Roadmaps for awarding 5G spectrum: A focus on Indonesia

July 2022

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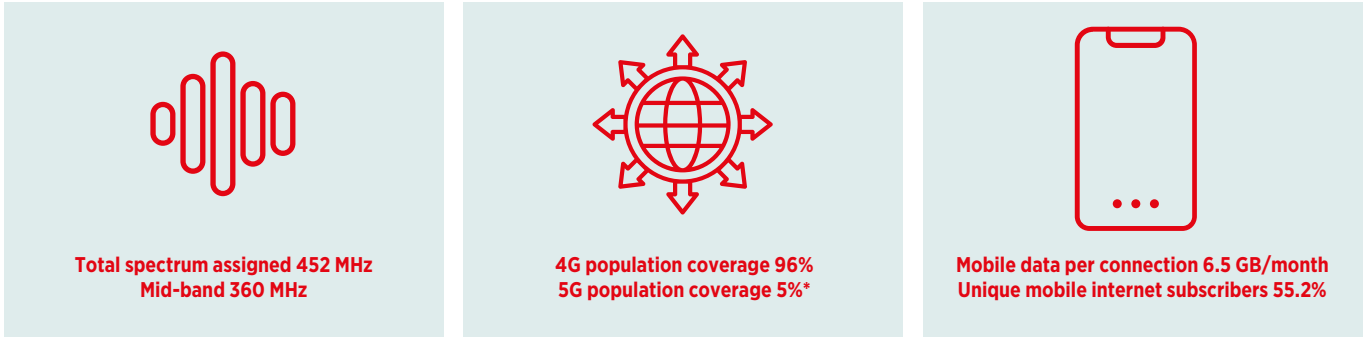
Summary

Broadband connectivity and digital services have played a vital role in the way people lived and businesses operated during the COVID-19 outbreak. As the world emerges from the pandemic, and social and economic activities begin to recover, mobile connectivity's integration into our day-to-day economic and social activities will continue to grow. Digital transformation is already well underway in many sectors and the 5G era will help to accelerate this process and boost economic growth in the years ahead.

In Indonesia, mobile data traffic per connection in Indonesia (6.5 GB per month in 2020) has been growing strongly in recent years. 5G is just beginning, with limited launches by operators using existing spectrum holdings. As of end of 2021, 5G network coverage is around 5% of the population.

FIGURE 1

INDONESIA MOBILE MARKET – KEY INDICATORS



* 5G is only available in selected cities as of end 2021

There is much work to be done to ensure the adequate supply of spectrum resources to support 5G development in Indonesia, especially in the crucial mid-band spectrum (1-7 GHz). The GSMA estimates that mid-band 5G spectrum will drive an increase of more than $610 billion in global GDP in 2030, almost 65% of the overall socio-economic value generated by 5G. In Southeast Asia, 5G mid-bands will boost annual GDP by $35 billion by 2030, heavily driven by the large Indonesian market which will account for 41% of this increment.

To secure these benefits, markets will need an average of 2 GHz of mid-band spectrum during this decade. In Indonesia, there is currently 360 MHz of mid-band spectrum assigned for mobile services.

The 5G era promises to unlock a wealth of new use cases across different industries and accelerate economic growth in Indonesia. To realise this, it is important to build on current plans that are in place by prioritising the following actions for 5G development:

- Make available at least 300 MHz of spectrum in the globally harmonised 3.5 GHz range by 2023.
- For the 3.5 GHz range, avoid an unnecessarily large guard band between mobile and fixed satellite services (FSS). Implement appropriate coexistence measures, such as site shielding and upgrading FSS receiver filters, to allow more spectrum to be assigned for 5G without impacting on other users in adjacent bands.
- Consider a phased approach involving the initial release of the 3.5 GHz band in urban areas where demand is currently highest.
- Ensure the release of 700 MHz remains on track by completing the digital TV switchover by November 2022 in accordance with the Omnibus Law.
- Consider options for refarming the 2.6 GHz band for 5G earlier than the 2024 expiry of current satellite broadcasting licences.
- Work towards making 2-2.4 GHz[1] of mid-band spectrum available by developing a spectrum roadmap for 2025-2030, taking into account future IMT spectrum supply including the 4.8 GHz and 6 GHz bands.

1 Mid-band need range for Jakarta, p.4: https://www.gsma.com/spectrum/wp-content/uploads/2021/07/5G-Mid-Band-Spectrum-Needs-Vision-2030.pdf

1. Introduction

Digital services, underpinned by high speed and high performance networks, are set to become more integral to society in a post-pandemic world. With digital transformation already well underway in many sectors, the introduction of 5G will help accelerate this process and boost economic growth in the years ahead.

Increasing smartphone adoption and video usage has driven mobile data traffic growth over the last decade. This trend is set to continue in the 5G era with more immersive media-rich services, new online gaming technologies and extended reality (XR) applications. With more than 180 5G networks across 72 countries as of the end of 2021, 5G is rapidly moving towards mainstream adoption and the total number of 5G connections is set to reach 1 billion in 2022.[2]

This report takes a closer look at the state of 5G spectrum planning in Indonesia and discusses the key issues and challenges in securing sufficient spectrum resources for 5G, particularly in the mid-bands. It then provides some recommendations on the way forward.

2 Source: GSMA Intelligence

1.1 The Indonesia mobile market

High-bandwidth Internet connectivity is becoming increasingly important for enhancing productivity, social welfare, and wellbeing.

In many emerging markets, where fibre penetration is typically lower, there tends to be a greater reliance on wireless technology – both mobile and fixed wireless – to meet growing demand for affordable and expandable connectivity. As of the end of 2020, mobile broadband adoption in Indonesia stood at 89.1 per 100 inhabitants compared to 3.9 for fixed broadband.[3] As of 2021 network coverage for 3G and 4G services was at 95% and 96% of national population respectively.

The Indonesia mobile market comprises the following main players.

- Telkomsel, the largest mobile operator by subscriber base, has around 47% market share.
- Indosat Ooredoo Hutchison, formed in January 2022 following a merger between Indosat Ooredoo and 3 (Hutchison). As of end 2021, the two entities had a combined market share of around 30%.
- XL Axiata has a market share of around 15%.
- Smartfren has a market share of around 8%.

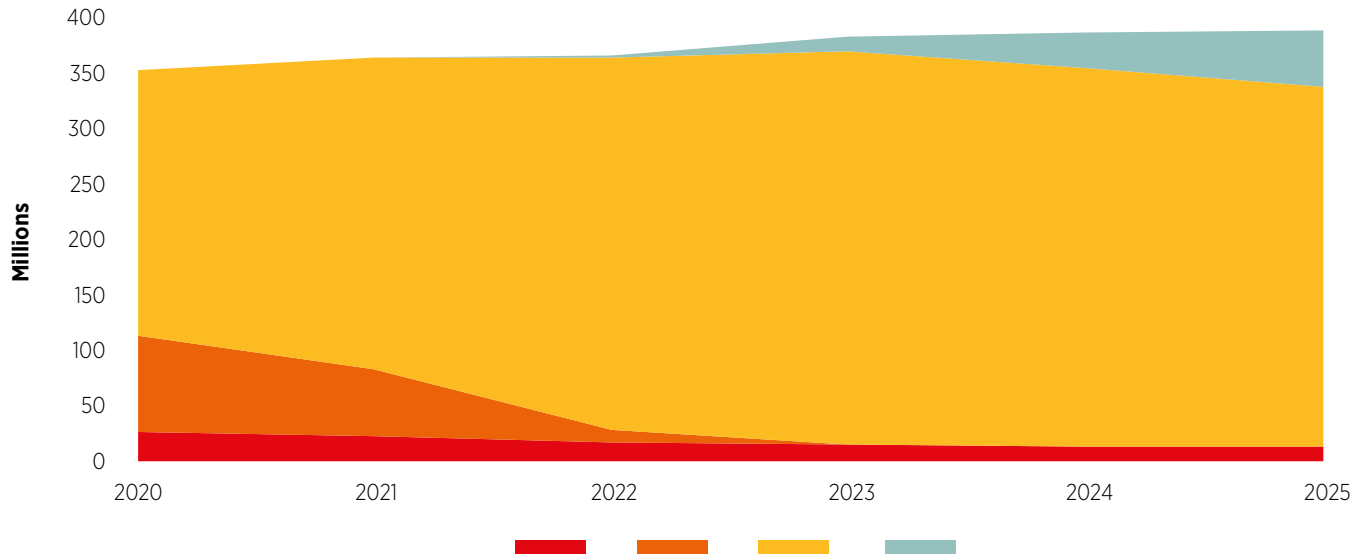
In Indonesia, 5G rollout is still at a very early stage – commercial services were launched by Telkomsel, Indosat Ooredoo and XL Axiata in 2021 utilising existing spectrum holdings such as 1800 MHz, 2100 MHz and 2300 MHz. Deployments are currently limited to selected cities. Smartfren is preparing to launch 5G services in 2022. As of the end of 2021, 5G networks covered 4.6% of Indonesia's population and the number of 5G connections was around 347,000.

