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ENHANCING CONNECTIVITY THROUGH SPECTRUM SHARING

A White Paper

SEPTEMBER 2019

CONTENTS

1. EXECUTIVE SUMMARY AND KEY INSIGHTS

This paper, based on research conducted by Policy Impact Partners (PIP), in association with the Dynamic Spectrum Alliance, explores how new forms of spectrum sharing could enable many more people to benefit from broadband connectivity and digital services. In particular, it considers the opportunities in Colombia, Malaysia and South Africa – large and populous economies in very different regions of the world.

In all three countries, government and industry stakeholders are open to exploring new approaches to spectrum sharing in different frequency bands, including those identified for international mobile telecommunications (IMT), which are served by a large and competitive LTE device market. Today, this IMT spectrum is not being fully exploited: public sector officials and industry players in Colombia, Malaysia and South Africa recognize that more efficient use of this spectrum could help close the digital divide between urban and rural areas. In Colombia, some stakeholders believe spectrum sharing could also increase spectrum efficiency in suburban/urban areas, as well as rural areas, and boost competition.

But the research also uncovered some concerns: In Malaysia, for example, some industry players raised questions relating to the development of a sustainable business model for spectrum sharing and rural connectivity, while in South Africa, some stakeholders believe that the existing regulatory provisions for spectrum sharing are too vague. Although there are no significant regulatory obstacles in Colombia, Malaysia and South Africa, regulatory frameworks may be needed to clarify the rules that would govern new forms of spectrum sharing.

Renewed interest in spectrum sharing is being kindled by increasingly sophisticated techniques that use databases of assignments and environmental sensing technologies to dynamically allocate spectrum between different tiers of users, while protecting incumbents. In cases where an IMT band is being partially used by an incumbent, such as a public agency or the military, the band could be a candidate for tiered spectrum sharing of the kind employed in the 3.5GHz band in the U.S.

PREPARING FOR TECHNOLOGY TRIALS

Public sector and industry stakeholders in Colombia, Malaysia and South Africa indicate they would support trials of new spectrum sharing technologies in IMT bands. Such trials would provide stakeholders with insights into the potential of tiered models for spectrum sharing and any related technological and regulatory issues that might arise. Within Colombia, Malaysia, South Africa and other countries, technology trials would also help to raise awareness of the potential of new forms of spectrum sharing.

The optimum way to implement technology trials would be through partnerships between the relevant industry players, authorized by the spectrum authorities and, in some cases, with the support of an independent entity, such as the Council for Scientific and Industrial Research (CSIR) in South Africa, which has already conducted a broadband gap analysis and participated in TVWS spectrum sharing trials.

Also in Colombia, the Ministry of Information and Communications Technology and Colnodo, are running a technology trial in the 900MHz band to determine the viability of community networks in remote unserved areas. Tiered spectrum sharing trials could provide a framework for this kind of not-for-profit initiatives.

Ideally, technology trials would be conducted in the 2.3GHz and 2.6GHz bands, as they could typically offer 30MHz to 50MHz of spectrum – sufficient to provide reasonable speeds for rural connectivity and to provide 5G services.

However, in some cases, it may be necessary to conduct the initial technology trials in other IMT bands. That's because some countries are in the process of licensing frequencies in the 2.3GHz and 2.6GHz bands, which may make it impractical to use this spectrum for a near-term technology trial.

In Colombia, for example, the 2.3GHz and 2.6GHz bands are reserved for IMT, but some of this spectrum has not yet been assigned. The government has announced that the remaining spectrum in the 2.6GHz band will be auctioned in Q4 2019, but it is unclear when the 2.3GHz band will be licensed.

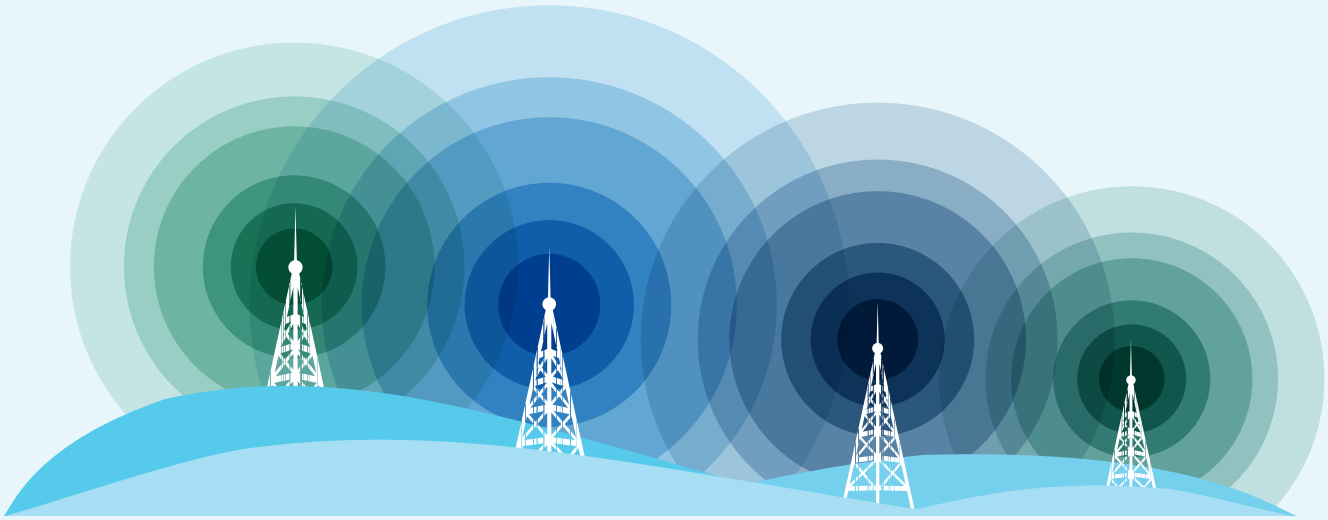
In Malaysia, spectrum in the 2.3GHz and 2.6GHz bands have been subject to short-term Apparatus Assignments, which confer rights on a person to use the spectrum to operate a network facility of a specified kind at a specified frequency. But a Public Inquiry on 'Allocation of Spectrum Bands for Mobile Broadband Service' undertaken by the regulator in Q3 2019 is likely to result in these bands being licensed on a longer-term basis to support IMT services.

