and re-assigned recently to accommodate both FDD and TDD technologies. The table in Appendix A: shows the new assignments.

7.4 Migration plan for other spectrum bands

7.4.1. Appendix B: shows a table with an overview of main other spectrum bands, their current use and expected short or medium/long term changes.

7.4.2. Most of these bands show no expected need for migrations of spectrum assignments. The main exception is mmWave bands in the 26GHz and 28GHz region, which may need to be vacated for 5G service assignments in the medium / long term.

7.4.3. WRC-19 will address the needs of upcoming evolutions of mobile networks. Spectrum between 24.25 and 86 GHz will be considered for IMT under WRC-19 Agenda Item 1.13.

7.4.4. The 26GHz band (24.5 - 26.5GHz) is expected to be dedicated to 5G use following WRC-19 and may therefore require the migration of current users in Botswana to alternative spectrum bands.

7.4.5. The 28GHz band (27.5 - 29.5GHz) is likely to remain unaffected, since Europe already harmonized this band for satellite use.

Section 8. Spectrum Licensing

8.1 Best practice in spectrum licensing

8.1.1. Key elements of best practice in spectrum licensing include the following:

a. regulators should support a "mixed market" in spectrum with a combination of licence-exempt spectrum and spectrum licensed for exclusive use;

b. spectrum licensed for exclusive use should be available for Government and other users whose operation has been identified as vital to the security or social needs of the nation;

c. spectrum licensed for exclusive use to commercial providers should be assigned to market participants who value it most highly, subject to ensuring market competitiveness is maintained or enhanced;

d. forms of sharing, trading and assignment of spectrum should be permitted, subject to ensuring market competitiveness is maintained or enhanced;

e. all spectrum users, whether licence-exempt or licensed, must operate subject to conditions designed to limit the risk of interference with other national and international users;

f. conditions of operation applying to licence-exempt and licensed spectrum should be transparent and predictable and set out in spectrum licences or other regulation; and

g. to support investment spectrum licences should be of relatively long duration accompanied by a presumption of renewal at the end of the licence term.

8.2 Spectrum trading, leasing and assignment

8.2.1. Spectrum trading establishes a market for spectrum and provides a secondary means for providers to access spectrum. It can promote efficient spectrum use by creating incentives for spectrum to flow to the most profitable uses.

8.2.2. Spectrum trading was first introduced in the late 1980s in the US and New Zealand and has since been introduced in many countries around the world. Many European Union Member States introduced trading, after the European Commission actively encouraged spectrum trading in the Revised Framework Directive of 2009[22].

8.2.3. A spectrum trade is a transfer of the rights to use a specified set of frequencies from one person to another. It can be the transfer of all the frequencies associated with a licence or it can be a partial transfer in terms of frequency, geography and even by time. Time limited spectrum trades are sometimes described as leasing, and usually take place under a less formal framework. Where a spectrum licence is transferred from one licence holder to another this is sometimes described as assignment. Irrespective of approach regulatory approval will normally be required for the transfer of spectrum rights from one licence holder to another.

8.2.4. Typically, regulators have introduced spectrum trading in phases, focusing first on the bands which were most congested and where excess demand for spectrum was likely to be greatest such as PMR, public mobile, fixed wireless access and fixed links.

8.3 Licence duration

8.3.1. In a major recent study carried for the European Commission[23] LS Telecom et al[24] considered the impact of different spectrum licensing approaches used in EU Member States on the performance of national electronic communications markets.

22 Directive 2009/140/EC, https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0140

23 “Study on spectrum assignment in the European Union” by LS Telcom, Policy Tracker and VVA for the EC (2017): https://publications.europa.eu/en/publication-detail/-/publication/2388b227-a978-11e7-837e-01aa75ed71a1/language-en/format-PDF/source-search

24 “Mobile Wireless Performance in the EU and U.S” by Navigant Economics (2013) https://www.gsma.com/gsmaeurope/positions-and-publications/new-gsma-report/

8.3.2. LS Telecom found large variations in spectrum assignment and licensing across EU Member States. In comparing approaches against market performance, it detected few one-to-one associations between spectrum licensing conditions and market outcomes. Two exceptions were that the study found that:

- "*low prices in spectrum auctions were associated with better availability of 4G networks, and*
- *longer licence lengths [were] associated with higher CAPEX*."

8.3.3. Overall the study concluded that:

"[EU] countries which practiced a group of investment friendly practices, namely low reserve prices; market-led coverage obligations and long licence lengths exhibited more positive market outcomes, namely wider network roll-out; better quality and choice of services; higher take-up of services and greater competition."

8.3.4. While the market conditions in Botswana are materially different from core EU nations, there are also a range of smaller and more peripheral EU markets with low GDP / capita and challenging geographies which suggests to Coleago that these findings apply more widely, including to Botswana.

8.4 Presumption of renewal

8.4.1. In a 2013 study carried out for the GSMA, Navigant Economics et al[25] assessed the performance of the European Union and United States' mobile markets. This work examined EU and US mobile markets and argued that the EU was lagging the US in the deployment of next-generation (4G) mobile technologies and the advanced services made possible by mobile broadband.

8.4.2. The study explored the factors that have contributed to EU and US performance and identified policy proposals designed to boost the EU as a centre for mobile investment and innovation. In an article summarising the divergence in performance between EU and US mobile markets, study authors commented that:

"As recently as five years ago, markets for mobile wireless services in Europe were performing on par with, or even better than, markets in the United States. Today [2013] there is broad agreement that the EU has fallen behind in at least some dimensions, especially with respect to deployment of next generation LTE networks."

8.4.3. Improved harmonisation of spectrum licensing would improve the performance of EU mobile wireless markets and, in particular, while spectrum in the US is subject to a robust presumption of renewal, this is not the case in the EU. The authors advocated that in the EU:

"Spectrum licenses should be routinely renewed rather than repossessed and re-auctioned: problems also exist with respect to spectrum that has already been deployed, but for which license terms are nearing expiration. Little formal guidance exists [within the EU] for GSM licenses reaching the end of 15-year terms, giving rise to uncertainty with respect to the future assignment of these rights. Furthermore, the EU's electronic communications regulatory framework requires national regulatory authorities to conduct 'competition reviews' of spectrum currently in use, creating considerable uncertainty by presenting several divergent legal standards that could potentially be applied to any given matter".

25 "Mobile Wireless Performance in the EU and the US: Implications for Policy" by Bohlin, Caves and Eisenach for GSMA (2013): https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2510315

Section 9. Spectrum Licensing - Initial Consultation Responses

9.1 Overview

9.1.1. BOCRA carried out an initial consultation on a broad range of spectrum management issues, including licensing. The consultation process addressed a number of key policy questions relating to licensing:

a. which frequencies should be licensed, and which should be licence-exempt;

b. for those frequencies that are to be licensed for exclusive use, what licensing approach should be adopted;

c. what obligations and rights for communications providers should be contained within the licences; and

d. what approach should be adopted for the renewal of licences at the end of the licence term.

9.2 Licensed and licence-exempt spectrum

9.2.1. For all spectrum and spectrum users, a key initial question is whether it should be licenced for exclusive use or made available to multiple providers and / or users on a licence-exempt basis.

9.2.2. In general, spectrum for broadcasting, fixed and mobile services has historically been licenced on an exclusive basis using service and technology-specific licences of 10 years or more. In contrast, spectrum bands identified internationally by the ITU's World Radio Conferences for use as licence-exempt, are normally made available in national markets on a licence-exempt basis.

9.2.3. This "mixed" model of exclusive spectrum assignment and licence-exempt use provides a heterogeneous spectrum environment which allows contrasting spectrum uses to be deployed on an efficient basis.

9.2.4. In its recent Consultation Document on Spectrum Licensing stakeholders were asked:

a. what are your views on BOCRA continuing to adopt a "mixed" model for spectrum assignment, combing both a licensed and licence-exempt approach? and

b. which specific frequencies do you believe should be licensed and which do you believe should be licence-exempt and why

9.2.5. Non-confidential responses received are shown in the Exhibits below.

Exhibit 6: Mixed model for spectrum assignment

Respondent	Comment
DBS	BOCRA can continue with mixed model for assignment of spectrum, combining both a licensed and license-exempt approach. BOCRA should consider licensing all operators in case they use that for business. E.g. state broadcaster should be licensed.
Concerotel	It has been widely noted that the availability of license-exempt spectrum stimulates innovation in products and services. More and more policy-makers are demanding that licenses be adapted to achieve policy goals without hindering market development and technological advancement. The allocation of spectrum for license-exempt use is increasingly viewed as a catalyst for the development of more efficient and cost-effective wireless technologies. However, eliminating the need for an official permit to exploit frequency resources makes license-exempt bands different in principle from licensed spectrum access, and the principle at stake is all about interference, spectrum sharing and services protection which are all important and defines how licensed spectrum shall be identified. Concerotel agrees with the mixed model for spectrum licensed and license-exempt approach and urges BOCRA to continue adopting this model.

Respondent	Comment
MASCOM	MASCOM fully supports the mixed approach,
Meteorological Service	Maintain the approach since it is efficient.
Paratus	We support this fully. It supports the market and allows for various solutions to be deployed without too much complication.

Source: CD Respondents

9.2.6. Respondents supported the continuation of a "mixed" approach to spectrum provision with both licenced and licence-exempt provision made available by BOCRA.

Proposal 15: BOCRA should continue to follow international developments in the identification of licenced and licence-exempt spectrum for high-value services, such as broadband, and its relevance to Botswana.

Exhibit 7: Specific frequencies for licensing or licence-exempt use

Respondent	Comment
DBS	All frequencies must be licensed for proper management.
Concerotel	Concerotel finds Fixed-Satellite Services (FSS) in the downlink can be shared according to relevant ITU resolutions and regulatory limits without interference. However, the FSS uplinks bands shall be licensed in order to monitor all these links for interference and other related issues. Hence, BOCRA is advised to continue license-exempt FSS downlink bands and license FSS uplinks bands. Please also refer to our input in the proposed inputs to the National Radio Frequency Plan and Footnotes.
e-Botswana	We currently are looking for a frequency on DTT to connect to the satellite for Digital migration.
MASCOM	There is an absolute need of having the licenses for land mobile use and for fixed links on an exclusive basis, for a minimum of 15 years duration and a straightforward process for revalidation.
Paratus	Current Standard ISM Bands of lower 2.4Ghz and lower 5Ghz, as well FWA upper 5Ghz sub-bands, should remain license-exempt as this is a consistent trend in the region. All other spectrum should be regulated.

Source: CD Respondents

9.2.7. Respondents identified specific spectrum for either licenced or licence-exempt use reflecting their business priorities.

Proposal 16: Coleago believes the optimal approach for Botswana should be for BOCRA to reflect international consensus and regional practice in the identification of spectrum for licence-exempt use and licenced use for high-value services and bring this spectrum into use in a timely manner.

9.2.8. In addition to spectrum licensed for exclusive use or assigned on a licence-exempt basis, regulators internationally are also now considering forms of licence-exempt shared use subject to technical conditions and Licensed Shared Access. These issues are explored further in an accompanying section on Television White Spaces.

9.3 Impact of unified licensing on spectrum licensing

9.3.1. Unified licence regimes are progressively being established internationally and are replacing earlier service and technology-specific licensing. Service and technology-specific licensing was characterised by large numbers of different types of licences with providers' business models and choice of technology determining the licence, or licences, needed. This complex approach has now become redundant.

9.3.2. Driving this change are advances in technology and services offered by providers. This means that the same services can be offered using different technologies and make previous service and technology-specific licence regimes obsolete. Newer, unified licences are intended to simplify a national licensing regime, ensure providers are treated consistently, and allow greater flexibility in the way providers offer communications facilities and services and the technology they use. Unified licences are normally framed to be technology and service neutral.

9.3.3. Unified licence models are generally characterised by either: a single licence for all national communications facilities / infrastructure and services; or by two to four horizontally tiered licences each for separate layers of provision. Botswana has recently instituted a two-tier ICT licensing regime for communications infrastructure and services which is progressively being adopted.

9.3.4. This model consists of: fixed and mobile Network Facilities Provider (NFP) licences for facilities / infrastructure and Service and Applications Provider (SAP) licences for services and applications. This model is expected to continue under the revised Spectrum Management Strategy which is being developed by BOCRA with the support of Coleago.

9.3.5. Under the revised Spectrum Management Strategy, where new spectrum for exclusive use is assigned by BOCRA, Coleago proposes that this will be licensed though the mechanism of a separate spectrum licence as at present. Any provider wishing to offer services on new, exclusive use spectrum will require to hold an ICT NFP Licence in addition to a new, separate spectrum licence.

9.3.6. Where a provider wishes to use multiple new spectrum bands on an exclusive basis it will require a separate Spectrum licence for each band. Such a licence should include only rights and obligations relevant to the use of spectrum. Other rights and obligations will be contained in the relevant ICT NFP and SAP Licences.

9.3.7. Providers using designated licence-exempt spectrum are free to do this subject to national rules on interference, range and power limits. Such providers will still normally require relevant unified licence or licences. This will replace previous service and technology-specific licences which included spectrum for fixed and mobile licence categories and may also apply in the case of new broadcasting licences, subject to further consideration by BOCRA at the relevant time.

9.3.8. In its recent Consultation Document on Spectrum Licensing stakeholders were asked:

a. what are your views on the proposed licensing approach?

9.3.9. Non-confidential responses received are shown in Exhibit 7.

Exhibit 8: Proposed licensing approach

Respondent	Comment
DBS	The proposed licensing approach is welcome.
Concerotel	Concerotel agrees with the proposed “unified licensing approach” that is based on technology neutral service provision; it allows services to be offered using different technologies and by default results in increasing availability and penetration rate of connectivity.
MASCOM	We support the licensing approach as it should assist in driving innovation and shortening the lead times for deployment of new services. Critically though, it is this licensing context essential to ensure that there are no delays in availing frequency spectrum for existing technologies to ensure operators can promptly and efficiently avail services to as many users as possible.
Paratus	We support this and see the proposed strategy as leading. It matches international trends and carries our support.

Source: CD Respondent

9.3.10. Respondents supported the continuation of the Unified Licence framework recently established by BOCRA.

Proposal 17: Where BOCRA proposes to licence new spectrum for exclusive use, it should provide a separate spectrum licence for each band. Such a licence should include only the rights and obligations relevant to the use of this spectrum.

9.3.11. All licensees should, in addition, hold an ICT NFP licence which will contain other rights and obligations relevant to the operation of infrastructure.

9.4 Fixed link spectrum

9.4.1. Spectrum for fixed microwave links is currently assigned to users on a link-by-link basis by BOCRA. This allows BOCRA to manage the interference between fixed link users, particularly in Gaborone and other urban areas. An alternative approach, which has been introduced in certain other national markets, is to assign users specific fixed-link frequencies on an exclusive, national basis.

9.4.2. In its recent Consultation Document on Spectrum Licensing stakeholders were asked:

a. do you support continuation of the existing link-by-link management of fixed links by BOCRA? and

b. what are your views on alternative approaches, such as exclusive, national frequency assignments?

9.4.3. Non-confidential responses received are shown in Exhibits 8 and 9.

Exhibit 9: Fixed Link Licensing Approach

Respondent	Comment
DBS	No.
MASCOM	See answer to Q11.
Meteorological Service	Support the existing link-by-link approach.

Source: CD Respondents

9.4.4. Respondents generally preferred to retain BOCRA link-by-link management for existing fixed links.

Exhibit 10: Alternative approaches

Respondent	Comment
DBS	The alternative approaches, such as exclusive, national frequency assignments are welcome and can be easily managed.
MASCOM	MASCOM prefers the alternative solution of assigning users specific fixed link frequencies and giving the users the ability of managing those frequencies on a national or regional basis. This solution, together with the potential for spectrum trading among telecom operators, would allow for a simpler and quicker management with the possibility of resolving interference problems between the operators.
Meteorological Service	May be considered after consulting the stakeholders on how transition will be done; for them to prepare for transformation.
Paratus	We would like this to be adopted but with our comments in 10 above.

Source: CD Respondents

9.4.5. Respondents were, however, open to alternative approaches to BOCRA's link-by-link management for new fixed link spectrum.

9.4.6. Alternative spectrum management approaches are explored further in an accompanying section on Television White Spaces (TVWS). Depending on the spectrum management approach preferred by BOCRA after its planned TVWS consultation it may be appropriate to return to this issue with stakeholders.

9.5 License duration

9.5.1. Licence duration is a key consideration for all stakeholders. The licence duration should be sufficiently long to ensure that the users of spectrum are able to earn a reasonable return on their investment. However, BOCRA also needs to ensure that, as technology and spectrum users and requirements change over time, spectrum can be re-assigned to ensure that it continues to be used efficiently.

9.5.2. In the case of mobile services, there is evidence that licence duration has affected the success of mobile markets with longer licence durations providing a more secure basis for investment. For this reason, international practice in many markets is tending towards offering providers longer licence terms and the consideration, in certain markets, of perpetual licences.

9.5.3. In Botswana mobile operators are currently using a mix of 2G, 3G and 4G radio access network technologies. Within the period of the current National Radio Frequency Plan, BOCRA envisages that operators will deploy 4G radio access network technology on new IMT spectrum assigned and will progressively upgrade 2G and 3G technology across existing frequencies where supported by their business plans. Towards the end of the period operators may also begin to deploy 5G technology.

9.5.4. Currently, Botswana ICT licences have been offered with a 15-year term. Spectrum licences for use with Long Term Evolution (LTE) technology in the 1800 MHz spectrum band were assigned in 2015 and for Fixed Wireless Access Spectrum in the 2300-2400 MHz and 3500-3600 MHz band in 2017 for 10-year terms.

9.5.5. Coleago would argue that BOCRA should offer new spectrum licences also with a minimum 15-year term irrespective of services or technology used and provide spectrum licence holders with a presumption of renewal, except in the case of significant licence breach or licence holder non-performance.

9.5.6. Longer licence terms and a presumption of renewal are to be preferred where requirements for capital investment are substantial and the likely period of return long, especially where a licence may extend over the replacement of multiple network technology cycles.

9.5.7. In its recent Consultation Document on Spectrum Licensing stakeholders were asked:

a. what are your views on spectrum licence duration?

9.5.8. Non-confidential responses received are shown in Exhibit 10.

Exhibit 11:Spectrum Licence Duration

Respondent	Comment
DBS	The 15-year approach is fine, and it gives operators time to stabilize.
MASCOM	MASCOM agrees with BOCRA's key conclusion on the advantages of long-term spectrum licence durations. Spectrum licence duration should be at minimum of 15 years, but preferably evolve to 25 years. The presumption of renewal in favour of the existing providers is also fundamental to lower the risks involved in network investments, especially in the final years of the licence usage. Therefore, the renewal process must be started and finished before the operator enters the last 5 years of licence period. Otherwise it risks having a substantial negative impact on network investment in the final license years, which would also negatively affect end-user services. Long-term spectrum license duration is key to ensure predictability which is a pre-requisite for sustainable investments and development. Another critical issue is the need to harmonise, on time, the different licenses an operator uses. Imagine the possible situation where a 900MHz band license elapses and a 2.6GHz license starts. The impact of having to maintain service (assuming a service obligation and not a technology specific use) without one of the main bands is immense. It would imply a huge

Respondent	Comment
	migration of clients to the new band with a corresponding significant impact on investment, without any benefits to anyone.
Meteorological Service	Longer term is preferred but where requirements for investment are not substantial and the period of return not long the term can be determined on specific submission.
Paratus	Spectrum should be attached to the NFP license as a minimum but we do not have any objection to the license term suggested. It must be supported by a 'use or lose it' policy where the bandwidth utilized is assessed in relation to the channel sizes.

Source: CD Respondents

9.5.9. Respondents generally supported longer durations for spectrum licences.

Proposal 18: Coleago believes it is in Botswana's interests for BOCRA to offer longer terms for new spectrum licences reflecting international practice. New spectrum licences should be offered for a period of 15 years.

9.6 Coverage and quality of service obligations

9.6.1. The National Broadband Plan describes Botswana's ambitions for the extension of broadband access networks and services nationally. Critical to achieving this plan will be the deployment of wireless broadband coverage and capacity to the fullest practical extent. Coleago believes that the release of new, low frequency spectrum for IMT services provides a key potential opportunity to extend broadband access. To achieve this BOCRA should consider including coverage obligations as part of the spectrum licensing process. In addition, BOCRA may also consider introducing quality of service obligations.

9.6.2. In its recent Consultation Document on Spectrum Licensing stakeholders were asked:

a. what are your views on the introduction of coverage and quality of service obligations?

9.6.3. Non-confidential responses received are shown in Exhibit 11.

Exhibit 12:Coverage and Quality of Service Obligations

Responder	Comment
DBS	The introduction of coverage and quality of service is a welcome development is it will give customers value for money and encourage competition.
MASCOM	Coverage conditions are already a part of the obligations with respect to existing services and technologies. In MASCOM's opinion sound coverage and QoS obligations can of course, from a policy perspective, assist in ensuring that socio-economic objectives are achieved. In our view, it is however critical to adopt a balanced approach, where realistic targets are set which take into account inter alia geographic and demographic factors. Coverage and quality of service are key considerations for network operators when deciding where and how to do business. The level of coverage has an important impact on investment and corresponding returns; a high level of coverage obligation will correspond to high costs. In specifying these conditions BOCRA should be aware that this is like adding to the cost of the spectrum. Similarly, the obligations for quality of service have a direct impact on network capacity that will be used only in short durations. That would correspond to an investment with low usage meaning low return. There are limits on the capacity of operators to invest without profitability, so the

Responder	Comment
	issue is if the obligations are similar to the operator criteria, or very far from the operator criteria.
Meteorological Service	The obligation will ensure stakeholders deliver as required and in return boost confidence of the users on service providers.
Paratus	Difficult. Perhaps with specific spectrum, such as consumer based and those for mobile devices.

Source: CD Respondents

9.6.4. Respondents generally welcomed coverage and quality of service conditions in licences although with caveats in some cases. Commercial operators whose spectrum requirements may be more likely to be accompanied by conditions were the most cautious in their views and on the impact of coverage and quality of service obligations on their operation.

Proposal 19: Coleago believes that coverage and service quality obligations in spectrum licences are appropriate to achieve relevant public policy objectives, including those set out in the National Broadband Strategy.

9.6.5. As argued by certain respondents, coverage and quality of service targets should be realistic taking into account the Botswana market's geographic and demographic factors. BOCRA, like other regulators, must achieve a balance between getting the widest coverage at the earliest time while allowing operators to earn a reasonable rate of return overall.