In advance of the making of new IMT spectrum available by the SDPPI, Indonesian mobile operators have little choice, given spectrum scarcity, but to refarm legacy IMT spectrum holdings from 3G to 4G and 5G services. Such moves have already accelerated the switch off of legacy 2G and 3G services in Indonesia with XL Axiata switching off 3G services at the end of March 2022.[4] Telkomsel and Indosat Ooredoo Hutchison (IOH) also expect to switch off 3G services in 2022.

The pace of 5G deployment and adoption is forecast to grow over the next three years – by 2025, the number of 5G connections is also forecast to reach 52 million with 5G networks covering 32% of the population.[5] While 4G will continue to account for most of mobile connections, the share of 4G connections will start to decline from 2023 onwards.

FIGURE 2

CONNECTIONS BY TECHNOLOGY (INDONESIA)



Source: GSMA Intelligence

3 Source: ITU, World Telecommunication/ICT Indicators Database, August 2021

4 Refer to https://newsbeezer.com/indonesiaeng/xl-to-switch-off-all-3g-signals-at-the-end-of-march-2022-all/

5 GSMA Intelligence. July 2022.

In Indonesia, monthly mobile data traffic per connection has grown by 4.3 times over the 2017-2020 period, reaching 6.5 GB in 2020.[6] According to Ericsson estimates, mobile data traffic per smartphone in Southeast Asia will grow by 5.8 times over the 2021-2027 period from 8.0 GB to 46.0 GB per month.[7] Opensignal[8] data also shows that Indonesian users on the five national mobile operators on average consumed between 14.6 and 17.7 GB a month in 2021.

At the same time 5G enterprise use cases are also emerging across different industrial verticals which will drive growth in cellular IoT connections. Across Asia Pacific, operators are using the scale and utility of mobile networks and services to facilitate innovative digital solutions for large and small enterprises in line with Industry 4.0 objectives. In particular, 5G and IoT will play key roles in the implementation of digital transformation projects across different industries, which will further drive demand for 5G connectivity and economic growth for the rest of the decade.

There is currently 452 MHz of mobile spectrum assigned in Indonesia as shown below. In the mid-band range, only 360 MHz across the 1800 MHz, 2100 MHz and 2300 MHz has been assigned, compared to an average of 850 MHz in the Asia Pacific region today. There is thus a clear need for more mid-band spectrum in order to support the development of 5G.

FIGURE 3

CURRENT IMT SPECTRUM ASSIGNED IN INDONESIA

Type of spectrum	Bandwidth assigned	Notes
Low band (sub-1 GHz)	92 MHz	850, 900 MHz
Mid-band (1-7 GHz)	360 MHz	1800, 2100, 2300 MHz
High bands (above 24 GHz)	-	-

Source: GSMA, APT

6 ITU. World Telecommunication/ICT Indicators Database. August 2021.

7 GSMA. The Mobile Economy 2022. www.gsma.com/mobileeconomy/wp-content/uploads/2022/02/280222-The-Mobile-Economy-2022.pdf

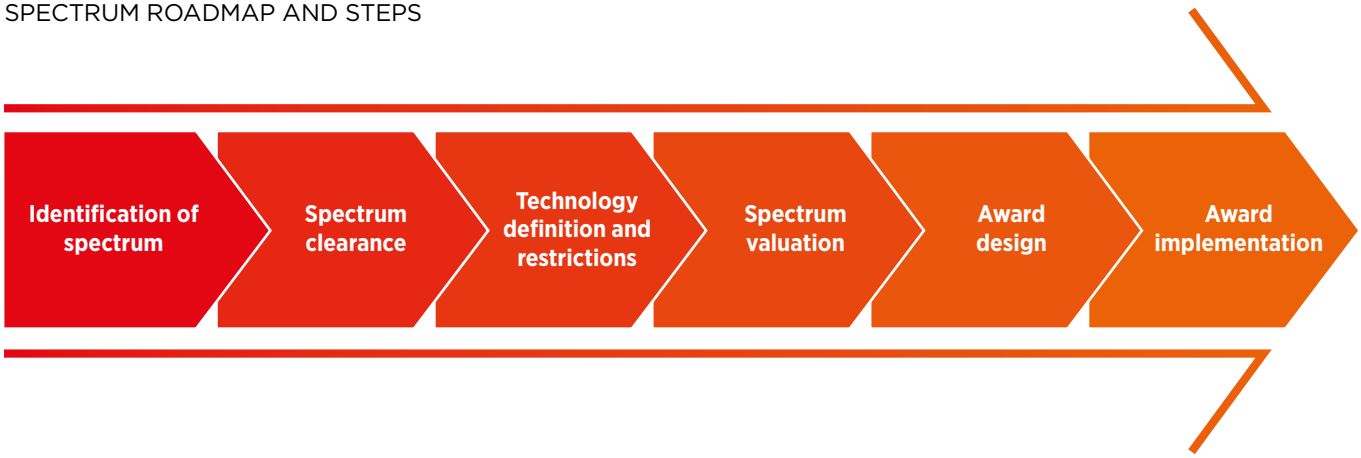
8 OpenSignal December 21 2021: www.opensignal.com/2021/12/21/amid-rising-competition-indonesian-mobile-operators-need-to-focus-on-retaining-their-high-value

1.2 A roadmap for 5G

As with all previous generations of mobile services, the road to 5G in each country starts with the release of spectrum to support the network rollout. A typical spectrum roadmap, as illustrated below, involves the following steps. [9]

FIGURE 4

SPECTRUM ROADMAP AND STEPS



1.	**Identification of spectrum.** Spectrum is essential for the provision of mobile services and 5G needs significant new harmonised spectrum.[10] Care must be taken to consider the socio-economic benefits that arise from both old and new uses of spectrum and in balancing needs of different users. Consultations provide a forum for the perspectives of different industry stakeholders and allow both governments and industries the opportunity to understand the likely effects of different options. Where competing demands arise, cost-benefit analysis should also be carried out to assess the impacts of proposed changes in spectrum allocation and to ensure efficient use of scarce spectrum and achieve optimal outcomes for society.[11]
2.	**Spectrum clearance.** Approaches for clearing spectrum are dependent on factors such as the density of use; ease of moving incumbents to alternative frequency bands or alternative technologies; and impact on services and users. In some cases, geographic sharing with adequate mitigation measures will address interference concerns. For assigned spectrum, it may only be necessary to realign the band assignments to provide contiguous frequencies and maximise spectrum efficiency for 4G and 5G.
3.	**Technology definition and restrictions.** Technical licence obligations should be clearly defined, along with conditions of usage and the amount and geographic availability of the spectrum.
4.	**Spectrum valuation and pricing.** Assessing the value of spectrum guides up-front and annual fees. There are different valuation approaches, including benchmarking and modelling analysis, and both methods should be used to improve accuracy and to capture local market factors. Costs relating to licensing obligations should be taken into account when setting prices for spectrum.
5.	**Award design.** There are three main approaches to awarding spectrum: auctions, beauty contests and direct award.[12] The approach adopted, and associated licence obligations, will need to take account of policy objectives, available spectrum, and market specifics (for example, the number of operators, or current spectrum holdings). Depending on the timescales for availability of different frequency bands and award design, it may be appropriate to have a single multi-band award or several separate ones.
6.	**Award implementation.** The final step is the actual award. This will normally be underpinned by documentation that provides all the necessary details of the award process, spectrum on offer, licence obligations and other essential information for potential licensees.