In South Africa, parts of the 2.3GHz, 2.6GHz and 3.5GHz bands have been assigned to mobile operators. The government looks set to license several IMT spectrum bands to the WOAN (wireless open access network) and other licensees during Q2 2020. This could involve auctions of frequencies in the 700MHz, 800MHz, 2.3GHz, 2.6GHz and 3.5GHz bands. However, if necessary, the 900MHz and 1800MHz bands could be employed for a near-term spectrum sharing technology trial in South Africa.

In summary, the best way to trial and ultimately implement spectrum sharing will vary country by country, depending on how the specific frequency band is being used today, the regulatory framework, existing authorizations and potential partnership opportunities.

Yet there is a clear consensus, across public and private sector stakeholders, that well-designed dynamic and other spectrum sharing models could expand access to mobile broadband, whilst ensuring incumbent applications are protected. Both governments and industry players recognize the clear need to make far more efficient use of this valuable resource.

In Colombia, Malaysia and South Africa, PIP is now engaging with the relevant stakeholders to identify potential geographies, spectrum bands and technological mechanisms for trials that will explore the potential of spectrum sharing to significantly boost the availability and adoption of mobile broadband.



2. INTRODUCTION

With the latest technological advances, spectrum sharing presents new opportunities to bridge the digital divides between urban and rural areas and between the connected and the unconnected. But what is spectrum sharing? How can new developments in technology make this a useful tool for rural connectivity? Are governments ready to adopt this new solution?

This white paper addresses the above questions and offers some insights into what needs to happen to enable spectrum sharing to better optimize usage of spectrum, improve connectivity and achieve governments' broader goals of digital inclusion and a digital economy that is open to all.

As well as exploring how technological advances can enable new forms of spectrum sharing, the paper outlines the findings of PIP's research into the spectrum sharing opportunities in Colombia, Malaysia and South Africa – large and populous economies in very different regions of the world. These three countries were selected following a proof of concept analysis undertaken by PIP in December 2018, which highlighted the potential for spectrum sharing in each market. During Q3 of 2019, PIP engaged with government and industry stakeholders in these three countries to identify whether they could harness spectrum sharing to increase access to broadband in line with their policy objectives and the United Nations' Sustainable Development Goals.

BACKGROUND

In September 2015, United Nations Member States adopted the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs). The SDGs call on all nations and stakeholders to work together to build economic prosperity and a better quality of life for all – through a set of integrated priorities for people, the planet, prosperity and growth, partnership, and peace (see Figure 1).

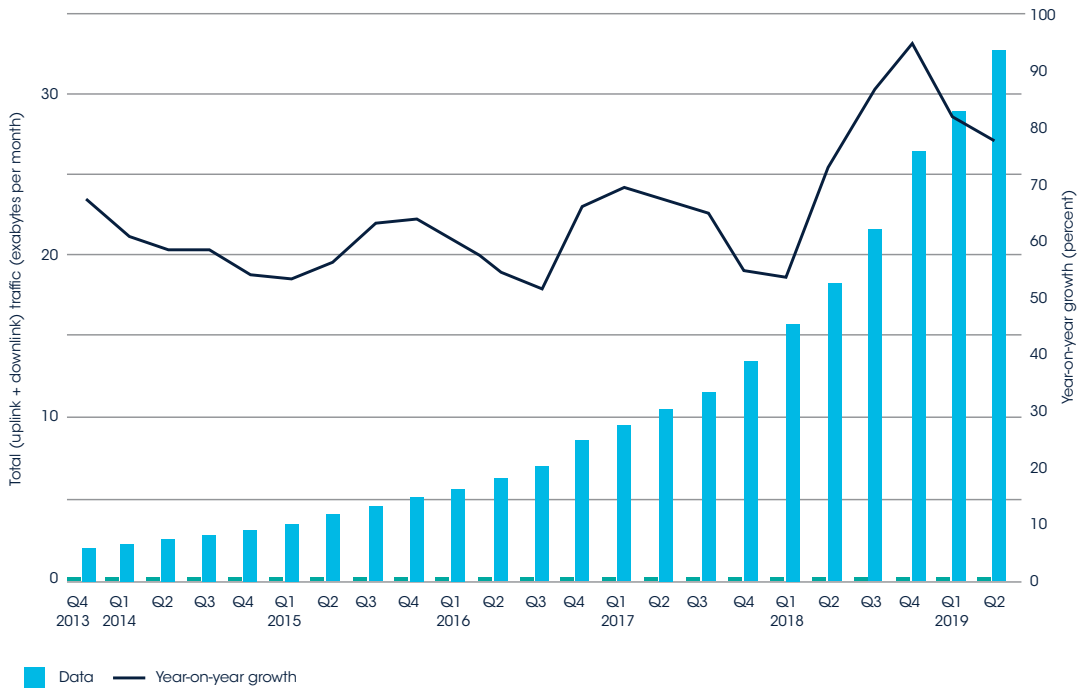
Information and communications technology (ICT) is playing an important role in achieving progress towards the SDGs and the tech and telecoms industries have thus been a strong advocate of these global goals. The pervasiveness of mobile technology[1], for example, has made the mobile phone the main consumer device to access the internet, pay for goods and services, check basic health status, and access various government and other public services, as well as make voice calls and exchange messages. It has become an enabling tool for information and learning, commerce, financial services, health and well-being, and social inclusion.