9.6.6. Coverage targets in spectrum licences should reflect the propagation characteristics of the spectrum concerned and it should be open to communications providers to meet coverage targets by using their most efficient frequency where they hold a mix of low and high frequency spectrum.

9.6.7. For example, where spectrum bands in a provider's portfolio contain distinct coverage obligations a provider should be able to apply to BOCRA to meet its obligations using low frequency spectrum (such as spectrum in the 800 MHz band) rather than high frequency spectrum (such as spectrum in the 1800 MHz band).

9.7 Licence renewal

9.7.1. Licence renewal is important because a poorly managed process will have adverse impacts for investment and for consumers. A lack of clarity over the renewal process near the end of a licence period could negatively impact network investment and services to consumers. Furthermore, significant disruptions to service continuity and consumer harm could result if operators do not have sufficient time to adjust in the event that some spectrum changed hands.

9.7.2. In its recent Consultation Document on Spectrum Licensing stakeholders were asked:

a. what are your views on the most suitable approach to spectrum renewal in Botswana?

9.7.3. Non-confidential responses received are shown in Exhibit 12.

Exhibit 13: Approach to spectrum renewal

Respondent	Comment
DBS	License terms be nominally fixed with renewal for existing users, new entrants should not be disadvantaged.
Concerotel	Concerotel advises to adopt a simple approach for spectrum renewal. This would be by simply paying the spectrum renewal fees. However, criteria of spectrum renewal shall be based on a balanced approach between encouraging operators to invest in infrastructure but at the same time avoid spectrum warehousing.

Respondent	Comment
MASCOM	We note that the examples given by BOCRA in the document relate to developed countries and markets with large populations (over 5m, and some cases over 50m inhabitants). In a developed country the main drivers are often different to those in a developing country, especially with a small population spread over a large territory like Botswana. The operators in the examples have almost unlimited resources and high knowledge to enter auctions and discussions with regulators.
Paratus	We believe that the best approach for Botswana would be a hybrid model but with a bias toward administered renewal. If a FCFS policy with strict use it or lose it policy is applied, it will be better for all and make renewal easier due to a demonstrated use case.

Source: CD Respondents

9.7.4. On licence renewal, respondents supported a presumption of renewal of spectrum held by existing providers.

Proposal 20: Coleago proposes that BOCRA applies a presumption of renewal in favour of spectrum holders, subject to progressively re-farming spectrum towards higher value use, and overall spectrum assignments meeting efficiency and competition concerns.

9.8 Other rights and obligations

9.8.1. Coleago anticipated that stakeholders may have a wide range of views regarding the rights and obligations attached to licensed spectrum in Botswana.

9.8.2. In its recent Consultation Document stakeholders' views on the rights and obligations associated with all potentially licenced spectrum were solicited.

a. what are your views in relation to licence rights and obligations in relation to any specific frequencies?

9.8.3. Non-confidential responses received are shown in Exhibit 13.

Exhibit 14:Other Rights and Obligations

Respondent	Comment
DBS	No comment.
MASCOM	Regarding exclusive frequency assignments for fixed and mobile use, the operators should have the right to re-farm the available frequencies, meaning the right to use the best technology and the decision to specify internal parameters (as guard bands or masks) according to best of breed in the industry.
Paratus	We support a light-touch model as mentioned in the draft allowing an operator to use the spectrum as they see fit but within the confines of the operating license.

Source: CD Respondents

9.8.4. The issue of re-use of licensed frequencies in remote areas of Botswana by end-users / third parties was raised in the consultation. Coleago believes that this may be appropriate in certain contexts, however, should be approached through a formal framework such as through spectrum leasing.

Proposal 21: Coleago believes that spectrum licences should be service and technology neutral and should allow operator re-farming of frequency assignments.

Section 10. TV White Space Licensing – International Background

10.1 Introduction

10.1.1. Regulators in a number of markets have decided to support the introduction of TVWS device, service and application use. This section discusses approaches of: the US, Canada, the UK and South Africa where regulators have permitted TVWS devices to operate in unused television spectrum below 694/698 MHz.

10.1.2. In addition, TVWS trials have taken place, or are ongoing, in a number of African markets, including Botswana, where no formal decision has yet been taken to permit large-scale TVWS device operation.

10.2 The US

10.2.1. The use of white space spectrum for communications purposes was initially raised in a US Spectrum Policy Task Force report of 2002. The US Government subsequently initiated discussions on applying the concept to digital television spectrum which has historically been shared with other radiocommunication applications, including low power local TV services, cable TV distribution and wireless microphones.

10.2.2. The Federal Communications Commission (FCC) has systematically supported the development of unlicensed use of US TVWS spectrum. Between 2002 and 2010 the FCC issued a series of proposed rule makings, opinions, reports and other regulatory measures designed to support US TVWS use. FCC rules provide for fixed and mobile devices to operate in TVWS nationwide on an unlicensed basis using spectrum primarily assigned to existing US broadcast television between 54 MHz and 698 MHz.

10.2.3. The FCC issued draft final rules for the use of TVWS in September 2010. It designated nine companies as potential providers of database services required by white space devices in January 2011 and conditionally designated a tenth company as a database administrator in July 2011. It subsequently issued amended final TVWS rules in the form of a memorandum opinion and order in April 2012[26]. The detailed rules for TVWS device operation in the US are contained in Part 15.701 of Title 47 of the U.S. Code of Federal Regulations.

10.2.4. Devices must be certificated before they are permitted to operate in the US and must combine geolocation and technical access to a database of existing spectrum users. Prior to operation each TVWS device location must be provided to an FCC-approved database, which responds with details of channels it may use. TVWS devices are not permitted to transmit without a database check and must also periodically re-check channels available for use. Each device must transmit at minimum power to support its operation. Most US unused digital TV spectrum has now been opened for TVWS device use. Regulation requires that devices do not use an occupied TV channel or channels adjacent to an occupied channel. A number of channels have also been reserved for other services including the two lowest frequency channels for use by low power consumer devices, channel 37 for radio-astronomy, and adjacent channels 36 and 38 for wireless microphones.

10.2.5. Reflecting the complexity of new TVWS device technology, and also the US rule-making approach, the FCC has repeatedly refined its rules for TVWS device operation. In its final 2012 rule-making the FCC addressed issues relating to the operation of TVWS which had been raised by stakeholders including: height above average terrain limit for TVWS devices, out-of-band emission limits, protection of wireless services, creation of a new category of fixed indoor TV bands and TV database confidentiality.

10.2.6. However, existing US digital TV broadcasters continue to raise concerns[27] regarding the accuracy and operation of TVWS databases and have pressed for elimination of “professional installation” option for fixed TVWS devices where location is identified by the installer rather than use geolocation. US broadcasters also note that a number of previously-authorized TVWS database providers no longer provide services which may call into question the operation of devices reliant on these and suggests difficulties in the development of the wider market for unlicensed TVWS devices, services and applications.

[26] See: FCC Third Memorandum Opinion and Order at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-12-36A1.pdf
[27] See, for example: https://www.nab.org/documents/newsRoom/pdfs/031915_TVWS_Emergency_Petition.pdf

10.3 Canada

10.3.1. Industry Canada published a "Consultation on a Policy and Technical Framework for the Use of Non-Broadcasting Applications in the Television Broadcasting Bands below 698 MHz in August 2011[28]. The consultation invited comments on the use of non-broadcasting applications in certain TV bands between 54 and 698 MHz. Issues consulted on included: the regulatory framework for licensed Remote Rural Broadband Systems, licence-exempt TVWS devices and licensed Low-Power Apparatus such as wireless microphones.

10.3.2. Industry Canada anticipated TVWS devices would be offered for consumers to use in the home on a similar basis to Wi-Fi. Service providers would improve internet access by using longer range wireless broadband equipment exploiting the propagation characteristics of TV spectrum. TVWS technology might also be used for future machine to machine communications and other innovative products and services.

10.3.3. Responses to the consultation supported the use of TVWS in unused Canadian broadcast spectrum, arguing that this would increase access to the internet, including in rural areas, and increase device and service innovation. Existing TV providers identified interference concerns and the need to act conservatively in introducing TVWS devices. One respondent noted that more efficient TV broadcast spectrum use – packing remaining digital TV channels more closely together and repurposing spectrum for mobile broadband – would mean less unused white space, and so, less spectrum for new TVWS devices to use.

10.3.4. Following its consultation, Industry Canada announced a "Framework for the Use of Certain Non-broadcasting Applications in the Television Broadcasting Bands Below 698 MHz in April 2013"[29]. This framework provides access to spectrum for unlicensed TVWS devices and was justified by encouraging more efficient spectrum use and facilitating the introduction of new wireless communications services. Canadian TVWS devices are to operate on a no-protection, no-interference basis with respect to TV broadcast and other licensed users. Devices must be certified under applicable Canadian technical standards which are broadly harmonized with those of the United States in order to facilitate a common market for equipment across the two countries. Remote Rural Broadband Systems will be able to continue in operation on or licensed basis or providers may choose to migrate to unlicensed operation.

10.3.5. While noting the development of spectrum sensing approaches to interference protection, Industry Canada mandated the use of device geolocation combined with access to one or more approved central databases to determine the TVWS spectrum, if any, available for use by a device at its location.

10.4 The UK

10.4.1. In the United Kingdom, Ofcom published an initial public consultation "Implementing Geolocation"[30] in relation to TVWS technology in November 2010 and published further proposals for consultation on the launch of white space or interleaved spectrum in December 2013. Ofcom's proposed approach was to consider how to make TVWS devices available in the.UK on an unlicensed basis. In addition to its consultation of stakeholders, Ofcom carried out pilot trials and testing to understand the interference risks associated with TVWS device operation.

10.4.2. In its 2013 consultation "White Space Co-existence"[31] Ofcom proposed allowing TVWS devices access to the unused parts of digital terrestrial television spectrum in the 470 to 790 MHz frequency band. TVWS devices would share the band with existing users, such as Local TV, Programme Making and Special Events, including for wireless microphones.

10.4.1. Ofcom proposed a modified, more conservative approach to "Implementing TVWS Use"[32] in February 2015. Its plans to introduce TVWS devices in the UK have been justified by the increasing number of wireless devices in use and so the growing demand for spectrum to deliver existing and new services. Spectrum will be made available for TVWS device use on an unlicensed basis and Ofcom notes its approach to dynamic access may be applied to other bands in future.

[28] See: https://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/consultation-smse012e.pdf/$FILE/consultation-smse012e.pdf
[29] See: https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10493.html
[30] See: https://www.ofcom.org.uk/consultations-and-statements/category-3/geolocation
[31] See: https://www.ofcom.org.uk/consultations-and-statements/category-1/white-space-coexistence
[32] See: https://www.ofcom.org.uk/__data/assets/pdf_file/0034/68668/tvws-statement.pdf

10.4.2. Intelligent TVWS devices in the UK will have access to spectrum on a dynamic basis controlled by databases which will identify the location of TV and other users and TVWS devices. Spectrum co-existence in the UK will be achieved by TVWS devices operating in places where, or at times when, digital TV spectrum is not in use and meeting a minimum technical specification which has been designed to reduce the risk of harmful interference to existing spectrum users.

10.4.3. Ofcom has described its revised approach to setting co-existence criteria as "cautious, designed to ensure a low probability of interference with existing users". In taking this approach Ofcom notes: database use to control access to spectrum is a new approach not yet demonstrated on a large scale, equipment for TVWS use is still at an early stage of development and the characteristics of mass-market use are not yet known.

10.4.4. Overall, Ofcom has described the market for TVWS devices as subject to a high degree of uncertainty which justifies it setting criteria for the protection of existing users from interference in a conservative way, ensuring Ofcom's ability to manage the possible interaction of worst-case market developments.

South Africa

10.4.5. In October 2015 the Independent Communications Authority of South Africa (ICASA) published a Discussion Document on a “Draft Framework for Dynamic and Opportunistic Spectrum Management”. In June 2016 ICASA published a Findings Document and, subsequently in April 2017, a Position Paper[33] setting out its policy of support for the introduction of dynamic spectrum management, including for TVWS spectrum.

10.4.6. In its discussion document, ICASA proposed the adoption, in principle, of Dynamic Spectrum Assignment techniques on a geolocation basis to improve South African broadband connectivity, to promote more effective and efficient use of national radio frequency spectrum and to encourage innovation.

10.4.7. ICASA proposed a regulatory framework to enable broadband services to operate in the broadcast TV band between 470 MHz and 694 MHz currently used by terrestrial broadcasting services on an exclusive basis. New broadband devices, services and applications would be permitted to operate as secondary users of this broadcast TV band, subject to not interfering with primary broadcast service use. ICASA argued that this approach would enable providers to access to up to 168Mhz of otherwise unused South African spectrum.

10.4.8. ICASA concluded that the introduction of a TVWS regulatory framework is in the best interests of South Africa’s digital future and in accordance with the strategic objectives of the National Development Plan and SA Connect to increase broadband access and take-up. Provided technical interference management measures are in place to govern secondary use, ICASA believes that primary broadcast users will be protected from harmful interference.

10.4.9. The risk of interference may be managed effectively by device use of geolocation, by spectrum “sensing” or by a hybrid approach which combines both techniques. However, ICASA concluded that an accurate database of frequency assignments and associated propagation models (that is a geolocation spectrum database) are “cornerstones of successful implementation”.

10.4.10. Research conducted by ICASA’s technology partners and most international studies on TVWS use have focussed on fixed wireless devices, services and applications. Because of this ICASA has decided to apply the concept of TVWS to fixed devices only, arguing that mobility in TVWS has not been sufficiently demonstrated.

10.4.1. South African stakeholders were divided on support for a license-exempt managed regime and for full or light licensing. Arguments made in support of a license-exempt approach were that this would improve network and service innovation and lower barriers to entry for local network operators. In contrast arguments for full licensing were that a license-exempt approach would distort competition and reduce compliance. There was little support for an unmanaged licence-exempt approach or for a mixed licensing regime which would be unnecessarily complex if applied to a single band.

[33] See: https://www.icasa.org.za/position-paper-on-dynamic-and-opportunistic-spectrum-management-government-gazette-no-40772-notice-282-of-2017

10.4.2. ICASA decided to adopt “managed automatic licensing”. This will require TVWS device parameters to conform to a South African technical standard and to operate in conjunction with a geolocation spectrum database intended to protect existing users from interference.

10.4.3. During the consultation process one stakeholder argued TVWS “will not have a material, positive impact on encouraging investment and innovation” and that the “FCC has had a long history of policies designed to encourage [TVWS] investment and innovation, however, there has been little progress […] since US regulatory efforts began over a decade ago”. ICASA, however, responded that “the need for TVWS was driven by the lack of ubiquitous broadband access and adoption [and] is therefore expected to be more rapid in [South Africa’s] access-deprived environment”.

10.4.4. ICASA has followed its Position Paper with the publication in March 2018 of “Regulations on the use of Television White Spaces”[34] which sets out in regulation how TVWS devices are to operate and has recently published an “Invitation to Higher Learning and Research Institutions to submit proposals on the development, implementation, hosting and management of the Reference Geo-Location Spectrum Database”[35] to enable the implementation of its TVWS Regulations in South Africa”.

10.5 International TVWS developments

10.5.1. The possibility of allowing unused broadcast TV spectrum for unlicensed devices, services and applications was raised at a Communications Regulators Association of Southern Africa (CRASA) at a meeting in Botswana in 2013[36]. BOCRA notes that this issue has also been raised at other African regulatory fora including the West African Spectrum Group and the African Telecommunications Union.

10.5.2. Trials have been carried out in a number of African nations including: Kenya, Malawi, South Africa, Tanzania and Botswana itself. These trials have, in general, demonstrated that TVWS devices, services and applications in limited operation can successfully provide connectivity to a small number of socially important locations (such as hospitals, schools and other shared community facilities) in a specific region without causing interference to users of regional broadcast TV.

10.6 International Standardisation and operation of TVWS devices

10.6.1. While the use of TVWS should, in principle, be technology-neutral, regulators considering the introduction of TVWS devices, services and applications have emphasised the need for an internationally harmonized approach to the performance characteristics of TVWS devices and to ensuring their low-interference operation. An internationally harmonized approach will be important for Botswana to ensure that any national introduction of TVWS devices can take advantage of economies of scale in their manufacture.

10.6.2. A key advantage of unused television broadcast spectrum is that the propagation characteristics of this spectrum are substantially better than for existing unlicensed spectrum. BOCRA understands that TVWS standards have been under consideration which will take advantage of the greater propagation characteristics of unused television broadcast spectrum. Two which are relevant are the international IEEE 802.22 and IEEE 802.11af standards.

- The IEEE 802.22 or Wi-FAR standard is designed to support wireless regional networks with point-to-point and point-to-multi-point broadband services. In operation 802.22 equipment may have a range of some 10 Km and can support the distribution of broadband services to base stations over a relatively wide area.

- IEEE 802.11af is an evolution of the core Wi-Fi standard from the IEEE 802 Wi-Fi family of standards which supports existing wireless local area networks. This standard will allow existing dual-band Wi-Fi access points to be replaced by multi-band Wi-Fi improving coverage and capacity.

10.6.3. TVWS equipment operating to either standard will typically connect to an outdoor or indoor access point or router to support a Wi-Fi hot-spot or school, office or home network.

[34] See: https://www.icasa.org.za/legislation-and-regulations/regulations-on-the-use-of-television-white-spaces-2018
[35] See: https://www.icasa.org.za/tenders/icasa-09-2018-geo-location-spectrum-database
[36] See: https://www.tenet.ac.za/tvws/05-cape-town-tvws-trial-learnings-and-recommendations-report

Section 11. Input from Stakeholders of Television White Space

11.1 Introduction

11.1.1. BOCRA welcomes views of all current and future users of spectrum as well as other stakeholders on this consultation on TVWS spectrum use in Botswana.

11.2 Views of Botswanan service providers, TVWS trialists and existing television spectrum users

11.2.1. An important factor in deciding BOCRA's TVWS policy will be an assessment of the level of demand from national communications service providers for the introduction of TVWS devices, services and applications. This consultation therefore seeks input from these stakeholders on their assessment of national and regional demand for the use of TVWS devices, services and applications over the coming 10-year period.

11.2.2. BOCRA is aware that there have been trials of TVWS technology in Botswana and in other African markets and seeks input from stakeholders with experience of these trials on their views of TVWS technology and its national suitability for the Botswanan market.

11.2.3. The consultation presents two options which will have different implications for the Botswanan ICT industry. These are:

a. Option1: adopting an unlicensed approach to TVWS device use; or
b. Option 2: adopting wider Licensed Shared Access in TVWS spectrum.

Stakeholders are particularly invited to comment on these two options and their implications for the Botswanan market.

11.2.4. BOCRA also welcomes input from existing users of national television broadcast spectrum on the potential impact of allowing TVWS devices to operate on national television broadcast spectrum and, in particular, how the risks of interference with existing primary users can most effectively be managed.

Section 12. Licensing Approach to Television White Space

12.1 Introduction

12.1.1. This section considers the regulatory issues relating to Television White Spaces (TVWS) including: unused spectrum available for TVWS use, unlicensed or licensed shared access approaches to the use of unused television spectrum and how existing television and other users may be protected should BOCRA decide to permit new TVWS devices, services and applications to use this spectrum.

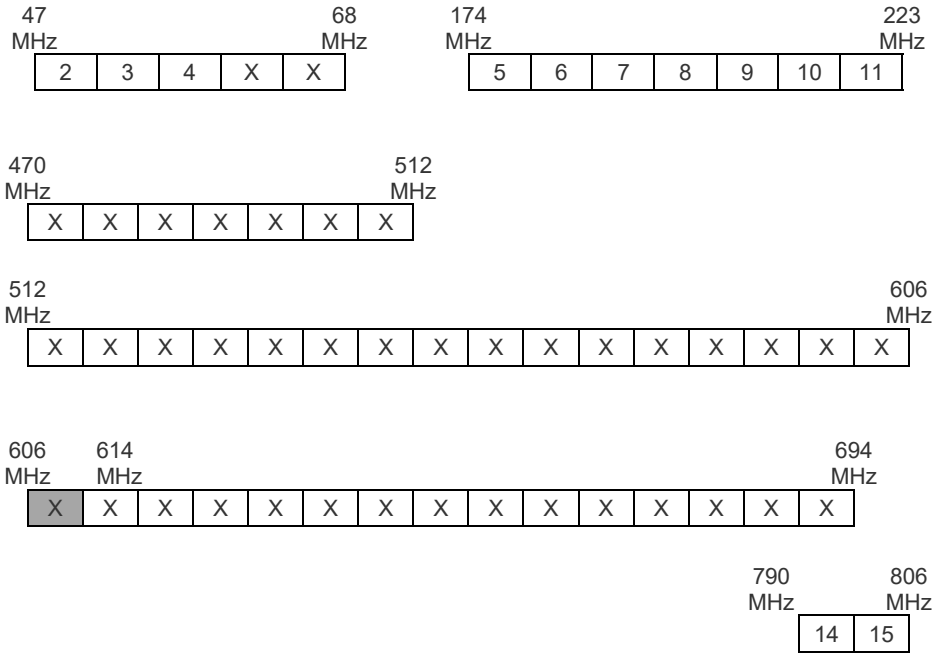
12.2 Unused Spectrum Available for TVWS use

12.2.1. As part of its update of the national Spectrum Management Strategy BOCRA is considering whether it would be beneficial for Botswana to permit TVWS devices, services and applications to operate on unused television spectrum.

12.2.2. Unused television broadcast spectrum sits within existing primary assignments of spectrum to terrestrial broadcasting. Spectrum is unused where this is required to avoid interference between high-power broadcast transmitters serving adjacent geographical regions, where broadcast transmission services only operate during certain periods or where spectrum is unassigned because of limited demand. This unused spectrum is generically referred to as Television White Spaces.

12.2.3. TV terrestrial broadcast in Botswana operates on a number of VHF bands between 47 MHz and 54 MHz and 174 MHz and 223 MHz and in UHF bands between 790 MHz and 806 MHz. In addition, UHF spectrum between 470 MHz and 694 MHz is assigned to broadcasting in the National Radio Frequency Plan. Exhibits 2 and 2A show Current available TV Broadcasting Spectrum in Botswana.