9 GSMA. Roadmaps for awarding 5G spectrum in the APAC region. April 2022. www.gsma.com/spectrum/resources/5g-spectrum-in-the-apac-region-roadmaps-for-success/

10 The key frequency bands to prioritise for 5G are outlined in section 1.3.

11 GSMA. Maximising the socio-economic value of spectrum. A best practice guide for the cost-benefit analysis of 5G spectrum assignment. January 2022. www.gsma.com/spectrum/wp-content/uploads/2022/01/mobile-spectrum-maximising-socio-economic-value.pdf

12 For the GSMA auction best practice position see www.gsma.com/spectrum/wp-content/uploads/2021/09/Auction-Best-Practice.pdf

1.3 5G spectrum needs

To get the most out of 5G, spectrum is needed across low-, mid- and high-bands to deliver widespread coverage and support all use cases. In the coming years, growth in user take-up, new 5G applications, and the availability of new devices and applications (e.g. new smartphones, embedded OEM V2X devices, sensors, autonomous vehicles, video, IoT, VR/AR) will further drive demand for mobile data services.

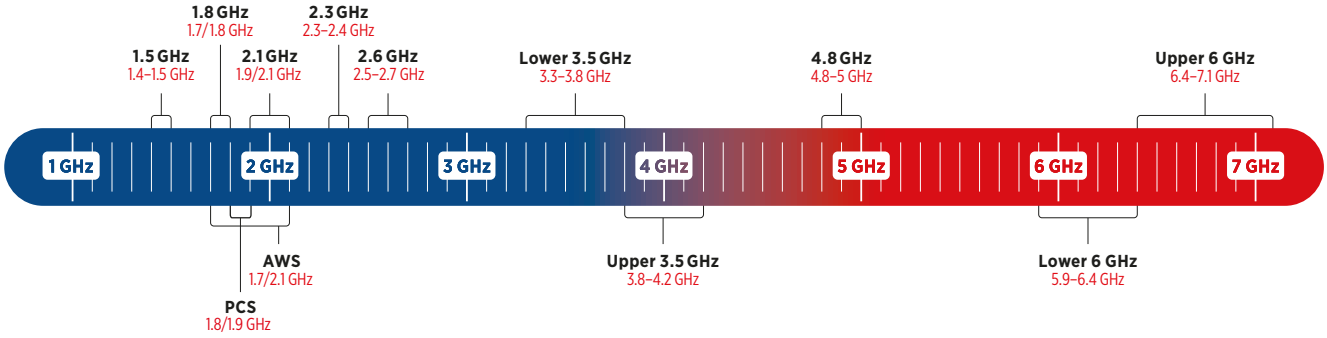
Low-band spectrum is important for covering less-populated areas, delivering deep in-building penetration and lowering the urban / rural digital divide. mmWave will be used for the highest capacity, lowest latency applications.

Mid-band spectrum, which lies in the 1-7 GHz range, is necessary for city-wide coverage to address the increases in bandwidth and capacity that 5G applications will require. New mobile broadband use cases such as enhanced mobile broadband (eMBB), fixed wireless access (FWA), IoT and Industry 4.0 depend on mid-band spectrum. These use cases will grow the impact of mobile services on society and economies.

Mid-band spectrum resources include both lower mid-bands (i.e. 1500 MHz, 1800 MHz, 2100 MHz, 2300 MHz and 2600 MHz) and upper mid-bands (i.e. 3.3–4.2 GHz, 4.5–5.0 GHz and 5.925–7.125 GHz). To launch 5G services that are consistent with the ITU's IMT-2020 requirements,[13] each operator needs access to 100 MHz of contiguous mid-band spectrum in the short term.

FIGURE 5

MID-BAND SPECTRUM OPTIONS



However, as 5G matures, an average of 2 GHz of mid-band spectrum will be required in total to deliver the full range of 5G services.[14] The latest research by GSMA on the socio-economic benefits of mid-band 5G services indicate that mid-band 5G spectrum will drive an increase of more than $610 billion in global GDP in 2030, accounting for almost 65% of the overall socio-economic value generated by 5G.[15] In Southeast Asia, 5G mid-band services will generate addition GDP contribution of $35 billion (which represents 0.64% of GDP) with Indonesia accounting for 41% of this increment.

A separate study[16] conducted by the Bandung Institute of Technology's Industrial and Research Affiliation Institution (LAPI-ITB) projects that a progressive release of spectrum for 5G from 2021 to 2023 will drive significant increase in adoption rate of 5G across all industry verticals and consumers. It is estimated that 5G will contribute 9.3% to Indonesia GDP by 2030 and 9.8% by 2035.

13 User experience of 100 Mbps DL, 50 Mbps UL rates.

14 www.gsma.com/spectrum/resources/5g-mid-band-spectrum-needs-vision-2030/

15 GSMA. The Socio-Economic Benefits of Mid-Band 5G Services. February 2022.

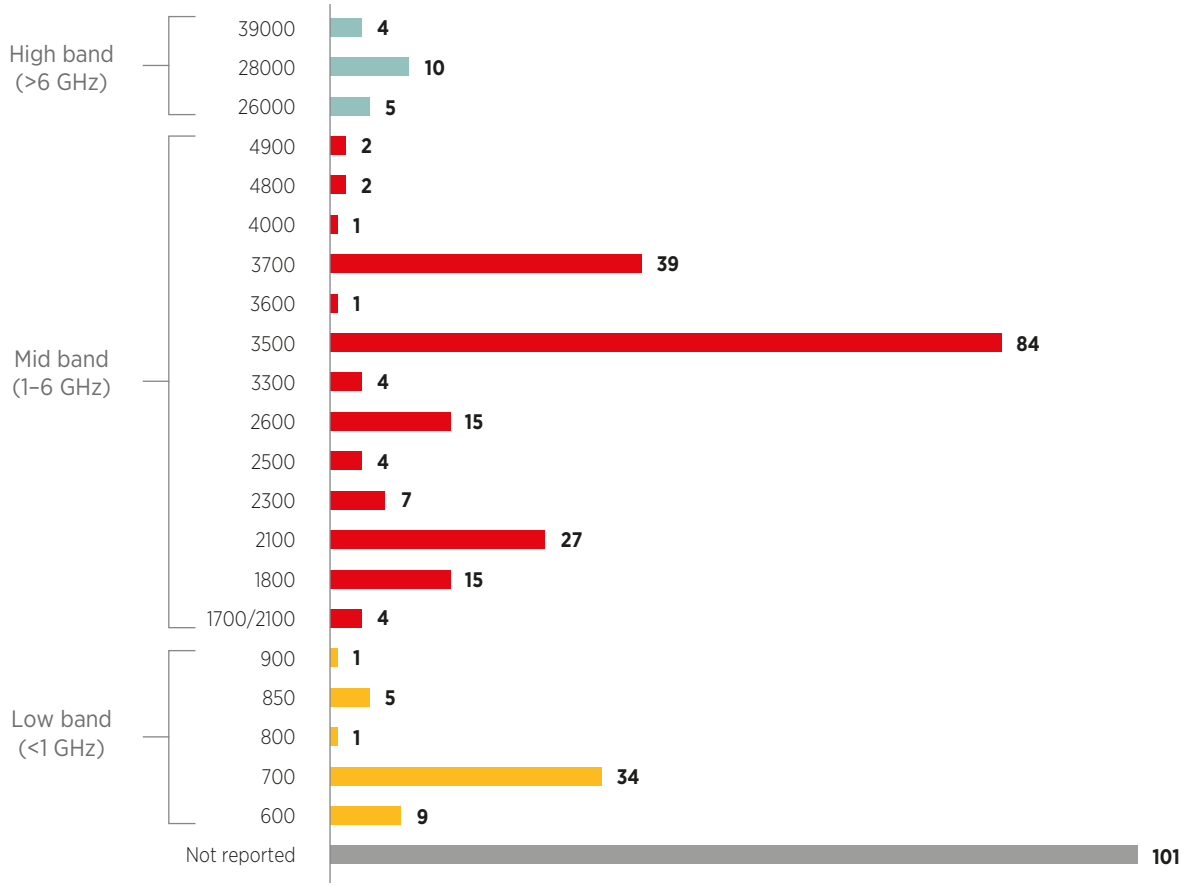
16 https://kumparan.com/kumparantech/riset-itb-internet-5g-sumbang-rp-2-802-triliun-ke-indonesia-2021-2030-1uGlnZMIDzk

Why is 3.5 GHz key for 5G?