FIGURE 1: THE 17 SUSTAINABLE DEVELOPMENT GOALS

Source: The United Nations

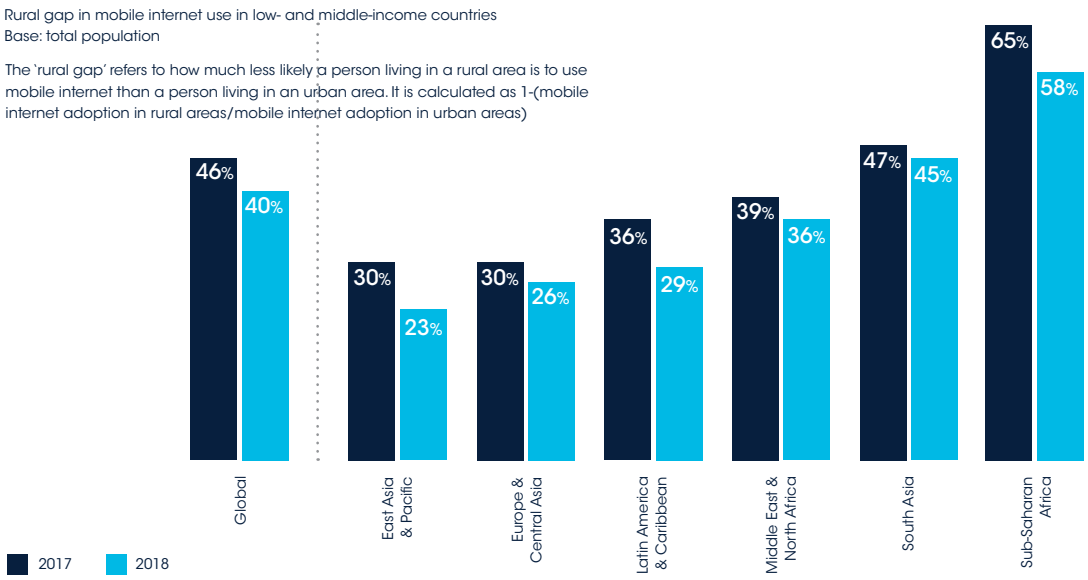
[1] At the end of 2018, 5.1 billion people were connected to mobile services. That's more than two third of the world's population. See GSMA, The Mobile Economy 2019.

FIGURE 2: THE DATA TRAFFIC ON MOBILE NETWORKS IS GROWING BY MORE THAN 70% A YEAR



Source: Ericsson Mobility Report, June 2019.

FIGURE 3: MANY RURAL COMMUNITIES IN THE DEVELOPING WORLD REMAIN OFFLINE



Source: the GSMA, The State of Mobile Internet Connectivity Report 2019

There are now more than 3.5 billion mobile internet users worldwide[2] and mobile data traffic is rising fast[3] (see Figure 2). Traffic on Wi-Fi networks is also growing rapidly. By 2022, wired networks will account for just 29% of IP traffic, while Wi-Fi and mobile networks will account for 71% of IP traffic, according to Cisco, up from 52% in 2017. Globally, there will be nearly 549 million public Wi-Fi hot spots by 2022, up from 124 million hot spots in 2017, Cisco says.

While internet usage continues to grow at impressive rates, it is important to recognize that the growth is not evenly distributed – the rural-urban divide still exists in many countries[4] (see Figure 3) and fairly large segments of the population remain unconnected.[5] In South Africa, for example, a study by the Council for Scientific and Industrial Research (CSIR) found that more than one fifth of the population live in areas without LTE/4G coverage (see box).

The persistent digital divide between urban and rural areas presents multiple challenges for policymakers. On the one hand, they have to grapple with how to best use their limited spectrum resources to enable new technologies, such as 5G, Wi-Fi 6 and the industrial Internet-of-things, which will continue to drive data traffic levels even higher. At the same time, proactive steps must be taken to close the digital divide, advance the SDGs and deliver on the promise of a thriving digital economy for all citizens.

Bold ambitions call for bold actions: there is a need for a new level of openness on the part of all stakeholders to explore new ideas and collaborative efforts to find viable solutions. Whilst many governments have put in place new ICT strategies, and taken steps to improve their universal service programs, much more needs to happen and sooner rather than later.

Traditional approaches to driving internet network roll-out and uptake are failing to reach the remaining half of the global population still lacking online access, according to a new report by the Broadband Commission for Sustainable Development.[6] The report calls for new collaborative strategies to drive "meaningful universal connectivity" through greater emphasis on resource sharing and a more holistic approach that treats broadband as a vital enabler of global development.

Technological advances have made it possible for spectrum to be shared in a more efficient manner and boost connectivity. Sharing spectrum could potentially help governments ensure that no citizen is left behind in the digital age, and that access to connectivity and the internet is not a luxury, but a basic service accessible to all.

[2] Globally, there were 3.54 billion mobile internet users in 2018. See GSMA, The State of Mobile Internet Connectivity Report 2019.
[3] Mobile data traffic grew 82% between Q1 2018 and Q1 2019 – driven mostly by new smartphone subscriptions and an increasing average data volume per subscription. See Ericsson Mobility Report, June 2019. In the last 20 years, total internet traffic has grown exponentially. In 1992 for example, global internet networks carried approximately 100 GB of traffic per day whereas ten years later, that traffic amounted to 100 Gigabytes per second in 2002. In 2017, global internet traffic reached more than 45,000 Gigabytes per second. See Cisco Visual Networking Index: Forecast and Trends, 2017–2022 White Paper.
[4] For example, 3G mobile broadband coverage extends to 89% of the world's urban population, but only 29% of the rural population (see United Nations, The Sustainable Development Goals Report 2016). By 2016, the proportion of the population covered by a 3G mobile broadband network stood at 61% in least developed countries and 84% globally (see United Nations, The Sustainable Development Goals Report 2018).
[5] More than 4 billion people remain offline and this is due to both coverage challenges (which refer to populations with no access to 3G or 4G network coverage) and usage challenges (which refer to populations that live within the footprint of a mobile internet network (3G or 4G) but are not accessing mobile internet services). See GSMA, State of Mobile Internet Connectivity 2018.
[6] State of Broadband Report: https://www.broadbandcommission.org/Documents/StateofBroadband19.pdf

IDENTIFYING SOUTH AFRICA'S UNCONNECTED

Summary of network coverage gap analysis conducted by the Council for Scientific and Industrial Research (CSIR) in November 2018

The objectives of the CSIR study were to:

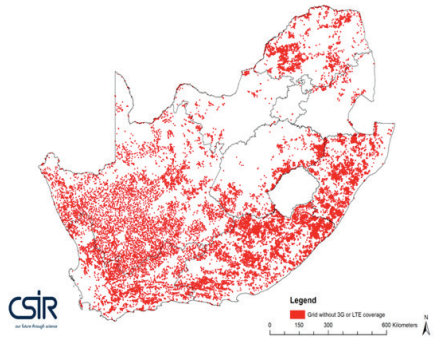
- Determine the telecommunications infrastructure gap at a municipal district, provincial and country level, in relation to the 22 million people who are not connected to the internet.
- Conduct an analysis of this gap and identify priority areas for the provision of connectivity.
- Provide a basis/guideline for addressing infrastructure deployment/roll-out in a targeted, prioritized and focused approach.