Exhibit 15: Current TV Broadcasting Spectrum: 47 MHz – 223 MHz (VHF), 470 MHz – 694 MHz and 790 MHz – 806 MHz (UHF)



Note: 606 – 614 MHz is used internationally for Radio-Astronomy
Note: 526.5-535 MHz is also allocated to the mobile service on a secondary basis

Source: BOCRA

12.2.4. The following exhibit shows current TV Broadcasting Spectrum as noted in the Botswana National Radio Frequency Plan

Exhibit 16: Current TV Broadcasting Spectrum in Botswana

Frequency Band Start	Frequency Band Stop	Botswana National Radio Frequency Plan (NRFP)	ITI Region 1 Radio Regulation Footnotes
47 MHz	68 MHz	Broadcasting Specified as Primary User: Television Band I (CH 2-4) ST61	5.164 specifies Land Mobile as Co-Primary on 47 MHz to 68 MHz 5.169 specifies Amateur as Co-Primary on 50 MHz to 54 MHz 5.171 specifies Mobile and Fixed as Co-Primary on 54 MHz to 68 MHz Co-Primary users must not cause interference to Broadcast Stations.
174 MHz	223 MHz	Broadcasting Specified as Primary User: Television. Band III. Channel 5 - 11. ST61.	n/a
470 MHz	694 MHz	Broadcasting Specified as Primary User:	n/a
790 MHz	806 MHz	Broadcasting, Fixed and Mobile Specified as Co-Primary Users	A number of footnotes relate to this band and its use for IMT services and reference “Order 9.21”: an obligation on all parties to avoid causing interference to others.

Source: BOCRA National Frequency Plan Tables

12.3 Unlicensed or Licensed TVWS Spectrum Use

12.3.1. International consideration identifies two licensing approaches for the use of TV spectrum for TVWS devices, services and applications. Countries examined in Section 4, including the US, Canada, the UK and South Africa, have decided to permit TVWS devices to operate within unused television spectrum below 694 MHz on an unlicensed basis, subject to technical measures to manage the risk of interference (Option 1).

12.3.2. Canada has a pre-existing regulatory framework for licensed Remote Rural Broadband Systems to provide internet access services to rural and remote regions which might also be appropriate for Botswana. Under this model, licences to use TVWS spectrum would be provided by BOCRA on a region-by-region basis where spectrum was not in use by BTV and the geographic location was sufficiently far from BTV's existing use and would not limit future plans for national TV broadcasting. To facilitate this BOCRA could adopt a form of Licensed Shared Access regime of identified providers nationally or in specific geographic regions (Option 2).

12.3.3. Protection from interference would be provided through administrative spectrum management - that is by identifying and licencing spectrum for use by region and ensuring that this was separated geographically from BTV's use of the same spectrum for broadcast TV. An LSA approach would facilitate BOCRA's ability to identify and licence regional providers to meet specific internet coverage and quality requirements in support of by the National Broadband Strategy. This would avoid the need for technical measures to manage interference between new TVWS devices and existing users.

12.3.4. Under an unlicensed approach (Option 1) it seems likely that new device, service and application deployment will be concentrated in urban and suburban areas where demand is greatest and where existing unlicensed spectrum is subject to congestion. There may also be benefits for rural and remote users as equipment using TVWS spectrum at lower frequencies is likely to expand the regions which can be economically connected using equipment which uses TVWS spectrum.

12.3.5. In contrast, an LSA approach (Option 2) may allow BOCRA to identify providers who will undertake specific national or regional network deployments which may facilitate a wider roll out of TVWS devices, services and applications nationally. Licensing of spectrum to improve communications access in remote and rural areas of Botswana is in line with the Government's National Broadband Plan and BOCRA wishes to encourage such provision.

12.3.6. The adoption of an unlicensed approach or of LSA does not imply that that one approach to spectrum use will have a lower cost than another. Both licencing models would be on a technical and service neutral basis, subject to equipment conforming with applicable international standards and an agreed national approach to limit interference.

12.4 Protection for Existing TV Spectrum Users

12.4.1. Whether spectrum is provided for TVWS devices, services and applications on an unlicensed or licensed basis, operators will continue to require the relevant ICT licence(s) to operate their networks and provide services as is currently the case.

12.4.2. Unlicensed spectrum use (Option1) would be subject to a requirement for TVWS devices to use a spectrum geolocation database, spectrum "sensing" or a hybrid approach combining both techniques to avoid interference with existing spectrum users. While technical approaches continue to be the subject of international trials, BOCRA notes that TVWS introductions in the US, Canada, the UK and South Africa have required the introduction of one or more national device registration databases. Spectrum "sensing" approaches have been viewed as too immature technically to be adopted, at least initially, in those markets. This suggests to BOCRA that spectrum "sensing" may also not be appropriate for Botswana at this time.

12.4.3. Hence, any decision to permit unlicensed use is likely to be accompanied by the introduction of device registration and a spectrum geolocation database to avoid interference with existing users. Annex A contains an illustrative set of technical rules for operating TVWS on an unlicensed basis which provides details of possible approaches.

12.4.4. Establishing and operating a spectrum geo-location database to ensure unlicensed TVWS devices do not interfere with existing users in Botswana would be a new frequency management activity. In the US, Canada and UK private providers are developing spectrum geo-location databases. Another model, proposed by ICASA in South Africa, is to commission the development of a national database. In either case costs may have to be recovered from national providers and, ultimately, users or met from other communications revenues.

12.4.5. Coleago understands that take-up of unlicensed TVWS devices remains modest internationally and, while viable technically, current approaches may be considered as equivalent to expanded trials. In many situations, TVWS broadband use is static, operating consistently on the same frequency, and this seems to be the case for most rural use. Dynamic spectrum usage, requiring an operational database, may only be needed in urban locations subject to peaks of demand for local wireless microphones or other devices

12.4.6. Given Botswana's market size, the creation of a spectrum database to support TVWS devices could impose significant costs on individual devices and users. If this proved not to be viable, BOCRA would face a choice of either subsidizing national geolocation database provision from other national communications revenues or the use an international spectrum use geolocation database.

12.4.7. Coleago notes that BOCRA could, alternatively, adopt a form of licensing of identified providers nationally or in specific geographic regions (Option 2). Such License Shared Access would support the provision of broadband access services and has been used in Canada to serve rural and remote areas. Licences to use spectrum could be provided by BOCRA on a case-by-case basis where:

a. spectrum was not in use by Botswana BTV;
b. the geographic location was sufficiently far from BTV's existing uses in other locations; and
c. use would not limit future plans for national TV broadcasting adoption or evolution or impede the future release of broadcasting spectrum for mobile broadband.

12.4.8. Protection from interference would be provided through administrative spectrum management - that is by identifying unused television spectrum available for use regionally. Providers will then be responsible for operating their TVWS equipment on specified bands agreed with BOCRA.

12.4.9. Introducing Licensed Shared Access would not require the provision of a geo-location database covering Botswana. Instead BOCRA would be able to use existing spectrum management approaches to license TVWS frequencies to providers by region and/or specific route.

12.4.10. BOCRA would identify unused television frequencies by geographic region and provide details of these to industry. Available frequencies would reflect current and future television transmission requirements and would be expected to evolve over time. Communications providers would apply to BOCRA for a licence to use frequencies by geographic region to meet specific communications requirements. LSA applications would require:

a. the applicants name and address;
b. the company's ownership and structure;
c. a full description of the proposed system including numbers of customers and their locations;
d. a full list of preferred television channels / frequencies requested and the technical parameters of the proposed system;
e. justification for the amount of spectrum requested to support the proposed system; and
f. a map showing the proposed region, or regions, of deployment.

12.4.11. BOCRA would assess companies' proposals on a case-by-case basis against a framework which reflected its statutory and policy objectives, including the delivery of broadband services to rural communities and would consider whether indicative demand exceeded supply in any region.

12.4.12. On the basis that demand did not exceed supply, BOCRA would use a First-Come, First-Served (FCFS) licensing process subject to concerns about competition and efficiency of spectrum use.

12.4.13. Frequencies will be assigned by BOCRA by geographic region and in frequency blocks, reflecting frequency use in the Botswana national broadcast channel plan.

12.4.14. Given the nature of TVWS spectrum Coleago proposes BOCRA offer licences with a one (1) year term with a presumption of renewal unless a licence breach or competition or spectrum efficiency concerns require a different policy approach.

12.4.15. Option 2 has the benefit that it can be adopted rapidly. However, in the longer term, it may be less efficient than Option 1 in regions where large numbers of devices share available spectrum. The impact of this is likely to be that urban capacity (where spectrum demand is strongest) in TVWS spectrum will be less if LSA is adopted. This is not likely to affect the operation of providers offering rural or remote access where lower demand can be catered for under either approach.

12.4.16. Stakeholders should be aware that the use of an unlicensed approach or of Licensed Shared Access does not imply any regulatory difference in radio technology to be used or of services to be offered or that one approach to spectrum use will be at a lower cost than another.

Section 13. Spectrum Pricing – Best Practice

13.1 Spectrum pricing overview

13.1.1. In this section Coleago begins by defining spectrum pricing terms before discussing the objectives and principles of best practice. The subsequent sections describe the current situation in Botswana and the results of the initial consultation before providing Coleago's pricing proposals. The resulting revised spectrum prices are provided in Annex C.

13.2 Definition of spectrum pricing terms

13.2.1. Regulators use a variety of definitions for different types of spectrum prices. For the purposes of this consultation, Coleago will make the distinction between Spectrum Usage Fees and Spectrum Access Fees.

a. Spectrum Access Fees: These are the prices for gaining access to the rights of spectrum use and are usually a one-off charge, although they can also be spread over time. They may be determined by some form of market-based mechanism (e.g. an auction) or they may be determined administratively.

b. Spectrum Usage Fees: These are typically annual charges and usually relate to the recovery of the costs of spectrum management incurred by the regulator although they can also be set to reflect the market value or opportunity cost of spectrum (e.g. Administered Incentive Pricing).

13.3 Objectives

Economic efficiency

13.3.1. The use of spectrum to provide communication services can generate significant socio-economic benefits. Spectrum should therefore be used in a manner which maximises these benefits.

13.3.2. Ensuring the most economically efficient use of spectrum means allocating the spectrum to those users that will generate the greatest economic value from it[37]. Efficient use encompasses both allocative and productive considerations. Spectrum is used efficiently when it is being used to provide the most valuable services (allocative) by the provider which generates the greatest value from those services (productive). Spectrum pricing can be used to provide incentives for spectrum to move to its most valuable use and to the provider able to generate the greatest value from it. Spectrum is efficiently used when it is not possible to increase socio-economic welfare from a transfer of spectrum resources.

13.3.3. Ensuring the efficient use of spectrum is stated by many regulators as a primary policy objective. Consultants retained by BOCRA stated in their 2008[38] report that their first proposal was:

"Proposal 1: Economic efficiency should be the default objective of radio spectrum management".

13.3.4. This position was confirmed by BOCRA in their Position Paper on the "Development of Spectrum Management Strategy" published in February 2008.

13.3.5. However, there are other factors that should also be considered in determining the approach to spectrum pricing.

Other government objectives

13.3.6. There are a range of important industry, social and cultural objectives that can be impacted by the use of the spectrum and hence, spectrum pricing decisions:

a. Investment and innovation: Users of spectrum will only invest if they anticipate earning a return on their investment which exceeds their cost of capital. For example, the socio-economic benefits of access to

37 Regulators typically assume that the company that can generate the greatest private value from the spectrum, subject to competition considerations, will also be the company that generates the greatest societal value from the spectrum.

38 A new policy for spectrum licensing and spectrum pricing in Botswana, January 2008

broadband services are widely recognised. Increasing broadband services to rural areas and under-served communities is a key objective for many regulators. Investment in coverage and service, as well as in research and development for innovation, requires spectrum users to anticipate a reasonable return on their investment above their cost of capital. If spectrum is priced too highly, it will reduce the incentives for such investment. Future anticipated returns can be impacted by the level of spectrum prices and so regulators will wish to take into account how their spectrum pricing policy impacts investment incentives.

b. Competition: Many telecommunication markets are characterised by one or two strong operators with significant market share and a number of smaller operators. If spectrum prices are set too high for the smaller operators but low enough for the larger operators, then the result can be a concentration of spectrum in the hands of the large operators which only reinforces their market power. Spectrum prices must therefore take account of the structure of the market, the ability of operators to pay, and the need to promote and enhance competition to deliver benefits to consumers. This applies to all methods of spectrum assignment, which means that market-based methods may have to be structured to prevent excessive concentration of spectrum to the detriment of competition.

c. Price levels: Spectrum prices may influence the prices that spectrum users charge to their customers. To ensure that services are affordable, especially for low income groups, regulators will need to consider how their pricing policies impact the end consumer pricing decisions of spectrum users.

d. Funding spectrum management activities: The value of spectrum can be enhanced through the spectrum management activities of regulators such as seeking to avoid interference. Regulators face both direct and indirect costs associated with their spectrum management activities and so those that benefit from spectrum management services may be expected to contribute to these costs. Spectrum pricing policy should therefore potentially take into account the need to fund spectrum management activities of the regulator.

13.4 Spectrum price principles

13.4.1. The ITU[39] published a set of guidelines for spectrum pricing which provide a good summary of best practice pricing principles based on the approaches adopted by leading regulators. These principles are:

a. spectrum prices should enable and encourage spectrum to move to its highest value use and discourage spectrum hoarding to ensure economic efficiency;

b. where appropriate, spectrum prices should also be set to support the attainment of wider public policy objectives such as promoting social and cultural benefits;

c. to the extent possible, regulators and spectrum managers need to promote both regulatory certainty and flexibility in how spectrum is used and priced;

d. fairness and objectivity require that spectrum prices are based on objective factors and all licence holders in a given frequency band should be treated on an equitable basis;

e. the prices charged for spectrum should be sufficient to ensure that the costs of spectrum management can be recovered from those that benefit from the use of the spectrum;

f. transparency requires that the basis on which prices are calculated should be made clear in a published document resulting from consultation with stakeholders and that all prices should be set based on a published schedule;

g. the administrative costs of implementing the spectrum pricing approach should be as low as possible which leads towards a preference for simple pricing models (however, simple models, such as flat fees, may not always be consistent with the attainment of other policy goals such as efficiency);

h. 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; and

i. the approach to pricing and pricing levels should be reviewed periodically to ensure that the pricing regime reflects the developments within the market.

13.4.2. In addition to the principles articulated by the ITU, consideration should also be given to two further points:

a. the charging of spectrum should be structured in such a way that it minimises the impact on future investment and end-user pricing decisions; and

39 Guidelines for the Review of Spectrum Pricing Methodologies and the Preparation of Spectrum Fee Schedules, ITIU 2016

b. spectrum pricing should not necessarily be restricted to the private sector; public sector entities should also be required to consider the cost of spectrum and the alternative uses to which their current spectrum allocations could be applied.

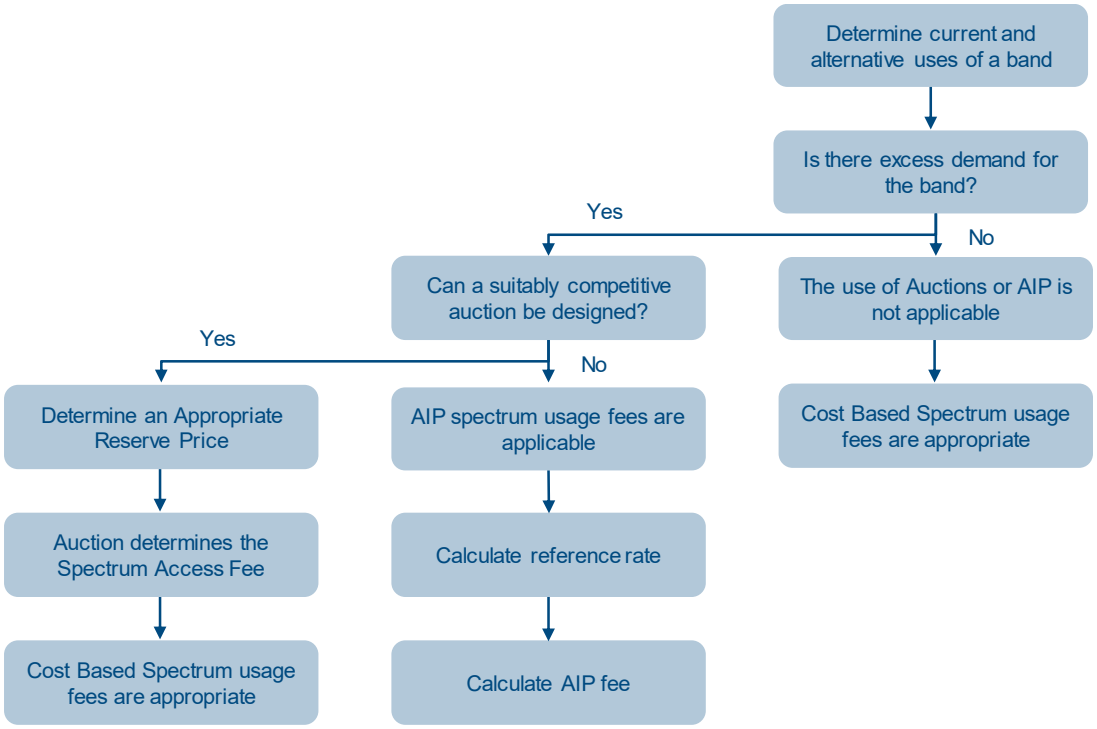
13.5 Best practice approach to spectrum pricing

13.5.1. The overall best practice approach is described in the Exhibit below and is similar to the approach adopted by Ofcom, the United Kingdom telecoms regulator. The first two steps evaluate whether there is congestion or excess demand for the frequency in question in either its current or an alternative use. If there is no congestion or excess demand the spectrum fees are based on an allocation of the costs of spectrum management incurred by the regulator.

13.5.2. Where congestion or excess demand exists then the scope for using a market-based mechanism, usually an auction, is considered. If a suitable auction can be designed, then the price of spectrum access is determined by auction although cost-based spectrum usage fees will also be applied. The use of an auction can ensure that spectrum is assigned efficiently. However, over the duration of the typical licence term the most efficient use may change. The presence of spectrum trading will continue to provide an incentive for spectrum to move to its most efficient use by creating a market-based opportunity cost for current users.

13.5.3. When it is not possible to design a suitable auction, or the spectrum has already been assigned but is congested, then spectrum fees are determined by applying Administered Incentive Pricing. The use of AIP seeks to replicate the outcome of a market-based approach to encourage spectrum to be used efficiently.

Exhibit 17:Best practice approach to spectrum pricing



Source: Coleago

Proposal 23: Coleago proposes that BOCRA adopts this decision tree approach to spectrum pricing decisions.

13.6 Assessing excess demand and congestion

Excess demand and congestion

13.6.1. Congestion and demand have both a frequency and geographic dimension and possibly a time component. Spectrum assigned on an exclusive basis provides users with the right to transmit on a specified set of frequencies. These frequencies may be specified in the licence (e.g. mobile, fixed wireless access) or may be implicit in the nature of the service licensed such as maritime VHF. The licence may also provide the licensee with the rights to use the spectrum in either a particular coverage area or along a defined route in the case of point-to-point licences. In some cases, the frequencies may only be heavily utilised at certain times during the day or during particular events (e.g. in the case of Programme Making and Special Events).

13.6.2. In terms of supply, each frequency band and location will typically have a finite capacity to support transmissions of a given type at any point in time. The limit to the number of users that can be accommodated in any given band and area will be largely determined by the need to keep interference to an acceptable level.

13.6.3. Demand for spectrum is not evenly distributed across frequencies and time. Certain frequencies are more in demand than others due, for example, due to their superior propagation characteristics. The inclusion of certain frequencies within internationally harmonised standards, such as those of 3GPP, can also increase their demand.

13.6.4. The level of demand may also differ by geography. Typically, more densely populated areas tend to experience greater demand than more sparsely populated areas. Higher levels of demand can also be experienced along certain routes in the case of point-to-point licences such as along roads or on hills.

13.6.5. The supply of spectrum is finite although the supply of spectrum for a particular use can be increased by re-assigning spectrum from other uses. The introduction of digital broadcasting released frequencies in the 700 and 800 MHz range for mobile use is a good example. Generally, spectrum in lower frequencies tends to be less abundant or more in demand compared to higher frequencies where there is typically more spectrum available and less demand.

13.6.6. Demand can be assessed within its current use as well as in alternative uses. The latter is harder to assess due to the absence of any empirical observations. The usual assessment approach is to consider whether the frequencies in the alternative use are broadly substitutable with the band being assessed. If they are, the approach considers whether the bands in the alternative use are congested and if the band being assessed could be used to mitigate them. If they can be substituted, then AIP is applied to the band being assessed even if there is no congestion in its current use.

13.6.7. Ideally, congestion and demand would be assessed on a frequency-by-frequency and location-by-location basis and spectrum prices set accordingly. However, it is not always practical or proportionate to do so and certain compromises are often required.

Demand for new spectrum assignments

13.6.8. Assessing demand for new spectrum assignments is challenging due to an asymmetry of information between the regulator and users as to the true level of demand. To overcome this asymmetry, a process is required that compels potential users to reveal their demand. A number of regulators (e.g. Norway and Guatemala) adopt a formal process for assessing whether there is excess demand for spectrum to be assigned. A typical process is described below[40]:

a. an applicant reviews the available online database of spectrum assignments;
b. the applicant submits an application for additional spectrum along with an application fee to deter frivolous applications;
c. the application is reviewed by the regulator and considered from the perspective of interference and other current or planned use;

40 The 2010 report commissioned by BOCRA recommended a similar approach be adopted in Botswana

d. if the regulator does not see any obstacles to potentially assigning the spectrum, a public notice is issued highlighting the request for the allocation of additional spectrum and any conditions and fees that would be attached to its assignment;
e. stakeholders have a period of time (typically 20 to 30 days) in which to either challenge the assignment and / or file their own application;
f. challenges are considered and if they are found to be without merit then the regulator examines whether there is excess demand for the available spectrum;
g. if all requests can be met from the available spectrum then there is no excess demand and congestion is unlikely; but
h. if all requests cannot be met from available spectrum then there is excess demand.

Proposal 24: Coleago proposes that BOCRA adopts this approach to assessing demand for new spectrum assignment.

Assessing congestion and demand within existing spectrum assignments

13.6.9. A pragmatic approach to assessing frequency demand is to group frequencies into a number of categories representing different levels of demand. In the UK, for example, Ofcom has created three categories of demand for business radio licences. Historically, frequencies were analysed in terms of their measured channel loading during certain busy hours of the day and classified as heavily congested, congested or not-congested based on the blocking probability (i.e. the proportion of unsuccessful call attempts). Today, Ofcom sometimes relies on its frequency assignment database to examine the number of assignments made in each band relative to available capacity to identify whether each band is more or less congested. Frequencies are now classified as Highly Popular, Medium Popular or Less Popular.