The 3.5 GHz band (3.3-4.2 GHz), which is widely harmonised for mobile, has been the basis for the first phase of 5G rollouts in many markets. To date 3.5 GHz accounts for the majority of 5G network launches,[17] driving the wider ecosystem, device diversity and competition. It has been deployed for eMBB enabling faster data speeds and greater capacity required in urban, densely populated areas, as well as for FWA in sub-urban and rural areas where the availability of fixed broadband tends to be more limited.

FIGURE 6

5G NETWORK LAUNCHES BY SPECTRUM FREQUENCY (UP TO Q1 2022)[18]



Source: GSMA Intelligence

In markets where 5G spectrum has yet to be assigned, operators are using Dynamic Spectrum Sharing (DSS) technology and refarming existing spectrum bands, mainly in 1800, 2100, 2300 and 2600 MHz, to support 5G deployments. While these approaches enable more flexible and efficient use of spectrum, capacity in 4G bands is limited and they cannot provide the necessary capacity that additional licensed spectrum would provide. Further supply, especially in the mid-bands, will be needed to sustain 5G developments for the rest of the 2020s and beyond.

17 Excluding frequencies not reported.

18 These figures refer to trials, assignments and launches, not individual operators. A range of operators have trialled or launched their 5G networks on more than one frequency.

2. Progress on Indonesia's spectrum plan for 5G

2.1 Indonesia's 5G Taskforce and activities

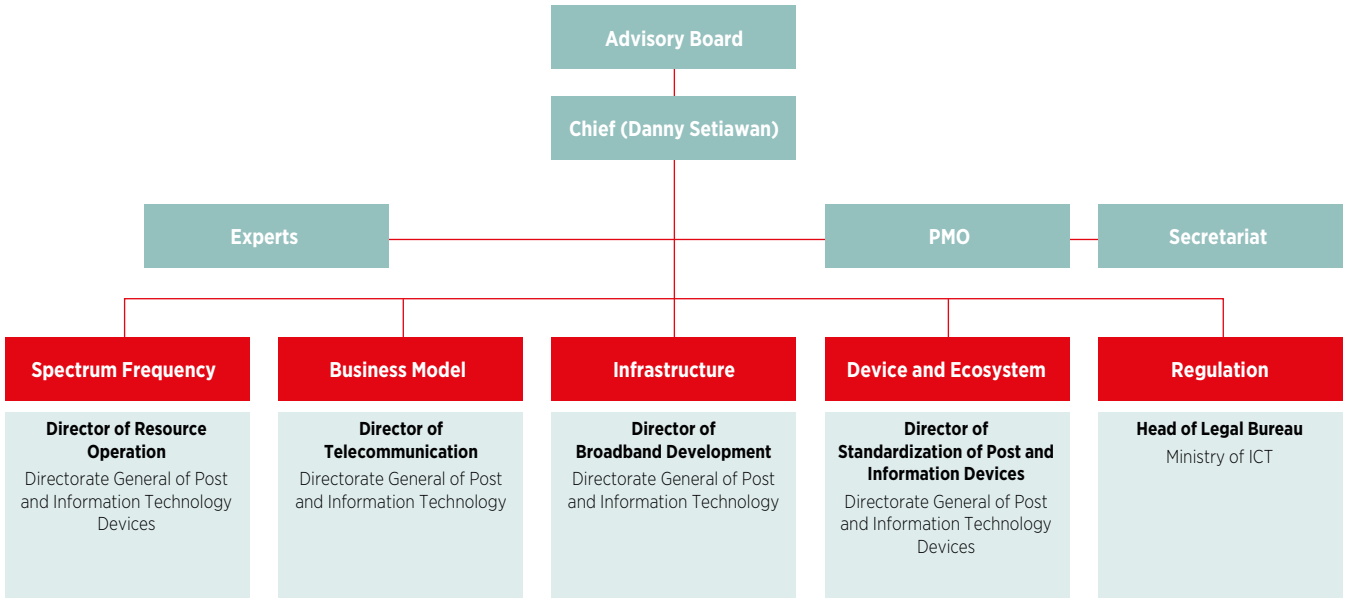
The Ministry of Communication and Information Technology ('Kominfo') (in Bahasa Indonesia: Kementerian Komunikasi dan Informatika) is responsible for telecommunications policy including spectrum management. Inside Kominfo, Directorate General of Resources and Equipment for Post and Information Technology (SDPPI) (in Bahasa Indonesia: *Direktorat Jenderal Sumber Daya dan Perangkat Pos dan Informatika*) regulates frequency spectrum.

Since 2017, 5G trials have been ongoing in Indonesia with XL Axiata, Telkomsel, Smartfren and Indosat Ooredoo conducting indoor and outdoor trials. Following on from earlier actions to improve the availability of mobile spectrum in Indonesia, Kominfo through KM 354/2020 and KM 97/2021, formed a 5G Task Force Preparation of 5G Implementation Policies (Road Map) on the targets in the *Strategic Plan of Communication and Informatics 2020 – 2024.*

There are five Working Groups that focus respectively on spectrum Frequency, business models, infrastructure, devices and ecosystem, and regulation as detailed in Figure 7.

FIGURE 7

TASK FORCE FOR 5G POLICY IMPLEMENTATION



Source: Kominfo, PMO Report, 5G Roadmap Draft, 7 December 2021, page 4

The focus of the Taskforce is developing national 5G implementation targets within Kominfo's Strategic Plan 2020 – 2024 focusing on the following areas:

- The six provincial capitals in Java,
- The top five national priority tourist destinations,
- The new National Capital City, Nusantara, and
- Support for the manufacturing Industry.

The output will be a Policy recommendation roadmap of 5G implementation and a 5G Roadmap Implementation Strategy.

As at December 2021, the 5G Roadmap summary for Indonesia is summarised in Figure 8. Detailed implementation plans have been developed for each of the four focus areas. New spectrum is being made available to support 5G deployment in Indonesia in the priority bands 700 MHz, 2.3 GHz (assigned in 2021), 2.6 GHz, 3.5 GHz and 26 and 28 GHz. This is in addition to the refarming of the existing IMT bands.[19]

19 One example is Telkomsel's refarming of the 2.1 GHz band for 5G services. Refer to www.opensignal.com/2021/09/23/telkomsel-is-boosting-capacity-for-4g-by-refarming-3g-spectrum-in-the-2100MHz-band

FIGURE 8

5G SPECTRUM ROADMAP SUMMARY

	Legacy Spectrum Bands	Refarmed for 5G	New Spectrum bands				
Spectrum Bands	450/850/900/ 1800/2100 MHz	2.3 GHz	700 MHz	2.6 GHz	3.5 GHz	mmWave	Other bands – eg 4.8 GHz
Spectrum to made available	All(377 MHz)	90 MHz	2 x 45 MHz (90 MHz)	190 MHz	200-300 MHz	To be determined	To be determined
When available	Currently	Made available in 2021	End 2022	After 2024	2023	2022/23	To be determined
Comments	1800 and 2100 MHz being used for 5G DSS. Bands refarmed to be contiguous	Auction of old regional FWA spectrum and then band refarming to create to contiguous spectrum	Available post ASO.	Available after end of satellite broadcasting licence	Post assessment and refarming of 3.3 GHz FWA licences	26 GHz is the key focus. Available when licensed by SDPPI	

Source: Modified version of Kominfo, PMO Report, 5G Roadmap Draft, 7 December 2021, page 13

Following the successful auction of remaining blocks of the 2.3 GHz band in April 2021 and band refarming to create contiguous spectrum in the band, the subsequent plan is to make 700 MHz and mmWave spectrum available by way of an auction in 2022. The auction of cleared 3.5 GHz band spectrum is planned for the first half of 2023 and the auction of the 2.6 GHz band is planned for early to mid 2024.