Methodology: Using coverage maps supplied by South Africa's MNOs, the study identified areas without 3G or 4G/LTE coverage. The number of people in each area with no 3G or 4G coverage was then obtained from Census 2011 and Dwelling Frame data 2015 from Statistics South Africa, as well as the Eskom Spot Building Count (SBC) data, which together help to determine where people live in an area.

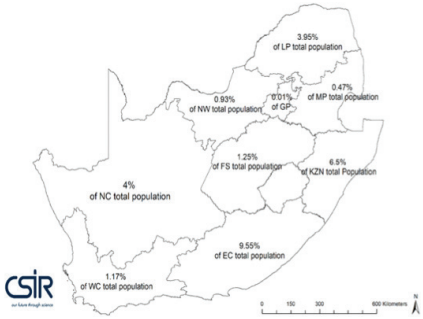
Findings: In South Africa, there is extensive 3G population coverage (only 3.5% lack coverage), but 21.8% of the population live in areas without 4G/LTE coverage. Approximately two million people, out of the total population of 55.8 million, do not have coverage from a 3G or 4G network.

The provinces with the largest coverage gaps are Eastern Cape (9.55%), Kwa-Zulu Natal (6.5%), Northern Cape (4%) and Limpopo (3.95%).

NETWORK COVERAGE GAP FOR SOUTH AFRICA



SOUTH AFRICA POPULATION NETWORK COVERAGE GAP



	DATA SET	TOTAL POPULATION	POPULATION NO 3G	POPULATION NO LTE
Gauteng Province	1km Grid Population 2016	13,896,326	4,799 (0.03%)	86,337 (0.62%)
WC Province	1km Grid Population 2016	6.410,241	77,230 (1.2%)	579,419 (9%)
NC Province	1km Grid Population 2016	1,192,280	48,337 (4%)	361,730 (30.3%)
MP Province	1km Grid Population 2016	4,393,769	21,102 (0.48%)	522,597 (11.8%)
KZN Province	1km Grid Population 2016	11,017,001	859,245 (7.7%)	5,147,354 (46.7%)
FS Province	1km Grid Population 2016	2,916,956	37,171 (1.27%)	409,492 (14%)
NW Province	1km Grid Population 2016	3,780,907	35,428 (0.93%)	447,927 (11.8%)
EC Province	1km Grid Population 2016	6,530,207	682,698 (10.45)	3,460,872 (52.99%)
Limpopo Province	1km Grid Population 2016	5,691,667	239,100 (4.2%)	1,177,324 (20.68%)
South Africa	**1km Grid Population Total 55,569,390**	**55,829,354**	**2,005,110 (3.5%)**	**12,193,052 (21.8%)**

3. SHARING IMT SPECTRUM

More efficient use of spectrum can help countries pursue their strategic objectives to improve broadband connectivity and increase digital inclusion.

Through the ITU, a number of spectrum bands in the 700MHz to 3GHz range have been identified to support international mobile telecommunications (IMT). These include the 700MHz, 900MHz, AWS, 1800MHz, 2100MHz, 2.3GHz, 2.6GHz and 3.5GHz bands.

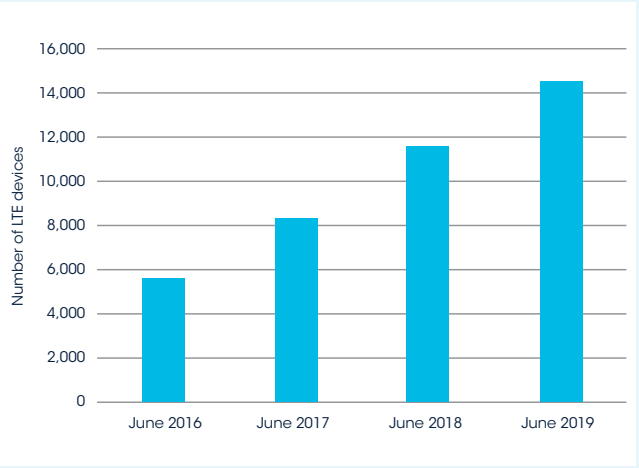
Spectrum bands below 3GHz have good propagation characteristics, helping to reduce the cost of providing extensive coverage, thereby enabling end-users to benefit from low service prices. However, in many countries, this IMT spectrum, which is generally used by mobile network operators to provide cellular connectivity, is not being fully exploited.

Research undertaken by PIP suggests that well-designed dynamic and other spectrum sharing models could help countries make more efficient use of this valuable resource to expand access to mobile broadband, whilst ensuring incumbent applications are protected. Spectrum sharing in bands that have already been identified for use by IMT could allow for service providers to deploy infrastructure quickly and take advantage of the large and competitive LTE device market (see Figure 4).

FIGURE 4: A WIDE RANGE OF LTE DEVICES ARE AVAILABLE IN EACH OF THE IMT BANDS

LTE FDD BAND	NUMBER OF DEVICES
1800 MHz Band 3	9,976
2600 MHz Band 7	8,790
2100 MHz Band 1	8,236
800 MHz Band 20	5,865
850 MHz Band 5	5,330
900 MHz Band 8	5,014
AWS Band 4	4,054
1900 MHz Band 2	3,805
700 MHz Band 17	2,605
APT700 Band 28	1,789
700 MHz Band 13	1,565
700 MHz Band 12	1,554
1900 MHz Band 25	801

LTE TDD BAND	NUMBER OF DEVICES
2300 MHz Band 40	5,052
2600 MHz Band 38	3,857
2600 MHz Band 41	3,804
1900 MHz Band 39	2,795
2000 MHz Band 34	294
3500 MHz Band 42	261
3500 MHz Band 43	199



Source: GSA, Status of the LTE Ecosystem, June 2019

Increasingly sophisticated technologies using databases of assignments and radio sensing technologies could allow for the implementation of innovative new spectrum sharing models that can dynamically allocate spectrum between different tiers of users, while protecting incumbents. In cases where an IMT band is being partially used by an incumbent, such as a public agency or the military, the band could be a candidate for tiered spectrum sharing of the kind employed in the 3.5GHz band in the U.S.