13.6.10. In terms of geographical congestion, Ofcom, for example, identifies three different location types – High Population, Medium Population and Low Population. This area of the UK is classified into these three categories based on a 50 km by 50 km grid.

13.6.11. In the case of fixed links, it was originally recommended that specific geographic sites should be considered congested if more than a certain percentage of the available spectrum had been assigned. However, on a fixed links site, it is not unusual for most links to point in the same azimuth[41] directions along the main trunk routes, with few or no links pointing in other directions. Hence, while a site might be highly congested in a certain direction, other directions might be uncongested. Consequently, Ofcom does not include a geographic component in setting spectrum prices for fixed links.

Proposal 25: BOCRA should adopt a flexible and varied response to assessing congestion with assigned frequencies including reference to its spectrum assignment database as well as assessing reports of congestion from stakeholders.

13.7 Spectrum pricing in the absence of excess demand

13.7.1. Spectrum is scarce when there are competing uses and users of spectrum and there is insufficient spectrum to meet all the demands when the price of spectrum is zero. However, not all spectrum is scarce. There are some frequency ranges for which there are limited uses and so demand is low. There are other frequencies, such as those identified as IMT bands for mobile use, where demand is typically higher and can exceed the spectrum available. The degree of excess demand depends on a range of factors including the number of competing users and the size of the market. In a market such as Botswana, with a relatively small population and three mobile operators, there may not necessarily be excess demand for certain IMT frequency bands, especially higher frequencies where bandwidths are considerably wider.

41 The direction of a celestial object from the observer, expressed as the angular distance from the north or south point of the horizon to the point at which a vertical circle passing through the object intersects the horizon

13.7.2. When a spectrum frequency band is not scarce it means that all the demands for spectrum can be met from the available resources. This implies that when assigning spectrum to one user, no other user is deprived of access. In other words, the assignment of spectrum does not impose a cost on others - the spectrum does not have an opportunity cost. When spectrum is not scarce the regulator does not need to consider what else could be done with the spectrum and what value is foregone from assigning the spectrum to one user rather than another. Socio-economic welfare is therefore maximised by assigning spectrum in abundant supply to anyone that can create value from the spectrum.

13.7.3. At the margin, socio-economic welfare would potentially be maximised by assigning spectrum to a user who generates only one dollar in value from employing that spectrum. However, the management of that spectrum by the regulator generates a cost and so in order for the net socio-economic welfare to be maximised the value generated by the user must at least cover the costs of managing the use of that spectrum. Therefore, best practice proposes that when spectrum is not scarce, the price of spectrum should be set such that the costs of managing that spectrum are recovered from the user of the spectrum.

13.7.4. Ideally, a regulator would be able to identify perfectly the incremental costs associated with managing each MHz of spectrum and price spectrum accordingly. In practice this is not possible and so the costs of spectrum management, including indirect or common costs, must be allocated across the different frequency ranges. However, frequencies are not all equally valuable and so if the costs of spectrum management are allocated uniformly across all frequencies then there may be cases where the apportioned costs exceed the value generated from the spectrum resulting in a loss of efficiency. The allocation of spectrum management costs should therefore take account of the value of spectrum to ensure that spectrum prices do not result in a loss of efficiency.

13.7.5. In summary, when there is no spectrum scarcity the price of spectrum should reflect only the costs of spectrum management. As a precaution, the costs should be allocated in such a way to take account of the value of the spectrum so as to avoid any risk of inefficiencies arising from pricing spectrum too high resulting in valuable spectrum lying idle.

Proposal 26: When there is no spectrum scarcity the price of spectrum should reflect only the costs of spectrum management.

13.8 Spectrum management cost-based spectrum prices

13.8.1. Fees based on spectrum management costs require the regulator to identify the relevant costs associated with managing spectrum and determine an appropriate allocation model that does not lead to distortions in spectrum assignment.

13.8.2. Spectrum management encompasses a wide range of activities including the costs of issuing licences, maintaining data, spectrum monitoring and enforcement activities as well as planning and coordination, including at the international level. Given the broad range of activities of the spectrum management role, a broad set of costs should be considered when determining the total costs of managing spectrum.

13.8.3. Some costs are specific to a specific service, frequency or group of frequencies and where there is a direct link between certain spectrum management activities and specific frequencies these are called 'direct' costs. Examples of direct costs include specific band planning, consultations on the assignment of a particular set of frequencies and the design and implementation of the assignment process. However, there are other costs which are common to all frequencies such as the cost of renting office space in which the regulator is based or membership of international institutions such as the ITU. These common costs cannot be directly linked to a specific frequency or frequency range and so are usually referred to as 'indirect' costs. For most regulators the 'indirect' costs represent the largest proportion of the total costs of spectrum management.

13.8.4. Regulators adopt a wide range of different approaches for allocating costs to spectrum and service licences and the determination of prices. These approaches include:

a. charging spectrum users and licensees only for the identifiable, direct costs they generate and ignoring the more challenging indirect costs;
b. developing detailed costing models which seek to apportion direct and indirect costs to spectrum users in relation to the level of activity and cost they generate within the spectrum management function of the regulator (the approach adopted by Ofcom in the UK);
c. applying simple "rules of thumb" such as charging a percentage of a licensee's turnover; and
d. developing a set of usage fees which are related to a cost driver such as the number of devices or, more commonly, the amount of bandwidth allocated.

13.8.5. Developing cost models for allocating direct and indirect costs can be complex and costly in itself. This approach is not commonly adopted and only large regulators such as the UK's Ofcom follow this approach. Charging for only direct costs has the merit of being simpler to implement although tracking all direct costs is not without its challenges. However, ignoring the dominant indirect costs means that spectrum users are not confronted with the full costs of the activities they generate within the regulator.

13.8.6. Another approach is to consider the nature of the frequencies when apportioning costs. For example, lower frequency bands tend to travel further and higher frequency bands. Lower frequencies are therefore more likely to result in interference, incurring higher spectrum management and enforcement costs.

13.8.7. A great many regulators are not explicit about the basis upon which their spectrum usage fees are based. Nearly all regulators use one or more formulae for setting spectrum usage fees, however, they are not explicit about the value element of the formulae. Regulators often state that their formulae reflect the costs of spectrum management, but they also sometimes state they are designed to provide an incentive for spectrum to move to its most efficient use by introducing an element of opportunity cost. Very few regulators however provide any justification for their estimates of value or opportunity costs. In contrast, the UK, Australia and Hong Kong explicitly model and estimate opportunity cost.

13.8.8. There is no well-defined view of what constitutes best practice in terms of spectrum management cost allocation which would be relevant for smaller and medium sized regulators that do not have the resources of regulators such as Ofcom. This consultation therefore defines best practice as allocating both direct and indirect spectrum management costs to all spectrum users by using an approach which best approximates the cost drivers within the regulator. The approach should also take into account the difference in value between frequencies in order to avoid the risk of introducing distortionary effects.

Proposal 27: BOCRA should seek to recover both direct and indirect spectrum management costs.

Cost recovery

13.8.9. Regulators also need to consider what is the appropriate level of cost recovery. The regulator can choose from three levels of spectrum management cost recovery:

a. partial costs recovery resulting in the regulator requiring revenue from government general revenues;
b. full cost recovery that may mean the regulator is financially self-sufficient; or
c. fee revenues exceed spectrum management costs and the surplus is contributed to other regulatory programmes or government general revenues.

13.8.10. Coleago proposes that BOCRA seeks to fully recover the costs of spectrum management so that those that benefit from the private use of that spectrum also face the full costs that BOCRA incur in ensuring that the spectrum is valuable, e.g. free of interference, assigned on a coordinated basis, etc. Such an approach is consistent with BOCRA's value of transparency and may also be regarded as more equitable. Ensuring that the use of spectrum also generates sufficient value to cover the costs of managing the spectrum in the first place is also consistent with the goal of the efficient use and management of spectrum. In addition, Coleago agrees with the 2008 proposal, which was adopted by BOCRA, to introduce spectrum fees to previously exempt users of spectrum.

Proposal 28: BOCRA should seek to fully recover the costs of its spectrum management activities from all spectrum users.

13.9 Market based approaches to assignment and pricing

13.9.1. Spectrum is scarce when demand exceeds available supply at a spectrum price of zero. When spectrum is scarce, assigning spectrum to one user deprives another user of that spectrum creating an opportunity cost - the value that could have been generated from the alternative use of the spectrum. Market based approaches allow competitive forces to determine the allocation and price of spectrum. A well-designed and competitive market-based assignment process, assuming that the post assignment market is sufficiently competitive, can result in spectrum being assigned efficiently at a price which reflects the opportunity cost of the spectrum. Market-based approaches can be used to assign and price spectrum when it is first available (e.g. through auction) as well as providing continuing incentives for spectrum to be deployed efficiently (e.g. through spectrum trading).

13.10 Administered Incentive Pricing

Limitations of market mechanisms

13.10.1. Generally, market mechanisms should be used where demand exceeds supply, and the costs of running an auction would not outweigh its benefits. Even when these conditions are met, there are a number of reasons why market mechanisms may not achieve the objective of efficiency. For example:

a. duration of the licence: it is generally simpler and more efficient to administratively allocate shorter term licences;

b. coordination problems: auctions may prevent larger numbers of small users being able to express their demand for spectrum (for example, in the case of regional bidders and larger national bidders competing for spectrum auctioned on a regional basis); and

c. the desire for continuity: auctions may increase uncertainty for incumbent spectrum holders and may reduce incentives for long-term investment.

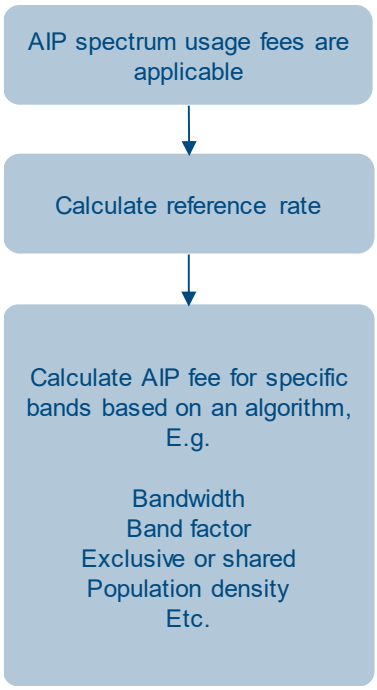
13.10.2. If spectrum has already been assigned through administrative approaches such as First Come, First Served then the original assignment may not have been efficient. Even where spectrum was originally assigned on the basis of a market mechanism, technological change may mean that the original assignment is no longer efficient. If spectrum trading is not permitted or not possible (for example, due to competition concerns) then there is no continuing incentive for spectrum to move to its most efficient use. Even where spectrum trading is permitted it can take considerable time for a well-functioning secondary spectrum market to develop. Governments and regulators in many countries have responded to the need to provide an effective mechanism to promote long term efficiency by introducing Administered Incentive Pricing.

Overview of AIP

13.10.3. Administered Incentive Pricing (AIP) is an approach adopted by a number of regulators which uses administratively determined prices to provide incentives for spectrum to be used efficiently. AIP seeks to mimic the outcome that would be achieved were spectrum to be assigned based on the use of some form of market mechanism. The regulator seeks to estimate what the opportunity cost or price of spectrum would be in a competitive, efficient market and then charges that price to the users of spectrum. Inefficient users of spectrum would be incentivised to relinquish their spectrum holdings which would then be re-assigned to efficient users.

13.10.4. The process of implementing AIP is presented in the Exhibit below.

Exhibit 18: Implementing AIP



Source: Coleago

13.10.5. The typical process for implementing AIP involves first establishing a reference rate. The reference rate represents the market value or opportunity cost of the spectrum band. As it is not practical to estimate a reference rate for every specific frequency and each individual assignment, an algorithm is used to adjust the reference rate to reflect the characteristics of different frequencies and individual assignments. The more closely the reference rate reflects the characteristics of the specific frequency and assignment, the better AIP will mimic the outcome of a market-based approach to spectrum pricing.

13.10.6. The process of developing AIP is simple in theory but presents significant practical challenges. The greatest challenge is developing appropriate reference rates as these must reflect the opportunity cost or market value of the spectrum. The regulator is forced to confront the asymmetry of information in relation to spectrum values and the incentives of users to misrepresent the value of spectrum. Many regulators adopt administered pricing regimes that resemble or claim to achieve the same outcomes as an AIP approach however, they often are not explicit about the way in which the reference rates are established. Where regulators are explicit about their approach to estimating reference rates, they commonly adopt one of two approaches - spectrum value benchmarking and cost modelling.

Opportunity cost modelling

13.10.7. A number of different approaches are adopted by regulators when seeking to estimate opportunity cost through a cost modelling exercise. The United Kingdom regulator, Ofcom, has a long track record in implementing AIP and typically relies upon two approaches – the Least Cost Alternative (LCA) approach and Discounted Profit (DP) method.

Least Cost Alternative

13.10.8. This approach is used when estimating the opportunity cost of spectrum in its current use. The approach was first developed by Smith NERA[42] in 1996 and was subsequently refined by Indepen, Aegis and the Warwick

42 Smith NERA. Study into the Use of Spectrum, Report for the Radiocommunications Agency (1996)

Business School[43]. Ofcom have applied the approach to all spectrum licence classes. A similar approach is adopted by the New Zealand regulator.

13.10.9. The LCA approach considers how a reasonably efficient representative provider of a service responds to the loss of a small block of spectrum in the frequency band being considered. The approach estimates the minimum additional cost that the user would incur in order to maintain output at the same level. The additional costs could include investing in additional infrastructure, substituting with an alternative spectrum frequency band or switching to an alternative technology. The definition of the "representative provider" has to be developed with care when there are significant differences between users. Estimates are sensitive to assumptions regarding alternative equipment costs, useful economic lives and the discount rate used to convert the stream of future costs into an equivalent annual Spectrum Usage Fee.

13.10.10. If the block of spectrum were to be traded, a rational bidder would not be prepared to pay more than the cost of providing the same level of output through the most cost effective, alternative means. Provided that bidders have an alternative to providing the capacity the approach provides an estimate of the price that would be achieved were the spectrum to be traded. The LCA approach effectively measures the value of a block of spectrum in terms of the market prices of other inputs that can be substituted for it while maintaining output constant. In practical terms, the approach involves estimating the value of a (marginal) block of spectrum under each of the alternatives. The difference between the cost of providing the service at current levels, and that of the least cost alternative, is the value in existing use.

The Discounted Profit method

13.10.11. This approach is identical to the approach adopted by users when valuing spectrum prior to participating in an auction. Users develop and value a business case assuming they acquire the marginal block of spectrum and compare it with an alternative case where they assume that they do not acquire it. The delta between the two business cases represents the value of the spectrum. The key difference with the LCA approach is that the level of output under the two scenarios may not be the same. Where it is not reasonable to assume that a user would maintain output at a constant level the DP method is used.

13.10.12. The LCA method is relatively simple and practical to implement compared to the DP approach. The former avoids the need to make judgements about the impact of incremental spectrum on customers, capacity and revenues and therefore may be regarded as more objective. However, both approaches cannot fully overcome the asymmetry of information in relation to spectrum values and therefore any estimates of spectrum value have to be treated with considerable care. Ofcom recognises the limitations of this approach and writes:

"*Both methods have similar drawbacks, based on the fundamental problem of estimating costs (and revenues) on behalf of operators who would, in an efficient market, determine these in response to their own circumstances and information. Any cost-based methodology will always be second best compared with spectrum values determined by an efficient market. They can be very sensitive to the assumptions used, such as those concerning equipment lifetime, equipment costs, nature of the average user or the discount rate. Cost-based estimates will typically yield a range of possible values and we will have to exercise a degree of judgement when choosing the appropriate level of fees to apply given the range of values produced by the chosen method*[44]"".

13.10.13. Ofcom's comments recognise the challenges of overcoming the asymmetry of information between users and regulators in relation to the value of spectrum. Any estimate of spectrum value, by benchmarking, cost modelling or any other method, should be treated with care.

13.10.14. The main advantages of a modelling approach are:

a. it can be used for frequencies where there are limited available benchmarks; and

b. it is market and frequency specific and can capture the unique elements of the market and any specific licence conditions.

13.10.15. The approach, however, is not without its challenges. The key issues with this approach are:

a. it cannot fully eliminate the asymmetry of information between the operator and the regulator;

43 Indepen, Aegis Systems and Warwick Business School. An Economic Study to Review Spectrum Pricing (2004)
44 Ofcom, Appendix A: Our current practice in setting AIP fees, March 2010

b. the approach requires spectrum valuation and modelling expertise which the regulator may not possess in-house although working with a specialist adviser can address this challenge; and

c. the task is potentially more time consuming and costly to perform compared to other approaches.

13.10.16. The use of cost modelling is likely to represent best practice for large, well-funded regulators although validating the results of the modelling exercise with benchmark information will increase the confidence in the estimates. For other regulators benchmarking is likely to provide the best approach for estimating spectrum values for key bands such as 700, 800, 900, 1800, 2100, 2600 and increasingly 3500 MHz. These bands can also be used to infer the value of other, similar bands that are regarded as close substitutes. However, given the significant welfare costs imposed by setting spectrum prices too highly, resulting in spectrum lying idle, regulators should be conservative and consider setting reference prices at the low end of their valuation range.

Spectrum value benchmarking to estimate reference prices

13.10.17. A regulator seeking to infer the value of a frequency band from observed market-based transactions will first consider whether suitable transactions have taken place in their own market. Useful valuation information can be derived from previous auctions for similar bands or through observed market transactions (trades) for spectrum assets. Often however there are no or very few suitable transactions from which to infer spectrum values on a reliable basis.

13.10.18. Regulators can consider the use of auction information from other markets for spectrum in the same (or a similar) band to provide information on the value of spectrum in order to set reference prices. How useful the information is will depend on a number of factors, namely:

a. whether the auction was designed to achieve an efficient allocation of spectrum or to support other policy objectives such as maximising revenue;

b. whether the auction exhibited the necessary level of competitive tension to ensure that the resulting outcome was efficient;

c. whether the spectrum that was auctioned provided new entry opportunities, the ability to launch new technology or additional spectrum for existing networks;

d. whether the structure of the auctions and the spectrum being auctioned provides information on the valuation of the marginal excluded user; and

e. whether the market environment in which the auction took place closely matches the forward-looking environment for which the regulator is seeking to establish reference prices.

13.10.19. The benchmarking process is relatively simple, and typically follows the steps below:

a. Step 1: Collect auction price information for spectrum from other relevant markets;

b. Step 2: Make adjustments to increase the relevance of the benchmarks;

c. Step 3: Use the adjusted price information to determine the price for spectrum in the regulator's market; and

d. Step 4: Convert the lump-sum auction price into an equivalent annual spectrum usage fee using an appropriate weighted average cost of capital or WACC.

13.10.20. An alternative approach to spectrum auction benchmarking is to benchmark spectrum reference rates against the reference rates used by other regulators in similar markets. The key challenge in this approach is that the majority of regulators in similar markets to Botswana are not explicit about the approach they adopted for setting reference prices. There have been relatively few successful spectrum auctions in Africa and so Africa specific spectrum auctions are unlikely to have provided the basis for reference rates in Africa. Coleago is not aware of any African regulators who have conducted some form of cost modelling AIP exercise. Coleago's expectation is therefore that reference rates used by other African regulators are unlikely to be based on robust, local estimates of the value or opportunity cost of spectrum.

13.10.21. Coleago believes that regulators in Africa, in setting reference rates, are possibly in a mutually reinforcing process whereby reference rates are set based on a comparison with other reference rates, none of which reflects the opportunity cost of spectrum. Such reliance is therefore unlikely to support BOCRA's policy

objectives and BOCRA has the opportunity to break the cycle and seek to establish reference rates which reflect the opportunity cost of congested or high demand spectrum. Later in this consultation, Coleago proposes the use of spectrum auction benchmarking where possible to seek to establish reference rates which reflect opportunity or market values.

13.10.22. In the case of frequencies where there are very limited, or no benchmarks available additional care should be exercised. Regulators have the choice of inferring the value of other frequencies by adjusting more robust valuation estimates by a frequency factor to reflect the propagation characteristics of the band in question or performing a specific modelling exercise. Most regulators typically adopt the former strategy. A potential approach to determining the appropriate adjustment factor is to consider the relative values of the frequencies estimated by regulators who have undertaken detailed modelling exercises. Whilst the absolute valuation levels will not be relevant, the ratio of estimated values could provide useful information for other regulators. Once again however, significant care should be taken, and the regulator should be conservative in setting prices.

Proposal 29: BOCRA should use relevant spectrum auction benchmarks with appropriate adjustments for setting reference rates where possible. The results of benchmarking should be discounted to reduce the risk of spectrum prices being set at too high a level. Where auction benchmarks are not available then benchmarks from other markets which have made explicit attempts to estimate the opportunity cost of spectrum should be used, subject to appropriate adjustments.

AIP algorithm factors

13.10.23. Once the reference rate has been established it is used to calculate Spectrum Usage Fees for individual spectrum licence holders based on their actual spectrum holdings. In order to translate the reference rate into Spectrum Usage Fees, two sets of adjustments have to be made:

a. the first set reflects the effective amount of spectrum denied to others by the individual licensee; and
b. the second set captures variations in the value of spectrum being priced, relative to the value of the band and location on which the Reference Rate is based.

13.10.24. A very common approach adopted by regulators is to use formulae or an algorithm to determine the prices charged for individual spectrum assignments. The principle behind the formulae is to identify relevant, objective technical parameters that combined, measure the quantity and value of spectrum denied to others. The algorithm also seeks to identify the “area sterilised” by interference which prevents others from using those frequencies in the same vicinity.

13.10.25. The complexity of the formulae or algorithms used by regulators varies significantly as does the number of different formulae adopted to cover the range of frequencies subject to AIP. The more comparable the spectrum that was used to generate the reference rate is to the spectrum to be priced, the less complex the formulae need to be. A wide range of factors are often included within the formulae. Typical factors are:

a. reference rate / price / fee or value;
b. bandwidth;
c. frequency band;
d. area sterilised;
e. geographical area / location;
f. minimum hop length;
g. exclusive rights or sharing;
h. relative levels of supply and demand;
i. duration;
j. service factor; and
k. inflation.