Kominfo are continuing to discuss how frequency spectrum could be released earlier than the scheduled dates. In particular, they are attempting to find a compensation model and formula which will provide benefits for new operators and existing satellite operators (namely PT MNC Sky Vision Tbk which a subsidiary of MNC Group) so that the auction date for the 2.6 GHz band could be brought forward.[20]

20 Comments by Dr Ismail to the 2022 Digital Industry Forecast Webinar. Refer to https://teknologi.bisnis.com/read/20220113/101/1488628/lelang-frekuensi-26-ghz-dan-35-ghz-bisa-digelar-lebih-cepat-ini-syaratnya

The digital dividend, the 700 MHz band and changes to the applicable spectrum management law

In Indonesia there have been some delays in the securing of the release of the 700 MHz band (digital dividend) post the switchover from analogue to digital television. As such, following considerable internal debate, the switchover was legislated in late 2020 by the Indonesian Parliament with the digital dividend spectrum in the 700 MHz to be made available by late 2022 (see Figure 9 below).

FIGURE 9

SUMMARY OF KEY OMNIBUS LAW PROVISIONS RELATING TO SPECTRUM

Law No. 36 of 1999 on Telecommunications (Telecommunications Law), which is the core legislation governing the telecommunications sector in Indonesia, was one of over 70 laws amended by the Omnibus Law on Job Creation (Omnibus Law), passed by Indonesia's Parliament on 5 October 2020. Subsequently, on 2 February 2021, the Indonesian Government enacted 49 implementing regulations to the Omnibus Law.[21] These consisted of 45 Government Regulations and four Presidential Regulations including Government Regulation No. 46 of 2021 on Post, Telecommunication and Broadcasting.[22]

The main focus of the changes to the telecommunications sector regulation was to support the acceleration of Indonesia's digital economy – especially by optimising spectrum use in the 5G era, which is becoming increasingly important to Indonesia's national economy and recovery after the COVID-19 pandemic.

With respect to spectrum management issues, importantly the Omnibus Law inter alia:

- In Section 33, introduces significant changes to Indonesia's telecommunications sector regulatory framework by permitting telecommunications operators to cooperate in spectrum sharing for new technologies and to transfer spectrum rights to each other. It grants the central government the authority to regulate spectrum sharing arrangements among Indonesian telecommunications operators.
- In Section 60A, provides that the migration of terrestrial television broadcasting from analogue technology to digital technology shall be completed no later than 2 (two) years from the enactment of the Law and hence freeing up the digital dividend in the 700 MHz band.
- In Section 34, clarifies some previously unclear provisions in existing regulations, for example, as to who should pay the annual radio frequency spectrum fee to the State (ie, the spectrum user or the licence holder).

21 Refer to www.whitecase.com/publications/alert/omnibus-law-and-its-implementing-regulations

22 Refer to https://jdih.kominfo.go.id/produk_hukum/view/id/777/t/regulation+of+government+of+the+republic++of++indonesia+number+46+of+2021

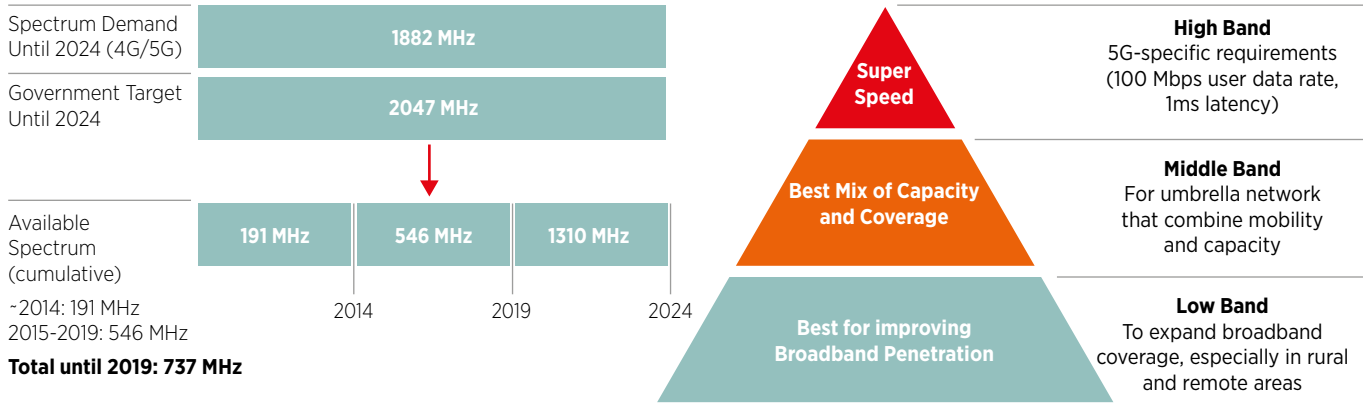
3. Key issues and challenges to secure sufficient spectrum for 5G services in Indonesia

3.1 Key spectrum challenges

The key spectrum challenges to secure Indonesia's 5G spectrum future are well understood by Kominfo and SDPPI. Based on the work done by the SDPPI, the Government target is to have a total of 2,047 MHz of IMT spectrum available for assignment and/or use in order to satisfy spectrum demand which was estimated to be 1,882 MHz by 2024. The challenges are summarised in Figure 10 below.

FIGURE 10

INDONESIA SPECTRUM TARGET AND CHALLENGES



Low Band and Mid Band Challenges in Indonesia		
700 MHz	**2.6 GHz**	**3.5 GHz (Ext-C Band)**
Incumbent service: 728 Analogue TV Broadcasters The Omnibus Law which has been enacted stated that ASO must be done at the latest 2 years (November 2022)	Incumbent service: Broadcast Satellite Service (BBS) that the frequency license last until 2024	Incumbent service: FSS, ±7 national satellites and 56 transponders operating in the band (the latest license is estimated to be in service until 2034) WRC–19: Indonesia joined the IMT identification footnotes in the bands of 3300 – 3600 MHz

Source: Dr Ismail, Kominfo, Indonesia's 5G Initial Roadmap conference on Indonesia 5G Roadmap and Digital Transformation, 10 December 2020, page 10. Note 2019 figure includes FWA spectrum in the 2.6 GHz and 3.3 GHz bands

Another challenge is how much mmWave band spectrum to make available. While Indonesia has decided to allocate the 26 and 28 GHz bands for 5G, demand in the 28 GHz band is uncertain. There are also fixed satellite services in the 28 GHz band across the Indonesian archipelago. However, unlike in 3.5 GHz, the interference is not to the FSS but rather FSS uplink to IMT services, therefore making interference co-ordination more manageable than in the 3.5 GHz band.

Specifically, as summarised above, the key challenges are:

(i) the analogue to digital television transition and securing the digital dividend in the 700 MHz band;

(ii) the current use of the 2.6 GHz band for satellite broadcasting with the current licence expiring in 2024 ;

(iii) the extensive use of the extended C-band (3400 – 3700 MHz) and standard C-band (3700 – 4200 MHz) frequencies for satellite services in Indonesia given the geography of the Indonesia archipelago.

The challenge in the 3.5 GHz band is explored below.