Our initial research indicates that in some countries, the 2.3GHz and 2.6GHz bands have either not been authorized for mobile broadband use, because they are used by public sector incumbents (such as the military), or are not being used by the incumbent in many areas for economic reasons. As a result, the 2.3GHz and 2.6GHz bands are currently under-utilized and could be employed to trial innovative spectrum sharing models. The 2.3GHz and 2.6GHz bands could typically offer 30MHz to 50MHz of spectrum – sufficient to provide reasonable speeds for rural connectivity and to provide 5G services. However, the situation varies country by country. In each market, the best way to implement spectrum sharing will depend on how the specific frequency band is being used today, the regulatory framework, existing authorizations and potential partnership opportunities.

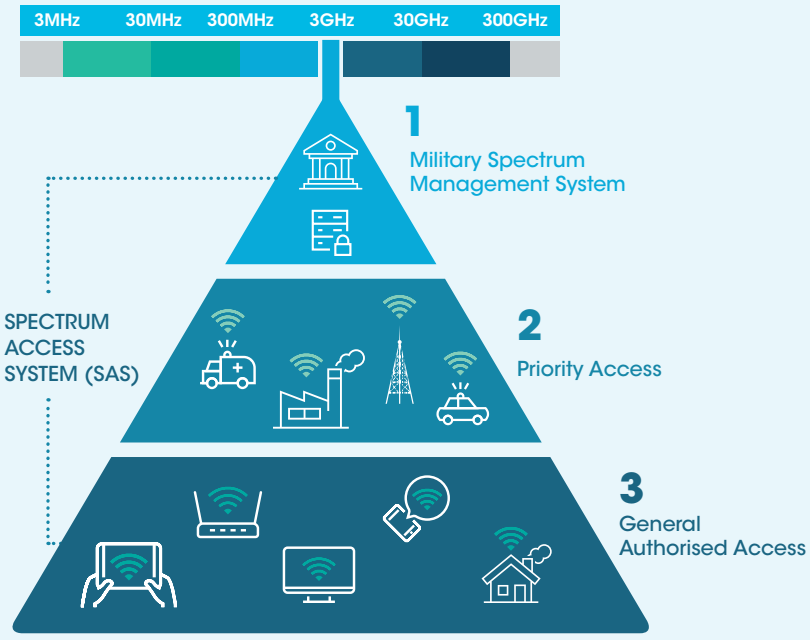
TIERED SPECTRUM SHARING MODELS

PIP is researching whether a tiered spectrum sharing model (TSSM), in which access to IMT spectrum is prioritized by user, could result in more efficient use of this valuable resource. In some cases, the spectrum could be prioritized dynamically using sensors to determine when specific frequencies are being used by the incumbent and when they are available to the next tier of users.

UNITED STATES

For example, the Federal Communications Commission (FCC) in the U.S. has developed a three-tiered spectrum sharing model called Citizens Broadband Radio Service (CBRS). It is administered and enforced by a spectrum access system (SAS) that is designed to provide dynamic and secure allocation of spectrum resources in real time.

FIGURE 5: THE THREE-TIER MODEL USED BY THE CITIZENS BROADBAND RADIO SERVICE



Source: http://federatedwireless.com/wp-content/uploads/2017/02/CBRS-Spectrum-Sharing-Overview.pdf

When the system's sensors detect a federal transmission (the top tier) using an environmental sensing capability (ESC), it activates a protection zone and informs the SAS to dynamically reallocate users in the area to alternative parts of the band. In this way, the SAS ensures that spectrum is always available for military applications and for other public sector incumbents at the time and place it is needed. In the second tier, spectrum is allocated to commercial users who buy priority access licenses for a specified location and period of time. The remaining spectrum can then be used for general authorized access (GAA). The FCC specifications require the SAS to ensure that 80MHz of spectrum will always be available for GAA use, and sometimes as much as the full 150MHz will be available, if none of the Tier 1 or Tier 2 users need the spectrum.

A TSSM model, similar to that used for CBRS, needs access to sufficient spectrum. For technology trials, at least 30MHz of spectrum would be needed, while 70-100MHz is optimal. The relatively complex ESC used for CBRS is due to the nature of the incumbents involved in the US. It may be easier to deploy simpler spectrum sharing models while ensuring protection for incumbents. The number of 'tiers' required in a TSSM depends on the number of uses involved in a given band. For example, a two-tier model could enable spectrum licensed to a mobile operator to be dynamically used by third parties to deliver services in a rural area. Or it could be feasible to sub-lease some of the frequencies held by a mobile operator to an MVNO or a third party. In some countries, vacant IMT spectrum could be utilized by mobile operators via a wholesale open access network (WOAN), such as that being deployed in South Africa.

THE NEW SPECTRUM SHARING FRAMEWORK IN THE U.K.

In the U.K., regulator Ofcom is taking a different approach to that of the FCC. It is making available frequencies in the 1800MHz, 2.3GHz and 3.8-4.2GHz bands to new users under a new spectrum sharing framework[7]. It plans to manage and coordinate access to these bands on a per location, first-come, first-served basis. It is also adding further spectrum in the 26GHz band to this framework. Ofcom says people can apply for two types of shared access licence to cater for different types of potential uses:

- Low power licence (per area licence) to deploy the required number of base stations in a circular area with a 50-metre radius. For large sites, people can apply for multiple licence areas to achieve the required coverage area.
- Medium power licence (per base station licence) to be issued on a per base station basis and, generally, for deployments in rural areas only, where they are unlikely to constrain low power users.

Where mobile terminals are deployed in the 3.8-4.2GHz band, licensees must keep an accurate record of them and of the address of the site or building they are limited to operate within. Ofcom says it is not permitting this band to be used to provide national mobile broadband services because this could deny opportunities for local users. It has published proposals to award national licences for spectrum in the 3.6-3.8GHz band for that purpose.