13.10.26. Whilst all regulators will endeavour to ensure that AIP fees represent the best estimate of the opportunity cost of spectrum, it is important to recognise that these estimates will be subject to error. As the welfare loss imposed by setting too high a spectrum price resulting in spectrum being left idle is likely to be greater than the welfare loss of spectrum not being in its most efficient use, regulators should exercise caution in determining the final AIP fees. Regulators should opt for setting lower rather than higher fees when there is uncertainty over the accuracy of the reference rate.

13.10.27. The estimate of the opportunity cost implied by the reference rate reflects a single point in time. As technology evolves, the opportunity cost of spectrum is likely to change, and so reference rates and AIP algorithms will need to be periodically reviewed. Regulators however need to provide a balance between providing spectrum users with certainty over spectrum fees and ensuring the spectrum remains in its most efficient use. Regulators should therefore monitor technological developments and conduct a periodic review probably every three to five years.

Proposal 30: BOCRA should generally adopt the simplest possible algorithm for adjusting the reference rate to set specific spectrum usage fees.

13.11 Sunk costs and decision making

13.11.1. A key role of spectrum pricing is to ensure that spectrum is used by those that generate the greatest socio-economic value from its use. If the retail market is competitive then private values should provide a reasonable guide as to the relative socio-economic values generated by each user. For a given amount of spectrum, the operator with the highest value is likely to be using the spectrum most efficiently. A key driver of value is revenue and so if spectrum is priced based on a proportion of turnover then efficient users are being penalised and charged more than inefficient users. Spectrum fees based on turnover are therefore not consistent with seeking to allocate spectrum efficiently.

13.11.2. The pricing of services and investment decisions are usually analysed "at the margin" or on an incremental basis. This means that when setting the prices for services operators will consider the marginal or incremental cost and marginal or incremental revenues associated with their pricing decisions. Similarly, when making investment decisions in new services or additional sites for example, operators will consider the incremental revenues and costs associated with the new investment. Given the key role that marginal costs play in decision making it is therefore preferable to price spectrum in such a way that it does not influence marginal costs.

13.11.3. If spectrum is priced based on a proportion of turnover, then the cost of spectrum impacts the marginal cost of services and investments as each marginal increment in revenue arising from a decision also leads to a marginal increase in spectrum costs. This can be distortionary and lead to higher prices for services if services are priced at their marginal cost. It may also deter additional investment as the investment will yield a lower net benefit for the business which will cause a firm to reject marginal investment decisions. In order to avoid such distortionary effects, spectrum pricing should be linked to the value of the spectrum or the cost of spectrum management, rather than revenues.

13.11.4. Economists generally assume that "sunk costs" are irrelevant for future decision making. Sunk costs are those costs which have already been incurred and cannot be recovered. Regulators have historically assumed that spectrum users ignore sunk costs when deciding on future pricing and investment decisions. This has led some regulators to seek to charge high spectrum prices in the belief that it will have no or limited impact on consumer prices or the levels of future investment. In response to the trend towards setting higher spectrum prices economists have developed arguments that challenge the conventional wisdom. NERA[45] present a number of arguments that suggest that spectrum users take spectrum prices into account when making future investment and pricing decisions. The arguments included experiments from the discipline of behavioural economics which revealed that managers do include elements of sunk costs in pricing decisions.

13.11.5. Regulators should ensure that spectrum costs are structured in such a way that operators regard them as "sunk". However, regulators should be aware that a relationship may exist between spectrum costs, investment and pricing and consider whether the absolute levels of spectrum fees could be detrimental to future investment or

45 NERA. The Impact of High Spectrum Costs on Mobile Network Investment and Consumer Prices (May 2017)

consumer welfare. Generally, where possible, spectrum fees should not be related to revenues so as to avoid any distortionary effects on consumer pricing or investment decisions.

13.12 Best practice spectrum pricing

13.12.1. Best practice can therefore be summarised as follows:

a. spectrum which is not congested or does not face excess demand should be priced based on an allocation of spectrum management costs;

b. where excess demand or congestion is present, market-based mechanisms should be used to assign spectrum and to determine the spectrum access fee, subject to on-going cost-based spectrum usage fees;

c. spectrum trading should be facilitated to provide ongoing market-based incentives for spectrum to move to its most economic use;

d. where spectrum is congested or faces excess demand, but a suitable market-based mechanism cannot be utilised then spectrum should be priced based on some form of Administered Incentive Pricing;

e. when implementing AIP:

   i. select reference rates which are based on spectrum bands which are as similar as possible to the frequencies subject to the AIP algorithm;

   ii. formulate an algorithm which is as simple as possible, and which best relates the reference rate to the spectrum subject to AIP (for example, avoid including multiple factors that seek to achieve the same objective);

   iii. avoid algorithms that create significant variations in price between similar frequencies;

   iv. are set conservatively; and

   v. are subject to periodic review.

Section 14. Spectrum Pricing - Current Situation

14.1 Overview

14.1.1. In this section, Coleago provides an overview of the current spectrum pricing regime Botswana. Coleago also presents the current level of spectrum management costs and the revenues generated by BOCRA. This section also provides the result of BOCRA's assessment of current levels of demand and congestion within Botswana.

14.2 Current spectrum fees

14.2.1. The current spectrum fees were established in 2008. The current spectrum fees applicable in Botswana are presented in Annex C.

14.3 Spectrum management revenue and cost review

BOCRA spectrum management costs

14.3.1. BOCRA has provided details of its full spectrum management costs for 2017 and 2018, based on its audited accounts, and which are presented below.

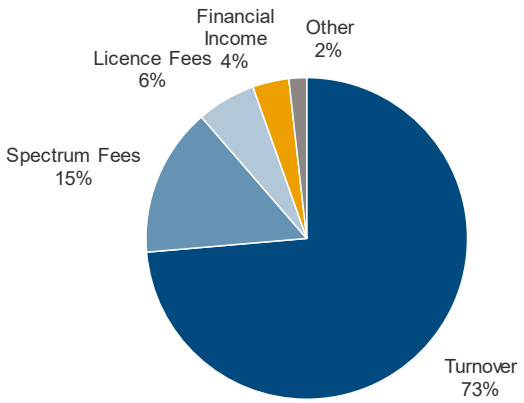
- 2017: Pula 24,975,632
- 2018: Pula 25,865,394

Proposal 31: BOCRA should continue to estimate the full direct and indirect costs associated with spectrum management activities on an ongoing and annual basis.

BOCRA current income

14.3.2. BOCRA revenues in 2018 were Pula 139,118,682 and are generated primarily by turnover fees from BTC, Mascom and Orange. A charge of 3% of turnover is made. Spectrum fees account for only 15% of BOCRA's total revenue. The breakdown on BOCRA's revenues and income are presented below.

Exhibit 19: BOCRA 2018 income



Source: BOCRA

14.3.3. The total spectrum fees reported by BOCRA for 2017 and 2018 are:

- 2017: Pula 18,102,296
- 2018: Pula 20,844,430

14.3.4. It is interesting to note that the current fee structure generates spectrum fees that were 81% of BOCRA's spectrum management costs in the same year. BOCRA has not increased spectrum fees since they were first established in 2008. If BOCRA had applied an inflation factor to licence fees, then the current fees would be 69% higher than current levels.

14.3.5. During the period 2008 to 2018 the Botswana population has increased from 1,995,000 to 2,335,000, an increase of 29.7%. If this change in the population were also applied the current fees schedule this would increase fees further.

14.3.6. If the increase in population and the inflation adjustment is applied to the current fee structure the spectrum related fees for 2018 would be:

a. 20,844,430 x 1.69 x 1.297 = 45,689,531 an increase of 119% over 2008 price levels. Spectrum fees at this level would represent a significant over recovery of BOCRA's spectrum management costs.

14.3.7. The current fee levels however result in an under recovery of the costs of spectrum management.

14.4 Congestion and excess demand

14.4.1. Botswana is a relatively small country with a small population and historically has not suffered from congestion in allocated spectrum frequencies. However, as the current spectrum pricing regime does not incentivise spectrum users to use their frequencies efficiently, BOCRA reports that some frequencies are now experiencing congestion.

VHF (136 - 174 MHz)

14.4.2. This band is mostly used by the security, transport and construction industry. There are provisions within the radio licence to compel users to share frequencies, but the historical norm is for each applicant to be assigned

a new channel. Today, there is insufficient spectrum to maintain this practice and only shared use is possible. BOCRA now receives regular complaints regarding interference in this band.

Fixed links

14.4.3. The current pricing regime (see Appendix) charges a flat fee per link irrespective of bandwidth. The fee is Pula 300 for links below 28 GHz and Pula 250 for links above this level. The current pricing regime does not provide any incentive for the efficient use of spectrum. Consequently, applicants typically request frequencies in the 28 GHz range which are now facing congestion. Congestion in 28 GHz is likely to result in congestion occurring in other bands, especially as data services continue to grow. Frequencies in the 18 GHz range are also likely to face congestion according to BOCRA.

Mobile and FWA spectrum bands

14.4.4. The results of a large number of spectrum auctions, spectrum transactions and the market capitalisation of mobile and FWA operators demonstrate the value of frequencies used by mobile and FWA providers. If operators in Botswana were to be deprived of these key frequencies, they would all suffer a significant additional burden. Similarly, were these frequencies to be re-assigned from one user to another, they would be credited with a material valuation by the recipient. The current spectrum pricing regime does not reflect the value of the following bands:

a. 900 MHz;
b. 1800 MHz;
c. 2100 MHz;
d. 2400 MHz;
e. 2600 MHz; and
f. 3500 MHz.

14.4.5. As the current pricing regime does not reflect the value of the bands, the regime provides limited incentives for the frequencies to be used efficiently.

14.5 Comparison with best practice

14.5.1. Spectrum usage fees are reasonably close (81%) to the costs of spectrum management provided by BOCRA. In the absence of excess demand, the current spectrum pricing regime reflects best practice in that spectrum prices reflect only the cost of spectrum management (albeit with some under-recovery). The relative level of prices for different services has not resulted in any re-distributive effects and therefore suggests that the relative levels of prices are broadly appropriate.

14.5.2. The majority of the charges made for spectrum are made indirectly through the charge of 3% of turnover. Revenue based charging can have distortionary effects on pricing and investment decisions and so a rebalancing of pricing away from revenue, towards the opportunity cost of spectrum, would be less distortionary and a move towards best practice. Revenue based charging also penalises those operators who are using the spectrum most efficiently.

14.5.3. BOCRA has reported that certain frequencies are becoming increasingly congested. These include frequencies for fixed links as well as certain VHF frequencies. In the presence of excess demand, the spectrum prices will need to reflect opportunity cost or market value if they are to ensure that spectrum is used efficiently.

14.5.4. The current reference rates used for spectrum pricing are based on historical precedent and do not reflect the market value or opportunity cost of spectrum. As a result, the current spectrum pricing regime provides limited incentive for the efficient use of spectrum. The absence of spectrum pricing differentials for different frequencies or for the amount of bandwidth further limit the incentives for the efficient use of spectrum.

Section 15. Spectrum Pricing - Results of Initial Consultation

15.1 Introduction

15.1.1. BOCRA has conducted an initial consultation on general spectrum management issues which included pricing.

15.2 Review of stakeholder responses

15.2.1. From the responses received only five stakeholders commented on the spectrum pricing and associated issues highlighted in the consultation. The views of stakeholders were mixed.

15.2.2. Three stakeholders believe that the description of the demand assessment process provided in the 2008 proposals should be maintained. One stakeholder commented that the process is time-consuming and that a First Come, First Served approach should be used. Coleago notes that the proposed process set out in 2008 for demand assessment has not actually been implemented.

15.2.3. The views on the use of auctions was mixed with some stakeholders in favour and others against.

15.2.4. Stakeholders who commented were generally supportive of the spectrum pricing decision tree. Amongst those that commented, all agreed that spectrum management costs should be fully recovered.

15.3 Summary of key findings

15.3.1. The number of respondents who addressed spectrum pricing issues are too few to provide a coherent view of the beliefs of stakeholders in Botswana. Views varied in relation to spectrum pricing approaches.

Section 16. Spectrum Pricing - Proposals

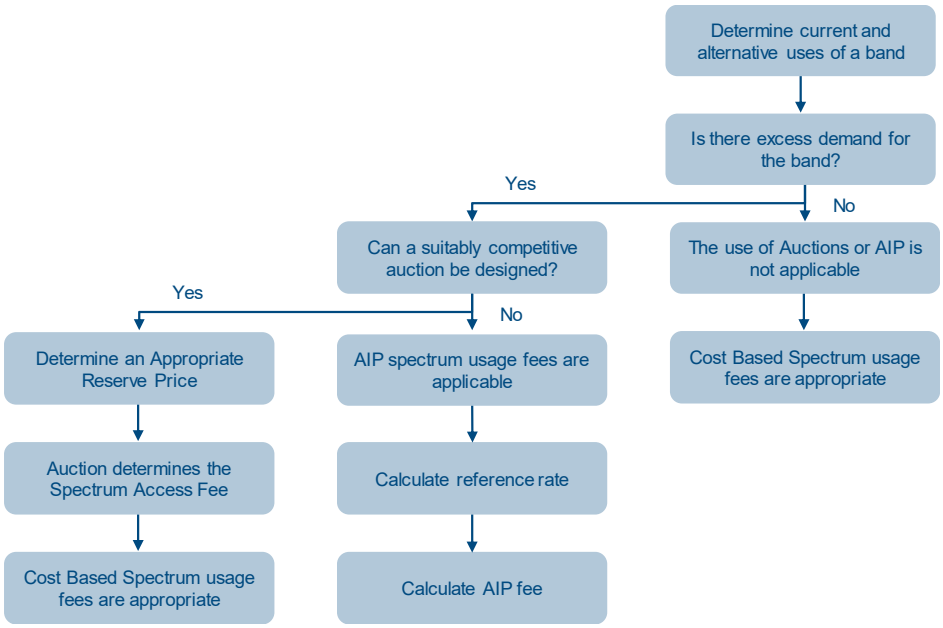
16.1 Introduction

16.1.1. In this section, Coleago applies the proposals developed earlier in this consultation to the situation in Botswana. The section begins by describing the overall approach to spectrum pricing and then provides detailed explanations of each aspect of the approach.

16.2 Overall approach to spectrum assignment and pricing

16.2.1. Coleago's recommended, overall approach to spectrum pricing and assignment is presented in the Exhibit below and expanded on in detail below.

Exhibit 20: Recommended approach to spectrum pricing



Source: Coleago

16.3 Assessing excess demand for new spectrum assignments

16.3.1. The recommended approach for new spectrum assignments is described below:

a. an applicant reviews the available online database of spectrum assignments;
b. the applicant submits an application for additional spectrum along with an application fee to deter frivolous applications;
c. the application is reviewed by the regulator and considered from the perspective of interference and other current or planned use.
d. if the regulator does not see any obstacles to potentially assigning the spectrum, a public notice is issued highlighting the request for the allocation of additional spectrum and any conditions and fees that would be attached to its assignment.
e. stakeholders have a period of time (typically 20 to 30 days) in which to either challenge the assignment and / or file their own application.
f. challenges are considered and if they are found to be without merit then the regulator examines whether there is excess demand for the available spectrum.

g. if all requests can be met from the available spectrum then there is no excess demand and congestion is unlikely.
h. if all requests cannot be met from available spectrum then there is excess demand.

16.4 Assessing demand and congestion for existing assignments

16.4.1. Coleago proposes that BOCRA adopts a flexible approach to assessing congestion within existing spectrum assignments. The assessment of congestion will comprise:

a. analysing assignments within BOCRA's spectrum assignment database;
b. considering reports of interference and congestion from spectrum users;
c. testing frequency occupation and utilisation with suitable equipment; and
d. any other techniques and approaches which are appropriate for specific circumstances.

16.5 Spectrum pricing in the absence of excess demand and congestion

16.5.1. Coleago proposes that where there is no excess demand for the assignment of new spectrum then spectrum is assigned on an administered basis (see the report on Spectrum Management). In the absence of excess demand or congestion for new assignments or existing spectrum holdings, then the users should be charged an annual Spectrum Usage Fee which reflects the cost of spectrum management.

16.5.2. The current spectrum fees under recover BOCRA's costs of spectrum management by circa 20% and the current fees have not given rise to any reported distortionary effects. BOCRA could consider increasing the cost-based fees by 25% over a period of two to three years to align them with the costs of spectrum management. However, in light of the material changes that are being made to mobile, VHF and fixed link spectrum prices Coleago proposes leaving fees unchanged for frequencies which are not congested or do not face excess demand although they should be subject to inflationary increases.

16.5.3. If BOCRA's spectrum management costs increase significantly in the future, then above inflation increases can be introduced over a period of time to align revenues and costs, whilst retaining the same differentials between fees. Even if BOCRA's spectrum management costs remain constant, BOCRA can consider introducing above inflation increases to align with the existing cost base, although we recommend introducing the VHF, Mobile and Fixed Link changes first as they are more material.

16.5.4. The annual fees should be subject to annual inflationary increases based on the Consumer Price Index (CPI). The increases should be based on the CPI from the preceding year less one, to provide greater predictability over future spectrum prices.

16.5.5. BOCRA should monitor its costs of spectrum management and should review its spectrum management costs and revenues to ensure that the cost-based fees continue to mirror overall costs. When BOCRA experiences an increase or decrease in the costs of spectrum management, then the overall fee structure should be adjusted proportionally to ensure that the differentials in fees are maintained.

Proposal 32: Coleago proposes leaving fees unchanged for frequencies which are not congested or face excess demand other than to apply an inflation-based increase for the coming year.

16.6 Spectrum pricing for new assignments with excess demand

16.6.1. Coleago proposes that where a new assignment of spectrum is likely to face excess demand then, in the first instance, BOCRA considers whether a market-based mechanism can be used to assign and price the spectrum. Such a mechanism is likely to be some form of auction. BOCRA should also consider whether the likely auction proceeds justify the cost associated with implementing such an approach.

16.6.2. The use of a well-designed and competitive auction will promote the efficient use of spectrum and ensure that the price of the spectrum represents its opportunity cost. The auction will determine the level of the Spectrum Access Fee and the winners of spectrum will also be required to pay an annual Spectrum Usage Fee which reflects the cost of spectrum management. The Spectrum Usage Fee should be based on the cost-based fees charged for similar frequencies.

16.6.3. When it is not possible to design a suitable Auction, then an administered allocation should be made (see the report on Spectrum Management) and those assigned spectrum will be required to pay annual Spectrum Usage Fees based on Administered Incentive Pricing (see below).

16.7 General approach to high demand and congested spectrum

16.7.1. Existing assignments of spectrum which are either congested or which are likely to face excess demand, were they to be re-assigned through auction, should be charged on the basis of Administered Incentive Pricing. New spectrum assignments which face excess demand, but where a suitable auction cannot be implemented, should also be charged on the basis of Administered Incentive Pricing. The AIP approach should seek to reflect the opportunity cost of the spectrum to encourage its migration to the most efficient use.

16.7.2. AIP should be implemented as an annual Spectrum Usage Fee calculated based on the general algorithm set out below:

SUF = reference rate x band factor x bandwidth x shared use factor x location factor x inflation index

16.7.3. Where:

a. reference rate: The best available estimate of the opportunity cost or market value of the frequency range subject to AIP.
b. band factor: An adjustment factor that compares the frequency range upon which the Reference Rate was based with the frequency range to be priced.
c. bandwidth: The quantity of spectrum assigned measured in either KHz or MHz on a paired or unpaired basis, as appropriate.
d. shared use factor: A factor to reflect whether the spectrum is assigned on an exclusive or shared basis.
e. location factor: An adjustment to reflect whether spectrum is assigned in densely (urban) or sparsely populated (rural) areas.
f. inflation index: An adjustment based on the Consumer Price Index.

16.7.4. The algorithm result should then be compared to a minimum value and the SUF set at the higher of the result of the algorithm and the minimum value. Coleago proposes that the minimum value be set at Pula 300. The minimum value should be subject to annual, inflationary increases.

Determining reference rates

16.7.5. The reference rate should reflect the opportunity cost or market value of the spectrum subject to the annual SUF. Where market-based information is available in Botswana on the value of spectrum then this should be used to inform the choice of reference rate. However, as no such transactions have yet taken place in Botswana this approach cannot currently be adopted for setting the reference rate. In the future, if auctions or spectrum trading generates relevant information on spectrum values in Botswana, then this information should be used to inform the decision on reference rates.

16.7.6. In the absence of Botswana specific spectrum values, BOCRA should use information from spectrum auctions in other markets. Auction benchmarks should be adjusted in such a way as to make them as relevant as possible for Botswana - for example, by adjusting for differences in relative levels of GDP per Capita on a PPP adjusted basis.

16.7.7. Where auction information is limited then BOCRA should consider using opportunity cost estimates calculated by other regulators in similar frequency bands. Any estimates should be adjusted to increase their relevance for Botswana in the same way that auction benchmarks would be adjusted.

16.7.8. In the absence of any relevant benchmark information to inform the level of reference rates we would recommend introducing above annual inflation increases which are a multiple of current levels of inflation until such time that price levels are such that users migrate to alternative frequencies.

16.7.9. The loss to overall socio-economic welfare of spectrum lying idle is likely to be materially greater than spectrum being utilised but sub-optimally. BOCRA should therefore exercise considerable caution in determining the reference rate and should be conservative, setting a lower rather higher reference rate when there is uncertainty over the market value or opportunity cost of the spectrum.

Determining the band factor

16.7.10. Based on the case studies from a wide range of markets, Coleago proposes the following band factors which are closely aligned with the factors used in other markets.

Exhibit 21: BOCRA band factors

Frequency Range	Band Factor
Below 500 MHz	1.3
500 MHz to 700 MHz	1.0
700 MHz to 1 GHz	1.0
1 GHz to 2 GHz	0.7
2 GHz to 3 GHz	0.5
3 GHz to 5 GHz	0.4
5 GHz to 10 GHz	0.3
10 GHz to 20 GHz	0.2
Above 20 GHz	0.1

Source: Coleago

16.7.11. In the Exhibit below the BOCRA band factors are applied to the frequency groupings used for Fixed Links.

Other factors

16.7.12. Bandwidth: This should be consistent with the units of measure for the Reference Rate. For example, if the Reference Rate is set in terms of a value for 2 x 1 MHz, then the Bandwidth should be set on an equivalent basis.