3.2 Securing the 3.5 GHz band for 5G services

Given heavy satellite usage, with an estimated total of more than 100,000 VSAT terminals in operation, a considerable amount of time and effort will be needed to optimize the use of the 3.5 GHz band for 5G, particularly in major cities and industrial complexes in Indonesia. National satellites operating on the C-band include:

1. TELKOM 3S, which was launched on 14 February 2017, and will be in operation for 15 years;
2. BRISAT, which was launched on 18 June 2016, and will be in operation for 15 years;
3. TELKOM-4, which was launched on 7 August 2018, and will be in operation for 15 years;
4. NUSANTARA SATU, which was launched on 22 February 2019, and will be in operation for 15 years; and
5. NUSANTARA DUA which was scheduled to replace Palapa-D in 2020 is now planned to be launched in 2024.[23]

While C-band satellite services continue to be important, there is a global trend towards the use of higher bands for satellite (see Brazil example in Figure 12). Satellite operators are rapidly expanding capacity in Ku- and Ka-bands with the development of advanced satellite modulation techniques. In Indonesia the SATRIA-1 High-Throughput Satellite, which utilises the Ka band, is designed to address the digital divide is scheduled for launch Q3, 2023.[24]

To address these issues and make spectrum available in the 3.5 GHz band (above 3.4 GHz) for IMT services, Indonesia through Telkom Group in 2020 has undertaken coexistence studies between the 5G networks and the Fixed Satellite Service (FSS) as used in the 3.5 GHz band (see Figure 11 below). Currently, Kominfo in collaboration with XL Axiata and BRI SAT has prepared a second co-existence test to strengthen the results of the previous trial, especially related to the guard band that will be used. As of January 2022, Kominfo is hopeful that a balance can be struck between satellite and IMT use. The objective is to make additional spectrum "available, clean, and affordable".[25]

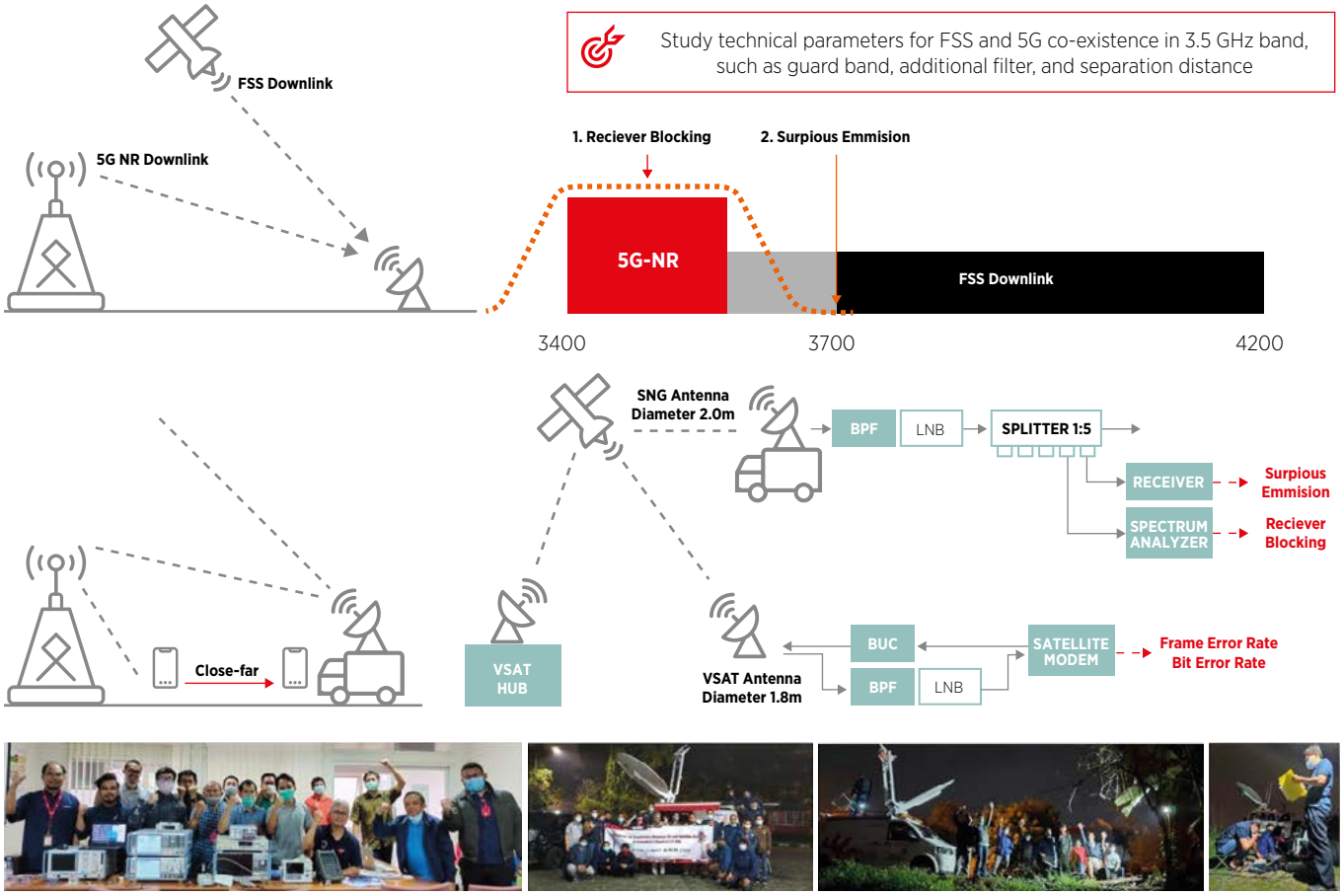
23 The original Nusantara Dua was due to be launched in 2020. However, the launch of Nusantara Dua on 9 April 2020 by Chinese Long March launch vehicle was a failure, resulting in the loss of the satellite. Following a tender, on 28 October 2021, Telkomsat announced it was awarded the replacement satellite (working designation HTS-113BT) to Thales Alenia with planned launch for 2024. The replacement is expected to have similar specifications with the lost one with C- Band and Ku- Band transponders. Refer to https://spacenews.com/indonesia-orders-thales-alenia-space-satellite-to-replace-lost-nusantara-2/

24 The SATRIA-1 High-Throughput Satellite which utilises the Ka band and is designed to address the digital divide is scheduled for launch Q3, 2023. Refer to https://voi.id/en/technology/65117/satria-1-satellite-reaches-25-percent-production-stage-director-of-bakti-kemenkominfo-like-rising-from-the-grave

25 Refer to https://teknologi.bisnis.com/read/20220113/101/1488628/lelang-frekuensi-26-ghz-dan-35-ghz-bisa-digelar-lebih-cepat-ini-syaratnya

FIGURE 11

5G & FSS CO-EXISTENCE FIELD TRIAL IN EXT C-BAND (3400-3700 MHz)



Source: Dr Ismail, Kominfo, Indonesia's 5G Initial Roadmap conference on Indonesia 5G Roadmap and Digital Transformation, 10 December 2020, page 14

Importantly, the 3.3 – 3.4 GHz band is currently being used for broadband wireless access (and is partly vacant).[26] This can also be available for 5G use subject to appropriate technical and regulatory measures.

26 The SDPPI is also checking that the 3.3-3.4 GHz band is not being used for radiolocation services. . Kominfo has determined Ministry Decree for moratorium on discharging BWA 3.3 GHz no later than end of 2022.

4. Recommended action plan to address key issues and challenges in Indonesia

4.1 Near term actions

Indonesia has developed plans to address its IMT spectrum shortfall and to make available a total of 2,047 MHz of IMT spectrum by 2024 to support the development of the country's digital economy. Work is still in progress and the following steps are recommended in order to accelerate IMT spectrum availability for 5G:

(i) **700 MHz band.** It is critical to secure additional low band spectrum for IMT services in order to provide affordable mobile broadband coverage in rural areas of the country including Sumatra, Sulawesi, Papua and Kalimantan, and to improve deep in-building coverage in urban areas. It is important to ensure that the transition to digital broadcasting which is scheduled to be completed by November 2022, remains on track and to avoid further delays in securing the digital dividend. Best practice guidelines from the ITU[27] and the GSMA[28] should be followed.

(ii) **2.6 GHz band.** While the 2.6 GHz band is currently allocated for satellite broadcasting,[29] it is a globally harmonised IMT band and public benefit is maximised by the use of all 190 MHz of the 2.6 GHz band for 4G/5G and future IMT services. In this context, firmly committing that the current licence will expire and not be renewed is critical to provide certainty for all industry stakeholders. Kominfo should continue to explore options to secure an earlier clearance of the band, possibly through an incentive-based auction which has been successful in certain markets[30] or a reasonable compensation model that will not place a significant financial burden to the industry.