Ofcom will charge the following annual licence fees for both the low power licence (charged on a per area basis) and medium power licence (charged on a per base station basis):

- £80 per 10MHz for 3.8-4.2GHz (so 20MHz = £160; 100MHz = £800 etc.)
- £80 for 2300MHz shared spectrum (10MHz) and 1800MHz shared spectrum (2 x 3.3MHz)

The licence will include conditions enabling Ofcom to require transmitting equipment to change frequency (within the 3.8-4.2GHz band) from time to time if necessary.

Where spectrum is licensed on a national basis to mobile network operators and is not being used in every location, Ofcom says it would be appropriate to enable access to this spectrum for new users. If Ofcom agrees, following discussion with the incumbent licensee, that the new user is unlikely to interfere with their network or constrain their future plans, it will issue a local access licence.

Ofcom anticipates that spectrum is only likely to be available to share in remote areas, but it could be used in these locations to support, for example, private networks or wireless broadband services. There may also be other locations that are not served by the existing mobile network, for example, underground mining operations, where mobile technology could be used to support a private network without impacting the incumbent networks or their future plans.

[7] Source: https://www.ofcom.org.uk/__data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf

Ofcom says it will consider applications for short-term access to licensed mobile bands (the default period will be three years) in specified locations. The first consideration will be to confirm that the spectrum is not being used in that location and that a new user in that area would not interfere with existing or planned use of the band.

Ofcom is also considering whether it would be appropriate to transition towards a dynamic spectrum access approach supported by a fully automated central database in the bands outlined under its spectrum sharing framework. It plans to work with industry in developing its approach.

4. EXPLORING SPECTRUM SHARING AS A SOLUTION FOR RURAL CONNECTIVITY

In 2018, PIP conducted an in-depth analysis of the relevant IMT bands in the 700MHz – 3GHz range across a representative sample of developing countries.

The analysis identified IMT bands where some of the spectrum has not been fully authorized. In some cases, an IMT band is being partially used by an incumbent, such as a public agency or the military, but new technological mechanisms could allow such applications to co-exist with mobile broadband services. In particular, this proof of concept analysis highlighted the potential for spectrum sharing in Colombia and Malaysia in the 2.3GHz and 2.6GHz bands, and additional opportunities in the 3.5GHz band in South Africa. PIP's analysis found that these frequency bands typically have more spectrum available than other IMT bands.

In engagements with key stakeholders in Colombia, Malaysia and South Africa during Q3 2019, PIP discussed the potential of spectrum sharing with public sector and industry stakeholders and explored opportunities for conducting a technology trial. The key takeaways from these meetings, which are summarized in the following tables, are likely to be applicable or partly applicable to many other developing countries where a significant portion of the population remains unconnected.

METHODOLOGY

STAGE 1	STAGE 2	STAGE 3
Proof-of-concept phase consisting of interviews, one-to-one meetings and desk research	In-country research consisting of in-person meetings with key stakeholders including senior industry executives, government officials and regulators	Future engagements consisting of in-country stakeholder workshops to identify potential geographies, spectrum bands and technological mechanisms for trials

COLOMBIA

RELEVANT POLICY AND REGULATORY FRAMEWORK

Under the ICT Law of 2009, modified by Law 1978 of 2019, if service providers require spectrum, the Ministry of Information & Communications Technologies (MINTIC) grants a permit for spectrum use, usually through an auction.

Although Colombia does not have regulation for spectrum sharing, the government has indicated it will encourage spectrum sharing: In 2018, the National Spectrum Agency (ANE) commissioned a study to determine demand for IMT spectrum in Colombia and has consulted on new ways to access the spectrum, including proposals for spectrum sharing and commercialization of rights for spectrum use[8]. In 2015, ANE implemented a spectrum management system to keep the spectrum users' database up-to-date and facilitate the implementation of cognitive radio solutions in the mid-term. TVWS is fully regulated and recently ANE issued regulation on Free Spectrum Access that includes the V Band (57-71GHz) for point-to-point and RLAN services.

The new ICT Sector Modernization Law[9], which modified the ICT Law, allows spectrum cession with previous authorization by the MINTIC, which will regulate the conditions for the spectrum cession.

NATIONAL ICT AND BROADBAND GOALS

The government's new sectoral plan[10] 2018-2022 *The Digital Future Belongs to Everyone* covers many lines of action, based on public-private cooperation and with a focus on long-term sustainability. It has the following goals:

- Increase household Internet penetration from 50% to 70% (500,000 new households)
- Raise the percentage of population accessing the Internet from 62.3% to 80%
- Raise the number of Internet connections with throughput of > 10Mbps from 14.9 million to 32 million
- 15 million new 4G connections

To achieve these goals, the MINITIC has designed two programs:

1. Universal Service Program: Deployment of telecommunications infrastructure to provide connectivity to low-income households in rural areas (500,000 households).
2. Universal Access Program: Installation and operation of community Internet access centers. i) 1,000 Wi-Fi hotspots in rural areas around the country (378 municipalities) as part of the Sustainable Universal Access initiative (public-private partnerships); and ii) 10,000 digital centers in rural areas with satellite access (with public investment for 15 years operation). In addition, the ICT Ministry plans to reduce the digital divide by including in-kind payment obligations in current and future spectrum auction processes.

Finally the Peace Agreement signed between the government and the FARC-EP, section 1.31.3 calls for the development of a national plan for rural connectivity with the provision of solutions for community access to the internet, the deployment of infrastructure, and technical assistance to the communities concerned.

SPECTRUM USAGE AND EXISTING AUTHORIZATIONS

In Colombia, the 2.3GHz band is reserved for IMT, but the spectrum has not yet been assigned and it is unclear when this will happen. Some incumbents are already in the process of migrating to other bands.

In the 2.6GHz band, Claro and DirecTV have been assigned 4G spectrum licenses (30MHz and 70MHz respectively), but not all of the spectrum is being used.

The government plans to auction the remaining spectrum in the 2.6GHz band in Q4 2019.

TOWARDS SPECTRUM SHARING AND TECHNOLOGY TRIAL

The Ministry of Information and Communications Technologies and the ANE are open to the concept of spectrum sharing and the possibility of a technology trial.

Some stakeholders believe spectrum sharing could increase spectrum efficiency in suburban/urban areas, as well as rural areas, and boost competition.

Given the uncertainty around the availability of the 2.3GHz band, the 2.6GHz band is probably the best option for a technology trial in the near-term.