16.7.13. Shared Use Factor: This factor should be set at 1 for exclusive use and 0.5 for spectrum licensed on a shared basis.

16.7.14. Location Factor: The default value should be 1 for urban areas and can be set to 0.5 for rural areas where appropriate.

16.8 Spectrum pricing for mobile and FWA bands

16.8.1. Coleago proposes setting the reference rate for mobile and FWA bands based on the results of relevant spectrum auctions. Reference rates have been calculated for the following bands:

a. 900 MHz;
b. 1800 MHz;
c. 2100 MHz;

d. 2300 MHz;
e. 2600 MHz; and
f. 3500 MHz.

16.8.2. In order to maximise the sample size, all auction results have been included, including those where spectrum was sold at the reserve price. Including only competitive auctions (those where final auction prices were above the reserve) results in smaller sample sizes and generally higher estimates for spectrum values.

16.8.3. In order to adopt the most conservative approach to estimating spectrum values significant outliers have been removed from the sample of auction outcomes. Coleago has also calculated estimated values based on the median rather than the average as the median places a lower emphasis on values at the extreme ends of the range. The median auction prices are consistently lower than average auction prices.

16.8.4. The results of the auctions were subject to a number of adjustments to increase their relevance to Botswana:

a. auction prices were converted into a US$ / MHz / Population figure based on the local price paid, the amount of spectrum assigned, the population of the country and the exchange rate between the local currency and the US$.
b. auction prices were adjusted by a US$ inflation factor to take into account the year in which the auction took place; and
c. auction prices are then adjusted based on a comparison of the relative levels of GDP per Capita (PPP adjusted) between the auction country and Botswana.

16.8.5. The results of the auction benchmarking provide an estimate of the value of spectrum on a lump-sum basis, i.e. the potential level of the Spectrum Access Fee if the spectrum has been assigned through auction in Botswana.

16.8.6. The lump-sum value must be converted into an equivalent annual Spectrum Usage Fee. The annual fee is calculated based on the following formula.

$$\left[\frac{r}{1-(1+r)^{-t}}\right] \times \left[\frac{1}{(1+r)}\right]$$

Where r is the real weighted average cost of capital and t is the licence term. Based on Coleago's experience of working with operators in the region we have set the real weighted average cost of capital at 8%. The typical licence duration for spectrum subject to auction in the Coleago database is 15 years and so we have set t equal to 15.

16.8.7. The annual equivalent SUF is then converted to local currency at the rate of 0.083 Pula per US$. The figures in MHz / Pop are then applied to the Botswana population assumption of 2.25 million to provide a SUF per MHz.

16.8.8. In accordance with our recommended approach we have then applied a 25% discount to the resulting annual SUF to ensure that fees are set conservatively.

Exhibit 22: Mobile and FWA reference rates

Frequency	Benchmark USD / MHz / Pop	Lump Sum Value USD Millions	Annual Ref Rate USD / MHz	Annual Ref. Rate Pula / MHz	Discounted Ref. Rate Pula / MHz
900 MHz	0.20	0.44	47,806	575,972	431,979
1800 MHz	0.13	0.30	32,009	385,656	289,242
2100 MHz	0.13	0.29	30,910	372,404	279,303
2300 MHz	0.02	0.05	5,215	62,831	47,124
2600 MHz	0.03	0.06	6,390	76,983	57,737

Frequency	Benchmark USD / MHz / Pop	Lump Sum Value USD Millions	Annual Ref Rate USD / MHz	Annual Ref. Rate Pula / MHz	Discounted Ref. Rate Pula / MHz
3500 MHz	0.01	0.02	2,551	30,731	23,049
10 – 10.5 GHz					13,829
24 – 26.5 GHz					8,195

Source: Coleago

16.8.9. The fees for 10 to 10.5 GHz and 24 to 26.5 GHz utilise the 3500 MHz benchmark as the reference rate. This is adjusted for the difference in the relative bandwidth factor between 3500 MHz (0.4) and 10 to 10.5 GHz and 24 to 26.5 GHz which are 0.2 and 0.1 respectively.

16.8.10. The Discounted Reference Rate is applied in the formula below.

SUF = reference rate x band factor x bandwidth x shared use factor x location factor x inflation index

16.8.11. The following assumptions are made for the remaining factors:

a. Band Factor: Set to 1 as the Reference Rate and the frequencies being priced are the same.
b. Bandwidth: See the table below.
c. Shared Use Factor: Set to 1 as spectrum is assigned exclusively.
d. Location Factor: Set to 1 as the spectrum is assigned nationally

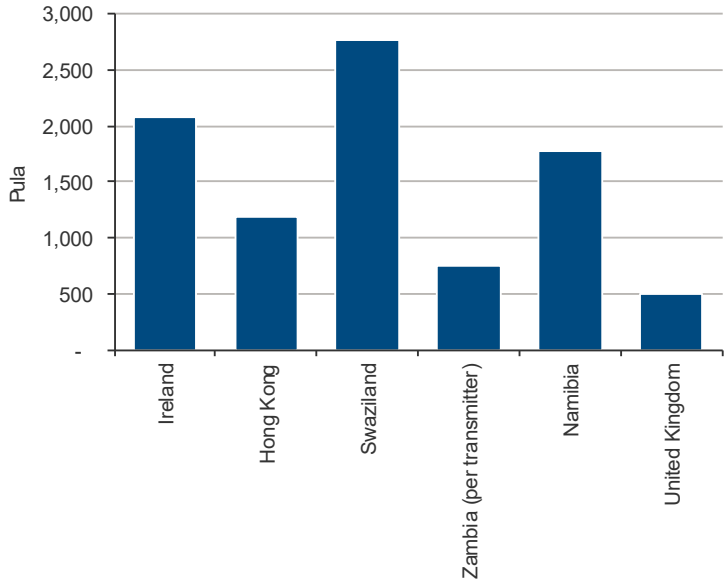
16.9 Spectrum pricing for fixed links

16.9.1. Spectrum Usage Fees for Fixed Links are calculated based on the formula below:

SUF = reference rate x band factor x bandwidth x shared use factor x location factor x inflation index

16.9.2. Determining an appropriate reference rate for fixed links is challenging due to the absence of market-based data. The basis of fixed link prices in other markets is opaque and likely to be based on judgement or historical precedent – neither of which provide a reliable basis for setting a reference rate for Botswana. As the exhibit below shows, there is considerable variation in the pricing for fixed links. The Exhibit adjusts fixed link prices for relative differences in GDP per Capita on a PPP Adjusted basis as well converting to Pula.

Exhibit 23: Fixed link comparisons



Source: Regulator publications

16.9.3. Prices are typically expressed as a price per MHz although Zambia charges a flat fee per transmitter for all frequency ranges. Namibia and Swaziland charge a flat fee per MHz for all frequencies. Ireland charges a fixed fee for links based on four bandwidth ranges with fees that decline with higher frequencies.

16.9.4. BOCRA currently charges on a per link basis and does not take bandwidth into account making a comparison of fees challenging. The current price is 300 Pula / Link for all frequencies below 24 GHz and 250 Pula / Link for frequencies above 24 GHz. Based on the profile of an existing operator's portfolio of Fixed Links, the average bandwidth per link is 24.7 MHz. If the average bandwidth is applied to the current BOCRA pricing structure, then the implied price per MHz is 12 Pula. This suggests that the pricing for Fixed Links is too low to encourage efficient use.

16.9.5. Very few regulators, with the exception of the UK's Ofcom and Hong Kong's OFTA have undertaken the onerous task of modelling the opportunity cost of fixed links. As the estimate of the UK is the lowest, Coleago has selected this as the basis for the Botswana reference rate to reflect a conservative approach to spectrum pricing.

16.9.6. Ofcom has estimated a reference price of GB£ 88 for a 2 x 1 MHz bi-directional link for frequencies in the 1.3 to 6 GHz range. The UK GDP / Capita (PPP adjusted) is 43,620 (source: IMF 2017) and that of Botswana is 18,146 (source: IMF 2017). The ratio is 42%. This ratio is applied to the UK reference price to provide a Reference Rate for Botswana. The result is GB£ 37 per 2 x 1 MHZ. Converting this to Pula at the rate of 13.88 Pula / GBP this implies a Botswana Reference Price of 381 Pula / 2 x 1 MHz.

16.9.7. The band factor is based on the band factors for Botswana discussed previously and then mapped onto the frequency ranges for Fixed Links adopted by BOCRA. The Exhibit below sets out the Band Factors.

Exhibit 24: BOCRA fixed link band factors

Frequency Range	Band Factor
1 to 3 GHz	0.6
3 to 5 GHz	0.4
5 to 10 GHz	0.3
10 to 17 GHz	0.2

Frequency Range	Band Factor
17 to 24 GHz	0.2
24 to 30 GHz	0.1
Above 30 GHz	0.1

Source: Coleago

16.9.8. Bandwidth is expressed in MHz for a 2 x 1 MHz link. The Shared Use Factor is set to 1 as is the Location Factor. Prices will be subject to annual inflationary increases. The application of the algorithm is subject to a minimum link fee of Pula 250. The resulting Fixed Link prices are shown in the Exhibit below.

Exhibit 25: BOCRA fixed link prices

Frequency Range	Pula per 2 x 1 MHz Link
1 to 3 GHz	381
3 to 5 GHz	235
5 to 10 GHz	196
10 to 17 GHz	141
17 to 24 GHz	141
24 to 30 GHz	84
Above 30 GHz	84

Source: Coleago

16.9.9. In order to ensure the pricing regime is as simple as possible we have not proposed that the Fixed Link fees contain a factor related to the demand or popularity of the bands. If BOCRA wanted to adjust the Fixed Link fees to reflect different levels of congestion in rural versus urban areas, for example, then the location factor could be used to adjust the fees so that they are lower in less areas where there is limited congestion. BOCRA may wish to set to the Location Factor at say 50% for rural areas to provide support for greater geographic coverage.

16.10 Spectrum pricing for VHF bands

16.10.1. The key challenge in pricing the VHF frequencies is once again the selection of an appropriate reference rate. Ofcom has performed task of modelling the opportunity cost of VHF frequencies and so Coleago proposes basing the Botswana price on the figures estimated for the UK. Ofcom adopts a complex pricing regime which develops prices across three dimensions: band popularity, geographic location and coverage. Each dimension has three categories which results in a complex matrix of prices. Coleago proposes a simplified approach.

16.10.2. Ofcom has calculated a reference price from which all VHF SUFs are derived. Reference price information from the UK is available on the SUFs for 900 MHz and also for the SUF's for VHF frequencies. It is therefore possible to calculate the ratio of VHF SUFs to 900 MHz SUFs, which is 35%. This same ratio can be applied to the Botswana SUF for 900 MHz to provide a suitable reference rate. VHF pricing for Botswana can then be calculated for different dimensions using the same ratios as Ofcom.

16.10.3. The calculations are as follows:

a. The Botswana SUF for 900 MHz (on an undiscounted basis) is Pula 575,972 / MHz of Pula 575 per KHz;
b. Applying the 35% ratio gives a price of 202 Pula / KHz for VHF frequencies;
c. This implies a Reference Rate of Pula 5,055 per 2 x 12.5 KHz channel

16.10.4. Ofcom provides a table of fees based on:

a. The popularity of the band - three levels (Highly, Medium and Low popularity)
b. The location of the frequencies - three levels (High, Medium and Low population density)
c. The coverage of the licensee - three categories based on the table below

16.10.5. Coverage is based on:

a. Category 1: Power ≤ 5W and Antenna height ? 10m implying a coverage radius 0 < R ≤ 3
b. Category 2: Power ≤ 5W and 10m < Antenna height ? 30m and P> 5W and Ah ? 10m implying a coverage radius 3 < R ≤ 15
c. Category 3: Power > 5W and Antenna height > 10m and Power ≤ 5W and Antenna height > 30m implying a coverage radius 15 < R ≤ 30

16.10.6. Coleago proposes a simplified structure as BOCRA does not hold sufficient data to analyse users across these multiple categories. The proposed structure is simply to classify frequencies as Low, Medium or High popularity. Popularity will be characterised by both the frequency and also the location. The proposed fees for VHF frequencies are shown in the Exhibit below.

Exhibit 26: VHF fees for 2 x 12.5 MHz

Popularity	Pula
Low	200
Medium	378
High	756

Source: Coleago

16.10.7. Frequencies assigned on a shared basis would be charged at 50% of these levels. A simplex channel would be charged at 50% of the duplex price. Coleago proposes making no distinction between fixed and mobile stations. In the event that BOCRA wishes to maintain a distinction between fixed and mobile then Coleago proposes applying the same ratio as previously adopted such that mobile is 75% of the fixed fee.

16.11 Other fees

16.11.1. Coleago proposes making no changes to the other spectrum and licence charges.

16.12 Turnover fee

16.12.1. The significant increase in the fees charged for spectrum will allow BOCRA to rebalance its total fees away from turnover based charges. In order to broadly maintain BOCRA's total income we recommend that the turnover fee be set at 1%.

Proposal 33: The turnover fee should be set at 1%.

16.13 Implementation plan

16.13.1. Coleago has proposed some significant changes for spectrum pricing in Botswana. In order to allow spectrum users time to adapt their plans we would recommend a phased implementation plan.

16.13.2. Fixed Links are usually the easiest for operators to plan for, but it is likely that the RF units will need to be replaced entirely and if they are more than five years old then the base-band unit will probably also need to be replaced. Typically, an operator would expect 12 months to retire fixed link frequencies although in the USA provided operators with a three-year window.

16.13.3. VHF systems are more challenging to migrate to new frequencies as it is likely that all the handsets will also need to be changed (depending on how much of a frequency / modulation shift is required). For large systems a minimum time to change out would typically be around two years. The longest changeover period Coleago is aware of is Singapore where Singtel were given five years for the change-over and hand-back.

16.13.4. Coleago therefore proposes the following implementation plan:

a. Announce the revised fee structure;
b. Allow a period of 12 months prior to the application of the revised fees;
c. In year 2 introduce 50% of the revised fee levels; and
d. In year 3 introduce 100% of the revised fee levels.

Proposal 34: The revised prices should be phased in over three years.

Annexes

Annex A. Summary of Proposals

A.1. Spectrum Management proposals

e. Proposal 1: Coleago proposes that, for the award of exclusive spectrum licences and where the demand for spectrum is likely to exceed supply, auctions are used as the assignment mechanism. Spectrum caps and coverage obligations should apply where appropriate.

f. Proposal 2: Coleago proposes that administrative assignment is used where the supply of spectrum is likely to exceed demand, including equal administered assignment where necessary to promote competition.

g. Proposal 3: BOCRA should apply its existing demand assessment procedure to 800 MHz spectrum and should award the spectrum by competitive process if there is evidence of excess demand.

h. Proposal 4: BOCRA should consider introducing a licence condition in future mobile spectrum awards, including 800 MHz, to permit infrastructure and spectrum sharing between operators to meet coverage obligations. Sharing should be limited to specific rural areas.

i. Proposal 5: BOCRA should consider reverse auctions for subsidies in relation to the rollout of coverage to areas that would be otherwise commercially unviable in order to meet the objectives of the NBS. BOCRA should permit operators to share infrastructure and spectrum in covering these areas.

j. Proposal 6: BOCRA should include coverage obligations in future spectrum licences for services such as mobile and fixed wireless access, setting spectrum and technology agnostic targets for covering specific areas by specified dates and at designated service levels.

k. Proposal 7: BOCRA should include conditions in spectrum licences to allow transfers of spectrum. BOCRA should create a framework to facilitate the development of a secondary market including a register of spectrum holdings and spectrum trades and a procedure to address competition concerns.

l. Proposal 8: BOCRA should require any operators wanting to actively share networks to request prior approval from BOCRA. BOCRA should review each request on its merits taking into account competition concerns and the potential benefits for investment and should set out the criteria it would use in a set of guidelines.

m. Proposal 9: BOCRA should consult on the need for and priority attached to introducing the shared access form of spectrum sharing. If BOCRA decides to proceed, it should initially address specific requests for shared access on a trial basis until developments have stabilised enough for a more general framework to be introduced. The general framework should apply to specific bands, such as 3.4 GHz where there is considerable momentum internationally.

n. Proposal 10: BOCRA should permit spectrum pooling in new spectrum licences subject to approval by BOCRA on competition grounds. BOCRA should also issue guidelines setting out the issues it would take into account.

o. Proposal 11: BOCRA should not mandate the establishment of a single wholesale network for mobile broadband at this time.

p. Proposal 12: BOCRA should apply a presumption of renewal in favour of the incumbents, subject to any efficiency and competition concerns, for spectrum licences. The renewal fee should reflect the economic value of the spectrum.

q. Proposal 13: BOCRA should set the duration of licences for spectrum associated with significant network investment at 15 years.

r. Proposal 14: BOCRA should conduct a review into the options for providing mobile broadband capability for public safety and emergency services examining the costs and benefits of dedicated versus shared network solutions.

A.2. Spectrum licensing proposals

s. Proposal 15: BOCRA should continue to follow international developments in the identification of licenced and licence-exempt spectrum for high-value services, such as broadband, and its relevance to Botswana.

t. Proposal 16: Coleago believes the optimal approach for Botswana should be for BOCRA to reflect international consensus and regional practice in the identification of spectrum for licence-exempt use and licenced use for high-value services and bring this spectrum into use in a timely manner.

u. Proposal17: Where BOCRA proposes to licence new spectrum for exclusive use, it should provide a separate spectrum licence for each band. Such a licence should include only rights and obligations relevant to the use of the spectrum.

v. Proposal 18: Coleago believes it is in Botswana's interests for BOCRA to offer longer terms for new spectrum licences reflecting international practice. New spectrum licences should be offered for a minimum period of 15 years.

w. Proposal 19: Coleago believes that coverage and service quality obligations in spectrum licences are appropriate to achieve relevant public policy objectives, including those set out in the National Broadband Strategy.

x. Proposal 20: Coleago proposes that BOCRA applies a presumption of renewal in favour of spectrum holders, subject to progressively re-farming spectrum towards higher value use and overall spectrum assignments meeting efficiency and competition concerns.

y. Proposal 21: Coleago believes that spectrum licences should be service and technology neutral and should allow operators to re-farm frequency assignments.

A.3. TW White Space

z. Proposal 22: Coleago proposes that a Licensed Shared Access model be adopted for TVWS

A.4. Spectrum pricing proposals

aa. Proposal 23: Coleago proposes that BOCRA adopts the decision tree approach to spectrum pricing decisions.

bb. Proposal 24: Coleago proposes that BOCRA adopts a formal approach to assessing demand for new spectrum assignment.

cc. Proposal 25: BOCRA should adopt a flexible and varied response to assessing congestion within assigned frequencies including reference to its spectrum assignment database as well as assessing reports of congestion from stakeholders

dd. Proposal 26: When there is no spectrum scarcity the price of spectrum should reflect only the costs of spectrum management.

ee. Proposal 27: BOCRA should seek to recover both direct and indirect spectrum management costs.

ff. Proposal 28: BOCRA should seek to fully recover the costs of its spectrum management activities.

gg. Proposal 29: BOCRA should use relevant spectrum auction benchmarks with appropriate adjustments for setting Reference Prices where possible. The results of benchmarking should be discounted to reduce the risk of spectrum prices being set at too high a level. Where auction benchmarks are not available then benchmarks from other markets which have made explicit attempts to estimate the opportunity cost of spectrum should be used, subject to appropriate adjustments.

hh. Proposal 30: BOCRA should generally adopt the simplest possible algorithm for adjusting the Reference Rate to set specific spectrum usage fees.

ii. Proposal 31: BOCRA should continue to estimate the full direct and indirect costs associated with spectrum management activities on an ongoing and annual basis.

jj. Proposal 32: Coleago proposes leaving fees unchanged for frequencies which are not congested or face excess demand other than to apply an inflation-based increase for the coming year.

kk. Proposal 33: The turnover fee should be set at 1%.

ll. Proposal 34: The revised spectrum prices should be introduced on a phased basis over three years.

Annex B. Spectrum Migration

B.1. High demand spectrum migration

B.1.1. The following table shows existing high-demand spectrum band use and proposals for short or medium/long term migration.

Exhibit 27: Proposals for high-demand spectrum bands

Band	Existing use	Short term proposals	Medium/long term proposals	Migration Strategy
450 – 470 MHz	Private mobile radio and government use	Vacate	Assign rural mobile services / Regional Telecom operators	As described in main document
694 - 790 MHz	Mainly TV broadcasting	Move active TV broadcasters to other channels	Assign mobile licences (703 – 733 MHz UL, 758 – 788 MHz DL)	Vacate band of TV broadcasters
790 – 862 MHz	Government use (825 – 835 MHz)		Assign mobile licences (791 – 821 MHz DL, 832 – 862 MHz UL)	Migrate government channels to other bands
E-GSM band 880 – 890, 915 – 925 MHz	None		Possible additional national mobile licence	
GSM band 890 – 915, 935 – 960 MHz	GSM			In-band: align non-contiguous BTC assignment
IMT-E band 2500 – 2690 MHz	Some TDD allocations	Finalize re-assignment of TDD and FDD allocations		Transition to IMT-E band plan already ongoing.

Source: Coleago and BOCRA

B.2. Other spectrum band migration

B.2.1. The following table shows existing other spectrum band use and proposals for short or medium/long term migration.