(iii) **3.5 GHz band.** As detailed above, there are significant challenges for Indonesia to make the 3.5 GHz band available for 5G services especially in the quantum needed to address the country's mid-band spectrum shortfall.

a) Supply – At least 300 MHz of 3.5 GHz spectrum in the 3.3-3.7 GHz should be made available by 2023. If this is not possible, then consistent with the phased approaches in other markets, 200 MHz should be released first. Additional 3.5 GHz spectrum should be released in future subject to clearance and/or the implementation of adequate mitigation measures. If a phased approach is taken, all the spectrum released during such a process should be subject to a condition that provides for a reorganisation of the band to create larger contiguous blocks of spectrum. The aim is for all mobile operators to secure up to 100 MHz of contiguous spectrum in this band.

b) Clearance and/or mitigation measures – To facilitate the release of 3.5 GHz process Indonesia should accelerate clearance or introduce adequate mitigation measures to ensure coexistence with incumbent users in the band. Figure 12 gives the background on how this was achieved in Brazil.

27 ITU, Guidelines for the Transition from Analogue to Digital Broadcasting - including the Asia-Pacific Region , August 2012. Available at www.itu.int/en/ITU-D/Spectrum-Broadcasting/DSO/Pages/publications.aspx

28 Refer to www.gsma.com/spectrum/wp-content/uploads/2017/10/Practical-Recommendations-to-Digital-Migration-in-ASEAN-full.pdf and GSMA, Securing the digital dividend across entire ASEAN:A report on status of the implementation of the APT700 band for ATRC, August 2018 https://www.gsma.com/spectrum/wp-content/uploads/2018/08/GSMA_700MHz_ASEAN_Executive_Summary_Aug2018.pdf

29 Around 150 MHz is assigned to MNC Group, while 2x15 MHz previously assigned to BWA is not utilized.

30 Refer to www.fcc.gov/about-fcc/fcc-initiatives/incentive-auctions/resources

FIGURE 12

BRAZIL CASE STUDY ON 3.5 GHz BAND CLEARANCE FOR MOBILE BROADBAND SERVICES

In November 2021, Brazil successfully ran a multi-band spectrum auction covering the 700 MHz and 2.3, 3.5 and 26 GHz band spectrum bands.[31] The auction which was designed to facilitate the development of 5G, was originally scheduled for March 2020 but was delayed due to potential interference issues with satellite TV broadcasting and the COVID-19 pandemic. The licensees are obliged to provide 5G services to all capital cities by July 2022, as well as about 35,500km of the national highway network.

The successful spectrum assignment process in Brazil focussed on striking a balance between government objectives, operators' requirements and consumer welfare. This process began several years ago with the modernisation of various Brazilian regulatory policies that were designed to support investment. In 2019, an updated telecommunications law was introduced with three crucial aspects:

- Introduction of longer licence terms;
- A secondary spectrum market; and
- Unlimited renewal terms.[32]

These decisions were crucial to support current networks, attract new players and guarantee better services to end users. Certain auction policies also focused on long-term network investment. In particular, new payment terms were introduced including yearly instalments for the duration of the licence, the exchange of the premium for investments and the deduction of obligation costs from reserve prices. The auction conditions also included support of Brazilian policy objectives such as the coverage of motorways, protection of adjacent services, 4G in remote areas and a set timeline for 5G to be introduced.

The most significant long term spectrum management challenge in making sufficient spectrum available in the pioneer 3.5 GHz band was how to accommodate the current Television Receive Only (TVRO) services which utilised the 3.5 GHz band in Brazil.Initial considerations centred around either continuing TVRO services above 3.8 GHz or maintaining them in 3.6 GHz band. To achieve this, the Brazilian regulator Anatel, broadcasters, operators and suppliers worked to develop a bespoke low noise block filter with a performance gain above the previous commercially available devices. The model was finalised, is 100 percent effective and is now commercially available.[33]

However, as the demand in Brazil for mid-band spectrum for 5G and future services became clearer during the band planning process, Brazil decided to go in an alternative direction after engagement with the entire industry. Specifically, Brazil decided that TVRO services would be migrated to the Ku-band. This approach was seen to have several benefits, not least creating a pathway to the future availability of the 3.8-4.2 GHz range for 5G. Fixed Satellite Service, in the band from 3,600 MHz to 3,700 MHz, would therefore start operating on a secondary basis.[34]

Historically, Ku- and Ka-band satellite services have been more susceptible to rain fade and Brazil, which has periods of high rainfall, has previously been an extensive user of C-band satellite services. The approach adopted by Brazil is consistent with a global trend of using higher spectrum bands for satellite services. It highlights the technical advances of the satellite industry which has moved beyond reliance on the C-band with the development of advanced satellite modulation techniques. As such the delivery of services in higher spectrum bands without appreciable rain fade issues is now a common global approach.

31 The mobile spectrum offered in the auction comprised some 510 MHz in low and mid band spectrum plus mmWave (26 GHz) spectrum in national and regional licences. It raised a total of BRL47.2 billion (USD8.5 billion) with the auction of the 3.5 GHz band spectrum of 380 MHz (3 national licences of 100 MHz and a regional licences of 80 MHz) comprising just under 50 percent of those total proceeds. Refer to ANATEL, Edital 5G Resultados, (in Portuguese) 5 November 2021

32 Refer to www.gsma.com/spectrum/brazil-multi-band-auction-one-of-the-largest-in-mobile-history/

33 Frank Yuan, Huawei, ASEAN Workshop on Frequency Harmonization for Implementation of 5G, 26 November 2021, page 6

34 GSMA, Op cit

c) **Efficient guard band.** Indonesia should adopt guard bands that maximise spectral efficiency. There are both studies and real-world regulatory examples of the necessary guard band between 5G and FSS. For example, studies have concluded that a guard band in the range of 18[35] to 25 MHz is needed.[36] In Canada[37] and the US[38], a guard band of 20MHz has been adopted.

   Regionally, after originally proposing a guard band of 100 MHz in the 3.5 GHz band between IMT and FSS services, Singapore has successfully instituted a guard band of 50 MHz. Similarly, in India the TRAI opted to reduce the guard band from 100 MHz to 30 MHz.[39]

   In addition to guard bands, other possible measures to ensure coexistence between IMT and FSS include:[40]

   Earth station site shielding;

   - Restriction zones to protect FSS;
   - Improved FSS receivers;
   - Addition of filters to FSS receivers;
   - IMT base station location limits;
   - Reduced base station transmitter power; and
   - Detailed coordination.

d) **Phased introduction by geography**. Indonesia should consider whether to adopt a policy of geographical separation for VSAT in regional and rural areas while restricting the use of satellite direct to home (DTH) and TVRO in the 3.4-3.7 GHz spectrum in key urban areas, such as Java and the top 10 urban areas of the country.[41] This approach would allow 5G services to be introduced in the 3.5 GHz band in urban areas where demand is highest while permitting continued access to the band for FSS services in more rural parts of the archipelago where satellite access is more important. A decision on future deployment of 5G in rural regions can be reviewed and taken at a later stage depending on changes in demand.

As detailed in Figure 13, the ACMA in Australia adopted such an approach and as such has only cleared and then auctioned the 3.6 GHz band in key urban areas. The auction of the 3.6 GHz band was successfully completed in December 2018. The ACMA is currently exploring other licensing approaches to make the 3.5 GHz band spectrum available in remote Australia.[42]

35 Refer to the Transfinite study in 2019 which concluded that an 18 MHz guard band is sufficient to mitigate co-frequency interference. Available at www.transfinite.com/papers/Report_for_GSMA_on_3.4-3.8_GHz_Compatibility.pdf

36 A guard band of 25 MHz was proposed in Brazil based on studies by Anatel.

37 ISED. Decision on the Technical and Policy Framework for the 3650-4200 MHz Band and Changes to the Frequency Allocation of the 3500-3650 MHz Band. May 2021. Available at https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11699.html

38 FCC. Expanding Flexible Use of the 3.7 to 4.2 GHz Band, 3 March 2020. Available at https://docs.fcc.gov/public/attachments/FCC-20-22A1.pdf

39 TRAI. Recommendations on Auction of Spectrum in frequency bands identified for IMT/5G. April 2022. https://www.trai.gov.in/sites/default/files/Recommendations_11042022_0.pdf

40 GSMA, Roadmap for C-Band Spectrum in ASEAN, August 2019, page 5

41 Including for example Greater Jakarta, Surabaya, Bandung, Makassar, Medan, Denpasar, Palembang, Semarang, etc and the new Indonesian capital.