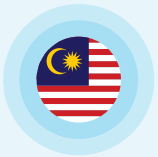
ISSUES / CONCERNS

The new "ICT Sector Modernization Law" does not regulate spectrum sharing directly. However, it allows spectrum cession and urges the government to regulate the conditions under which cession can be done, based on several criteria, such as efficient spectrum use, amongst others.

Although current regulation does not preclude spectrum sharing, either in assigned or unassigned bands, it is likely to be more feasible to implement spectrum sharing through existing licenses, than future licenses, in the near-term.

[8] https://www.ane.gov.co/images/ArchivosDescargables/consultapublica/esqcomparticion/EsquemasComparticionEspectro.pdf
[9] Law 1978 of 2019
[10] Introduced by President Ivan Duque´s new government, which came to office in August 2018

The Dynamic Spectrum Alliance President was not involved in the Colombian case study



MALAYSIA

RELEVANT POLICY AND REGULATORY FRAMEWORK

From as early as 2002, the Malaysian Communications and Multimedia Commission (MCMC) has encouraged industry players to be open towards infrastructure and network sharing[11]. This is to ensure efficiency and better optimization of scarce resources such as spectrum. To use radiofrequency spectrum, an entity has to be granted the appropriate rights and permission to use it. This could be in the form of a Spectrum Assignment[12], an Apparatus Assignment[13], or a Class Assignment[14].

In the 2.3GHz and 2.6GHz bands, service providers with Apparatus Assignments have entered into spectrum sharing arrangements on a commercial basis. However, a tiered approach towards spectrum sharing is something quite different and would require the MCMC to put in place a regulatory framework to enable it to happen. For example, in a two tier scenario (i.e. without any incumbents), two key aspects the regulator may have to address are: eligibility requirements for the third party to share authorized spectrum with licensed service providers; and what sort of authorization would the third party be required to obtain from the regulator.

NATIONAL ICT AND BROADBAND GOALS

Similar to many other countries, Malaysia has focused on the need to increase broadband connectivity in the country and to bridge the digital divide, especially in rural areas and underserved communities. The most recent ICT policy, the *National Fiberisation and Connectivity Plan (NFCP) 2019 – 2023*[15], is aimed at enabling wider service coverage, delivering faster broadband speeds, providing more choice to consumers, and leveraging the opportunities afforded by the digital economy. Key targets identified under the NFCP include:

1. affordable entry level fixed broadband packages;
2. provision of an average speed of 30 Mbps in 98% of populated areas;
3. gigabit per second availability in selected industrial areas by 2020 and all state capitals by 2023;
4. fiber connections at 70% of schools, hospitals, libraries, police stations and post offices by 2022;
5. improved mobile coverage along the Pan Borneo highway upon its completion.

SPECTRUM USAGE AND EXISTING AUTHORIZATIONS

Used for LTE and WiMAX services, the 2.3GHz band is authorized via Apparatus Assignments[16].

The 2.6GHz band is used to deliver LTE-based mobile/fixed wireless services, and is authorized via Apparatus Assignments.

However, these Apparatus Assignments are likely to be replaced with long-term Spectrum Assignments in the near future following the MCMC Public Inquiry on '*Allocation of Spectrum Bands For Mobile Broadband Service In Malaysia*' (Spectrum PI) .

TOWARDS SPECTRUM SHARING AND TECHNOLOGY TRIAL

The industry is open to spectrum sharing[17]. Generally, current arrangements involve leasing and/or sub-leasing scenarios that enable more efficient use of spectrum.

A tiered approach towards spectrum sharing would be something new and there is interest to explore this further potentially through a technology trial.

ISSUES / CONCERNS

The Spectrum PI and the spectrum tender/conversion process that is likely to follow from it may limit the near-term scope for a technology trial in the 2.3GHz or 2.6GHz bands. But it may be possible to use other spectrum bands, such as the 3.5GHz band, for a technology trial.

Also, there are questions relating to the development of a sustainable business model for spectrum sharing and rural connectivity.

[11] See MCMC, Applicant Information Package No. 1 of 2002 for IMT-2000 spectrum.
[12] This is a full authorization that enables a person to use specified frequency bands for any purpose consistent with the assignment conditions. The assignment is for a longer period of time (generally between 10 and 20 years). It is akin to an 'exclusive license' subject to terms & conditions of the grant.
[13] This confers rights to use the spectrum to operate a network of a specified kind at a specified frequency band or bands. Typically, this permission is valid for between 1 and 5 years, subject to terms and conditions of use.
[14] This provides a general authorization to any person for use of a specified frequency band for a specific purpose subject to terms and conditions of use. For example, some user devices such as cordless telephone devices, Radio Frequency Identification (RFID) and wireless microphone devices fall into this category.
[15] The announcement of the NFCP was part of Budget 2019 and its implementation was recently endorsed by the Malaysian Cabinet (see MCMC media statement dated 28 August 2019).
[16] The Apparatus Assignments are set to expire on 31 December 2019. See MCMC, Spectrum PI, 2019.
[17] There are commercial arrangements between industry players to share spectrum in the 850MHz band, 2300MHz band, and 2600MHz band. See MCMC, Spectrum PI, 2019.

SOUTH AFRICA

RELEVANT POLICY AND REGULATORY FRAMEWORK

Under South African regulations[18], spectrum sharing can be initiated by the ICASA (Independent Communications Authority of South Africa) or by two or more persons (licensees). All radio frequency spectrum sharing agreements are subject to approval by ICASA, and to a non-discriminatory approach.

Moreover, ICASA has indicated that the Dynamic Spectrum Assignment (DSA) concept is applicable across spectrum bands[19]: The first phase of the DSA implementation involves the TV White Spaces. ICASA has also indicated that the Licensed Shared Access (LSA) model is out of scope of the current regulatory process of non-exclusive licensing and could be considered as part of future studies on DSA.