Exhibit 28: Proposals for other spectrum bands

Band	Existing use	Proposal / Comments
526.5 – 1606.5Khz	MW broadcasting band 526.5-535 kHz is also allocated to mobile service on a secondary basis	
68 – 87.5 MHz	PMR	
87.5 – 108 MHz	FM broadcasting	
146 – 174 MHz	PMR	
174 – 214 MHz	Analogue Television	Finalize migration to DTT
214 – 230 MHz	Analogue Television	Finalize migration to DTT
440 – 470 MHz	PMR	
446 – 446.1 MHz	PMR 446	
446.1 – 446.2 MHz	DMR 446 unlicensed	
450 – 470 MHz	Standardized by 3GPP for use by LTE (bands 72 and 73)	Consider vacating this band in rural areas for mobile use

Band	Existing use	Proposal / Comments
470 – 694 MHz	Analogue TV broadcasting Digital Terrestrial Television	Finalize migration to DTT
864 – 868 MHz	CT2	
914 – 915 MHz 959 – 960 MHz	CT1	Consider discontinuation of CT1 equipment use
1880 – 1900 MHz	DECT	
3700 -4200	FSS Receive	
5925 – 6425 MHz	FSS transmit (C-band)	
6425 – 7145 MHz	BTC Fixed links	
7145 – 7425 MHz	Fixed links - Heavily used on FCFS	
7425 – 7725 MHz	Fixed links - Heavily used on FCFS	
7725 – 8275 MHz	Fixed links Only a few allocations in Francistown	
8275 – 8500 MHz	Fixed links	
10.7 – 11.7 GHz	Satellite receive: 10.95 – 11.7 (mainly broadcasting in 10.95 – 11.2 and 11.45 – 11.7)	
11.7 – 12.75	Some satellite FSS downlink	
12.75 – 13.25 GHz	Fixed links	
14 – 14.8 GHz	Some satellite FSS uplink	
14.8 – 15.35 GHz	Government fixed links	
17.7 – 19.7 GHz	Some satellite and fixed links Heavily used for fixed links on FCFS	
24.5 – 26.5 GHz	Allocated to fixed links and FWA	May require migration of current assignments if band is dedicated to 5G use following WRC-19
27.5 – 29.5 GHz	Allocated to fixed links and uncoordinated Earth stations (FSS earth to space)	Likely to remain reserved for satellite use, since Europe already harmonized this band

Source: Coleago and BOCRA

Annex C. Recommended radio licence fees

C.1.1. The Exhibit below shows the recommended radio licence fees. All fees would be subject to annual inflationary increases based on the Consumer Price Index, lagged 12 months. Prices which have been revised are shown in bold.

Exhibit 29: Recommended radio licence fees

Radio Licence Type	Annual Fee (Pula)
CATEGORY A: SERVICE RELATED RADIO LICENCE	
Amateur	
Botswana National	100
Non-Botswana National	100
Citizen Band	
Citizen Band 27Mhz	
Botswana National	100
Non-Botswana National	100
Base or Mobile Station 29Mhz	
Botswana National	100
Non-Botswana National	100
Aeronautical Service Band	
Botswana National	200
Non-Botswana National	200
CATEGORY B: SITE LICENCES	
Television and Sound Broadcasting Band	
Fixed Station, Broadcasting MW > 100kW	1,000.00
Fixed Station, Broadcasting MW 25-100kW	700
Fixed Station, Broadcasting MW < 25kW	400
Fixed Station, Broadcasting HF	700
Fixed Station, Broadcasting FM > 10kW	700
Fixed Station, Broadcasting 0-10kW	400
Mobile station, Broadcasting FM	400
Fixed station, Television > 10 kW	1,500.00
Fixed station, Television 0 - 10 kW	700
Mobile station, Television	700
Fixed Station, Uplink Broadcasting	1,500.00
Fixed Station, Uplink Broadcasting (temporary)	750
Satellite News Gathering Station (SNG)	750
Mobile or fixed news gathering station (temporary)	750
Stations in 2 - 30 MHz band	
Fixed Stations (Urban Areas)	500
Fixed Stations (Rural Areas)	300
Mobile station	200
VHF/UHF (Land Mobile)	
Fixed, Base or Repeater station VHF/UHF - High Demand	756
Fixed, Base or Repeater station VHF/UHF - Medium Demand	378
Fixed, Base or Repeater station VHF/UHF - Low Demand	200
Paging systems, Base stations	2,500.00

Radio Licence Type	Annual Fee (Pula)
Radio Trunking Base Station	2,500.00
Community repeater	2,500.00
Wireless LAN (2.4 / 5.7 GHz)	
Wireless LAN, (rural areas)	2,500.00
Wireless LAN, (urban areas)	6,500.00
Radio transmitter for security	
Base station (Alarm)	15.00/month
Remote station (Alarm) Subscriber Transmit	7.50/month
Satellite	
Earth station (C-Band)	3,000.00
VSAT terminal (Ku-band)	1,500.00
Mobile tracking system terminal	150
Inmarsat A-terminal	400
Inmarsat B-terminal	400
Inmarsat C-terminal	300
Inmarsat M-terminal	400
Fixed Links (Point-to-Point Microwave Links)	Fee / MHz
1 – 3 GHz	381
3 – 5 GHz	235
5 – 10 GHz	196
10 – 17 GHz	141
17 – 24 GHz	141
24 – 30 GHz	84
Above 30 GHz	84
CATEGORY C: SPECTRUM LICENCES	
Public Cellular Service Bands	Fee / MHz
900 MHz	431,979
1800 MHz	289,242
2100 MHz	279,303
2300 MHz	47,124
2600 MHz	57,737
3500 MHz	23,049
Cost based Spectrum Usage Fee for new assignments	10,000
Fixed/Broadband Wireless Access Bands	Fee / MHz
2.3 - 2.4 GHz	47,124
2.5 - 2.69 GHz	57,737
3.4 - 3.6 GHz	23,049
10 – 10.5 GHz	13,829
24 – 26.5 GHz	8,195
Other Fees	
Radio Dealers	350
Licence Amendment	20
Duplicate Licence	20
Experimental Station	750

Source: Coleago

Annex D. Current radio licence fees

D.1.1. The Exhibit below shows the current fees charged by BOCRA.

Exhibit 30: Current radio licence fees

Radio Licence Type	Annual Fee (Pula)
CATEGORY A: SERVICE RELATED RADIO LICENCE	
Amateur	
Botswana National	100.00
Non-Botswana National	100.00
Citizen Band	
Citizen Band 27Mhz	
Botswana National	100.00
Non-Botswana National	100.00
Base or Mobile Station 29Mhz	
Botswana National	100.00
Non-Botswana National	100.00
Aeronautical Service Band	
Botswana National	200.00
Non-Botswana National	200.00
CATEGORY B: SITE LICENCES	
Television and Sound Broadcasting Band	
Fixed Station, Broadcasting MW > 100kW	1,000.00
Fixed Station, Broadcasting MW 25-100kW	700.00
Fixed Station, Broadcasting MW < 25kW	400.00
Fixed Station, Broadcasting HF	700.00
Fixed Station, Broadcasting FM > 10kW	700.00
Fixed Station, Broadcasting 0-10kW	400.00
Mobile station, Broadcasting FM	400.00
Fixed station, Television > 10 kW	1,500.00
Fixed station, Television 0 - 10 kW	700.00
Mobile station, Television	700.00
Fixed Station, Uplink Broadcasting	1,500.00
Fixed Station, Uplink Broadcasting (temporary)	750.00
Satellite News Gathering Station (SNG)	750.00
Mobile or fixed news gathering station (temporary)	750.00
Stations in 2 - 30 MHz band	
Fixed Stations (Urban Areas)	500.00
Fixed Stations (Rural Areas)	300.00
Mobile station	200.00
VHF/UHF (Land Mobile)	
Fixed, Base or Repeater station VHF/UHF	200.00
Mobile station VHF/UHF	150.00
Paging systems, Base stations	2,500.00
Radio Trunking Base Station	2,500.00
Community repeater	2,500.00
Wireless LAN (2.4 / 5.7 GHz)	

Radio Licence Type	Annual Fee (Pula)
Wireless LAN, (rural areas)	2,500.00
Wireless LAN, (urban areas)	6,500.00
Radio transmitter for security	
Base station (Alarm)	15.00/month
Remote station (Alarm) Subscriber Transmit	7.50/month
Satellite	
Earth station (C-Band)	3,000.00
VSAT terminal (Ku-band)	1,500.00
Mobile tracking system terminal	150.00
Inmarsat A-terminal	400.00
Inmarsat B-terminal	400.00
Inmarsat C-terminal	300.00
Inmarsat M-terminal	400.00
Fixed Links (Point-to-Point Microwave Links)	Fee/Link
1 - 3Ghz	300.00
3 - 5Ghz	300.00
5 - 10Ghz	300.00
10 - 17Ghz	300.00
17 - 24Ghz	300.00
24 - 30Ghz	250.00
Above 30Ghz	250.00
CATEGORY C: SPECTRUM LICENCES	
Public Cellular Service Bands	Fee/MHz
GSM900	43,459.00
GSM1800	34,767.00
3G Core band (1.9 - 2.1 GHz)	39,982.00
3G Ext. band (2.5 - 2.690 GHz)	39,982.00
Fixed/Broadband Wireless Access Bands	Fee/MHz
450 - 470MHz	10,321.00
850Mhz	9,778.00
1.3 - 1.5 Ghz	5,215.00
1785 – 1805 Mhz	10,430.00
2.3 - 2.4 Ghz *	53,962.73
2.5 - 2.69 Ghz	12,168.00
3.4 - 3.6 Ghz *	53,962.73
10 – 10.5 GHz *	43,844.72
24 – 26.5 Ghz *	33,726.71
Other Fees	
Radio Dealers	350.00
Licence Amendment	20.00
Duplicate Licence	20.00
Experimental Station	750.00

Source: BOCRA

Annex E. Illustrative Technical Rules for Unlicensed TVWS Devices

E.1. Introduction

E.1.1. In these Technical Rules for operating Television White Spaces (TVWS), BOCRA illustrates the rules which would be necessary to allow unlicensed radio transmitters to operate in the broadcast television spectrum at locations where that spectrum is not being used by licensed services, known as "Television White Spaces".

E.1.2. These Technical Rules illustrate an approach to the resolution of certain legal and technical issues in order to provide certainty concerning the rules for operation of unlicensed transmitting devices in the TV broadcasting and other available bands should BOCRA decide to introduce Option1.

E.1.3. The rules would allow the use of new devices to provide broadband services for businesses and consumers with the key constraint of non-interfering with incumbent users of the spectrum. The devices will use geolocation technology and database lookup.

E.2. User Information

E.2.1. Every person using White Space Device (WSD) equipment shall ensure that the equipment is tested and found to comply with the technical rules and regulations for WSDs, in line with type approval regulations.

E.2.2. Every person using the WSD equipment shall ensure that the equipment does not cause harmful interference to radio and/or Television reception.

E.3. Allowed Channels of Operation

E.3.1. WSDs shall be licenced to operate in the UHF and any other bands subject to the interference protection requirements set forth in these technical rules and regulations.

E.3.2. WSDs shall only operate on available channels determined in accordance with the interference avoidance mechanisms.

E.3.3. Client WSDs shall only operate on available channels determined by database lookup or an approved spectrum sensing mechanism permitted by BOCRA.

E.4. General Technical Requirements for WSDs

E.4.1. WSDs shall transmit power levels provided by the database depending on the geolocation and database method of determining channel availability.

E.4.2. The maximum EIRP levels for WSDs shall never exceed the following values:

E.4.3. The antenna attached to the WSD shall not exceed an EIRP of 10 watts, taking into account the transmit power of the WSD's radio, loss from cable and connectors, and directional gain of the antenna.

E.4.4. Personal/portable WSDs shall be treated the same as fixed devices, except:

E.4.5. In the event that the personal/portable WSD doe not report its height information, it will be considered as a fixed device operating at 1.5 meters above ground.

E.4.6. In the event that the personal/portable WSD does report its height information, and that height is more than 2 meters above the ground, an additional 7 dB of power may be permitted beyond what is allowed for fixed devices.

E.4.7. Fixed WSDs communicating with Base Station for the purpose of establishing initial contact with a geolocation database shall transmit using the maximum power levels stipulated in section A.6.

E.4.8. WSDs shall transmit at 50 mW per channel (8MHz), depending on an approved spectrum sensing technique of determining channel availability.

E.4.9. Emissions from WSDs relying on the geolocation and database technique of determining channel availability shall comply with the following emissions limits:

a. Fixed devices operating adjacent to occupied TV channels: -42.8 dBm conducted power per 100 kHz.
b. All other fixed devices: -52.8 dBm conducted power per 100 kHz.
c. Personal/portable device operating adjacent to occupied TV channels: -56.8 dBm EIRP per 100 kHz.
d. All other personal/portable devices: -52.8 dBm EIRP per 100 kHz

E.4.10. Emissions from WSDs relying on an approved spectrum sensing technique of determining channel availability shall not exceed -55.8 dBm EIRP per 100 kHz in the television channels immediately adjacent to the channel in which the WSDs is operating,

E.5. Protections of Primary Services

E.5.1. Availability of channels for use by WSDs shall be determined based on the geolocation and database method described in section 6 or based on an approved spectrum sensing method described in section 9.

E.6. Geolocation and Database Access

E.6.1. WSD shall rely on the geolocation and database access mechanism described in this section to identify available channels.

E.6.2. The geolocation of the fixed and personal/portable/WSD shall be determined by:

a. For fixed WSD, obtaining the geographic coordinates to an accuracy of ± 50 m by either an incorporated geolocation capability or a professional installer. The geographic coordinates shall be determined at the time of installation and first activation from a power-off condition, and this information shall be stored by the device.
b. If the fixed WSD is moved to another location or if its stored coordinates become altered, the operator shall re-establish the device's geographic location either by means of the device's incorporated geolocation capability or through the services of a professional installer.
c. The geolocation of the personal/portable WSD shall be determined by;
d. Incorporating a geolocation capability to determine its geographic coordinates to an accuracy of ± 50 meters from the transmission.
e. Re-establishing its position each time it is activated from a power-off condition and use its geolocation capability to check its location at least once every 60 seconds while in operation, except while in sleep mode.

E.6.3. Determination of available channels and maximum transmit power shall be done as follows:

a. A TVWS Base Station shall access a geolocation database designated by the Authority over the Internet to determine the channels and maximum transmit power available at the device's geographic coordinates. A database will determine available channels and maximum transmit power based on the Longley-Rice algorithm and other models that support point to point modelling.
b. The maximum transmit power shall not exceed the maximum transmit power emissions limit restrictions that exceed the values provided in A.4.

c. TVWS Base Station shall provide the database with the device's geographic coordinates in WGS84 format, model number, and unique device identifier such as a serial number.

d. Fixed master devices shall also provide the database with the antenna height of the transmitting antenna specified in meters Above Mean Sea Level (AMSL) or Above Ground Level (AGL).

E.6.4. When determining channels of operation and maximum transmit power, the geolocation database shall also take into account additional information voluntarily provided by a master WSD about its operating parameters and indicate to the WSDs that different channels and/or higher maximum transmit power are available based on this additional information.

E.6.5. WSDs operation in a frequency range shall cease transmitting immediately if the database indicates that the frequencies are no longer available.

E.6.6. A personal/portable master device shall access a geolocation database to re-check the database for available channels and maximum operating power when:

a. The device changes location by more than 100 meters from the location at which it last accessed the database.

b. The device is activated from a power-off condition.

c. A personal/portable master WSD shall load channel availability information for multiple locations around its current location and use that information in its operation.

d. A personal/portable master WSD shall use such available channel information define a geographic area within which it can operate on the same available channels at all locations; for example, a master WSD could calculate a bounded area in which channels are available at all locations within the area and operate on a mobile basis within that area.

e. A master WSD using available channel information for multiple locations shall contact the database again if/when it moves beyond the boundary of the area where the channel availability data is valid, and shall access the database daily even if it has not moved beyond that range to verify that the operating channels continue to be available.

f. A master WSD shall cease operation immediately if the database indicates that the channels are no longer available.

E.6.7. Time validity and database re-check requirements.

a. A geolocation database shall provide master devices with a time period of validity for the channels of operation and maximum transmit power values.

Fixed device registration.

E.6.8. A fixed WSD shall register with a database prior to operating for the first time or after changing location.

E.6.9. The party responsible for a fixed WSD shall ensure that a database has the most current, up-to-date information for that device.

E.6.10. The database shall contain the following information for fixed WSDs:

a. A unique alphanumeric code supplied by the manufacturer that identifies the make and model of the device.

b. Manufacturer's serial number of the device.

c. Device's geographic coordinates (latitude and longitude, accurate to ± 50 meters).

d. Device's antenna height above ground level (meters).

e. Name of the individual or business that owns the device.

f. Name of a contact person responsible for the device's operation.

g. Physical address for the contact person.

h. Email address for the contact person.

i. Phone number for the contact person.

Client device operation.

E.6.11. A client WSD shall only transmit upon receiving a list of available channels and power limits from a master WSD that has contacted a database.

E.6.12. To initiate contact with a master device, a client device shall transmit on available channels used by the master WSD or on channels that the master WSD indicates are available for use by a client device on a signal seeking such contacts.

E.6.13. A client WSD may optionally provide additional information about its operating parameters to a master device that may be taken into account by the database when determining available channels and/or maximum transmit power for the client device.

E.6.14. The client device shall also provide the master device with a unique alphanumeric code supplied by the manufacturer that identifies the make and model of the client device, which shall be supplied to a geolocation database.

E.6.15. A client device shall communicate with a master device at least once every 60 seconds, except when in sleep mode, which may include contacting the master device to re-verify/re-establish channel availability or receiving a contact verification signal from the master device that provided its current list of available channels.

E.6.16. A client device shall cease operation immediately if it has not communicated with the master device as described above after more than 60 seconds.

E.6.17. A client device shall re-check/re-establish contact with a master device to obtain a list of available channels if the client device resumes operation from a powered down state. If a master device loses power and obtains a new channel list, it shall signal all client devices it is serving to acquire a new channel list.

Fixed devices without a direct connection to the Internet.

E.6.18. If a fixed WSD does not have a direct connection to the Internet and has not yet been initialized and communicated with a geolocation database consistent with this section, but can receive the transmissions of a master WSD, the fixed WSD needing initialization shall transmit to the master WSD on either a channel on which the master WSD has transmitted or on a channel which the master WSD indicates is available for use to access the geolocation database to receive a list of channels and power levels that are available for the fixed WSD to use.

E.6.19. Fixed devices needing initialization shall transmit at the power levels specified under the technical requirements in these rules for the applicable channels.

E.6.20. After communicating with the database, the fixed WSD shall then only use the channels and power levels that the database indicates are available for it to use.

E.6.21. For purposes of security, the following aspects should be taken into account:

a. To obtain a list of available channels and related matters, master WSDs shall be capable of contacting only those geolocation databases operated by administrators authorized by the Authority.

b. Communications between WSDs and geolocation databases shall be transmitted using secure methods that protect against corruption or unauthorized modification of the data; this requirement also applies to communications of channel availability and other spectrum access information between master devices.

c. Communications between a client device and a master device for purposes of obtaining a list of available channels shall employ secure methods that protect against corruption or unauthorized modification of the data.

d. Contact verification signals transmitted for client devices shall be encoded with encryption to secure the identity of the transmitting device.
e. Client devices using contact verification signals shall accept as valid for authorization only the signals of the device from which they obtained their list of available channels.
f. Geolocation database(s) shall be protected from unauthorized data input or alteration of stored data.

E.7. Database Algorithm

E.7.1. The input to a geolocation database shall be positional information from a master WSD, the height of the transmitting antenna for fixed master devices and use by licensed primary users in or near the geographic area of operation of the WSDs. The database may, at its discretion, accept additional information about WSDs operating parameters.

E.7.2. The database shall supply a list of available channels and associated radiated powers to WSDs.

E.7.3. Any facilities that the Authority determines are entitled to protection but not contained in the Authorities databases shall be permitted to register with a geolocation database pursuant to section 8.

E.8. Database Administrator

Database administrator responsibilities.

E.8.1. The Authority shall designate one public entity or multiple private entities to administer geolocation database(s).

E.8.2. Each geolocation database administrator designated by the Authority shall:
a. Maintain a database that contains information about primary licensees to be protected.
b. Implement propagation algorithms and interference parameters issued by the Authority in accordance to section 7 to calculate operating parameters for WSDs at a given location.
c. Alternatively, a database operator shall implement other algorithms and interference parameters that can be shown to return results that provide at least the same protection to licensed primary users as those supplied by the Authority.
d. Database operators shall update the algorithms or parameter values that have been supplied by the Authority after receiving notification from the Authority that they are to do so.
e. Establish a process for acquiring and storing in the database necessary and appropriate information from the Authority's databases and synchronizing the database with current Authority databases at least twice a week to include newly licensed facilities or any changes to licensed facilities.
f. Establish a process for the database administrator to register fixed WSDs.
g. Establish a process for the database administrator to include in the geolocation database any facilities that the Authority determines are entitled to protection but not contained in a database maintained by the Authority.
h. Provide accurate information regarding allowed channels of operation and maximum transmit power available at a master WSDs geographic coordinates based on the information provided by the device in accordance with section 6.3.
i. Database operators shall allow prospective operators of WSDs to query the database and determine whether there are free channels at a particular location.
j. Establish protocols and procedures to ensure that all communications and interactions between the database and WSDs are accurate and secure and that unauthorized parties cannot access or alter the database, or the list of available channels sent to a WSD.
k. Respond in a timely manner to verify, correct and/or remove, as appropriate, data in the event that the Authority or a party brings a claim of inaccuracies in the database to its attention. This requirement applies only to information that the Authority requires to be stored in the database.

l. Transfer its database, along with the IP addresses and URLs used to access the database and list of registered fixed WSDs, to another designated entity in the event it does not continue as the database administrator at the end of its term. It may charge a reasonable price for such conveyance.

m. Have database functionality such that upon request from the Authority it can indicate that no channels are available when queried by a specific WSD or model of WSDs.

n. Ensure that database administrators for a particular band shall cooperate to develop a standardized process for providing on a daily basis or more often, as appropriate, the data collected for the facilities listed in section 8.1.2.12 to all other WSD databases to ensure consistency in the records of protected facilities.

Non-discrimination and administration fees.

E.8.3. Geolocation databases shall not discriminate between devices in providing the minimum information levels but may provide additional information to certain classes of devices.

E.8.4. A database administrator shall charge a fee for provision of lists of available channels to fixed and personal/portable WSDs and for registering fixed WSDs.

E.8.5. The Authority shall review the fees and adjust them from time to time.

Application process and determination of operating parameters.

E.8.6. Upon receipt of an application submitted under this section, the Authority shall develop proposed test procedures and methodologies for the pre-production WSDs. The Authority shall make the application and proposed test plan available for public review and afford the public an opportunity to comment.

E.8.7. The Authority shall conduct laboratory and field tests of the pre-production WSDs. This testing shall be conducted to evaluate proof of performance of the WSDs, including characterization of an approved spectrum sensing capability and its interference potential. The testing shall be open to the public.

E.8.8. Subsequent to the completion of testing, the Authority shall issue a test report, including proposals for operating parameters and afford the public an opportunity to comment.

E.8.9. After completion of testing and a reasonable period for public comments, the Authority shall determine operating parameters for the production WSDs, including maximum transmit power and minimum sensing detection thresholds, which are sufficient to enable the WSDs to reliably avoid interfering with incumbent services.