42 Refer to www.acma.gov.au/consultations/2022-02/allocation-awls-34-40-ghz-band-remote-australia

FIGURE 13

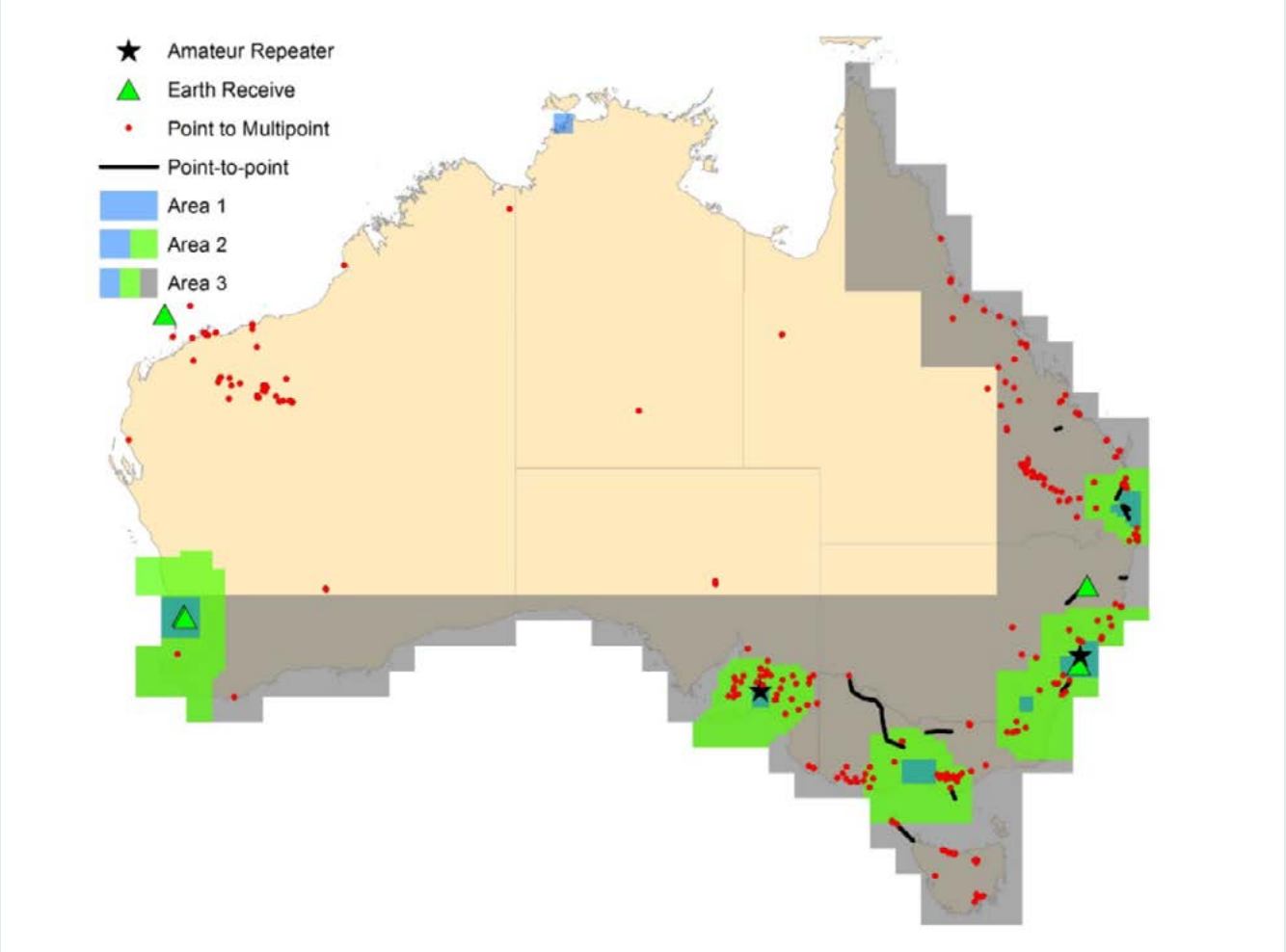
REFARMING THE 3.6 GHZ BAND FOR 5G IN AUSTRALIA

ACMA undertook an investigation and ultimately refarmed and auctioned the 3.6 GHz band to enable 5G networks in Australia. At the time ACMA began actively considering use of the 3.6 GHz band in October 2016, the band was being considered as a pioneer band for 5G.

ACMA released its first discussion paper in October 2016 regarding the future use of the 3.6 GHz band in Australia titled *Future Use of the 1.5 GHz and 3.6 GHz bands.* Historically, the 3.6 GHz band was used by the Fixed-Satellite Service (FSS) and point-to-point links. However, in 2005 as part of the ACMA's Strategies for Wireless Access Services consultation process, the band was embargoed Australia-wide. In 2009, the ACMA made the band available for MBB applications in regional and remote areas. The band remains embargoed in capital cities (excluding Hobart) for mobile broadband services and Australia-wide for all other services.

As part of the consultation, ACMA considered the refarming options on a national or regional level. In June 2017, ACMA published the *Future Uses of the 3.6 GHz Band: Options Paper,* detailing their comprehensive highest value use assessment of the 3.6 GHz band. It was found that the highest value use of the band was in wide-area broadband deployments in metro and regional areas as shown below.

Figure: 3.6 GHz band geographical area refarming options overlaid with incumbent licences



Source: ACMA, Future Use of the 1.5 GHz and 3.6 GHz, page 39

4.2 Future IMT spectrum needs in 2025-2030

It is also important to recognise that the 5G journey is only just starting – for the rest of the decade and beyond, 5G will become central to mobile connectivity and underpin Indonesia's digital transformation and economic growth. It is thus important for policymakers and regulators to also take a longer-term view on spectrum supply especially in the mid-band frequencies.

By 2030, countries will need an average of 2 GHz of mid-band spectrum to deliver 5G services at a performance consistent with the ITU's IMT-2020 (5G) requirements. For Jakarta the estimated mid-and spectrum required is between 2 GHz and 2.4 GHz.[43] At present, only around 360 MHz of mid-band spectrum has been assigned for IMT in Indonesia. Even with the inclusion of the 2.6 GHz and 3.5 GHz bands, the total supply of mid-band spectrum in Indonesia will still be significantly below the 2 GHz required for IMT by 2030.

Thus, the following actions are recommended for Indonesia:

- Assess options for expanding the supply of spectrum for 5G in the 2025-2030 timeframe, particularly in the mid-bands. These can include the release of unassigned spectrum in existing mid-bands and identification of new spectrum in potential future bands;
- Plan for the use of 4.8 GHz and 6 GHz (5925–7125 MHz)44 to support further development of 5G;
- Gather information on usage trends for FSS in the 3.7-4.2 GHz band and assess possible options for the future introduction of 5G use in this range as satellite capacity in other bands such as Ku and Ka develops.

In this context, the Kominfo/SDPPI should consider the development of a long term Spectrum Roadmap covering at least till 2030. This roadmap which can be updated annually would incorporate NBTC's work on the release of different frequency bands, and information on evolving trends in technology and spectrum use, and harmonisation and standardisation activities.

This information will be critical for businesses to prepare investment plans, secure financing and develop arrangements for deploying particular technologies. In this way, Thailand will be better positioned to support the longer term growth of 5G and to realise its full socio-economic benefits for all citizens and enterprises across all sectors of the economy.

43 Coleago Consulting. Estimating the mid-band spectrum needs in the 2025-2030 time frame, July 2021. Available at www.gsma.com/spectrum/wp-content/uploads/2021/07/Estimating-Mid-Band-Spectrum-Needs.pdf

44 Considerations on the optimal approach for managing spectrum are currently at the forefront of the debate around the 6 GHz band. For example, GSMA Intelligence recently published a cost-benefit analysis for different authorisation models for the 6 GHz band in 24 countries. See GSMA Intelligence. The socioeconomic benefits of the 6 GHz band: considering licensed and unlicensed options. June 2022. Available at https://data.gsmaintelligence.com/research/research/research-2022/the-socioeconomic-benefits-of-the-6-ghz-band-considering-licensed-and-unlicensed-options

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