NATIONAL ICT AND BROADBAND GOALS

The National Broadband Policy – South Africa Connect, 2013, calls for 90% of the population to have a 5Mbps connection by 2020 and 100% of the population to have a 10Mbps connection by 2030. The policy recognizes that some areas are still underserved by affordable broadband networks. The immediate priorities with respect to spectrum are:

- The identification of unused spectrum and its reassignment;
- The removal of all bottlenecks preventing migration of terrestrial broadcasters from analogue to digital in order to realise the digital dividend;
- The reallocation and assignment of broadband spectrum taking into consideration job creation, small business development, national empowerment and the promotion of the goals of the National Development Plan;
- Approval of spectrum sharing between spectrum licensees and across services by ICASA in support of efficient use of spectrum and where it does not impact negatively on competition;
- The enabling of dynamic spectrum allocation;
- Ensuring sufficient spectrum for extensive WiFi and other public access technologies and services.

SPECTRUM USAGE AND EXISTING AUTHORIZATIONS

In the 2.3GHz band, 60MHz is assigned to Telkom, which uses it to provide LTE services, mostly in urban areas. In the 3.5GHz band, 2 x 28MHz has been assigned to Liquid Telecom, which was originally licensed as the second fixed line operator, while 2 x 14MHz is assigned to Telkom. Rain (formerly WBS) is assigned 15MHz in the 2.6GHz band.

ICASA looks set to license several IMT spectrum bands to the WOAN (*Wireless Open Access Network*) and other licensees during Q2 of 2020. This could involve auction frequencies in the 700MHz, 800MHz, 2.3GHz, 2.6GHz and 3.5GHz bands. However, the 3.5GHz band may be identified for 5G and excluded from this licensing process.

TOWARDS SPECTRUM SHARING AND TECHNOLOGY TRIAL

Key industry and policy stakeholders have a high level of interest in the concept of spectrum sharing and are willing to participate in or support a technology trial.

Which bands can be used for a technology trial will depend on how the licensing process for the 2.3GHz, 2.6GHz and 3.5GHz bands proceeds over the next 12 months. If necessary, the 900MHz and 1800MHz bands could be used for a near-term spectrum sharing technology trial in South Africa.

ISSUES / CONCERNS

Although current ICASA regulations make provision for spectrum sharing, it has not received any applications to date. Key stakeholders argue that the current provision for spectrum sharing is too vague and allows ICASA to use arbitrary criteria. They would like to see a standalone spectrum sharing regulation that clearly sets out the criteria for approval of spectrum sharing, the terms and conditions and fees, if any.

[18] Clause 18 of the ICASA Radio Frequency Spectrum Regulations 2015 makes provision for spectrum sharing
[19] In its Position Paper on the Framework for Dynamic and Opportunistic Spectrum Management 2017

5. CONCLUSIONS AND RECOMMENDATIONS

As the role of digital technologies in everyday life continues to grow, most developing countries are rightly aiming to bring broadband connectivity to their entire populations. But licensing IMT spectrum to individual mobile operators may not be enough to deliver this goal – in some cases, the mobile operator's business model doesn't make it financially viable to serve remote rural communities.

Technological and regulatory mechanisms that make it straightforward for service providers to share spectrum in specific geographic areas could change this paradigm. Flexible spectrum sharing models could make it cost-effective for service providers to bring broadband services to previously unconnected communities. Across the three countries studied for this report, policymakers and industry players are open to exploring this opportunity. Key stakeholders in Colombia, Malaysia and South Africa all recognized the need to use IMT spectrum as efficiently as possible to close the digital divide between urban and rural areas. Mobile operators are generally open to sharing spectrum to bring broadband connectivity to rural areas, assuming they can develop sustainable business models to underpin such services.

PIP's research in Colombia, Malaysia and South Africa did not reveal any major regulatory obstacles to spectrum sharing. However, in some cases, regulatory frameworks may be needed to clarify the rules that would govern dynamic spectrum sharing implemented via the kind of tiered models described in this paper.

NEXT STEPS

Public sector bodies and industry players in all three countries seem to be prepared to explore trials of new spectrum sharing technologies in IMT bands. Such trials would provide the key stakeholders with insights into the potential of tiered models for spectrum sharing and any related technological and regulatory issues that might arise. Within Colombia, Malaysia, South Africa and other parts of the developing world, technology trials would also help to raise awareness of the potential of new forms of spectrum sharing.

Although the 2.3GHz and 2.6GHz bands are likely to play a major role in facilitating spectrum sharing in many countries, it may be necessary to conduct the initial technology trials in other IMT bands. In countries that are in the process of licensing frequencies in the 2.3GHz and 2.6GHz bands, it may prove impractical to use this spectrum for a near-term technology trial.The best way to implement technology trials would be through partnerships between the relevant industry players, authorized by the regulator and, in some cases, with the support of a respected independent entity, such as the Council for Scientific and Industrial Research (CSIR) in South Africa.

As governments and industry players in Colombia, Malaysia and South Africa are open to explore spectrum sharing, it should be relatively straightforward to commence technology trials in each country in the near future. In this respect, the first step will be to bring the key public and private sector stakeholders together to identify suitable geographies and the optimum spectrum bands and technological mechanisms for the trials. Note, in some cases, such as South Africa, it won't be necessary to deploy the kind of ESC used by the CBRS system described in this paper, since the incumbents involved differ from the military incumbents in the U.S.

As well as reaching agreement on the scope of the trial, the partners will also need to agree how it will be funded. Once agreements have been reached, the partners would submit applications to the national regulators for trial licenses. Given the long lead times for the type approval of equipment, where applicable, this aspect of the application process should start before the agreements on the trial have been concluded between the different parties.

In Colombia, Malaysia and South Africa, PIP representatives are engaging with the relevant stakeholders to enable these technology trials to start as soon as possible. Once they are underway, these trials will yield important insights into how countries can make much more efficient use of IMT spectrum to bring their citizens online.

GLOSSARY

CBRS	Citizens Broadband Radio Service
DSA	the Dynamic Spectrum Alliance
ESC	environmental sensing capability
FCC	Federal Communications Commission (U.S. regulator)
GAA	general authorized access
IMT	international mobile telecommunications (systems that use standardized cellular technology)
ITU	International Telecommunication Union (part of the United Nations)
LTE	Long-Term Evolution (4G mobile technology)
Ofcom	the U.K. communications regulator
RLAN	radio local area networks
SAS	spectrum access system
TSSM	tiered spectrum sharing model
TVWS	television white spaces
WiMAX	worldwide interoperability for microwave access – wireless broadband communication standards based on the IEEE 802.16 set of standards
WOAN	wholesale open access network

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