Other spectrum sensing requirements

E.8.10. All WSDs that rely on an approved spectrum sensing shall implement the following additional requirements:

a. Channel availability check time.

   i. A WSD may start operating on a frequency band if no primary user device signals above the detection threshold determined in section 9.3 are detected within a minimum time interval of 30 seconds.

b. In-service monitoring.

   i. A WSD shall perform in-service monitoring of the channels used by the WSD at least once every 60 seconds. There is no minimum channel availability check time for in service monitoring.

c. Frequency move time.

   i. After a primary user device signal is detected on a frequency range used by the WSDs, all transmissions by the WSDs shall cease within two seconds.

Annex F. Draft Licence for Shared Access to Spectrum

LICENCE FOR SHARED RADIO SPECTRUM ACCESS

GRANTED BY

BOTSWANA COMMUNICATIONS REGULATORY AUTHORITY

TO

……

UNDER SECTION 45 OF THE

COMMUNICATIONS REGULATORY ACT NO. 19 OF 2012

Dated: …….2017

BOTSWANA COMMUNICATIONS REGULATORY

AUTHORITY

NOTICE OF GRANT OF SHARED ACCESS TO RADIO SPECTRUM UNDER

SECTION 45 OF THE COMMUNICATIONS REGULATORY ACT

Licence No.

Licensee

[the Licensee]

is hereby licensed under Section 45 of the COMMUNICATIONS ACT (hereinafter referred to as the Act) to:

(a) Use Radio frequency spectrum as specified in Schedule 1 to Annexure 1; in Botswana, with the Licensee's registered offices situated at …….., Botswana for a period of 1 (ONE) year subject to the terms and conditions which more fully appear in Annexure 1 attached hereto.

ADDITIONAL CONDITIONS

I. The Licence to use the applicable radio frequency spectrum shall only be valid provided the Licensee has a valid Network Facility Licence (NFL).

II. The Licensee shall at all times display this Licence Notice in a conspicuous place at the Licensee's registered offices.

Given under my hand and seal in GABORONE this ……day of …… 2017

[BOCRA Seal] ……

CHIEF EXECUTIVE

ANNEXURE 1 (LICENCE)

BOTSWANA COMMUNICATIONS REGULATORY AUTHORITY

RADIO SPECTRUM LICENCE:

TERMS AND CONDITIONS

Imposed on the Licensee under Section 45 of the COMMUNICATIONS

REGULATORY ACT hereinafter referred to as the Act.

Part 1: Definitions

1. Interpretation

1.1 All words and expressions used in this Licence which are defined in the Act shall have the same meanings as are ascribed to them under the Act, and as generally defined by the International Telecommunication Union.

1.2 For the purposes of this Licence, and unless the context otherwise requires:

1.2.1 "Act" means the COMMUNICATIONS REGULATORY AUTHORITY ACT;

1.2.2 "Assigned Frequency "means the centre of the frequency band assigned to a station;

1.2.3 "Assignment "means authorisation given by the Authority for a radio station to use a radio frequency or radio frequency channel under specified conditions;

1.2.4 "BOTSWANA COMMUNICATIONS REGULATORY AUTHORITY" means a body corporate established under Section 3 of the Act (hereinafter referred to as the BOCRA or the Authority);

1.2.5 "Clause" means a clause of this Licence as contained in this Annexure;

1.2.6 "Electromagnetic Compatibility" (EMC) means the prevailing condition under which telecommunications equipment is capable of operating under its specified performance range in a common electromagnetic environment without causing or suffering unacceptable degradation in performance due to unintentional electromagnetic radiation to or from other equipment within the same environment;

1.2.7 "Emission "means radiation produced, or the production of radiation by a radio transmitting station;

1.2.8 "Force Majeure" means any supervening law or regulation in Botswana, act of God, accident, natural phenomenon, fire, explosion, or incident involving exposure or potential exposure to toxic or radioactive materials disaster, act of war or insurrection or other event which is beyond the control of the Licensee and is not attributable to any fault on the part of the Licensee;

1.2.9 "Interference" means any form of unwanted radiation, whether intentional or non-intentional, that causes a degradation of or tolerable disturbance to a radio communication service to the extent that it does not cause a partial or total loss of service;

1.2.10 "Licence" means this Licence, including the Licence Notice and all the terms and conditions included in this Annexure and as may be amended from time to time;

1.2.11 "Licence Date" means the date of issue of this Licence;

1.2.12 "Licence Notice" means the formal notice of Licence issued to the Licensee to which these Conditions are attached;

1.2.13 "Licence Period" means the Licence validity period prescribed in this Annexure;

1.2.14 "Licensed System" means any public telecommunications system of any description (including a satellite uplink) which the BOCRA has authorised the Licensee to operate in accordance with Clause 2.

1.2.15 "Radiation" means the outward flow of energy from any source in the form of radio waves;

1.2.16 "Radio Spectrum Licence" means a Licence issued by the BOCRA to the Licensee under which the Licensee is assigned and authorised to use particular bands of radio frequency spectrum under Section 45 of the Act;

1.2.17 "Radio Station" means one or more transmitters or receivers or a combination of transmitters and receivers, including the accessory equipment, necessary at one location for carrying on a radio communication service, or the radio astronomy service;

1.2.18 "Regulations" means Regulations issued by the Minister under Section 94 of the Act;

1.2.19 "Signal" means any signs, sounds, text, images, information or data of any kind sent, or to be sent, for conveyance by means of a telecommunication system;

1.2.20 "Spectrum trading" means the transfer of spectrum usage rights from one entity to another for a consideration (i.e. reward, return, cash or otherwise);

1.2.22 "Spurious Emission" means the emission on a frequency or frequencies which are outside necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasite emissions, inter-modulation products and frequency conversion products, but exclude out-of-band emissions;

1.2.23"Subsidiary or Associated Companies" shall have the meanings assigned to them under the Companies Act 2003 [CAP. 42:01];

1.2.24"Terminal Equipment "means the user equipment;

1.2.25 "Network Facility Licence (NFL)" means a Licence issued to any person by the BOCRA to establish and operate communications facilities, systems or infrastructure in Botswana.

1.2.26 "Licensee" means the person or organization identified by the BOCRA as the holder of this Licence.

1.2.27 "Spectrum Sharing" means the sharing of Licensed Spectrum by the Licensee with another Spectrum Licensee.

Part 2: Authorisation, Geographic Coverage, Licence Period and Fees

2 Authorisation

2.1 The Licensee shall be entitled to use radio frequency spectrum as specified in Schedule 1 of this Annexure to establish and operate telecommunications facilities, systems or infrastructure as defined in its Network Facility Licence.

2.2 If the Licensee had no such authorisation, or wishes, at any time during the Licence Period, to establish or operate any further telecommunications facilities, systems or infrastructure within the scope of this Licence, the Licensee must first obtain the prior written approval of the BOCRA, which shall be given only if the BOCRA is reasonably satisfied that the Licensee has the technical, financial and human resources needed.

3 Geographical Coverage

3.1 The geographical area of operation of the Licensee shall be as specified in Schedule 2 of this annexure.

3.2 The licensee shall construct the network in order to achieve the deployment as set out in Schedule 2. The roll out speed shall be as specified in Schedule 2 from date of issue of the Licence.

3.4 In the event that the Licensee fails to achieve the deployment or any components thereof, the Licensee shall be liable to penalties as prescribed in this Licence and may lose the right to use the allocated spectrum.

4 Licence Period

4.1 The Licence shall be valid for a period of 1 (ONE) year, from the Licence Date, unless replaced or revoked by the Authority following adequate consultation.

4.2 This Licence shall expire and all operating authorisation under it shall terminate:

4.2.1 Upon the expiration of the Licence Period, unless renewed.

4.2.2 By Mutual Agreement between the Authority and the Licensee.

4.2.3 Upon the expiry, withdrawal or revocation of the Licensee's NFL Licence.

4.3 Pursuant to application by the Licensee and subject to Clauses 4.4 and 4.5, the Authority shall renew this Licence upon expiry of the Licence Period, provided that the Licensee shall apply for such renewal no more than three (3) months before the expiry date.

4.4 In all cases of renewal, the Authority shall have the right to refuse renewal in the event the Licensee

4.4.1 Has failed to comply with the Licence in any material way and has not remedied such failure to the Authority's satisfaction; or

4.4.2 Refuses, fails or neglects to pay any fees specified by the Authority in connection with such renewal.

4.5 The Authority may refuse renewal if it would not be in the best interests of Botswana as may be determined by the Authority in light of the Act, taking into account the continuity of services that depend upon the relevant spectrum, competition in the market for such services and efficient management of spectrum.

5 Fees

5.1 On award of the Licence, the Licensee shall pay an annual radio spectrum Licence fee calculated by the Authority. The annual radio Licence fees shall be subject to review in accordance with any radio Licence fee structures which the Authority may introduce from time to time: -

5.2 The annual fees due under this Licence shall be paid on the Licence Date and thereafter payable on 1 April of each year.

5.3 The Licensee shall not have the right or option to set off or counter claim in any case or instance relating to fees prescribed under this Annexure or the applicable Network Facility Licence.

5.4 The fees paid in terms of this Licence shall attract Value Added Tax (VAT), which shall be paid by the Licensee.

5.5 All fees paid in terms of this Licence are non-refundable.

5.6 The radio Licence fees cover only the radio equipment operating on the assigned frequency band. No radio Licence fees will be charged for the subscriber terminals which connect to the Licensee's communications network.

Part 3: Reporting

6 Records and Reporting

6.1 The Licensee shall maintain current records as required by the applicable regulatory framework, including but not limited to:

6.1.1 The equipment specifications of all stations and other radio communications equipment operating under the Radio Spectrum Licence;

6.1.2 The coordinates of the network of each emitting Station;

6.1.3 The effective radiated power of any emitting Station and its location and height;

6.1.4 The measures taken to ensure that each emitting station is not a source of harmful radiation to the public, and the Licensee's employees and contractors;

6.2 The Licensee shall send updated copy of such records to the Authority on a quarterly basis for every year during which the Licence is in force.

6.3 The licensee shall provide the Authority with the following details for all the radio base stations upon commissioning:

o Geographical coordinates;

o Transmit power;

o Antenna Height;

o Type of Antenna;

o Antenna gain;

o Type of Equipment

6.4 The Licensee shall provide the BOCRA, within 14 days of written request or any longer period allowed in writing by the BOCRA, with any documents, accounts, returns, estimates, reports or other information specified by the BOCRA in order to enable the BOCRA to exercise its functions and powers under the Act or to enable the BOCRA to monitor and enforce compliance with the Licence, Regulations and guidelines issued under the Act.

Part 4: Co-ordination and Standards

7 International Boundaries Co-ordination

7.1 All licensees of radio communication services, whose operating region is near or adjacent to the Botswana's international border, must ensure that radio signals from its equipment are contained within the geographical areas of the country. Where co-ordination is required with neighbouring countries, the licensee must make a written application for such co-ordination to the Authority.

8 Channel Co-ordination

8.1 Licensees are required to adhere to technical specifications on emission and to co-ordinate with spectrum licensees in the adjacent and co-channel frequency slots to control their out-of-band emissions to avoid interfering with each other.

9 Interference

9.1 The Licensee shall coordinate with other holders of spectrum licences as necessary to resolve radio frequency interference issues.

9.2 A Licensee’s service may not cause interference to existing TV broadcasting assignments.

9.3 In the event that a Licensee’s service does cause interference to existing TV broadcasting assignments., mitigation measures must be taken by the Licensee, even to the point of ceasing operation if other suitable frequencies cannot be found.

10 Technical Standards

10 The Licensee shall comply with any Regulations and any directions as may be issued under the Act in relation to technical standards to be used within the Licensed System and for Terminal Equipment.

11 Type Approval of Equipment

11.1 The Licensee shall ensure that its equipment is type approved by the Authority before commencing operations; and such other equipment as are acquired after commencement of operations shall also be type approved in accordance with the Act.

Part 5: Spectrum Sharing and trading

12 Spectrum Sharing

12.1 The Licensee may offer to make spectrum available to another holder of a spectrum licence, provided that the technical standards and specifications applicable to the relevant spectrum have been complied with.

12.2 Spectrum sharing between Licensees shall be subject to prior written approval by BOCRA;

12.3 The Authority shall have the right to refuse to permit sharing in the event that it would not be in the best interests of Botswana as may be determined by the Authority, taking into account competition in the market and efficient management of spectrum

13 Spectrum Trading

13.1 The Licensee may trade spectrum to another holder of a spectrum licence.

13.2 Spectrum trading between Licensees shall be subject to prior written approval by BOCRA;

13.3 The Authority shall have the right to refuse to permit trading in the event that it would not be in the best interests of Botswana as may be determined by the Authority, taking into account competition in the market and efficient management of spectrum.

Part 6: Health and Safety

14 Health and Safety

14.1 The Licensee shall comply with any rules, Industry Code of Conduct and any guidelines issued from time to time by the Authority in relation to health and safety standards or procedures.

14.2 The Licensee will ensure that non-ionising radiation emissions from each radio installation or terminal equipment which it operates under this Licence are within the limits set by the International Commission for Non-Ionising Radiation Protection (CNIRP) and will ensure that it complies with any radiation emission standards set by ICNIRP, the Botswana Bureau of Standards, or specified by any Legislation or Regulation in Botswana.

Part 7: Enforcement and General Conditions

15 Force Majeure

15.1 The Licensee shall not to be held in contravention of this Licence if and to the extent that the contravention arises from an event of Force Majeure. The Licensee's obligations shall, to the extent necessary, be suspended while the event of Force Majeure continues.

15.2 The Licensee shall advise the Authority as soon as reasonably practicable upon becoming aware of the existence of any Force Majeure event or circumstances likely to lead to such event. The Licensee shall have the onus of proving the existence of a Force Majeure event.

16 Enforcement and Penalties

16.1 Subject to Section 88 of the Act, the Authority may impose any penalty it deems fit in the event of breach of any of the Conditions.

17 Indemnity

17.1 The Licensee shall indemnify the Authority against any claims for liability or damage which may occur as a result of the Licensee failing to comply with any condition under this Licence or direction given by the Authority in terms of the Act.

18 Amendments

18.1 Subject to the provisions of section 83 (3) of the Act, the Authority may vary any term or condition of this Licence, provided that the Authority shall, in these circumstances, provide the Licensee with reasonable notice of its intentions to do so and afford the Licensee a reasonable opportunity to make any representations in response.

18.2 The Authority may, on service of written notice on the Licensee at any time cancel any condition or any part of a Condition and may, at the time of cancellation or subsequently, require Licensees of the same type of Licence to enter into and adhere to a Code of Practice in relation to the matters addressed in the cancelled condition or part.

19 Assignment of Licence

19.1 The Licensee may transfer or assign the rights, interests, or obligations under this Licence to another person.

19.2 Such transfer or assignment shall be subject to prior written approval by BOCRA;

19.3 The Authority shall have the right to refuse to permit transfer or assignment in the event that it would not be in the best interests of Botswana as may be determined by the Authority, taking into account competition in the market and efficient management of spectrum.

20 Use-It-Or-Lose-It

20.1 The Licensee shall use the assigned frequencies efficiently and shall notify the Authority promptly if the Licensee no longer requires the use of any portion of the frequency assigned.

20.2 The Authority may direct the Licensee to identify and release for return to the Authority any or all of the assigned frequencies if the Authority determines that the spectrum is not being used or that it is being used inefficiently. The Licensee shall comply with any instructions issued by the Authority in the interests of maximising spectrum efficiency and in the best interests of Botswana. The Licensee shall comply with any reasonable timetables for the release of radio spectrum bands designated by the Authority for return.

21 Financial capacity and Funding

21.1 The Licensee shall satisfy the Authority before the Licence Date that it has the financial capacity necessary to meet all of its obligations under this Licence through a financial guarantee which adequately covers the Licensee's peak funding requirements (as per schedule IV) or such other form of financial assurances as the Authority may approve in writing ("financial guarantee).

21.2 Subject to the Authority's prior written approval, the quantum of the financial guarantee may be reduced on a proportional basis from time to time as and when the Authority is satisfied that the Licensee has discharged the obligations to be covered by its peak funding requirements, including without limitation, achievement of infrastructure roll-out and the related coverage commitments contained in the Licence.

22 Revocation

22.1 Without limiting the general application of Section 86 of the Act, the BOCRA may, on service of written notice on the Licensee, revoke this Licence if the Licensee:

22.2 Ceases to operate facilities, systems or infrastructure for 12 consecutive months

22.3 Fails to pay any fees or penalty due under this Licence

22.4 Agrees in writing with the Authority that this Licence be revoked;

22.5 Without due authorisation from the Authority uses the frequency bands assigned to it under this Licence for the operation of facilities, systems or infrastructure

22.6 Fails to eliminate interference caused to other users after being duly directed to do so by the Authority;

22.7 Is placed into liquidation or under a provisional or final judicial management order.

22.8 Is in breach of any of the conditions of this Licence or the NFL Licence or any provisions of the Act, the Regulations, code of practice or industry standards and such breach has not been rectified within the period required by the Authority. In any such case the Authority may terminate this Licence and/or the NFL Licence.

23 Miscellaneous Provisions

23.1 The Licensee shall observe and abide by all laws of Botswana.

23.2 The BOCRA may direct the Licensee and any other Operators to design a code of practice in a form to be approved by the BOCRA, and such code of practice shall be binding on the Operators after approval by the BOCRA.

23.3 The Licensee shall comply with any other guidelines; industry codes or Regulations as shall be promulgated under the Act from time to time.

23.4 The Licensee shall at all times display its Radio Spectrum Licence in a conspicuous place at the Licensee's registered offices.

23.5 The Licensee's registered offices for the purposes of this Licence shall be as described on the Licence Notice, which shall not be changed without providing prior written notice to the Authority.

23.6 All written notices to the BOCRA shall be marked for the attention of the Chief Executive and shall be hand delivered to:

BOTSWANA COMMUNICATIONS REGULATORY AUTHORITY

206/7 Independence Avenue

Private Bag 00495

Gaborone, Botswana

or such other address, which the BOCRA may specify in writing to the Licensee.

LIST OF LICENCE SCHEDULES

o Frequency Assignment

o Geographic Area of Operation

o Technical Specifications

o Financial capacity and Funding

Annex G. How to respond

G.1. How to respond

G.1.1. BOCRA invites all Stakeholders to provide written views and comments on the issues raised in this document and answers to the specific questions raised be made by

G.1.2. 5pm on 18 January 2019. Any responses received after the closing date will not be opened and will not be considered as part of the consultation process.

G.1.3. Stakeholders should use the form to respond to the specific recommendations. This allows BOCRA to process the responses quickly and efficiently so as not to delay the development of the Spectrum Management Strategy. If Stakeholders wish to provide additional written comment, then they are free to do so. However, every response should be accompanied by a suitably completed Cover Sheet which ensures that respondents confidentiality issues can be respected.

G.1.4. Consultation responses should be sent in an editable Word document to mosinyi@bocra.org.bw.

G.1.5. BOCRA will acknowledge receipt of responses if they received at the above email address.

G.1.6. It would be appreciated by Coleago if your response could include direct answers to the proposals made in this document, which are listed together in Annex A. It would also be helpful if you can explain why you hold your views and how the alternative proposals or approaches would impact on you. This greatly increases BOCRA's ability to take your views into account as it develops its Spectrum Management Strategy and other ongoing spectrum-related work.

G.2. Further information

G.2.1. If you want to discuss the issues and proposals raised in this consultation, or need advice on the appropriate form of response, please contact Basebi Mosinyi on email mosinyi@bocra.org.bw.

G.3. Confidentiality

G.3.1. In accordance with BOCRA's values of openness and transparency, BOCRA believes that it is important for all stakeholders and interested parties to see the views of all those who provide input into the consultation process. BOCRA will therefore usually publish all responses on its website, www.bocra.org.bw.

G.3.2. If you believe that parts of your response should be kept confidential then please indicate which parts and why. Please provide reasons relating to the commercially sensitive nature of the information, the applicability of non-disclosure obligations to the information, concerns about reprisals from other market participants, or other genuine reasons. Blanket and unjustified requests will not be accepted. In addition, those elements that you wish to remain confidential should be placed in a separate document and clearly identified as confidential.

G.3.3. If a Stakeholder requests that part or all of a response should be confidential, then BOCRA will give this request due consideration and will endeavour to respect it. However, sometimes BOCRA will have to publish all responses, including those that are marked as confidential, in order to meet its legal obligations. Stakeholders should keep this in mind when preparing their responses.

G.3.4. Please be aware that copyright and all other intellectual property contained within the responses will be assumed to be licensed to BOCRA to use as it sees fit.

G.4. BOCRA's consultation processes

G.4.1. BOCRA is always seeking to improve the manner in which it communicates and engages with Stakeholders. If you have any comments or suggestions on how this process can be improved, then please e-mail BOCRA at info@bocra.org.bw.

G.4.2. If you would like to discuss these issues or BOCRA's consultation processes more generally you can contact Mr Aaron Nyelesi on email nyelesi@bocra.org.bw or by phone on 71313765. or in writing to P/Bag 00495 Gaborone.

Annex H. Consultation Response Forms

Final Consultation on Spectrum Management, Licensing and Pricing

Consultation Response Cover Sheet

Your title _____

Your name _____

Name of the company you represent _____

Your telephone number _____

Your email address _____

Confidentiality

Do you wish for some or all of your response to be kept confidential? YES ☐ NO ☐

If YES, please indicate below which part of your response is confidential and give your reasons:

Declaration

I confirm that the information I have submitted with this cover sheet is a formal response to the Initial Consultation on Spectrum Management, Licensing and Pricing and that BOCRA can publish all responses. I understand that BOCRA will respect any request for confidentiality indicated above except where it has to publish information in order to meet legal obligations. If I am submitting my response by email, BOCRA can disregard any standard email clause regarding disclosure of email contents and attachments.

BOCRA will publish all responses as and when they are received. However, if you prefer BOCRA to withold your non-confidential response until the consultation period has ended, please tick this box. ☐

Signed: _____ **Name:** _____

BOCRA

Final Consultation on Spectrum Management, Licensing and Pricing

Consultation Response Form

Please complete this form in full and return in Word format via email to mosinyi@bocra.org.bw .

Your name _____ Your telephone number _____

Company _____ Your email address _____

Please use the following table to provide your responses to the issues raised in the consultation document. For each comment, please indicate whether you would prefer your response to be kept confidential. Any responses which are marked neither "yes" or "no" to confidentiality will be taken as non-confidential.

Proposal Number	Subject	Your Comments	Confidential?
			Yes / No
			Yes / No
			Yes / No
			Yes / No
			Yes / No